How To Grow Organic Vegetables and Fruis

Introduction

Gardening can be highly rewarding, but it is not without problems and efforts. A successful garden requires a good site, careful planning, good management and considerable hard work. Insects, diseases and weeds require control measures. Acidic, infertile, poorly drained or sandy soil may have to be improved. Shade and extremes of moisture and temperature are other problems that must be overcome for a garden to be successful.

For those willing to plan carefully and to perform timely gardening tasks, gardening can be very worthwhile. A vegetable garden can produce a steady supply of vegetables from spring to fall. These vegetables can be harvested at optimum maturity and eaten or preserved while fresh. Fresh vegetables may be higher in flavor and nutritive value and lower in cost than purchased vegetables, which may have been harvested several days earlier. Vegetable production provides healthful exercise and an interesting outdoor activity for the entire family. Many gardeners feel the sense of accomplishment, self-sufficiency and security accompanying a successful garden are other significant rewards of gardening.

Basic Techniques

Site Selection

A good garden site is essential for high vegetable yields. Poor sites not only produce low yields, but may also be extremely difficult to grow a garden on at all.

Choose a garden site with deep, medium-textured, well-drained, nearly level soil. Fine-textured, clay soils stay wet late into the spring, are difficult to work and tend to crust badly. Sandy soils dry out very quickly and require frequent nutrient applications. Excessive slopes tend to erode. A slight slope, however, is desirable to prevent cool air from collecting and forming a frost pocket.

Most garden vegetables require six hours of sunlight or more per day to produce well. The more the garden is shaded, the slower the vegetables will grow and the lower their yields will be. Trees and large shrubs not only shade gardens, but also use nutrients and water needed for proper vegetable growth.

A site near the house makes it more convenient to care for the garden and to harvest vegetables. Water is available for transplanting and irrigation. Children or animals in the garden can be observed, and the garden may be protected from these and other potential problems.

Planning the Garden

A garden plan will save time, space and money. Yields will be increased, as will the length of the harvest season.

Begin by making a scale drawing of your available garden area on graph paper. Divide the drawing into cool-season and warm-season vegetable planting areas.

Cool-season vegetables are those such as onions, cabbage, radishes and English peas. They require cool weather to grow and mature properly and can withstand some frost. Cool-season vegetables are planted in the early spring and again in the fall. Warm-season vegetables require warm weather to grow properly and are planted after the soil has warmed up. Frost will kill warm-season vegetables. Examples of warm-season vegetables include okra, sweet potatoes, cucumbers and tomatoes.

The cool-season section of the garden will be planted early and harvested in time to be replanted. Alternate the cool and warm-season areas of the garden each year to reduce plant pest problems.

Decide which vegetables to grow and the amount of each vegetable you want. Use Tables 1-3 (pages 5 through 7) to estimate the row lengths required to obtain the desired amounts. Sketch and label the rows of each vegetable on your plan to scale, using the row spacings suggested in Tables 1-3. Be sure to arrange the rows so tall vegetables won't shade shorter ones. Make a note of the planting dates, varieties and amount of seeds required on your plan so a periodic glance will show what needs to be done.

Gardening Tools

An efficient garden that's fun to work in requires the correct tools. It is not necessary to have a lot of tools, but they should be good quality. All gardeners will require the following:

1. ***A shovel or a spade.*** Shovels are long-handled and have wide, rounded blades. Spades are shorter and

usually have narrow blades. Sharpshooter shovels are spades. Some prefer a long-handled shovel for nearly every gardening task from spading soil to planting and transplanting shrubs. The shorter spade is stronger but harder to use. The spade works well to dig a raised bed or a post hole. It is also a good tool for prying, cutting larger roots and even spading. All gardeners should have one or the other, and both would be a good investment.

2. ***A hoe.*** The hoe is a universal gardening tool. There are dozens of kinds, sizes and shapes. The standard square-bladed gooseneck hoe is the one to begin with. It is suitable for removing weeds as well as opening and closing furrows for seeding. Other hoes can be added if and when you need them.
3. ***A rake.*** The bow rake is essential for smoothing and leveling seed beds. It may also be used to cover planting furrows, move mulches, clean up debris and kill emerging weeds.
4. ***A trowel.*** Buy a good trowel, 3 or 4 inches wide. Use it to transplant small plants, open short rows, dig small holes and even to weed and cultivate around small plants.
5. ***Small supplies.*** Use twine and stakes for marking rows, maintaining straight rows and supporting plants. A bucket for carrying fertilizer and water to the garden and vegetables to the house is very helpful. A hose is essential for irrigation. Perhaps the most essential small tool is a good-quality file. Carry it with you when you work in the garden and use it frequently to keep tools sharp.

Store all tools away from sun and rain. Weather will deteriorate and roughen handles, as well as rust metal parts. Rust can be prevented by wiping a light coating of oil on metal after use. Rough handles can be smoothed with sandpaper. Well-cared for tools are easier to use and last much longer.

You will want to add additional tools and equipment as your needs grow and finances permit. The following items will prove useful:

1. ***Watering cans, hoes, nozzles and sprinklers*** for watering.
2. ***A spading fork*** for soil preparation and harvesting root crops.
3. ***A manure fork*** for turning compost and moving garden residues.
4. ***A wheelbarrow or garden cart*** for hauling large amounts of soil, fertilizer, plant residues or produce.
5. ***A rototiller*** for preparing large areas of soil and controlling weeds.

There are many sizes and types of rototillers. The large machines with tines in front of the wheels are the standard. They are less expensive and do a good job breaking up compacted soil, but require considerable physical strength to use.

Large, reartine machines are much easier to use and more suited to large garden areas, but they are also considerably more expensive to purchase. They do a better job of preparing a seedbed, especially in wet soils.

The last few years have seen the development of small rototillers weighing only about 20 pounds with an effective tilling width of 9 to 12 inches. These machines are too small for breaking up large gardens or sod, but they are excellent for working up a row in a previously turned garden or to remove weeds. They are especially good at working wet soil into a suitable seedbed.

Soil Preparation

Begin soil preparation by removing old plant supports, plastic mulches, excessive vegetative residues and other debris from the garden area several weeks before planting to allow the soil to dry out. The amount of plant residue that may be turned under depends on how large the pieces are, how the garden will be turned and how long before the area will be worked.

Long cucumber or tomato vines, for example, may be spaded or plowed under but may tangle on the tines of a rototiller. Cover crops and thick mulch or crop residue should be turned under six weeks or more before planting. This will promote decay and reduce nutritional and insect and disease problems in the garden. Adding three pounds of ammonium nitrate per 1000 square feet of soil surface before turning organic materials under will speed decay considerably.

Turning under significant amounts (an inch or more) of plant materials such as compost, organic mulches, leaves or cover crops annually will gradually increase soil organic matter content and improve most garden soils. The moisture-holding capacity will improve, as will the soil structure and nutrient-holding capability. Root penetration will improve on clay soils and soil crusting will be reduced.

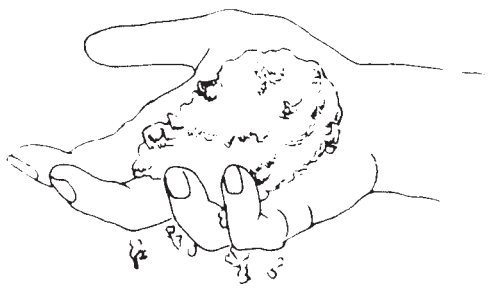


Figure 1. *Pick up a handful of soil and roll it into a ball. If the soil sticks together and will not crumble easily, it is too wet to work.*

Table 1. Guide to Spring-planted, Cool-season Vegetables							
Vegetable	Planting interval	Seed or plants per 100-foot row	Inches between rows	Inches between plants	Days to first harvest	Length of harvest season	Yield range per 100-foot row
Beets	Mar. 1 to Mar. 10	½ oz. seed	14 to 36	2 to 3	55 to 60	4 weeks	75 to 150 lbs.
Broccoli	Mar. 1 to Apr. 1	80 plants	24 to 36	15	60 to 70	4 weeks	50 to 100 lbs.
Cabbage	Feb. 20 to Apr. 1	80 plants	24 to 36	15	60 to 75	3 weeks	125 to 200 lbs.
Cauliflower	Mar. 1 to Apr. 1	80 plants	24 to 36	15	55 to 65	2 weeks	50 to 100 lbs.
Carrots	Mar. 1 to Apr. 1	¼ oz. seed	14 to 36	2 to 3	75 to 85	4 to 6 weeks	50 to 100 lbs.
Collards	Mar.	¼ oz. seed	18 to 36	15	65 to 75	4 to 30 weeks	100 to 150 lbs.
Kale	Feb.	¼ oz. seed	18 to 36	12 to 15	55 to 65	4 to 20 weeks	100 to 150 lbs.
Kohlrabi	Feb. or Mar.	¼ oz. seed	14 to 36	6	40 to 50	4 weeks	50 to 75 lbs.
Lettuce, Head	Feb. or Mar.	¼ oz. seed	14 to 36	12 to 15	65 to 80	2 to 3 weeks	50 to 100 lbs.
Lettuce, Leaf	Feb. to Apr.	½ oz. seed	14 to 36	6	40 to 50	4 to 6 weeks	50 to 75 lbs.
Mustard	Feb.	¼ oz. seed	14 to 36	5 to 10	35 to 45	3 to 6 weeks	75 to 100 lbs.
Onions, Bunch	Feb. or Mar.	400 to 600 sets	14 to 36	2 to 3	30 to 60	3 weeks	30 to 50 lbs.
Onions, Storage	Feb. or Mar.	200 to 400 sets	14 to 36	3 to 6	100 to 120	2 weeks	50 to 100 lbs.
Peas, English	Feb. 1 to Mar. 20	½ to 1 lb. seed	12 to 36	2 to 4	65 to 70	2 to 3 weeks	20 to 30 lbs.
Peas, Snap	Feb. 1 to Mar. 20	½ to 1 lb. seed	12 to 36	2 to 4	65 to 75	2 to 3 weeks	30 to 50 lbs.
Potatoes, Irish	Mar.	14 lbs. seed	30 to 36	12	90 to 110	4 months stored	100 to 120 lbs.
Radish	Feb. 15 to Apr. 15	½ oz. seed	14 to 36	1 to 2	25 to 30	3 weeks	50 bunches
Spinach	Feb.	1 oz. seed	14 to 36	3 to 4	40 to 50	3 weeks	10 to 30 lbs.
Swiss Chard	Mar.	½ oz. seed	18 to 36	6 to 8	50 to 60	4 to 30 weeks	50 to 150 lbs.
Turnip, Greens	Mar.	½ oz. seed	18 to 36	2 to 4	30 to 40	Several weeks	50 to 100 lbs.
Turnip, Roots	Mar.	¼ oz. seed	18 to 36	3	40 to 65	6 months	100 to 150 lbs.

Garden soil should not be worked when it is too wet. Pick up a handful of soil and roll it into a ball. If the soil sticks together and does not crumble when dropped, it is too wet to work. Soil worked too wet forms large, hard clods which are difficult to break up and are completely unsuitable for a seedbed.

Soil should be worked to a depth of at least 6 or 7 inches and smoothed before planting. Seed should be planted only in moist, finely aggregated soil. Soils worked into a powdery condition are more likely to crust. Small seed planted in cloddy soil usually dry out and germinate poorly. Garden soil may be worked with farm equipment, a rototiller or spaded with a shovel.

Fertilizer and Lime

Vegetable gardens will not reach their potential unless the soil is properly limed and fertilized. Liming decreases soil acidity, increases fertilizer availability and reduces certain physiological problems such as blossom-end-rot of tomatoes, peppers and watermelons. A soil test is the only reliable method of determining the optimum amount of lime and fertilizer to apply.

Table 2. Guide to Warm-season Vegetables							
Vegetable	Planting interval	Seed or plants per 100-foot row	Inches between rows	Inches between plants	Days to first harvest	Length of harvest season	Yield range per 100-foot row
Beans, Bush Snap	Apr.10 to June 20	¼ lb. seed	24 to 36	3 to 4	52 to 60	2 weeks or more	80 to 120 lbs.
Beans, Pole Snap	Apr.10 to June 20	¼ lb. seed	36 to 48	3 to 4	60 to 65	5 to 6 weeks	100 to 150 lbs.
Beans, Bush Lima	May or June	½ lb. seed	24 to 36	3 to 4	65 to 75	3 weeks	20 to 30 lbs. shelled
Beans, Pole Lima	May or June	½ lb. seed	36 to 48	3 to 4	80 to 90	4 weeks.	25 to 50 lbs.
Cantaloupe	May	¼ oz. seed	72	24	80 to 90	3 weeks	100+ melons
Corn, Sweet	Apr. 1 to June 1	¼ lb.seed	36	8 to 12	80 to 95	7 to 10 days	90 to 120 ears
Corn, Super Sweet	Apr.15 to June 1	¼ lb.seed	36	8 to 12	80 to 95	10 to 15 days	90 to 120 ears
Cucumber, Pickling	May	¼ oz. seed	72	12	50 to 55	3 to 6 weeks	115 to 250 lbs.
Cucumber, Slicing	May or June	¼ oz. seed	72	12	50 to 65	3 to 6 weeks	115 to 250 lbs.
Eggplant	May	50 plants	36	24	65 to 80	2 months or more	75 to 150 lbs.
Okra	May 5 to May 20	1 oz. seed	36	6 to 12	50 to 60	7 to 9 weeks	50 to 100 lbs.
Peas, Field	May or June	¼ lb. seed	36	4	65 to 80	3 to 5 weeks	30 to 40 lbs.
Pepper, Sweet	May or June	60 plants	36	18 to 24	55 to 80	2 to 3 months	50 to 75 lbs.
Pepper, Hot	May or June	60 plants	36	18 to 24	60 to 70	2 to 3 months	10 to 25 lbs.
Potato, Sweet	May	100 slips	36	12	110 to 120	5 months stored	75 to 125 lbs.
Pumpkin	May	1 oz. seed	120 to 144	48	100 to 120	4 months stored	40 to 50 pumpkins
Squash, Summer	May or June	1 oz. seed	48 to 60	12 to 24	40-50	6 weeks	100 to 150 lbs.
Squash, Winter	May or June	1 oz. seed	72 to 96	24 to 36	90-110	4 months stored	50 to 200 lbs.
Tomatoes	Apr. 10 to June 10	50 plants	48	24	70-80	8 weeks or more	200-300 lbs.
Watermelon	May	¼ oz. seed	120 to 144	48	80-90	3 weeks	20-25 melons

Table 3. Guide to Fall Vegetables							
Vegetable	Planting interval	Seed or plants per 100-foot row	Inches between rows	Inches between plants	Days to first harvest	Length of harvest season	Yield range per 100-foot row
Beans, Bush Snap	July 15 to Aug. 15	1/4 lb.	24 to 36	3 to 4	52 to 602	weeks or more	80 to 120 lbs.
Broccoli	July 15 to Aug. 15	66 plants	24 to 36	18	60 to 70	4 weeks	50 to 100 lbs.
Cabbage	July 5 to Aug 15	66 plants	24 to 36	18	60 to 75	3 weeks	125 to 200 lbs.
Cabbage Chinese	,July 1 to July 30	100 plants	24 to 36	12	40 to 50	4 weeks	200 to 300 lbs.
Cauliflower	July 15 to Aug. 15	66 plants	24 to 36	18	55 to 65	2 weeks	50 to 100 lbs.
Collards	July 1 to Sept.1	¼ oz. seed	18 to 36	18	65 to 75	4 to 30 weeks	100 to 150 lbs.
Cucumber, Pickling	July 1 to Aug. 1	¼ oz. seed	72	12	50 to 55	3 to 6 weeks	115 to 250 lbs.
Cucumber, Slicing	July 1 to Aug. 1	¼ oz. seed	72	12	50 to 65	3 to 6 weeks	115 to 250 lbs.
Kale	July 1 to Sept. 1	¼ oz. seed	18 to 36	12 to 15	55 to 65	4 to 20 weeks	100 to 150 lbs.
Kohlrabi	July 15 to Sept 1	¼ oz. seed	14 to 36	3 to 6	40 to 50	4 weeks	50 to 75 lbs.
Lettuce, Leaf	July 1 to Sept. 15	½ oz. seed	14 to 36	6	40 to 50	4 to 6 weeks	50 to 75 lbs.
Mustard	July 1 to Sept. 1	¼ oz. seed	14 to 36	5 to 10	35 to 45	3 to 6 weeks	75 to 100 lbs.
Potatoes, Irish	July 1 to July 31	14 lbs. of seeds	30 to 36	12	90 to 110	4 months stores	100 to 120 lbs.
Radish	Aug. 1 to Sept. 15	½ oz. seed	14 to 36	1 to 2	25 to 30	3 weeks	50 bunches
Spinach	Sept. 10 to Sept. 20	1 oz. seed	14 to 36	3 to 4	40 to 50	3 weeks	10 to 30 lbs.
Squash, Summer	July 15 to Aug. 15	1 oz. seed	48 to 60	12 to 24	40 to 50	6 weeks	100 to 150 lbs.
Tomatoes	July 1 to Aug. 1	50 plants	48	24	70 to 80	8 weeks or more	200 to 300 lbs.
Turnip Greens	Aug. 1 to Sept. 30	½ oz. seed	18 to 36	2 to 4	30 to 40	Several weeks	50 to 100 lbs.
Turnip Roots	Aug. 1 to Sept. 15	¼ oz. seed	18 to 36	3	40 to 65	6 months	100 to 150 lbs.

Instructions for taking soil samples and soil sample boxes are available at your county Extension office. The samples are sent to the University of Tennessee Soil Testing Laboratory in Nashville. The returned report indicates the amount of lime and fertilizer recommended. There is a small fee for this service.

Soil acidity is measured in pH units. Most vegetables grow best at a pH of 6 to 6.8. Once this pH is reached, it is generally necessary to check the pH only about every three years.

Lime requires time to dissolve and become be fully effective. For this reason, it is generally best to apply lime in the fall and to mix it into the soil. However, spring application of lime is better than no lime at all. The more finely ground lime is, the more likely a spring application is to produce the desired pH change.

Vegetable gardens require a "complete" fertilizer such as 6-12-12, 10-10-10, 13-13-13 or 15-15-15 for proper growth and development. The three numbers are referred to as the fertilizer analysis. The first number is the percentage of nitrogen in the fertilizer by weight. The second and third numbers are the percentages of phosphate and potash, respectively.

Manure is a complete fertilizer and may be used to supplement chemical fertilizer. Manure varies considerably in nutrient value, depending on the type of animal, length of storage, amount of bedding material and the moisture contained. Since most manure has less than 2 percent phosphate and less than 1 percent nitrogen and potash, several times more manure than chemical fertilizer must be applied fif onfly manure fis used.

Apply fertilizer to garden soils in the spring before planting. Manure is generally broadcast. Chemical fertilizers may be broadcast, applied in the rows or banded near or under the rows. If fertilizer is broadcast or applied in the rows, it should be worked into the soil before planting. Bands are most effective when placed about 2 inches to the side and 2 inches below the seed. Vegetable plants may be damaged by over-fertilization or fertilizer placed too near them. Soil test reports give amounts of fertilizer to broadcast in pounds per 1000 square feet and per acre. (Three rows 36 inches apart and 100 feet long equal 900 square feet). To convert the soil test recommendations to amounts per 100 foot of row, use Table 4.

Greens and vegetables with a long growing or production season benefit from additional nitrogen during the growing season. This is called "sidedressing." Sidedress by applying ammonium nitrate along the row, keeping 4 to 6 inches away from the base of the plants. Water or work the ammonium nitrate into the soil. Specific amounts of ammonium nitrate to use and growth stages where sidedressing is most effective are given in Table 5.

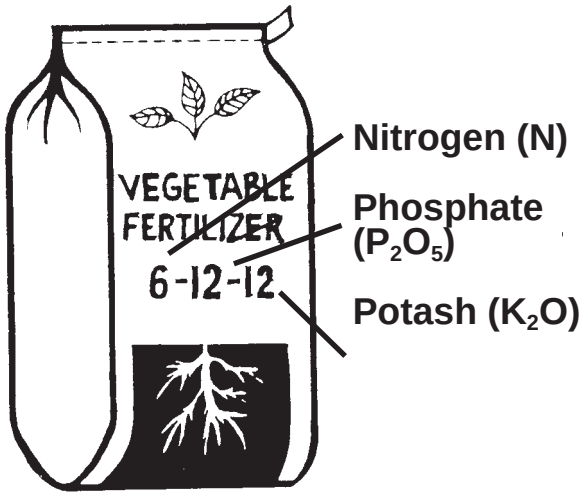


Figure 2. *Fertilizer analysis numbers refer to the percentage by weight of N, P_2O_5 and K_2O (nitrogen, phosphate and potash).*

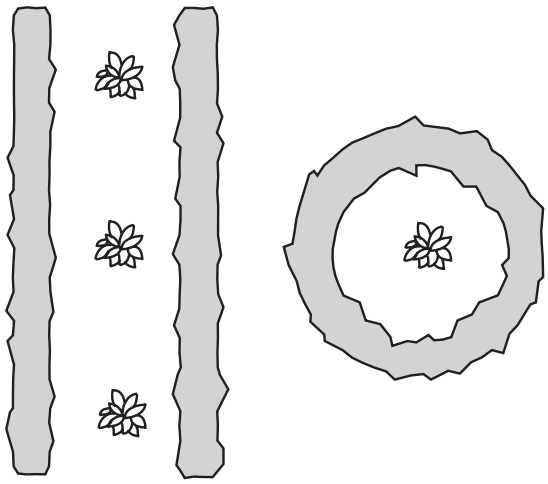


Figure 3. *Apply nitrgen sidedressings in bands along rows or circles around plants. Keep the fertilizer 4 to 6 inches from the plants.*

A complete fertilizer may also be used to sidedress vegetables, but the amount required will vary with the percentage of nitrogen in the fertilizer. Ammonium nitrate is about 34 percent nitrogen. Adjust the amount of other fertilizers used as sidedressing so the amount of nitrogen is the same as if ammonium nitrate were used.

Seeding and Spacing

Proper spacing among rows and between plants within rows is essential for maximum production of high-quality vegetables. Use the in row spacings suggested in Tables 1, 2 and 3. These spacings may be achieved by properly planting high-quality seed and thinning the rows, if necessary, when the seedlings are a few days old.

Tables 1, 2 and 3 also suggest between row spacings. These spacings assume mechanical equipment, such as a rototiller, is used to work the garden. If large farm equipment is used, the rows may need to be farther apart. If only a hoe is used, rows can be closer together.

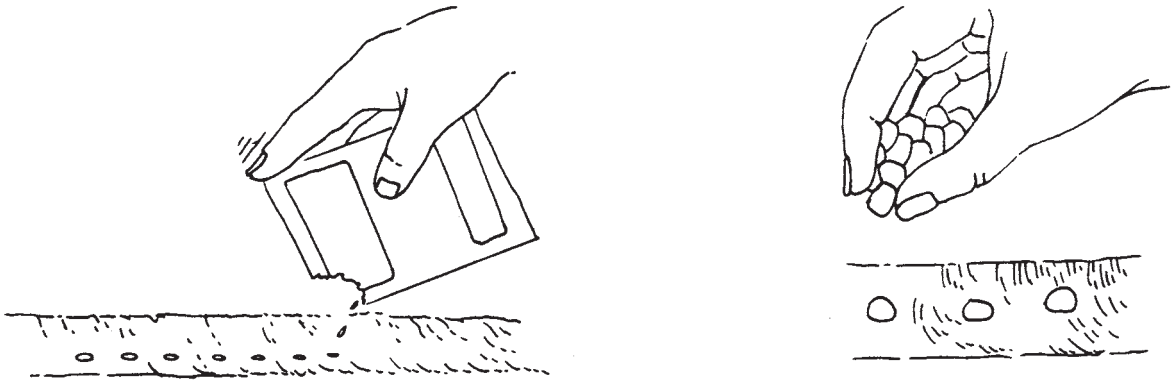


***Figure 4**. Small seeds may be sown directly from the packet (left); large seeds should be dropped from the fingers (right) and carefully spaced. Do not sow seeds too deeply or thickly.*

Be sure to plant in a good seedbed, as described previously under soil preparation. Planting on ridges will further ensure good stands of cool-season vegetables and make it easier to plant at the proper time. Ridges promote germination early in the spring because they warm up and dry out quickly. Ridges also reduce the chance of spring vegetables being flooded during heavy rains. Later in the season, ridges may reduce germination or plant growth by drying out too quickly.

The soil must not be allowed to crust or dry out before seedlings emerge. Sand, compost, potting soil or similar materials may be placed over seed to prevent crusting in gardens with heavy clay soils.

It is also important that seed be planted at the correct depth. As a general rule, seed should be planted at a depth equal to two to four times their diameter. Plant shallowly early in the spring when the soil is wet and cold and a little deeper in the summer when soils are drier. Plant shallowly in heavy clay soils and a little deeper in light sandy soils.

Timing Plantings

Tables 1, 2, and 3 divide vegetables into cool-season, warm-season and fall vegetables. The recommended planting dates for each type of vegetable are quite different. There is also considerable variation as to the heat or cold tolerance of each vegetable. Plant within the recommended planting interval for each vegetable to ensure that the vegetable will have the maximum chance of growing and maturing properly.

Within the planting interval for a crop, you will often have adequate time to stagger several plantings. With many vegetables, such as lettuce, you may prefer a small but steady supply rather than a lot all at once. One of the best ways to achieve this is by making several small plantings two or more weeks apart. The same technique is appropriate for corn. With corn, the first planting can be larger if you plan to preserve some. This large initial planting may be followed by one or more smaller plantings made when plants of the previous planting have three fully developed leaves.

Transplants

Some vegetables are easier to grow from transplants than from seed. Beginning with transplants rather than seed will also speed vegetable maturity. Other vegetables, such as sweet potatoes or Irish potatoes, may not be commonly grown from true seed. Thus, gardens will likely contain vegetables grown from transplants, slips or seed pieces as well as from true seed. Cabbage, cauliflower, broccoli, tomatoes, peppers and eggplant are usually transplanted into the garden rather than direct-seeded. Cantaloupe, cucumbers, squash and watermelon may be transplanted if they are grown in individual containers and are transplanted without disturbing their roots. These vining vegetables should be seeded in containers 3 inches or more across, and transplanted about three weeks after seeding.

Most home gardeners purchase transplants rather than growing them. Transplant production is discussed briefly flater fin thfis pubflficatfion .

When buying transplants, select short, stocky, healthy plants without yellowing or dying leaves. Avoid plants with dead spots or insects on the leaves. Choose plants in large containers over plants in smaller containers and plants in small containers over bare-root plants. Do not buy broccoli or cauliflower plants that are already beginning to form heads.

Transplants that are too old may be stunted. Very large transplants in small containers are often overhardened. They undergo considerable transplanting shock when set in the garden, because the small rootball has difficulty taking up sufficient water for the large leaf area. Vine crops should have only one or two sets of true leaves when set in the garden. Other transplants usually have three or four true leaves.

A small amount of purple color in the veins on the underside of the leaves is an indication of hardening. Transplants may be injured by sun, wind and cold temperatures if they are set in the garden without some hardening. You can

Table 4. Approximate Pounds of Fertilizer to Apply to 100-Foot Rows to Equal Recommended Rates

Recommended soil test rate		Fertilizer rates in pounds per 100-foot rows for various row widths*				
Per acre	Per 1000 sq. ft.	18 inches	24 inches	30 inches	36 inches	48 inches
435	10 lbs.	1.5	2.0	2.5	3.0	4.0
650	15 lbs.	2.3	3.0	3.8	4.5	6.0
870	20 lbs.	3.0	4.0	5.0	6.0	8.0
1090	25 lbs.	3.8	5.0	6.3	7.5	10.0
1305	30 lbs.	4.5	6.0	7.5	9.0	12.0

* One pint of dry fertilizer will weigh about one pound.

Table 5. Recommendations for Sidedressing Vegetable Crops

Crop	Ammonium nitrate per 100-foot row	Ammonium nitrate per plant	Time of application
Cucumbers, Cantaloupe, Pumpkins, Squash, Watermelon	1 to 1½ pounds	1 tablespoon	When vines are 1 foot long.
Tomatoes, Pepper, Eggplant	1 to 1½ pounds	1 tablespoon	When first fruits are 1 inch or more in diameter.
Sweet Corn Okra Lettuce	1 to 1½ pounds	----------	When 12 to 18 inches long. After the first picking. Three to four weeks after seeding.
Greens, (Turnips,Spinach, Collards, Kale, Mustard)	2 to 3 pounds	----------	Six weeks after seeding.
Broccoli, Cabbage, Cauliflower, Brussels Sprouts	1 to 1½ pounds	½ tablespoon	Three to four weeks after transplant.

harden vegetable plants by lowering temperatures 10 degrees for 10 to 14 days. Allowing the plants to wilt slightly between waterings will also harden them. However, lowering the temperature or water supply too much will stunt or kill the plants. If the leaf tissue between the veins is purple, the plant is probably overhardened or stunted. A stunted plant may never recover and is slow in producing if it recovers. Never harden cantaloupe or other vine crops.

Set transplants on a cool day or in the evening. Watering transplants with one-half to one pint of a starter solution per plant will reduce transplanting shock and produce earlier vegetables. Mix one tablespoon of water-soluble, high-phosphate fertilizer such as 10-50-10 per gallon of water to make a starter solution. Never set transplants in dry soil without watering them.

Set transplants at the depth they previously grew or slightly deeper. Leggy tomatoes may be set deeper as the stem will root if buried. Always be sure the top of peat containers are buried ½ to 1 inch below the soil surface or the containers will act as a wick and dry out the rootballs.

Transplants may need initial protection against strong winds, hot sun or freezing temperatures. Hotcaps can be made from newspapers or gallon milk jugs with the bottoms removed. Be sure to remove the caps from milk jugs to prevent plants from overheating on sunny days. A wooden shingle stuck into the ground on the sunny or windy side of a newly set transplant will also provide some temporary protectfion.

Irrigation

Vegetables require 1 to 1½ inches of water per week for maximum production. Most years have dry periods when irrigation will greatly increase growth, fruit set, total yield and quality.

The easiest way for most gardeners to irrigate is with a sprinkler. Apply water slowly to prevent runoff and erosion. Place several cylindrical containers in the area covered by the sprinkler to measure the water applied. Apply 1 to 1½ inches of water, then do not irrigate again for several days. Frequent shallow waterings promote shallow root growth, which is easily damaged by cultivation or dry periods. Irrigation early in the day so plants will dry before night is less likely to spread diseases. See also the section on trickle irrigation under "Advanced Gardening Techniques."

Weed Control

Weeds compete with vegetable plants for water, nutrients and sunlight. Weeds reduce yields and may cause crop failure unless they are controlled.

There are several methods of controlling weeds. Commercial vegetable growers use a combination of mechanical methods and chemical weed killers called herbicides. Most herbicides are not recommended for use in home gardens. They are difficult to use because no one chemical can be

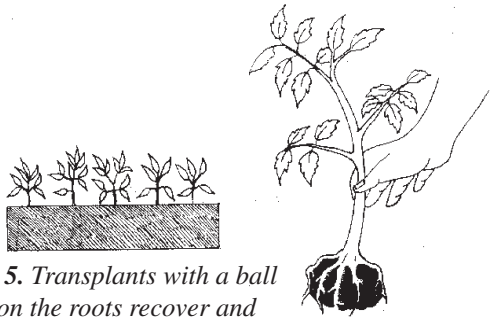


Figure 5. *Transplants with a ball of soil on the roots recover and begin to grow more quickly after transplanting than those whose roots have been dried or severely damaged.*

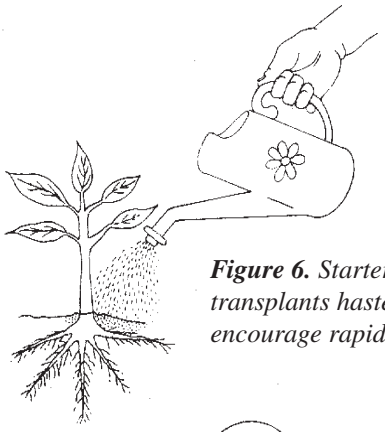


Figure 6. *Starter solutions applied to transplants hasten establishment and encourage rapid growth.*

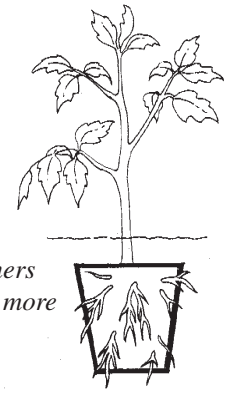


Figure 7. *The top of peat containers must be covered with 1/2 inch or more of soil.*

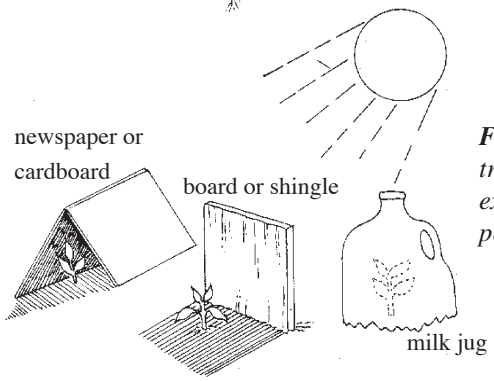


Figure 8. *Hotcaps protect transplants from wind and extreme temperatures and permit earlier planting.*

used on all vegetables and because it is difficult to apply small amounts of chemicals uniformly over the garden area.

Hoeing and cultivating are the most common methods of weed control for home gardeners. Hoe or cultivate shallowly to avoid the losing soil moisture or cutting the roots of desirable plants. Hand-pull weeds in or very near the vegetable row. There will be less damage to vegetable plants if weeds are removed while they are small.

Both plastic and organic mulches may also be used to control weeds. This is discussed in the mulching section (page 14).

Use of proper cultural practices will also help control weeds. Never allow weeds or vegetable crops to develop mature seed in or near the garden. Cultivate to prevent weeds from seeding, even if vegetable production is finished. If erosion is likely to be a problem, the vegetable garden area may be kept mowed when not in use.

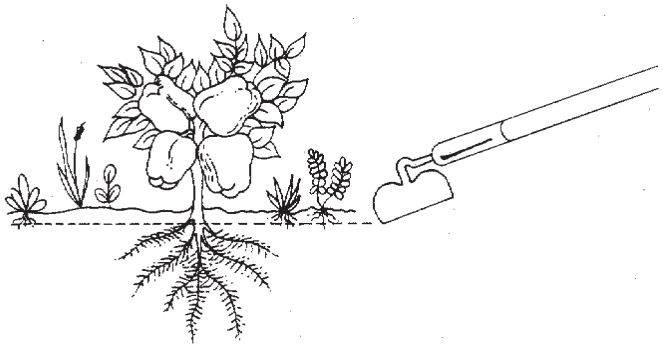


Figure 9. *Use very shallow cultivation to prevent damage to vegetable plant roots.*

Insect and Disease Control

Garden vegetables are susceptible to many insect and disease problems. Unless these problems are effectively controlled, they greatly reduce vegetable quantity and quality.

Begin control of garden insects and diseases by following good cultural and sanitation practices. Rake and burn or bury insect-infested or diseased plant residues after harvest so these problems will not overwinter in the garden. Turning plant residues under in the fall allows them ample time to decay before spring. Avoid the use of diseased plant material in a compost pile. Keep weeds and fencerows mowed.

Rotate families of vegetables among different areas of the garden each year. Grow resistant varieties whenever possible. Do not save seed if diseases are present. Other tips concerning cultural control of insects and diseases are found in Extension PB 1391, "**Organic Gardening and Pest Control**."

When insect and disease problems occur, they must be identified and treated as soon as possible if damage is to be minimized. County Extension offices can assist with identificatfion.

Gardeners should always be careful to apply chemicals according to the instructions on the container. Some diseases are present every year and are more easily controlled if preventative treatment begins soon after seedlings emerge or transplants are set in the garden. Other diseases and many insects should be treated as soon as they appear. Sprays are usually more effective than dusts, because they provide better coverage and are less likely to burn or otherwise harm growing plants. Compressed air sprayers are superior to other types of home garden sprayers.

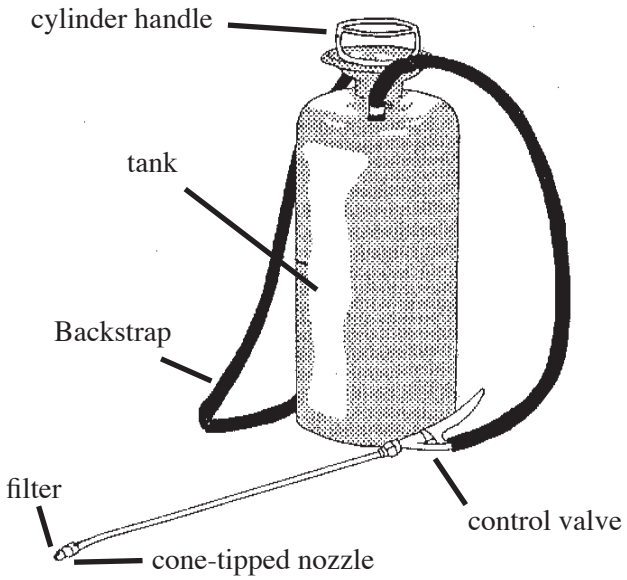


Figure 10*. Compressed air sprayer for use in home garden.*

Harvesting

Many vegetables must be kept harvested if the plants are to maintain production. Allowing oversized greenbeans, okra, summer squash or cucumbers to remain on vegetable plants will reduce future yields significantly.

Vegetables which ripen such as tomatoes and peppers will have greater nutritional value if they are harvested when fuflfly rfipe.

Table 6 contains suggestions as to when to harvest many common vegetables.

Table 6. When to Harvest Garden Vegetables

Vegetable	Vegetable appearance
Asparagus	When spears are 6 to 9 inches tall.
Beans, lima	When pods are full but seeds are green.
Beans, snap	While pods snap easily and are still smooth.
Beets	1½ - to 2½-inch beets have highest quality.
Broccoli	Before flowers show yellow color.
Cabbage	When heads become firm and heavy.
Cantaloupe	When melons can be lifted and the vine slips without pressure.
Carrot	Any time roots are firm and brittle.
Cauliflower	Before curd loosens and discolors.
Collard	When leaves are large but still green and firm.
Corn	When kernel juice is milky, silk begins to dry and ears are full to end.
Cucumber	When seeds are small, flesh is firm and color is green.
Eggplant	Before color begins to dull.
Kale	When leaves are large but before they yellow.
Kohlrabi	When 2 inches or more in diameter but still tender.
Lettuce	When tender and mild flavored. Before bolting.
Mustard	When leaves are crisp and tender.
Okra	When pods are 2½ to 3½ inches long.
Onion	For green onions: when bulb is ⅜ to 1 inch in diameter.
	For storing: after the tops have died down.
Parsnip	After cool weather has improved quality.
Peas, English	After pods have filled but before they turn yellow.
Peas, snap	After pods form but before yellowing.
Peas, Southern	For fresh use or freezing: When pods shell easily.
	For drying: After pods are dry and brittle.
Pepper, hot	After pods reach full size.
Pepper, sweet	When pods are full size and still firm.
Potato, Irish	For immediate use: After tubers are 1 inch in diameter.
	For storage: After vines have died and skin has set.
Potato, sweet	After reaching desired size but before cool fall rains.
Pumpkin	After they are full grown and mature colored. Before frost.
Radish	When firm and brilliantly colored.
Rutabaga	Before becoming tough.
Spinach	When leaves are crisp and dark green.
Squash, summer	When large end is 1-2½ inches in diameter and skin is still tender.
Squash, winter	When rind is not easily scratched by fingernail.
Swiss, chard	When leaves are crisp, tender and still green.
Tomato	When fully colored but still firm.
Turnip greens	While leaves are green and crisp.
Turnip roots	After 2 inches in diameter but while still tender.
Watermelon	When tendrils adjacent to fruit die and rind on ground becomes yellow.

Advanced Gardening Techniques

Plant Supports

Gardens will produce more in less area and quality will be higher if certain vegetables are grown vertically rather than horizontally. Vegetables grown vertically have an extended harvest season and are easier to spray, tend and harvest. They have fewer disease and insect problems because of improved air circulation and better spray coverage.

English peas, snap peas, cucumbers and pole beans are some of the vegetables that are commonly grown vertically. These vegetables may be trained on a fence, in a wire cage or on a trellis. Pole beans may be grouped around individual stakes or stakes may be pulled together at the top and tied for additional strength. Trellises may be constructed from cane supported by a wire on top, string woven between top and bottom wires or from nylon netting.

Tomatoes respond well to vertical culture, since many of the fruit will rot if they lay on moist soil. Home garden tomatoes are usually supported by 5- or 6-foot stakes or a wire cage. Use stakes at least 1½ inches square and drive them a foot or more into the ground. Plants are pruned to one or two stems and tied loosely to the support at 8- to 12-inch intervals.

A second method of supporting tomatoes is with wire cages constructed from concrete reinforcing wire. Cages should be 20 to 22 inches in diameter, which will require a 6-foot length of wire bent into a circle. Firmly anchor each cage so it will not blow over. Cages may be anchored by tying them to individual stakes or by tying them to a wire that is attached to posts at each end of the row of cages.

Set a single indeterminant tomato plant in each cage. Allow the plants to grow without pruning. Push the ends back into the cage as they grow. Harvest fruit by reaching through the mesh.

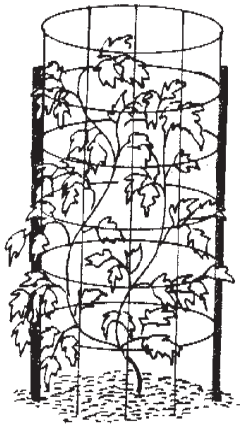


Figure 11. *Caging tomatoes reduces labor for supporting the plants and increases yield. Be sure to fasten cages to stakes driven into the ground.*

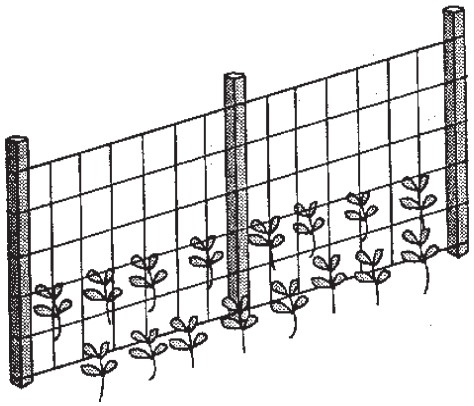


Figure 12. *A double row of English peas 8 inches apart will increase yields and may be supported by a single netting.*

Mulching

Either organic or inorganic mulches may be used in the home garden. Common organic mulches include straw, grass clippings, leaves, compost and rotted sawdust. The most common inorganic mulch is black plastic. Both organic and inorganic mulches reduce weed growth and conserve soil moisture. Organic mulches also improve soil structure and water-holding ability. They increase soil organic matter and eventually improve soil nutrient content. Black plastic mulch also increases soil temperatures.

Apply organic mulches around established plants in a layer 2 to 4 inches deep. Organic mulches are generally light-colored, reflect sunlight and keep the soil cool longer in the spring. They work best on cool-season vegetables early in the spring and on warm-season vegetables after soils warm. Add ¼ pound of ammonium nitrate fertilizer or its equivalent to each bushel of mulch.

Apply black plastic mulches over freshly fertilized and worked soils several days before planting. Shape the soil surface so drainage is toward the plants and use strips of plastic, not sheets. This will help water to reach the plants. It is important to thoroughly cover the edges of the plastic with soil to prevent wind damage. Insert plants or seed through holes or slits cut in the plastic. Because black plastic absorbs sunlight and warms the soil, warm-season plants such as tomatoes, eggplant, watermelon, peppers and cantaloupe can be set through plastic about a week earlier than they can be planted in bare soil. The first harvest of these crops will also be earlier when black plastic mulch is used. Because black plastic mulch warms the soil, it is not well suited to cool-season vegetables.

One disadvantage of black plastic is that it must be removed from the garden and discarded after the growing season. Another disadvantage is that it is hard to water or to apply nitrogen sidedressings under plastic. You can lay black plastic over a trickle irrigation tube and water through this tube. It is also possible to sidedress through irrigation water.

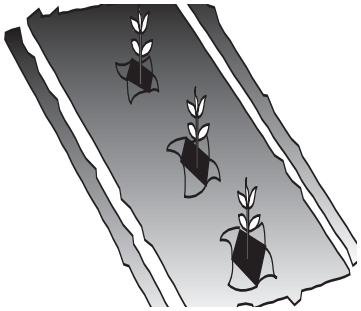


Figure 13. *Apply organic mulches 2 to 3 inches deep around established plants after the soil warms up.*

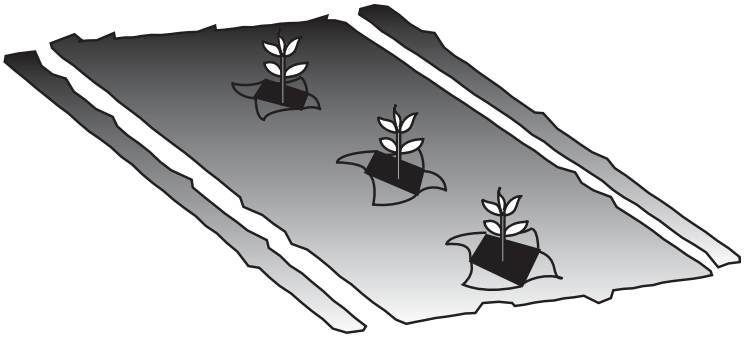


Figure 14. *Spread black plastic before planting. Plant warm season crops through slits or holes in the plastic.*

Composting

Compost is a dark, easily crumbled substance that develops from the partial decay of organic material. Making compost greatly reduces the volume of garden refuse, provides mulching materials for garden plants and contributes organic material to garden soils.

Most gardeners who compost produce compost in a "compost pile." Begin with almost any plant material. Examples include grassclippings, garden prunings, spent plants, leaves, hay, straw, manure and immature weeds. Do not compost meat scraps, diseased vegetables or plants or weeds with mature seed.

Start the pile directly on the ground. Sides of wire, wood or concrete block may be used to keep the pile in place. Begin the pile with a 6- to 8-inch layer of chopped organic material, since chopped materials have greater surface area and will decay more quickly. Moisten the layer and add 1 to 2 inches of manure or one cup of commercial fertilizer to supply nitrogen. Lastly, add a small amount of soil or finished compost to supply composting organisms. Repeat these layers to the height desired. The compost pile will require six to 12 months before it is dark, crumbly and ready to use. Turning the pile so the inside is moved to the outside and vice versa four to 10 weeks after it is begun will speed up the composting process somewhat. Keeping it moist but not soggy will also speed up the process.

You can also make compost by working organic material directly into the soil. Simply spread a 2- to 4-inch layer of a material such as leaves over the soil and work it in. Do this in the fall or several weeks before planting so the material will decay before planting.

Reduced Spacing

Several systems are designed to increase the number of vegetable plants grown and the produce harvested during a single season in a given area. These systems increase yields without increasing the area to be fertilized, irrigated or weeded. Some of them also increase the length of the harvest season. We have discussed succession planting previously, and now will look at intercropping, double cropping, multiple rows and planting in raised beds.

Intercropping is growing more than one crop in a single area at the same time. Fast-growing and slow-growing vegetables may be planted together, either by alternating rows or by alternating plants within the row. The fast-growing vegetable matures and is removed before the slow-growing vegetable needs the space. For example, radishes and tomatoes, or onions and peppers may be planted in alternate rows, closer together than usual, since the onions and radishes can be harvested in time to provide space for the tomatoes and peppers.

Pole beans are often intercropped with corn in Tennessee. The bean yield is reduced, but two crops are produced in the space usually required for corn alone. Another example of intercropping is planting lettuce, radishes or onions early in the spring and setting caged tomatoes or vine crops between the rows in late April or May. The spring crops will soon be harvested, making room for the tomatoes or vine crops to grow. With intercropping, the control of insects, diseases and weeds is more difficult. Many intercropping combinations are difficult to apply in commercial production.

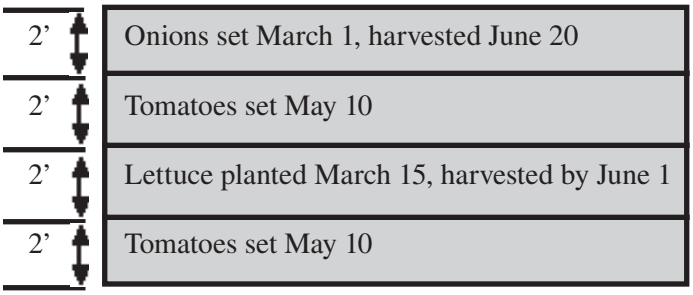


Figure 15. Intercropping of onions, lettuce and tomatoes.

Double-cropping is growing one crop and harvesting it, before planting and growing a second crop in the same spot the same year. By grouping cool-season and warm-season vegetables, you can grow spring and summer crops or spring and fall crops in the same space.

warm-season vegetable and then another cool-season vegetable in the same garden area in a single year. Two rapidly maturing warm-season vegetables, such as green beans or summer squash, may also follow each other in a single year.

Two or more rows of vegetables planted very close together are often called multiple rows. Vegetables are usually grown in long narrow rows with wide spacings between them. However, it is possible to increase production of some vegetables by planting two or more rows close together (double or multiple rows) or by broadcasting seed in a bed.

Vegetables suitable for multiple row or bed plantings are listed in Table 7, while the minimum spacings are contained in Table 8.

Begin by marking off multiple rows or beds. Beds may be any width as long as you can reach the center. Four feet is an often-selected width for raised beds. Leave aisles for walking between the beds or multiple rows. Beds or rows may be raised in home gardens if desired. Raised beds may be useful in poorly drained areas, because they will dry out earlier in the spring for planting and be easier to work. A small garden composed of raised beds can be extremely productive, attractive and may be edged with bricks, railroad ties, landscape timbers or other materials. Permanently raised beds, however, are very difficult to work with rototillers and other powered equipment.

Space the plants far enough apart so they will not be crowded, but close enough so they will occupy all available space when they mature. Recommended spacings for multiple rows of vegetables are given in Table 6.

Shade from mature vegetable plants reduces weed growth and evaporation from the soil surface. Because more vegetables are growing in less space, you must maintain a high fertility level and supply moisture during periods of drought. Be sure to fertilize beds as recommended by in your soil test, and apply nitrogen sidedressings as recommended in Table 4.

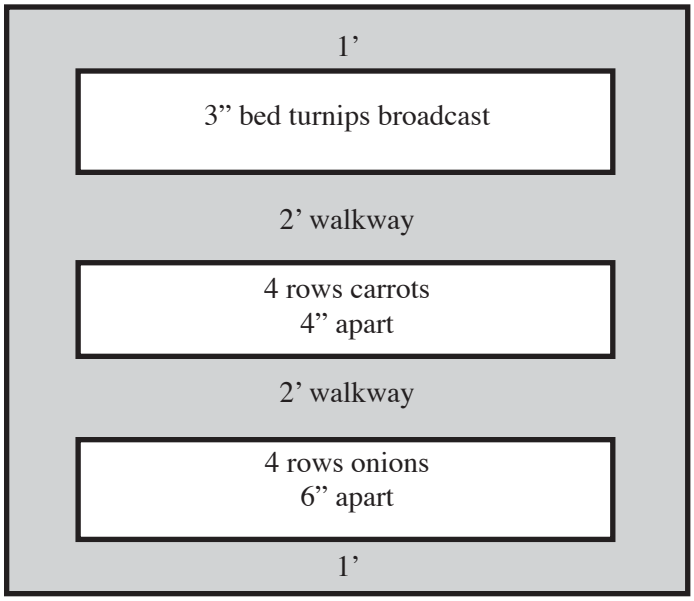


Figure 16. *Beds and multiple rows allow greater vegetable production in less space.*

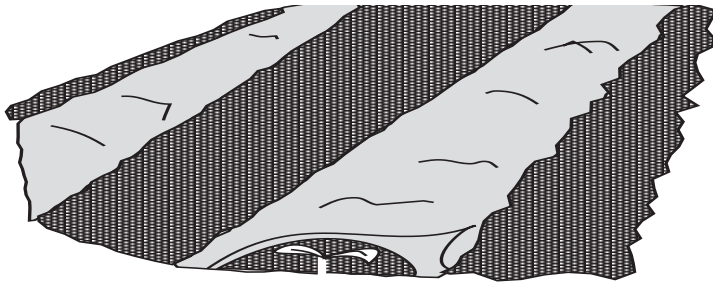


Figure 17. *Raised beds dry out early in spring. They may be both attractive and productive.*

Protective Devices

The most commonly used plant protectors formerly available to home gardeners were buckets and old blankets. These still work, of course, but protective devices have evolved considerably. Plants can be covered not only to prevent damage during cold weather, but to modify climates and extend growing seasons.

One-gallon milkjugs are cheap, readily available and highly useful. Simply cut out the bottoms, take off the caps and push the remainder of the jug 1 inch into the soil directly over the small plants. The plants will be protected from cold winds and freezing temperatures, and will grow faster. Protection from cutworms will be an additional benefit. Remove the milkjugs when the weather moderates. Your reward will be greater and earlier production.

The jugs can be pinned to the ground with a long wire hairpin if necessary. The bottoms of the jugs can be used as small platforms to support cantaloupe, pumpkins and winter squash off the ground.

You can protect groups of plants by modifying the climate under an entire row or even several rows. Spun-bonded or floating row covers, for example, are placed loosely over one or more rows of young plants. They lie directly on the plants and are lifted as the plants grow. Floating row covers raise the temperature considerably during the day and offer two or three degrees of frost protection at night. This results in more rapid plant growth and early harvests.

It is important to apply these covers loosely so they can be lifted as the plants grow. Remove them from plants requiring pollination when they flower so insects can reach the flowers. The protection of young plants from insects is an important secondary effect of spun-bonded row covers. Try these covers on cabbage and broccoli where protection from insects is important, and over watermelon and cantaloupe, which respond well to increased heat units. Be sure

to use them on weed-free soils or only on small areas, as they will have to be removed to control weeds.

There are also various kinds of small plastic tunnels used to protect plants. They consist of plastic strips 5 or 6 feet wide. The plastic may be clear or translucent with numerous slits or holes down the sides, or it may be solid.

The plastic is supported by 6-foot lengths of #10 wire bent into a hoop shape and inserted over the row at 6- to 10-foot intervals. The edge of the plastic must be well covered with soil to prevent its removal by wind.

Install plastic row covers immediately after planting or transplanting. Much of their benefit comes from increased soil temperature, which requires time to achieve. They are often used with black plastic mulch, which assists in weed control.

Table 7. Vegetables Suited to Multiple Row or Bed Planting

Double row only	Multiple row or bed
Beans, Bush	Beets
Beans, Pole	Carrots
Collards	Chard, Swiss
Corn, Sweet	Lettuce
Kale	Mustard
Peas, English	Onions
Pepper	Radishes
	Spinach
	Turnips

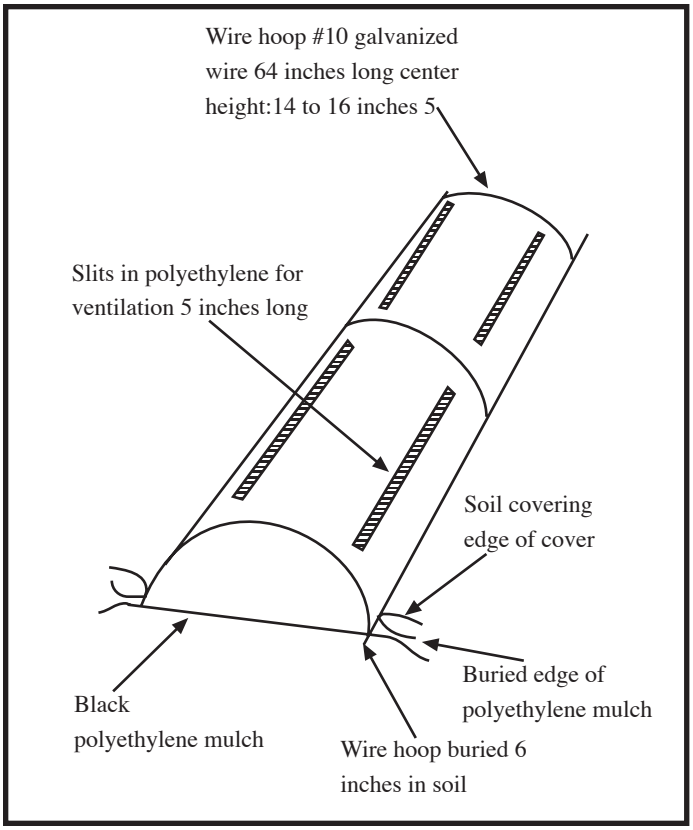


***Figure 18**. Slitted row cover.*

Table 8. Recommended Spacings for Vegetables Planted in Double or Multiple Rows

Vegetable	Inches between rows	Inches between plants
Beans, Bush	10 to 12	3 to 4
Beans, Pole On Wire	8	3 to 6
Beets	6	2 to 3
Carrots	4	2 to 3
Chard, Swiss	8	6 to 8
Collards	12	12
Corn, Sweet	12	8
Kale	6	6
Lettuce, Head	12	12 to 15
Lettuce, Leaf	6	6
Mustard	6	6
Onions	4	3
Peas, English	6	3
Pepper	10 to 12	12
Radishes	4	1 to 3
Spinach	6	3 to 4
Turnip, Greens	4	2 to 3
Turnip, Roots	6	3

Row covers provide two or three degrees of frost protection and a considerable increase in heat units. They can shorten the cantaloupe growing season as much as two weeks and increase both early and total yield.

Like floating row covers, slitted row covers reduce insect infestation. They must also be removed from plants requiring pollination when they flower and from crops that cannot withstand extreme summer temperatures. The wires and perhaps even the plastic may be re-used. Row covers are very conducive to high-yielding small gardens, but difficult to use with some other cultural devices, such as plant supports.

Trickle Irrigation

Trickle or drip irrigation systems use a network of water-conducting tubes placed at the side of plant rows to distribute small amounts of water directly to growing plants. Water emerges through small sprinkler heads, leaks through small emitter holes or soaks through the porous sides of the tubes.

Trickle systems are more costly than sprinkler systems, but they require much less water. This can be a real advantage to city gardeners who must pay for water, and perhaps for waste water treatment also. Trickle systems consist of a water source, a backflow valve, a filter, a pressure gauge, header pipes, emitter tubing and possibly emitters (see Figure 19.) They operate under very low pressure (six to 20 pounds) and are easily installed. Because the small holes are easily clogged, they require clean water and adequate filtration. City or well water is suitable for use in a trickle system, but river or pond water will require excellent filters.

Trickle systems use less water, partly because of reduced evaporation. Water is placed at the base of the plant, not released into the air where it may evaporate or blow away. The aisles between rows are not watered. Plants remain dry so diseases are less common and severe. Growth is rapid because of the constantly available moisture. Trickle tubes may also be placed under black plastic or used to fertilize vegetables.

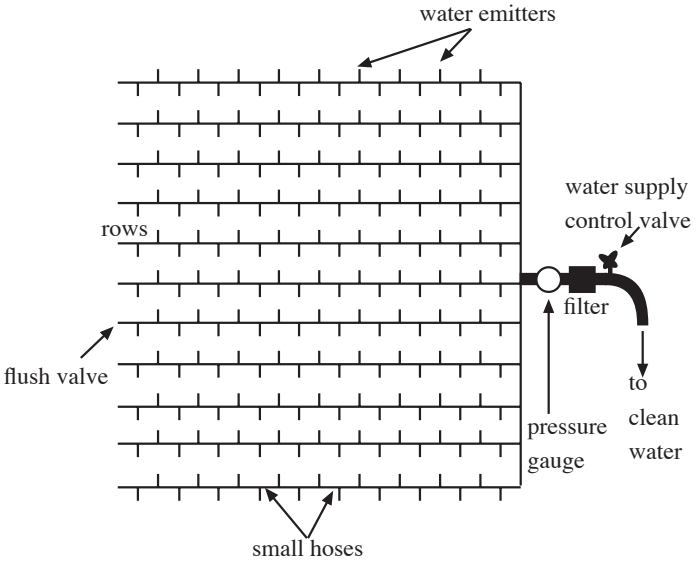


Figure 19. *Diagram of trickle irrigation system set up to water small garden area. Plants are set by water emitters.*

Because trickle tubes wet only a portion of the soil, they must run every day or two. It may be difficult to determine how long they need to run. Like traditional irrigation systems, they should wet the soil a foot deep. Gardeners should experiment and see how long this takes.

Transplant Production

Most home gardeners purchase vegetable transplants. There are, however, several advantages to growing your own. If you grow your own transplants, they will be the size you want when you are ready to plant them. The container size can be controlled, as can the variety. There will be less danger of bringing in insects and diseases, and you can properly harden the transplants before planting. The cost may also be less.

Unfortunately, vegetable transplants are not easy to produce in the home. Optimum growth requires a heated structure, a greenhouse. If you grow transplants in the home, you will face two severe problems. First, vegetable transplants usually grow best with night temperatures 10 degrees below day temperatures. Second, the light intensity, even in a south-facing window, is not adequate to produce most vegetable transplants.

The first difficulty can be overcome by growing transplants in an unheated room and supplying heat only in the daytime or by simply turning down the thermostat at night. You can increase the light to suitable levels by building a light box. A light box is a partial-box with bottom, back and ends only. Make it about 15 inches high, a little over 4 feet long and about 18 inches from front to back. Line the inside with foil. Place the box in front of a south-facing window and set a fluorescent light on the open top. Attach the light to a timer set to turn on near dawn and to turn off 16 hours later. The light will not be sufficient to grow plants, but it will supplement the natural light from the south-facing window nicely. Special plant grow lights are available and work better than ordinary fluorescent lights for growing plants.

Use this plant box to grow a few transplants or to germinate many. If seedlings are started in this box, they will need to be moved to a more roomy, protected environment when they require additional space. A coldframe may be used for thfis.

Saving Seed

You may occasionally acquire vegetable seed that you do not plant immediately. Sometimes, only part of a seed packet is planted. You may even wish to preserve a favorite heirloom variety. How can seed best be stored?

Seed is alive and must remain alive if it is to grow. The best way to keep it alive is to keep it cool and dry.

Begin by resealing partially filled seed packets with tape. Place the seed packets in containers such as glass jars with lids, plastic containers or boxes with tight-fitting lids.

Add a small envelope of calcium chloride or powdered milk to the container to absorb moisture, and then refrigerate or freeze the seed. Seed kept dry and cool will remain free of insects and may remain viable for several years.

Be careful what seed you attempt to collect and save. Seed of hybrid varieties should never be saved, because plants grown from it may vary considerably from the parent plants. Seed of cross-pollinated plants, such as vine crops, may not grow into plants exactly like the parents either. Some seed can also carry diseases. Bean and pea seed are examples that often carry bacterial or viral diseases. Therefore, saving seed is always risky. The best way to ensure healthy seed is to purchase fresh seed each year.

If you do have old seed, it may be wise to test it. Roll 10 to 20 seed in a paper towel and moisten the towel. Put the moistened towel in a glass jar with a top or in a plastic container with a tight-fitting lid so the paper towel will not dry out. Place the container where it will remain warm. After eight to 10 days, check to see how many seed appear to be vigorously sprouting. If less than half are sprouting, discard the remaining seed. If about half are sprouting, you may wish to plant the remaining seed thickly. If most are sprouting, then the seed may be planted at normal thickness.

Table 9. Details of Transplant Production

Vegetable	Approximate growing time (wks.)	Germination temperature (degrees F)	Growing temperature (degrees F)	Conditions for hardening
A. Cool-Season				
Broccoli	5 to 7	70	60 to 65	50 to 55F for 10 days
Cabbage	5 to 7	70	60 to 65	50 to 55F for 10 days
Cauliflower	5 to 7	70	60 to 65	50 to 55F for 10 days
Head Lettuce	5 to 7	70	60 to 65	Lower temperature and moisture
B. Warm-Season				
Cucumber	2 to 3	75	65 to 75	Reduce moisture
Cantaloupe	2 to 3	75	65 to 75	Reduce moisture
Eggplant	6 to 8	75	70 to 75	Reduce temperature and moisture
Pepper	7 to 9	75	60 to 70	Reduce temperature and moisture
Squash	2 to 3	75	65 to 75	Reduce moisture
Tomato	5 to 7	75	60 to 70	Reduce temperature and moisture
Watermelon	2 to 3	80	65 to 75	Reduce moisture

Vegetables

Raised Bed Gardening

Advantages

Raised bed gardening offers gardeners the opportunity to increase production while decreasing garden area. Raised beds are especially helpful to gardeners with limited gardening space and those who have difficulty with fine-textured, clayey soils which do not dry early. Efforts to improve undesirable soils can be concentrated on growing areas only.

Raised beds drain and warm up earlier in the spring, which allows planting of cool season vegetables at recommended planting dates. Raised bed gardens can be entered soon after rains or irrigation without compacting soils. Water will penetrate better during heavy rains and there will be less danger of erosion.

Once they are built, raised beds are easy to prepare for planting and to care for throughout the growing season. Root crops grow longer and straighter in medium- to coarse-textured soils. Raised beds are well suited to a wide range of intensive gardening techniques such as row covers, trickle irrigation, intercropping, successive plantings, use of plant supports, compact varieties and mixtures of food and ornamental plantings. Their orderliness usually produces an extremely attractive and appealing appearance.

Disadvantages

Raised beds also have a few disadvantages. They make it difficult or impossible to use large, mechanical equipment. Their edges break down unless they are supported. They require time, labor and perhaps money to develop. They are not well suited to sprawling vegetables such as pumpkins and winter squash. The close spacings used in raised beds can promote plant diseases by reducing air circulation and allowing plants to remain moist longer. The most severe problem associated with raised beds, however, is drainage.

Rapid drainage is an advantage when a gardener is trying to plant early spring vegetables. It is a disadvantage during the summer when drought stress can quickly lead to reduced yield and quality and increased physiological disease such as blossom-end-rot. Sandy soils and very high beds are particularly susceptible to drying out. Use low beds and add organic matter to them to help retain moisture.

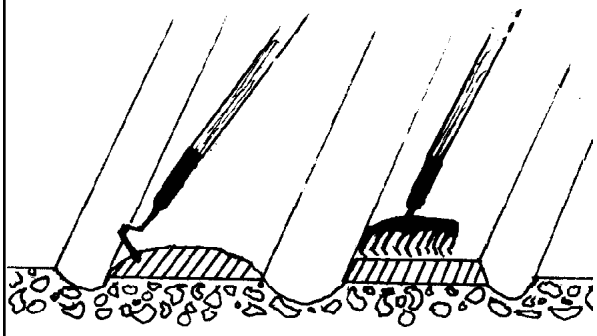
Apply mulches to the surface of the beds. Supplemental irrigation should also be considered essential when gardening on raised beds.

Developing Raised Beds

The simplest raised beds are temporary. They may be formed by raking or plowing freshly worked soil into ridges and away from aisles where one walks. Four- or 5-foot wide beds with 1 or 2 feet between beds are appropriate. Be sure that you can reach half way across each bed from one side to plant, weed and harvest. Make raised beds 4 to 8 inches high and any convenient length. Raised beds should never be walked on once they are formed. The absence of soil compaction in raised beds is one of their strongest advantages. Compost worked into the soil annually reduces soil crusting and enhances seedling emergence.

Flatten the top of temporary raised beds with a rake and they are ready to plant. Fertilizer, lime and organic matter are applied to the entire garden area before temporary raised beds are formed. These beds break down over the gardening season and must be reformed each year. Gardening with temporary raised beds is really not very different from traditional gardening. Formation of temporary raised beds is illustrated in figure 1.

Figure 1: Formation of Temporary Raised Beds



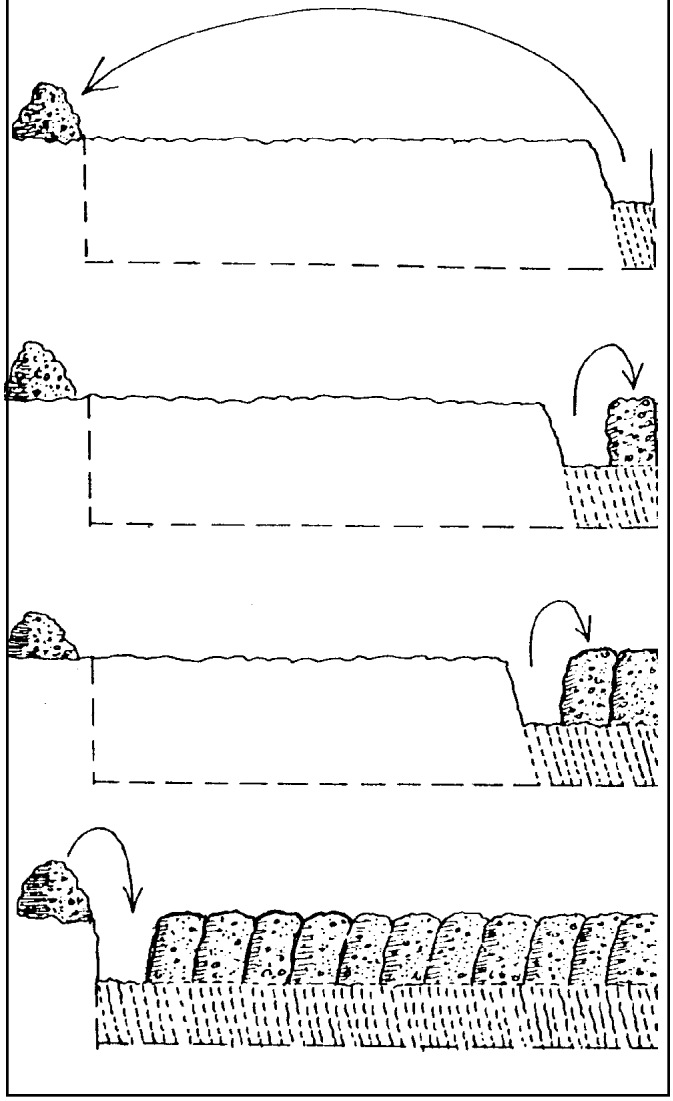
Pull soil into ridges and tamp down with a rake.

Permanently raised beds make much better use of the advantages of raised beds. Begin to form permanently raised beds by marking off the desired area with stakes and twine. Fertilize, lime and cover the enclosed area with compost, shredded leaves or other organic material as desired. Work this material into the soil as deeply as possible using a spading fork or rototiller. Next, edge the beds. Raised beds may be edged with old lumber, landscape timbers, railroad ties, concrete blocks or whatever is convenient.

A combination of soil from the aisles, top soil, compost, sand, shredded leaves and other material may be added to fill the raised bed to the desired height.

Some gardeners form permanently raised beds using a system known as double digging. Double digging (figure 2) is a lot more work than the above system but assures that the raised bed will contain soft, enriched soil to a depth of nearly 2 feet.

Figure 2: Double Digging a Raised Bed



Begin the double digging process by marking off the boundaries of the raised bed as described before. Use a spading fork to work the bed. Dig a trench 1 or 2 feet wide and one fork length deep across the end of the bed. Remove this soil to the far end of the bed. Apply fertilizer, lime and organic material to the trench. Using the

spading fork, loosen the soil in the bottom of the trench to the depth of the fork tines and work in the fertilizer, lime and organic material.

Now step back and dig another trench, placing the loosened soil on top of your previous trench. Again add what you wish, loosen the soil in the bottom of this trench and mix in the materials you have added. Continue to the end of the bed. Fill in the last trench with soil removed from the first trench. Edge the bed with the desired materials. The loosened soil will be several inches higher than the adjoining aisles. This double digging process is illustrated in figure 2. Never step in a raised bed after it has been double dug. The soil will settle gradually and beds will not need to be redug for one or even several years.

Using Raised Beds

Raised beds will have maximum efficiency if plants are spaced equidistant from each other rather than in rows. Plants should ideally just touch, forming a canopy over the soil when they are mature. One way to accomplish this spacing is to set plants a little farther apart than suggested spacings in the row and use the same distance between rows.

It may be more practical to plant two or three rows of vegetables such as bush beans parallel to the bed length without worrying about equidistant spacings. Small vegetables that tend to mature all at once or that are used only in small amounts may be planted in short rows across the bed. Several plantings two or three weeks apart will maintain uniform production over many weeks.

Vegetables such as tomatoes and cucumbers do well in raised beds if they are supported and allowed to grow up rather than to sprawl. Corn is not well adapted to raised beds as it needs to be well anchored. Large sprawling vegetables such as watermelons and pumpkins are also better suited to traditional gardening systems than raised beds.

Small vegetables such as radish and lettuce may also be interplanted between tomatoes and other large vegetables. They will mature and can be removed before the tomatoes need the space. Reversing this procedure, peppers can be interplanted between lettuce plants in the same way.

To use raised beds efficiently, they should be well fertilized, watered and kept filled with growing plants. When a spring vegetable is harvested, plant a summer vegetable in its place. Follow summer vegetables with fall vegetables. Recommended spacings for common vegetables in raised beds are given in Table 1.

Table 1: Recommended Spacings Between Plant Centers For Raised Beds*

Vegetable	Inches Between Plant Centers
beans, bush	4-6
beets	2-6
broccoli	10-15
cabbage	15-18
carrots	2-4
cauliflower	15-18
collards	8-15
eggplant	18-24
kale	8-15
kohlrabi	5-8
lettuce, leaf	6-10
okra	10-18
onions	3-5
potato, Irish	9-12
potato, Sweet	18-24
radish	2-4
spinach	4-6
squash, summer	18-24
Swiss chard	6-10
tomato	18-24
turnips	4-6

* Gardeners new to raised bed gardening should use the wider spacings. More experienced raised bed gardeners can use the closer spacings.

Vegetables

Planning the Vegetable Garden

Why Plan?

A garden plan will save time, space, work and money. Yields will be increased, as will the length of the harvest season. Best of all, you will be able to harvest the amount of high-quality garden produce you desire at the time you choose.

Evaluate Past Gardens

Begin to plan your next garden by considering your past gardens. What varieties did you like well or not at all? Would you like to extend the harvest season or increase or decrease the amount of your harvest? Would several small staggered plantings be desirable? Did you try something new last year that you want to include again this year? Is there something new that you want to try this year? Has your family increased or decreased in size? Do you want to preserve more or less food this year?

Select a Site

The ideal garden soil is deep, fertile, well-drained and medium-textured. Such soils are usually dark-colored. Fine-textured, clay soils are difficult to work and frequently form clods or crust as they dry, especially if they were turned while wet. Very sandy soils do not retain moisture or nutrients well. Poorly drained soils may be difficult to plant at recommended planting dates, may be very low in nutrients or high in acidity and may encourage plant diseases.

Full sunlight produces the most productive gardens. Six hours of daily sunlight are probably the minimum for good production. Trees and hedges should be avoided, as they not only reduce sunlight but also compete with vegetables for water and nutrients.

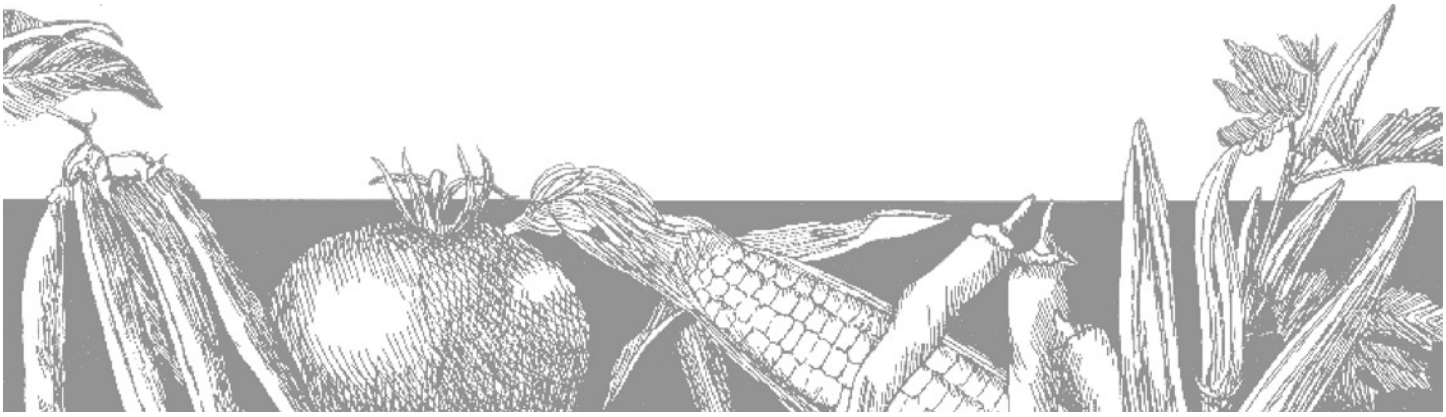
Level sites are less subject to erosion than sloping sites, but a slight slope toward the south hastens warming and drying of the soil early in the spring. A slightly sloping site will also have better air drainage and less frost damage than a level site or an exposed hilltop.

Gardens near the house are more accessible. They are also easier to care for and to protect. There are generally fewer wild animals near the house and water for irrigation will be available. It may be necessary to fence dogs, farm animals and children out of the garden. Frequent harvests are also easier and more likely when gardens are near the house.

Lastly, garden sites must correspond in size to the amount of garden produce desired. Intensive cultivation techniques can only partially substitute for a small site.

Soil Test

A soil test is the only accurate method of determining how much lime and fertilizer to apply to gardens. If too little fertilizer is applied, plants will be starved and yield and quality of vegetables will be reduced. Too much fertilizer will waste both fertilizer and money, as plants will be unable to fully utilize it. Too much fertilizer can also injure or kill plants.



Acid soils resulting from a lack of lime can also prevent nutrients from being taken up. Fertilization of acid soils can thus be ineffective. A soil test is a relatively inexpensive way of determining how much, if any, lime is required and obtaining a fertilizer recommendation at the same time.

Specific information concerning how to sample soil for a soil test and how to treat the sample after collection is available at all county Extension offices.

Vegetable Selection

After an appropriate site is located and evaluated, decide which vegetables to grow. Consider the likes and dislikes of your family. Consider also the space requirements of the vegetable. Winter squash and pumpkins require considerable space and may not be practical for small gardens. Corn requires quite a bit of space and bears only once. If space is limited, it might be better to plant vegetables such as summer squash, peppers and tomatoes rather than corn. All of these bear large amounts of fruit over an extended harvest period in a small area.

Consider also your philosophy about using agricultural chemicals in the garden. Some vegetables, such as okra, will nearly always produce a crop with or without chemical pest control. Others, such as cabbage and broccoli, are generally heavily infested by insect pests. Organic gardeners and others who wish to avoid the use of agricultural chemicals may wish to grow more pest-resistant crops such as okra and few crops highly susceptible to insects and diseases.

Plan for Rotation

Closely related plants can be grouped into families. Families of plants tend to be susceptible to many of the same insect, disease and nematode problems. By grouping vegetable plants into families and moving each family to a different location within the garden each year, many insect and disease problems can be reduced. Plan to group your vegetables by families and to rotate families to different areas of the garden each year. See Table 1 for suggested vegetable groups for rotation.

Sketch a Plan

Finally, if you really want to be organized, make a scale drawing of your garden. This is undoubtedly the greatest planning aid one can have.

Table 1: Examples of Crop Groupings to Reduce Diseases[1]

Group	Crop	Disease(s) Reduced
Group A	Cantaloupe Cucumber Pumpkin Squash Watermelon	Microdochium Blight Fusarium Wilt Gummy stem blight Anthracnose Scab, Belly Rot Angular leaf spot Nematodes
Group B	Brussels sprouts Cabbage Cauliflower Collards Lettuce Mustard Radish Rutabaga Spinach Swiss chard Turnip	Black leg Club root Black rot
Group C	Eggplant Irish potato Okra Pepper Tomato	Bacterial canker Early blight Nematodes Potato scab
Group D	Beet Carrot Garlic Shallot Sweet Potato	Scurf Black rot Wilt Nematodes
Group E	Sweet corn	Smut
Group F	Bean Cowpea Peas	Fusarium root rot Anthracnose Nematodes

[1]Rotate to a crop in a different group when planting successive crops in the same location in the garden.

Begin with a scale drawing of the site. Graph paper makes the drawing easy to construct and to work with, but any kind of paper will do. Divide the drawing into two sections. Plan to plant cool-season vegetables in one section and warm-season vegetables in the other. The cool-season section will be harvested by mid-summer and can be replanted for a fall garden. Alternate the warm- and cool-season sections each year to reduce plant disease.

Arrange the vegetables so tall vegetables will not shade shorter ones. Write the variety to be planted, planting or transplanting date and amount of seed required on the planting plan. Be sure to plan for staggered plantings to extend the season.

With a plan, you can plant an efficient garden when planting time arrives. Note on your plan or in a garden calendar the dates when you actually planted, special procedures used and how acceptable the varieties were. This information will be used in planning your next garden. Figure 1 illustrates a sample garden plan.

Figure 1: A sample garden plan

	36"	1 pkt. Clemson Spineless Okra planted in May	
	108"	1/4 lb. Silver Queen Sweet Corn planted in 3 half rows in late April 30” apart.	1/4 lb. Silver Queen Sweet Corn planted in 3 half rows in May.
	48"	11 Better Boy Tomatoes transplated in April--staked	11 Better Boy tomatoes set from pre-rooted suckers in June--staked
	60"	1 pkt. Butter Bar Summer Squash planted in May	1 pkt. Burpless Cucumber planted in May
	36"	10 Black Beauty Eggplant transplanted in May	6 California Wonder and 6 Hungarian Pepper set in May
	36"	2 oz. Provider Snapbeans planted in April in 2 rows 10” apart.	2 oz. Roma II Snapbeans planted in May
	36"	1/4 lb. Fordhook 242 Bush Lima Beans planted in May	
55ft.	36"	2 oz. Pinkeye Purple Hull Peas planted in May	
	48"	35 Centennial Sweet Potatoes set in May	
	36"	30 Stonehead Cabbage transplants set in March	
	36"	30 Premium Crop Broccoli transplants set in late March	
	36"	30 Snow Crown Cauliflower transplants set in late March	
	36"	2 pkt. Detroit Dark Red Beets in double row planted in March	1 pkt. Vates Collards planted in March
	24"	2 pkt. Danvers Carrots in double row 4” apart planted in March	1 pkt. Cherry Bell Radish planted in March
	24"	1 pkt. Just Right Turnip planted in March	1 pkt. Simpson Lettuce planted in March
	24"	200 Danvers Onion sets 3” apart set in March	

45 ft.

Vegetables

Soil Preparation for Vegetable Gardens

The first step in preparing vegetable gardens for planting is cleaning the site. Remove boards, rocks, old plant supports and general debris. Cut or chop weeds and crop residue. If the residue is free of disease and mature weed seed, the material may be worked into the soil or composted. Otherwise, it should be discarded. Bulky plant material, like corn stalks, will need to be chopped before it is incorporated into the soil.

If initiating a new garden into a sodded area, it is beneficial to plow the sod in the late fall or winter. The heavy root system of the sod will require several months to decompose. The excess root mass makes tillage and planting difficult. As soil organisms begin to decompose large amounts of organic matter, they utilize available nitrogen. As the process continues, nitrogen is released that can be used by the plants. However, it is often 45 to 60 days before the nitrogen becomes available for the plant to use.

Soil Sampling

One of the best ways to insure the garden will be successful is to have a soil test performed. A soil test is the only accurate way to determine how much lime and fertilizer to apply to the garden. However, if the soil test information is to be accurate, the sample must be collected correctly. Use a small trowel or spade to collect samples. Collect samples from eight to 10 locations throughout the garden. The soil should be dry, or at least free of excess moisture. Collect vertical slices of the top 4 to 6 inches of soil. Place the soil in a clean plastic bucket and mix thoroughly. Metal containers or those contaminated with detergents or other foreign material may cause invalid recommendations.

Avoid irregular areas in the garden when collecting a soil sample. Do not collect soil samples from areas where water stands, heavy amounts of ashes have been dumped or where debris has laid. For the most reliable results, collect the samples from the areas most representative of the garden.

Soil samples should be taken the same general time each year. Remember, the trends observed may be more important than the absolute values. Sampling during the fall one year and the spring the next will not allow you to observe the trends. If the soil test results report a consistent decrease in phosphorus and potassium levels, then you are not fertilizing enough. If the results show large increases in the phosphorus and potassium levels, then you are over-fertilizing. The goal of proper soil fertilization is to gradually increase the nutrient levels of the soil and then maintain them at a medium or high test result.

Liming

Lime should be applied to the garden according to soil test recommendations. Proper liming should adjust the soil pH to the correct range (6.0 to 6.5 for most vegetables). The proper soil pH promotes root development, optimizes nutrient availability, reduces the incidence of certain physiological disorders (blossom end rot) and reduces incidences of certain diseases (Fusarium wilt). Do not over-apply lime, as high soil pH reduces nutrient availability and causes nutrient imbalances.

A soil test report recommends the pounds of ground limestone to apply per 1,000 square feet of garden area. If hydrated lime is used, it should be applied at three-fourths the recommended rate of ground limestone. Hydrated lime reacts more quickly with the soil. However, it is more expensive and much more difficult to spread.

Ground limestone will be most effective if applied several weeks before the garden is planted. If you soil sample in the fall, lime can be applied prior to the establishment of the cover crop. A fall application gives the lime several months to react with the soil prior to planting. However, if a lime application is recommended, it is better to apply lime just prior to planting than not to apply it at all.

Broadcast lime evenly over the garden area, and work it into the top 6 inches of soil. Depending on the soil type, fertilizer practices and environmental conditions, a lime application should not be required more than every two to five years. Do not apply heavy concentrations of lime around the base of plants or sprinkle it over plants in an attempt to control insects. This practice can raise the pH above the desired level and result in reduced production.

Preplant Fertilization

Apply fertilizer to garden sites in accordance with the soil test recommendations. In the absence of a soil test, use two to three pounds of 6-12-12 fertilizer or its equivalent per 100 square feet of garden area. Broadcast the fertilizer evenly over the soil surface and incorporate it into the top 6 inches of soil.

Soil Preparation

Be careful not to work garden soils when they are too wet. If water can be squeezed from a handful of soil or if the squeezed lump of soil does not break apart when dropped, it is too wet to work. Working wet soil forms clods that become extremely hard as they dry and are entirely unsuitable for a seedbed. Clods significantly reduce soil-to-seed contact, which can severely reduce germination of vegetable crops, especially small-seeded species.

It may be difficult to work some soils early enough in the spring to plant cool-season crops by the recommended planting date. Sometimes these soils may be improved by establishment of drainage ditches, tiling, addition of sand or incorporation of organic material. Perhaps a part of the garden area that is higher than the rest may be used for the earliest planting.

Fall Soil Preparation and Ridging

Another solution is to work a portion of the garden in the fall, and to make 6- to 8-inch tall ridges in the area. Due to the increased surface area and improved drainage, the ridges will warm up and dry out earlier than the remainder of the garden. However, keep in mind that the ridges will stay dryer throughout the season; therefore, irrigation may need to be used later in the growing season.

If fertilizer is applied in the fall, these ridges can often be used for the earliest planting without further tillage or preparation. Nitrogen will be lost when using this system. However, it can be easily replaced with timely sidedress applications.

How To Grow Tomatoes

Absolutely nothing tastes better than a warm, home grown, vine-ripened tomato on fresh-baked bread! Easily raised in the home garden, or even on the patio, tomatoes produce heavy crops in small areas.

Tomato Varieties:

With dozens of varieties of tomatoes available to the home gardener, your choice will depend on what you want from your plants, as well as on which varieties grow best in your region. In localities with a relatively early fall frost and short growing season, pick tomatoes developed for early maturation. As well, there are tomato varieties available for slicing, special ones for canning and freezing, small tomatoes for patio and container planting, late maturing tomatoes, and yet others which make good ketchups and sauces. So if you have enough room, choose a selection of tomato varieties and then decide which is your favourite.

Planting & Culture:

The tomato is a warm-season plant which can require a fairly long growing season, depending on the variety selected. Plants may be bought from a greenhouse, or grown from seeds started indoors approx. 4 - 6 weeks before you plan to set them out into the garden. Tomatoes are very sensitive to frost, however, so they must not be put outside until the weather is reliably warm, or they are protected from sudden chills.

Germinating Tomato Seeds:

Tomato plants can be started in almost any type of container that has holes in the bottom of it for drainage. Fill the container with a mixture of two parts sterilized garden soil with one part pasteurized compost and one part vermiculite or perlite. Tomato seeds germinate best when soil temperatures are 24 - 32C (75 - 90F).

Space the seed evenly in holes 2 - 3 inches apart with three to four seeds to each hole, planted 1/2 inch deep. Keep warm and dark until the seedlings appear. The top of the refridgerator is a handy place to start your plants, as light isn't crucial until the seedlings have popped out of the soil. Expect to see sprouts in 6 - 14 days.

As soon as the tomato sprouts appear, move the plants to a bright, but cooler location, and grow your tomato seedlings at about 15C (60F) during the day, and no lower than 4C (40F) at night. This prevents the tomatoes from growing tall and straggley, and promotes strong root development. Watering your new plants from the bottom by placing the seed flat in a pan containing shallow water and allowing the flat to absorb the moisture it requires while at the same time keeping the surface of the soil on the dry side helps to prevent damping-off.

As your tomatoes continue to grow, transplant them to larger pots containing a richer soil when they have 1 or 2 true leaves - each time burying them a bit lower into the ground. Allow the surface of the soil to dry between waterings, but don't let the plants wilt. Every 10 days or so, add some organic balanced formula fertilizer, manure tea or fish emulsion to the water.

- **Staking & Pruning:**

  Indeterminate vines continue to grow and produce fruit until killed by frost. They need to be staked or trellised for best production. Drive a 5' stake into the ground alongside each planting spot. Plant seedlings deeply so that they send out side roots from the stem. This will help to anchor the plant as well as to feed it. Tie the plant to the stake with soft yarn or strips of cotton cloth by placing the cloth underneath a leaf node (where the leaf joins the main stem) and securing it loosely to the stake. This also helps prevent injury to the tomato plant during rapid growing, where heavy fruit can break the stems.

  If your tomatoes are the kind that require staking, be sure to pinch out the side shoots so that the plant produces only 2 main stems which are tied to the stake. Remove all suckers (stems growing from the leaf crotch) except the first one. This is allowed to develop into a second stem, which is tied to the stake like the first one. Other suckers should be allowed to grow 6 inches long before they are cut off with a sharp knife. To limit the height of the plant, pinch back the top when it reaches the desired height. By removing the suckers and keeping the foliage under control your tomatoes will set a later crop of larger fruit.

  Determinate Bush varieties of tomatoes normally set fruit in a concentrated time period. These types do not need staking, but some kind of support (cages or netting) is useful to keep plants from sprawling on wet ground. The "suckers" are not normally removed, though some trimming helps air circulation. If you remove some of the flowers, you will get larger-sized fruit.

- **Watering:**
  When watering tomato plants, avoid wetting the leaves. Try not to water towards the end of August so that the plants can be stressed enough to ripen the fruit faster. If it is a wet summer, use a plastic cover over the plants to keep them dry, help prevent fungus diseases, and hasten ripening.

- **Harvesting:**
  During the summer, tomato vines should provide a steady supply of fresh fruit for family use. Later, when the crop reaches its peak, you will probably want to preserve much of it for future use. Tomatoes and tomato juice can be frozen, canned, or preserved in recipes in a number of different ways.

  After most of the tomatoes have been gathered, and before the first killing frost, you will find a large number of green tomatoes on the vines. This crop should be gathered and stored. Larger tomatoes may be wrapped individually in newspaper and placed about 3 layers deep in open boxes or crates and keeping them at a cool room temperature until they mature.

Tomato Plant Pests & Diseases:

Tomatoes have a built-in insect repellent called solanine that will repel many insect pests. The tomato hornworm is probably the most serious pest of tomatoes, although Japanese beetles, cutworms and other insects will also bother the plants. Many of these can be controlled by interplanting with flowers or other crops. Nematodes can be discouraged by planting marigolds, or even planting tomatoes where marigolds grew the year before. Virus-free nasturtiums will trap aphids.
The hornworm, a green worm with white stripes, is also attracted to dill, and is easier to spot on those plants than on the tomato. It can be hand-picked and dropped into a can of kerosene. Some easy-to-make sprays such as red pepper or onion and garlic also serve as insect repellents.

Cutworm damage can be prevented by placing a paper collar around the stem, about an inch above and below ground level.

Many diseases plague tomatoes, but only a few are of major importance.

- **Blossom drop:**

  Tomato plants often fail to set a normal crop of fruit because the blossoms drop off just when the flowers have matured. This may occur wherever tomatoes are grown, but the trouble seems to be especially prevalent where soil moisture is low and plants are subjected to hot, drying winds. Such conditions prevent blossoms from setting fruit, as do sudden periods of cool weather or beating rains. Loss of blossoms also results from infection by parasitic bacteria or fungi.

  Since large-fruited varieties of the Ponderosa type are very susceptible, do not grow these where summers are going to be hot and dry. Instead grow resistant varieties in hot climates, especially in the Southwest. Irrigate, if possible, and avoid excessive applications of nitrogen, especially during early growth. To help pollination and fruit-set, shake the flower trusses on a warm, sunny day to help distribute the pollen.

- **Blossom-end rot:**

  This is a common, nonparasitic disorder of tomatoes. A water-soaked spot first appears near the blossom end of the tomato when the fruit is about 1/3 of the way to maturity. The spot enlarges and browns until it covers up to half the surface, and gets dark and leathery, flat, or even concave as it continues to grow. No soft rot of the tomato occurs unless it also has been attacked by bacteria or fungi.

  Blossom-end rot characteristically strikes during a long, dry spell after the plants have grown quickly and well during the earlier part of the season. Sometimes it appears after rainy periods. A deficiency of calcium is the basic cause of the trouble, but that condition is aggravated by excessive water or nitrogen. An excessive amount of total salts also causes blossom-end rot because the effective amount of calcium salts available to the plant is reduced.

Control should begin with a soil test very early in the spring or fall to find out whether there is already a shortage of lime in your soil. To raise the pH value of the soil by one unit, use about 1/2 lb of finely ground limestone for each 10 sq. ft. If soil pH needs to be raised more than one unit because it tests below 6, apply more lime. Add a little at a time and expect effects to last about 3 years. In a dry climate, be especially careful not to make your soil too alkaline.

- **Curly Top:**

  Also called Western Yellow Blight, curly top is destructive to both tomatoes and sugar beets, and can trouble beans, spinach, squash, peppers, and table beets. It is carried by beet leafhoppers from weedy, abandoned lands. Attacks may occur at any stage of the tomato's growth, causing leaflets to roll and turn over to expose their undersurfaces. Foliage becomes stiff and leathery. The petioles of the leaves curl downward. Branches and stems become very erect and the veins get purple in places. The plants are stunted and very few fruits ripen normally. Early tomatoes probably suffer more from curly top than late varieties, but both are affected.

  Control is difficult because the range of the leafhoppers is very wide. Set out transplants after the heaviest leafhopper infestation has passed. Plant more closely than usual. You can also plant in double-hill plantings, with 2 plants set 6 inches apart in hills planted in 42 inch rows. Yield is increased and damage decreased in this type of planting situation.

  If you have only a small area of tomatoes, shading of the entire area with slats or by using a muslin-covered frame will repel a fair number of the insects, as well as arrest the effect of the disease if it has already started.

- **Damping-off:**

  This wilt is caused by a fungus that attacks the stems at the ground level. The plants soon fall over and die. The disease can be combated by sterilizing planting soil and controlling excess moisture. Avoid overfeeding your seedlings and place them close to a lighted window or overhead fluorescent light.

- **Early blight** (Alternaria tomatophila) :

  Symptoms of early blight may appear first on the stems as dark, slightly sunken areas with concentric markings. Small, irregular, brown dead spots appear early in the season on the older leaves and enlarge until they are 1/4 to 1/2 inch in diameter. The spots are usually surrounded by yellow, and if there are many spots on the leaf, the entire leaf might be discolored.

  Most early blight injury occurs just as fruit begins to mature. High temperatures and humidity will cause much of the foliage to die and the fruit to be exposed to sunscald. This disease is easily spread. To avoid problems with early blight, sterilize soil for starting seedlings, use commercially grown seed or clean seed from your own plants, and do not crowd plants in a flat. If seedlings show signs of this disease, do not plant them in the garden.

- **Growth Cracks:**

  Cracks radiating from the stem or extending more or less concentrically around the shoulders of the fruit may seem normal, but in reality they invite infection and detract from the appearance of the fruits. Cracking often appears during rainy spells that are hot and conducive to rapid growth. Another kind of cracking comes when there is a dry period followed by a rainy period during the ripening season.

  To control this condition, refrain from applying water at crucial periods of the plant;s growth. Sometimes the cracks heal before harm is done.

- **Late Blight** (Phytophthora infestans):

  A fairly common disease in certain parts of the East and on the Pacific coast, late blight occurs sporadically elsewhere. The older leaves of infected plants develop irregular, black, water-soaked patched. Eventually, leaves drop and the disease destroys the fruit. Sometimes there is a white, downy growth of the fungus on the lower surfaces of the leaves, and if the weather is warm and moist, the plant will look as if it had been enveloped by frost. Damage to the fruit is likely to occur on the upper half. The first sign is a green-gray spot which becomes brown and hard. Infected plants must be dug up and destroyed or the blight will spread to other plants.

- **Leaf Roll:**

  During very wet seasons, tomato plants frequently show an upward rolling of the leaflets of the older leaves. At first this rolling gives the leaflet a cupped appearance. Later, the margins of the leaflets touch or overlap. The rolled leaves are firm and leathery to the touch. One half to three-fourths of the foliage may be affected. Plant growth is not noticeably checked, and a normal crop of fruit is produced. Frequently leaf roll occurs when tomato plants are pruned severely, and it is very common when unusually heavy rains cause the soil to remain moist for long periods of time.

  To prevent leaf roll, keep tomato plants on well-drained, well-aerated soil, and protect them from prolonged periods of heavy rainfall if you can.

- **Root Knot** (Root knot nematode - Meloidogyne)**:**

Nearly invisible nematodes which attack the roots of various plants are found wherever tomatoes are grown - especially in areas where crop rotation is not practiced. The attack results in the formation of root knots or galls that range in diameter from a pin-head to a full inch or more. Soon the whole outer area of the root is discolored, and may rot.

The results are not apparent above ground except that plant growth and yield are retarded. Infected plants wilt very easily on a hot day, and they may be stunted in appearance and somewhat yellowish. Some tomato plants are almost killed.

The best control for nematodes is the planting of marigolds along with tomatoes, or, even better, put tomatoes in parts of the garden where marigolds grew during previous years. The root exudate from marigolds has a powerful inhibiting effect on nematodes, and remains effective in the soil for 3 years. Interplanting of marigolds and tomatoes is effective the same year.

To control root knot, examine the roots of tomato plants, and discard any with root knots or rotten roots. Never use soil known to have had a nematode infestation the previous season. Plant marigolds instead. Burn infected plants.

- **Septoria Leaf Spot** (Septoria lycopersici)**:**

Not common in the South or on the Pacific coast, septoria leaf spot occurs in the mid-Atlantic and central states, and as far south as Arkansas and Tennessee, flourishing when temperatures are moderate and rainfall abundant. The disease destroys so much foliage that plants fail to make enough food to support an abundant crop of fruit. Absence of leaves exposes the fruit to sunscald. Fungus is most evident on plants that are just beginning to set fruit.

The first symptom of septoria leaf spot is the appearance of water-soaked spots on the older leaves. Spots are rough and circular, with gray centers and dark margins. Later, dark dots are evident in the centers where spores are produced. Eventually all the leaves are affected and drop off, leaving only a few at the stem top. Fruits are rarely attacked.

To control septoria leaf spot in tomatoes, plow under all crop and weed refuse; the fungus will not over-winter on plant remains that are buried deep in the soil.

- **Soil Rot** (Rhizoctonia solani)**:**

This disease can attack your tomato plants no matter where you have your garden. It is caused by the same organism that causes damping-off. The first symptom is a brown, slightly sunken spot on the fruit, with sharply outlined (not smooth) concentric markings close together. It enlarges and often breaks open.

Soil rot can invade either through wounds in the tomato or through uninjured skin. It usually occurs during wet periods and on moist soils where plants cover the ground; or when the fruit has been splashed by rain. Avoid poorly drained soil, use a good mulch, and use varieties of tomatoes suitable for staking.

- **Sunscald:**

During hot, dry weather, green tomatoes may develop sunscald. It is especially common on plants that have lost their foliage from other diseases. Symptoms, especially on young fruits, include a yellow or white patch on the side of the fruit toward the sun, which may remain yellow or turn blistery and later flatten to a large, gray-white spot with a very thin, paperlike surface. It is very likely that this spot will later become the site of a fungus infection.

To control sun scald in tomatoes, protect plants from defoliation and from wilt diseases and leaf spot. If excessive loss of protective foliage occurs, put a light covering of straw over the fruit clusters.

- **Tobacco Mosaic Virus:**

Also called tomato virus, it is found everywhere and infects many members of the Nightshade family. The green strain causes light and dark green mottling of the foliage, curling, and slight malformation of the leaflets. If seedlings or young plants are infected, mature plants may be stunted; but later attacks do not reduce the size of the plant,

especially if they do not occur until the fruiting stage. Yellow strains cause yellow mottling of the leaves and sometimes of stems and fruit, as well as curling, distortion and dwarfing of the foliage. Control is advisable, expecially since an infected plant is susceptible to attack by a second virus.

The tobacco mosaic virus is usually transmitted by first handling an infected plant and then a healthy one, or even by brushing against first one and then the other. Careful handling is important. Wash your hands in soap and water or milk if you are handling more than one plant. Greenhouse tomato plants are most susceptible to the virus, since they are so frequently handled. A few insects, such as the potato aphid, also transmit the virus from plant to plant. The virus will live for several years in dried stems and leaves, in greenhouses as well as in the soil, especially when one tomato crop is planted right after another in a warm climate. Garden soil does not seem to be the source of much infection, but seedlings intended for garden planting are often infected if grown in or near a greenhouse where the disease is present. The carry-over may be due to aphids. Eliminate jimsonweed, nightshade, bittersweet, matrimony vine, ground cherry, and horse nettle growing near your tomato patch. Mosaic virus is present to some extent in practically all cigar, cigarette and pipe tobaccos, so smokers are very likely to carry the virus on their hands.

To control or at least reduce losses from tobacco mosaic virus, remove all infected plants among the seedlings and spray with milk any tomato seedlings suspected of contracting the disease. For full protection, repeat at least once. Burn infected plants or place in a good, hot compost heap. Sterilize soil in which seedlings are grown, especially when a new crop is put in where an old crop has recently been dug up.

- **Verticillium Wilt:**

Verticillium wilt is a problem in the West, some of the north-central states, and in the Northeast. Unless the soil is pasteurized regularly, it can also invade greenhouses.

Infected plants show a slight wilting at the shoot tips during the day and yellowing of the older leaves. Eventually, the crown of the plant loses all its leaves, the higher stem leaves look dull and the leaflets curl. Finally, only the leaves

near the tips of the branches are alive. If the plant fruits, the tomatoes are very small and unattractive. When the leaves have been infected, they show yellow areas at their margins in a "V" design. Eventually, this tissue dies and the leaves drop off, but the fungus may have already invaded the vascular system and traveling through the whole plant. As with fusarium wilt, the best control is to locate seedbeds on soil that is free from the fungus. Use clean, pasteurized soil in flats, hotbeds, cold frames, and peat pots.

Vegetables

Growing Asparagus in Home Gardens

Asparagus (*Asparagus officinalis*) is a member of the lily family. It has been grown for more than 2,000 years and is quite popular in the home garden today. Asparagus is an excellent source of vitamin A and contains significant levels of calcium, phosphorus, riboflavin, thiamine and Vitamin C.

Plant Characteristics:

Asparagus is a perennial and will produce for many years when properly planted and maintained. It has underground storage roots and compact stems called rhizomes. The roots store food and the rhizomes produce edible shoots or asparagus spears. If the spears are not harvested, they rapidly develop into fern-like bushes 4 or more feet tall. The foliage produces carbohydrates, which is again stored in the roots.

Asparagus has both male and female plants. Both sexes flower and the female plants produce small, round, red berries in the fall. Female plants do not live as long or produce as well as male plants.

Climatic Requirements:

Asparagus is a cool-season vegetable and prefers cool temperatures without frosts throughout the growing season. It is better adapted to the Cumberland Plateau and the high elevations of East Tennessee than to West Tennessee, but will survive and produce significant yields throughout the state given a suitable location.

Location:

It is best to locate asparagus plantings to the side of the vegetable garden with other perennials such as rhubarb, strawberries and brambles. This will keep the plants away from cultivation and other gardening activities. Asparagus should be planted where it will receive a minimum of seven or eight hours of sunlight on sunny days.

North or east slopes are preferable to south or west slopes, as they are slower to warm in the spring. Early-developing asparagus spears are frequently killed by late freezes.

Soil:

Asparagus will survive in any well-drained soil. The best soils for asparagus are deep and loose, such as sandy loams. Heavy-textured clays and shallow soils should be avoided, since they restrict root development and promote root rots. Extremely sandy soils may not retain enough moisture for vigorous asparagus growth. Soils that warm up quickly in the spring promote early growth and harvest. This may be a disadvantage, as developing asparagus spears grow slowly in very cold weather and will be killed to the ground by freezes. Asparagus grows best on soils with a pH of 6.0 to 6.5.

Varieties:

'Martha Washington' is an old, standard asparagus variety. 'Mary Washington' appears to be a newer, improved cultivar. 'Purple Passion' is a relatively new variety with very large spears and a high sugar content.

In the last few years there have been many new hybrid asparagus varieties released. These varieties usually produce all or nearly all male plants. This increases their yield, because male plants produce about 25 percent more than female plants and because of hybrid vigor. These new hybrid varieties have not been fully tested in Tennessee, but they incorporate considerable disease resistance, are widely adapted and appear to be suitable for Tennessee gardens. They frequently produce two to four times more than 'Martha Washington' when grown in other states. These varieties include 'Jersey Gem', 'Jersey Giant', 'Jersey Knight' and 'UC 157.'

Fertilizer and Lime:

Asparagus grows best on soils with a pH of 6.0-6.5. Take a soil sample to determine lime, phosphate and potash levels before planting. Broadcast lime before planting, and 6-12-12 fertilizer or its equivalent before planting and immediately after harvest each year according to the following table:

Lime		**6-12-12 Fertilizer**	
pH	**Pounds per 100 square feet**	**Soil test level of P_2O_5 & K_2O**	**Pounds per 100 square feet**
6.6 and above	0	L-L	4.0
6.1-6.5	9	M-M	3.0
5.6-6.0	14	H-H	2.0
		VH-VH	1.0

In addition, before spears emerge in the spring and after harvest, annually supplement the above fertilizer recommendations with one pound of ammonium nitrate or its equivalent per 100 square feet of asparagus bed.

Planting and Spacing:

Plant asparagus early in the spring while it is still dormant, usually in February or early March.

Asparagus plants can be started from seed, but this is not recommended for home gardeners. Germination of asparagus seed is slow and weeds can be difficult to control. Plants grown from seed are transplanted to a permanent bed the following spring; so asparagus grown from seed also requires a longer time to begin bearing.

It is preferable to purchase 1-year old dormant crowns. This will cut the time before harvest by at least one year and eliminate caring for the tiny seedlings the first year.

Dig a trench 6 to 8 inches deep and place the crowns in the bottom. Space the plants 15 to 18 inches apart and leave 3 to 4 feet between rows. Spread the roots evenly and cover them with 2 to 4 inches of soil. Fill the remainder of the trench after the plants begin growth.

Do not try and fill in skips in an old planting with young plants, as the remaining old plants will inhibit the growth of smaller, younger plants. If seedlings appear in an old planting, they are best pulled out or transplanted to another area.

Irrigation:

During the first growing season, apply sufficient water to wet the soil 1 foot deep once a week. If it doesn't rain, this may require as much as 1 inch of water. After the first growing season, watering every other week is usually sufficient. A 2-inch layer of an organic mulch such as shredded leaves or pine needles will be of considerable help in retaining moisture, as well as in reducing weed growth. Mulch will also reduce fluctuations in soil temperature during the winter which, in turn, will reduce the incidence of crown rot.

Trickle or drip irrigation is preferable to sprinkler irrigation, as it reduces the possibility of foliage diseases. These systems may need to be run for two or more hours to wet the soil to the required depth of 1 foot.

Weed Control:

Weeds must be controlled if asparagus is to perform well. They can be pulled or removed with a hoe, cultivator or rototiller, but cultivation must be shallow to avoid damage to the asparagus roots.

Organic mulches such as grass clippings, straw or leaves help control weeds, as well as retaining moisture. Apply a 2- or 3-inch layer in the fall after the foliage dies. This will reduce weeds throughout the year. The asparagus spears will emerge through the mulch in the spring.

Do not use table salt or other salts to control weeds in asparagus. They build up in the soil and reduce yields, as well as shortening the lifespan of the asparagus planting.

Disease Control:

Asparagus is subject to asparagus rust and fusarium root or crown rot.

Rust appears as small, reddish-yellow spots on the stems near the ground. Spores may be scattered by the wind and, if sufficient moisture is present, all the plants may be infected. Rust is most effectively controlled by planting resistant varieties, such as those listed in this factsheet.

Fusarium rot attacks feeder rootlets, main storage roots and plant crowns. It weakens and eventually kills plants. It rarely produces wilt symptoms, except on young shoots of seedlings. The fungus builds up in the soil and persists for many years. Asparagus spears infected with fusarium may show a brown surface discoloration. The varieties in this publication have some tolerance to fusarium. In addition, gardeners should always plant asparagus in well-drained soil, avoid replanting in old asparagus beds and keep crowns cool during the winter by using organic mulches.

Insect Control:

Asparagus beetles are the main insect attacking asparagus. They are 1/4 inch long, blackish beetles with yellow-to-orange markings on their wings. They overwinter as adults in trash around the garden and in old asparagus stalks. The adults feed on young spears and attach tiny, black eggs to both spears and foliage. Larva hatch from the eggs and feed on the plant. In severe infestations, most of the foliage may be damaged.

Begin control of asparagus beetles by removing old foliage as soon as it is killed by freezing weather. Burn this residue or turn it under. Asparagus beetles are easily killed by available home garden chemicals.

Harvesting:

Asparagus should **not** be harvested the year it is planted. A light harvest of about two weeks the second year will increase the number of buds on the crowns and result in subsequent higher yields. Harvest for about four weeks the third year and six to eight weeks thereafter.

Harvest by snapping the spears off at the ground level when they are 6 to 10 inches tall. This will result in less damage to unemerged spears and less chance of introducing disease into the plant than the traditional harvesting method of cutting the spears below the ground level. It is desirable to harvest at least every other day during cool weather and every day during warm weather to prevent speers from growing too tall. Too many spindly spears indicate weak storage roots. Cease harvest for the season if too many spindly spears appear. Additional fertilizer may be needed and the harvest season may need to be shortened in future years.

How To Grow Garlic

Once you taste home-grown garlic, you won't be satisfied with supermarket varieties

Garlic isn’t hard to grow. In fact, growing garlic plants is almost ridiculously easy. It has a few important requirements that are easily met: decent soil, adequate moisture, and, of course, planting and harvesting at the right time.

When is the right time for planting garlic? Plant garlic four to six weeks before the ground freezes in your area. You can fudge the planting time a little. I have planted as early as September (by mistake) and as late as Thanksgiving (to experiment) and have had decent crops. Roots will start to grow soon after you plant. Your aim is to get good root development before the plants go dormant. Green shoots may appear in the fall, which is fine.

6 easy steps for a bumper crop of garlic

1. Prepare the soil

To grow nice, big heads of garlic, you need loose, fertile soil. Loosen the soil with a digging fork, spread a 2- to 3-inch-deep layer of organic matter over the area, and dig it in. For organic matter, I use a well-aged mixture of compost, leaf mold, and aged rabbit manure. To avoid disease problems, don’t plant garlic in the same spot two years running.

Prepare several shallow furrows in the soil that are 6 inches apart.

2. Choose your varieties

There are two main types of garlic: hardneck and softneck. Hardnecks have cloves growing around a hard central stalk. This stalk forms a curling scape (or flower stem) on top, which many growers cut off to redirect energy to the bulb. Softneck garlics form more cloves, with big ones around the outside of the head and numerous small ones at the center. Softnecks also tend to keep longer once harvested than hardnecks. Break apart a large head of garlic, and plant only the biggest cloves. The bigger the clove, the greater the likelihood it will yield a nice, big head of garlic. Save the smaller cloves to use in the kitchen.

Hardneck garlic

Softneck garlic

3. Plant a clove, get a head

To plant, place the cloves 4 inches apart in a furrow. Hold each clove pointed end up, and push it into the soil about 2 inches deep. After all the cloves are in the ground, smooth the soil surface using your fingers or a rake to fill in the holes, and water well. If you're planting more than one variety, be sure to label each one clearly. I also make a map of my planting, in case the labels go astray. I wait to mulch for a month or more after planting to give the soil a chance to cool down. When it's leaf-raking season, I put several inches of chopped leaves over the bed.

4. Fertilize and water

Top growth starts in earnest in spring, when the weather warms and the days lengthen. I fertilize twice with a solution of liquid kelp and fish emulsion: once, when the garlic has started growing strongly—about mid-April in my area—and, again, a month later. Garlic isn't greedy for water, but it doesn't like to dry out, either. When the soil feels dry an inch below the surface, it's time to water. In mid- to late June, I stop watering. By that time, the garlic has sized up and the heads are starting to form cloves.

5. Time the harvest carefully

Harvest in late spring or early summer when the plants have five or six green leaves, with no more than one or two beginning to turn brown. Each green leaf represents a wrapper layer surrounding the head. During harvest, you're liable to damage the outer layer. Later, while cleaning the heads, you're apt to lose another one or two layers. Your goal is to end up with two or three tight, papery layers enclosing each bulb. To harvest, drive a garden fork beneath the plants (be careful not to damage the bulbs), gently pry them loose, and then pull them out. Shake off any excess soil, and lay the plants in a pile. As soon as you've finished harvesting, move the plants to an airy location that is protected from sun and rain. If you're growing more than one variety, keep each variety separate and well labeled so that you know what's what.

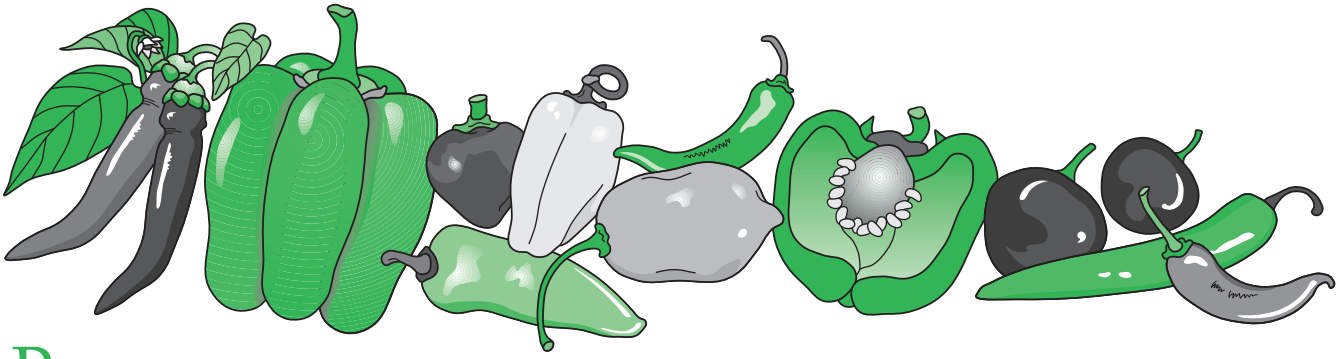
6. Cure, clean, and store the heads

To cure garlic in preparation for storage, hang the bare bulbs with their foliage in bundles or spread them out on a table or rack. You can begin eating them right away, but bulbs intended for storage must be cured.

After a few weeks of curing, it’s bulb-cleaning time. Trim the stalks to 12 inch above the bulb, and trim the roots close to the bulb. Rub off the outer layer of skin around the bulb, and use a nailbrush or toothbrush to gently remove any soil clinging to the base. Try not to remove more wrapper layers than you have to. Store the bulbs in a well-ventilated, dark spot. If you want, set aside the biggest bulbs for planting in the fall.

Pests. Occasionally onion thrips may attack garlic, but they don't constitute a real problem; hose them off the plants if they do appear. Garlic is a good crop for the organic gardener. Detailed information on pest control is given later in this book.

Disease. Mildew may occur in a warm, moist environment, but it's not common enough to be a problem. Keep the garlic fairly dry.



Peppers

Peppers were domesticated in Mexico. As early as 6,000 years ago, red peppers were used in tropical South America as a spice to disguise the taste of bland or unpalatable food. Chili peppers are called **chile** in Mexico and Central America and **aji** in South America and the West Indies. Columbus took peppers back to Europe where they rapidly became popular.

Pepper cultivars, which number in the hundreds, are usually classified as sweet or hot. Peppers also vary by fruit shape, flavor, pungency, color, and culinary use. Pickling, grinding, roasting, drying, and freezing can influence flavor.

All bell peppers belong to the species *Capsicum annuum*. Hot peppers may belong to several other species. The *C. chinense* varieties Habanero and Scotch Bonnet are considered the hottest.

Cultivars

Bell peppers are large, blocky, 3- or 4-lobed fruit that taper slightly at the bottom. Most bell peppers are sweet and dark green. Depending on the cultivar, the fruit will turn red, yellow, orange, or some other color at maturity.

Sweet peppers	Season	Color at maturity	Other
Bell Boy F1	70–72 days	green to red	Thick-walled fruit. TMV resistant
Bell Captain F2	72 days	green to red	Do well in stressed conditions. TMV tolerant
Big Bertha F1	72 days	green to red	Widely adapted proven performer. TMV tolerant
California Wonder	75 days	green to red	Good for stuffing
Jupiter	74 days	green to red	Consistently large size. TMV resistant
Keystone Resistant Giant	80 days	dark green to red	TMV resistant
Lady Bell F1	71 days	green to red	TMV resistant
North Star F1	63 days	green to red	Sets fruit under adverse conditions. TMV resistant
Yolo Wonder	75 days	green to red	Average size, thick-walled fruit

Pepper type	Size	Shape	Wall	Use
Bell or Sweet	large	blocky, few elongated	thick	fresh, cooked
Pimiento	large	heart-shaped	thick	processing
Ancho	large	long, blocky	thin	fresh
Anaheim	large	long, thin tapering	thin	fresh
Cayenne	medium	very thin, tapering	thin	fresh, dried, processed
Cubanelle	large	irregular, blunt	thin	processed, fresh
Jalapeno	small	oblong, blunt	thick	processed, fresh
Ornamental	small	slim	thin	processed, fresh
Cherry	small	round, flattened	thick	processed
Wax or Hungarian Wax	medium	oblong	thick	fresh

TMV = Tobacco Mosaic Virus

How hot is hot?

The pungency or heat of a pepper depends on seven closely related alkaloids or capsaicinoids. In the early 1900s, Wilbur L. Scoville devised a test to determine the relative hotness of different peppers. Capsaicin from a known weight of pepper was extracted with alcohol and mixed in various concentrations with sweetened water. Human tasters were asked to identify the point at which water neutralized the hotness. The volume of water required for each sample was assigned a rating in Scoville units—the larger the number, the more water needed and the hotter the pepper. A high-pressure liquid chromatography test replaced this technique in the early 1980s, but the measurements are still expressed in Scoville units. The following peppers are listed from most hot to least hot, according to Scoville units.

Find it on the thermometer!

Habanero
- Caribbean Red _____ 100,000–445,000
- Red _____ 80,000–285,000
- Scotch Bonnet _____ 80,000–260,000

Jamaican Hot _____ 100,000–200,000

Chiltepini _____ 50,000–100,000
Santaka
Thai

Cayenne _____ 50,000–70,000
Charleston Hot

Piquin _____ 30,000–50,000
Aji
Cayenne
Tabasco

Thai Dragon _____ 35,000–45,000

De Arbol _____ 15,000–30,000

Serrano _____ 5,000–23,000

Yellow Wax _____ 5,000–15,000

Jalapeño _____ 2,500–5,000
Mirasol

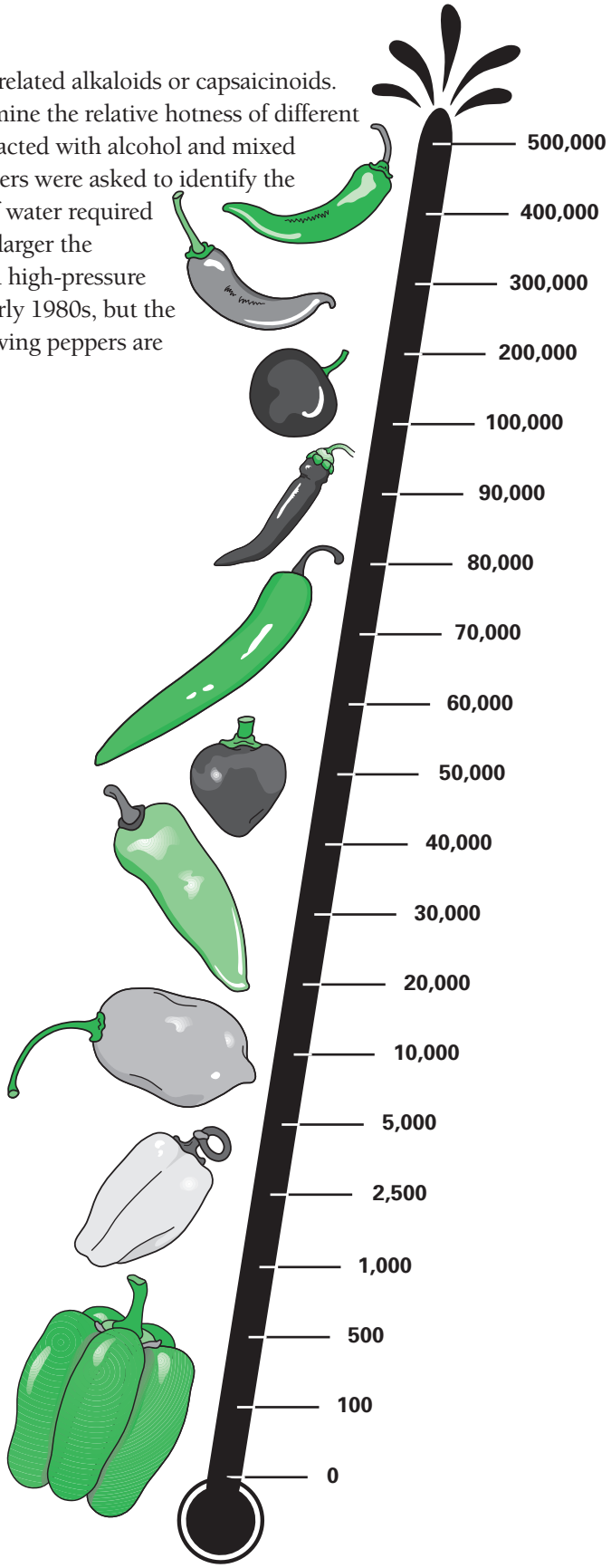
Cascabel _____ 1,500–2,500
Rocotillo
Sandia

Ancho _____ 1,000–1,500
Chilaca
Espanola
Pasilla
Poblano

Anaheim _____ 500-1,000
Big Jim
New Mexico

Cherry _____ 100–500
Mexi-Bell
Peperoncini

Bell _____ 0
False Alarm
Pimento
Sweet Banana
Sweet Italian



Planting

Pepper plants grow best in warm, well-drained soils of moderate fertility. The plants are not particularly sensitive to soil pH, but best results are obtained in the 6.0 to 6.8 range.

Peppers are a warm-season crop and need a long season for maximum production. Temperature has a large effect on the rate of plant and fruit growth and the development and quality of the red or yellow pigments. Ideal temperature for red pigment development is 65–75° F. Above this range the red color becomes yellowish. Below it, color development slows dramatically and stops completely below 55° F.

Pepper plants can be purchased at garden centers or started indoors 6 to 8 weeks before the intended outdoor planting date. Transplant peppers into the garden after the danger of frost is past. In central Iowa, May 15 is the suggested planting date. Gardeners in southern Iowa can plant one week earlier, while those in northern areas should wait an extra week. The last practical date for planting peppers is approximately June 20.

Water plants thoroughly after transplanting.

Spacing

Space plants 18 inches apart in rows 24 to 30 inches apart.

Estimated yield

Average yield with good management practices should be approximately 80 pounds per 10-foot row.

Fertilizing

It is generally safe to apply 2 to 3 pounds of 5-10-5 per 100 square feet to the garden area where peppers will be planted. Conduct a soil test for specific P and K recommendations.

After transplanting, feed the pepper plants with a starter fertilizer solution. Dissolve 2 tablespoons of a 5-10-5 fertilizer in a gallon of water, then pour 1 cup of the solution at the base of each plant.

Potential problems

Blossom end rot

Water-soaked areas that develop near the blossom end of the fruit characterize blossom end rot. The affected tissue desiccates, becoming brown and leathery. Affected fruit may ripen prematurely. Secondary fungi and bacteria may colonize the dead tissue, causing it to turn dark and rot. Blossom end rot is caused by a calcium deficiency in developing fruit. It occurs in fields with low or moderate soil calcium levels. Fluctuating soil moisture due to over watering or drought, high nitrogen fertilization, and root pruning during cultivation also can cause blossom end rot.

Poor crop

Blossoms of sweet bell peppers are sensitive to temperature extremes. Flowers will drop off when night temperatures are below 60° F or above 85° F. Maximum set of sweet bell peppers occurs between constant temperatures of 60–70° F. Temperature tolerance for sweet bell peppers varies with cultivar. Hot peppers usually set well in warm weather. An adequate moisture supply during flowering and fruit set also is important. Mulching helps conserve soil moisture.

Sunscald

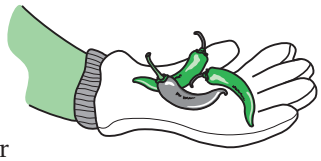
The heat of the sun may burn the side of the fruit exposed to the sun. Initially, a soft, light-colored area develops on the fruit. Later the area dries, becoming white and paper-like in appearance. The risk for sunscald can be reduced by controlling leaf diseases that may defoliate the plants, and by lightly fertilizing plants to promote growth.

Harvest and storage

Hot peppers and bell peppers can be harvested in the immature green stage or when fully ripe. They can be eaten fresh, used in sauces, pickled, frozen, or dried.

Bell peppers are usually harvested when large and firm in the immature green stage. They also may be allowed to fully ripen to red, yellow, orange, purple, or other colors. Fully ripe bell peppers are slightly sweeter and have a higher vitamin content than do the immature green peppers.

Fresh peppers may be stored for up to 3 weeks in cool, moist conditions (45 to 50° F. and 85 to 90 percent relative humidity).



Wearing gloves and working in a well ventilated room is recommended when working with hot peppers because their volatile oils can cause burns or irritate sensitive skin. Avoid touching your eyes and other sensitive areas after handling hot peppers.

How To Grow Potatoes

Production Requirements

The potato is a cool season crop and in U.S.A it is grown through the spring months and harvested in early summer. Fall potato production usually results in poor plant stands and low production, due to high soil temperatures at planting and during early crop development. Potatoes grow best in fertile, well-drained, sandy loam soils. Planting on poorly drained soils usually results in a poor plant stand, due to seed piece decay and poor quality potatoes at harvest. Soils which blow or have poor water holding capacity should be avoided. A good potato yield in U.S.A. is 200 to 250 cwt/acre. High temperatures or insufficient moisture in the late spring and early summer, while the potato tubers are forming reduces yield. Under good management and weather conditions, yields of 300 cwt/acre are possible.

Varieties

Select the potato variety best suited to your conditions and market. Buyers contracting potato production for chipping will designate the variety to be grown.

Red Skinned

Red LaSoda - Round to oblong, medium early, eyes medium deep, high yield, fresh market.

Viking - Round, medium maturity, relatively shallow eyes, fresh market.

White Skinned

Kennebec - Oblong, late, eyes shallow, high specific gravity, good chipper, general purpose use.

Superior - Round, early, eyes moderately deep, fresh market, and early chip processing.

Russet Skinned

Norgold Russet - Oblong to long, early, shallow eyes, early fresh market russet.

Soil pH and Fertilizer

Potatoes grow well on a wide variety of soils and soil pH can be as low as 5.0 with satisfactory production. Potatoes are less susceptible to scab when soil pH is between 5.0 and 5.5. If pH is too low apply dolomitic limestone. Based on OSU soil test results the following quantities of P_2O_5 and K_2O are recommended.

Phosphorus per acre

When test shows	0-19	20-39	40-69	70-99	100 +
Add lbs/A P_2O_5	150	100	75	50	0

Potassium per acre

When test shows	0-99	100-199	200-249	250-299	300 +
Add lbs/A K_2O	300	200	100	50	0

Nitrogen

Apply 75 lbs/A N along with recommended P_2O_5 and K_2O by either broadcast preplant incorporated or one half broadcast and one half with the planter in bands placed 3 to 4 inches to each side and 1 to 2 inches below the seed piece. Top dress or irrigate on additional N when tubers begin to form. Two or three N top dress applications of 30 to 40 lbs/acre each may be needed. Too much N can be detrimental and decrease tuber quality, grade, and yield. Soils having a high amount of nitrate-N from previous fertilization, green mature crops, or from livestock manure will require less N fertilizer. Potassium sulfate is preferred to potassium chloride as the potassium source, since skin color and specific gravity may be adversely affected by potassium chloride.

Soil Preparation

Good water penetration and aeration are musts for proper growth and tuber formation. Excessive tillage and land preparation causes compaction and should be avoided. To be effective the soil should be plowed below any compacted layer within the normal root zone and then disk harrowed before planting. Spike-tooth harrowing to break clods and level the soil may be needed just prior to planting.

Seed and Planting

Use only certified seed tubers. Potato production costs are too great to risk using noncertified seed. Certified seed of good quality grown in the northern states normally produces the largest yields, the highest quality tubers, and the fewest disease problems. Pieces of large seed tubers are used for

Disease Resistance of Recommended Potato Varieties[a]

Skin Color/ Variety	Fungal Diseases				Bacterial Disease
	Fusarium Seed Piece Decay	Early Blight	Verticillium wilt	Common Scab	Blackleg
Red Skinned					
Red LaSoda	MR[b]	MR (foliage) MR (tuber)	MS	MS	MS
Viking	_[c]	S (foliage)	__	MR	__
White Skinned	*[d]				
Kennebec		MS (foliage) MS (tuber)	S	S	MS
Superior	*	S	S	R	__
Russet Skinned					
Norgold Russet	S	S (foliage) R (tuber)	S	R	S

[a] This variety disease resistance information was gathered from several sources across the United States and is meant to serve only as a general guideline; the resistance or susceptibility of a particular variety to a given pathogen may vary under U.S. conditions.
[b] S = susceptible, MS = moderately susceptible, MR = moderately resistant, R = resistant.
[c] _ indicates no information available.
[d] indicates resistance to one or more strains of the fungus.

planting. Small whole tubers can be used with equal results. Seed pieces should be $1^1/_2$ to 2 ounces in size. Using smaller seed pieces usually results in lower yields. Cut seed pieces can be suberized (healed over) before planting, but planting fresh cut seed is a normal practice since growers usually lack the time and space to store large quantities of cut seed before planting. Treatment of seed pieces with fungicides may not always be necessary as OSU researchers have shown that such applications are likely to increase yield only when the cut seed pieces must be stored three or more days prior to planting. Seed required to plant an acre depends upon seed piece size and seed spacing. Distance between rows is commonly 36 inches.

Spacing of seed pieces within 36" rows	Seed needed per acre when seed pieces weigh an average of —		
	$1^1/_2$ OZ	$1^3/_4$ OZ	2 oz
		(cwt/acre)	
8 inches	20.4	23.8	27.2
10 inches	16 3	19.0	21.8
12 inches	13.5	15.8	18.1

Planting should begin in early March to promote early crop development and avoid extreme summer temperatures. There are several types of planters available that place the seed pieces in the soil and apply fertilizer and systemic insecticides in one operation. Seed depth should be about 4 inches below the top of the planted bed. Soil is ridged over the row by throwing soil to the plants during early cultivation, so that about 6 inches of soil cover the seed piece when tuber formation occurs. Depth for hilling differs between varieties.

Cultivation

Potatoes develop larger and more extensive root systems in response to proper cultivation. Loose, friable soil improves tuber set and development of smooth, well-shaped and even-colored potatoes. Cultivation may be necessary to control weeds, keep soil hilled-up, and aid water penetration and soil aeration. Cultivate only when needed. Deep cultivation should be avoided since many roots are destroyed. Extra cultivations are expensive, increase soil compaction, and reduce yield. By the time plants reach full bloom cultivation should cease.

Weed Control

Weeds should be controlled in potato fields, since they cause many problems besides being hosts for insects and diseases. An effective weed control program takes into account the weed problem, cultivation, and herbicides. Fields containing perennial weeds should be avoided. When herbicides are used, the choice of which one or ones to use should be tailored to the specific weed problems and when these weeds germinate. Methods of application vary from preplant incorporation, post-plant and preemergence, to post-emergence applications. Various herbicides can be applied by ground rig, airplane, or through the sprinkler irrigation system.

Irrigation

Soil moisture is probably the most important factor determining potato yield and quality. About 20 inches of water are needed to produce a potato crop in central U.S. When irrigation is practiced to supplement rainfall it should be applied in frequent light amounts. Secondary growth and growth cracks occur when irrigation or rainfall occurs after moisture stress. The soil should be kept uniformly moist until tubers have reached full size. For irrigation management decisions: 1) the effective rooting depth of potatoes is two feet, 2) the soil should not be allowed to dry below 65% of field capacity, and 3) moisture levels above field capacity will seriously

affect yield and quality. On extremely sandy soils it is nearly impossible to prevent the soil from drying below 65% of field capacity due to the low water holding capacity.

Insects

Potatoes should never be planted in fields that have been in sod or grass the previous year. By avoiding this situation, one greatly decreases the chance of having wireworm and grubworm problems. If potatoes are planted in soil that was in sod the year before, a soil insecticide should be used to prevent damage to the tubers from these insects.

Once emerged, potatoes are susceptible to cutworms, flea beetles, and leaflhoppers. Flea beetles and leaflhoppers generally are not major problems in the U.S. Cutworms are sporadic problems and can be severe in certain years. Treatment for cutworms is usually performed at planting or just after emergence.

Colorado potato beetles are the major insect problems. The adults overwinter in the soil and emerge about the same time that the potatoes are emerging. They usually appear in mid-April and feed on the young foliage. Eggs are deposited on the lower third of the plant on the underside of the leaves. The larvae appear in mid-May and can cause extensive defoliation. Larvae are more easily controlled when they are small. They also do the least damage when they are small, so controls should be timed to kill the majority of the small larvae present.

Colorado potato beetles can be controlled with systemic soil insecticides or with foliar sprays. Crop rotation also aids in reducing their numbers. Potato fields planted after non-host crops (peanuts, wheat, sorghum, etc.) have fewer beetle problems than fields planted to potatoes the previous year(s). Defoliation by Colorado potato beetles affects potato yields most when the tubers are sizing. Early and late defoliation usually does not decrease yields enough to warrant treatments. Late defoliation, after tuber sizing, can be beneficial from the standpoint of defoliation. The beetles can actually help in the defoliation process and assist in killing the vines.

Other potato insects include aphids, which transmit viruses and can also stress the plants by sucking plant juices. Blister beetles can cause defoliation when they feed as they move en masse across the field; however, they are seldom plentiful enough to warrant treatment.

Diseases

A very common fungal disease of the foliage is early blight (*Alternaria*). Fusarium and Verticillium wilts are also caused by fungi. Blackleg, a bacterial disease, is characterized by a blackening of stems and a yellowing and curling of leaves. Tubers of the potato are also subject to attack by a variety of pathogens. Various *Fusarium* species and the blackleg bacterium cause tuber rots. *Rhizoctonie solani* forms black sclerotia on the surface of tubers, which gave rise to the name black scurf for this particular disease. Another fungal disease of the tuber surface is common scab (*Streptomyces*).

Root-knot nematodes form irregular bumps on the tubers. The potato plant is also susceptible to a variety of virus diseases such as potato leaf roll, rugose mosaic, and purple top. A three to four year rotation helps avoid certain disease problems. Non-parasitic diseases in the U.S. potatoes are represented by sunscald, sunburn, and tipburn.

Harvesting, Handling, and Marketing

Digging potatoes begins in late June and continues to the end of July. For best quality table stock potatoes, the tubers should be fully matured before digging. Vines may need to be killed by vine beaters or chemicals to promote good skin set. However, since potatoes are edible at any time, the question of when to dig must be decided by the grower. Considerations include price, demand, market conditions, and expected yields. Early potatoes are sometimes dug before optimum maturity to take advantage of certain limited market demands and high prices. Processors may require that a test for reducing sugars be made to determine if tubers are in the acceptable range for chipping into light colored chips.

Potato harvesting is almost fully mechanized. The harvester digs and loads the potatoes on trucks for transport to a shed where tubers are washed, graded, and sized for bulk marketing or packed in bags or boxes. Due to high temperature conditions during harvest, speed is very important in handling the potato crop from digging to loading for shipment. Tubers bruise easily during harvest at temperature above 85°F and below 50° F. Soil condition, tuber condition, and harvester operation are important factors that influence bruising. Besides bruising, other common market defects are rots, cracks, skinning, enlarged lenticels, heat sprouts, greening, and numerous diseases.

Summer harvested potatoes are not stored or held any longer than necessary before marketing. The best temperature for holding potatoes is 40 to 42° F. U.S. potatoes are usually sold on the open market at prevailing prices. Chipping potatoes are normally sold at contract prices and may be graded or ungraded. B size and creamer potatoes are usually sold to processors for canning.

Growing Cucumbers, Melons, Squash, Pumpkins and Gourds

Cucurbits, which include cucumbers, muskmelons, watermelons, pumpkins, summer squash, winter squash, and gourds, are some of the most popular garden vegetables planted today. Cucurbit crops are similar in their appearance and requirements for growth. They are prostrate, sprawling vines, usually with tendrils. Each vine bears many large, lobed leaves. On all cucurbits, except for the bottle gourd, the flowers are bright yellow. Each vine bears two kinds of flowers: pistillate (female) and staminate (male).

Cucurbits are warm season crops which grow best during periods of warm nights and warm days. New dwarf and/or bush types enable gardeners with limited space to enjoy the fresh home grown taste of cucumbers, watermelons, and squash. Although traditional cucurbit types require substantial growing space, they can still be grown in small gardens by training vines onto vertical structures that conserve garden space.

Site

Cucurbits require full sun to grow well. Plant them in well-drained, neutral or slightly alkaline soil with a pH of 7.0. Soil types that contain clay can be improved by adding organic matter. Peat, compost or rotted manure can be added to improve heavier soils. Light, sandy soils are preferred for northern gardens, as they warm quickly in the spring.

For good growth, work fresh animal manure or a cover crop into the soil in the fall, or well-rotted manure or compost into the soil before planting. Spread the organic matter to a depth of 2 inches and work it into the soil 6-8 inches deep. If limited organic matter is available, concentrate it in the area where the seed is expected to be planted.

If you are unsure of the fertility of your soil, get a soil test. This will inform you of nutrients that are present in the soil, as well as the soil pH. Contact your county extension educator for information on soil testing.

Fertilization

Cucurbits require low nitrogen and high potassium and phosphorous for good fruit development. Add a complete fertilizer such as 4-8-5 or 6-10-10 or similar analysis at a rate of 1 to 2 tablespoons per hill prior to planting. Nitrogen is readily leached from light, sandy soils. Ensure an adequate nitrogen supply by side-dressing with ammonium nitrate (33-0-0) or similar analysis at the rate of 1 tablespoon per hill 1 week after blossoming begins. Make a second application 3 weeks later.

Do not over fertilize with nitrogen as this encourages vine growth and retards fruiting. Bush, dwarf, and short-vined plants do not need as much fertilizer as standard types.

Saving Seed

Saving seeds is not recommended because many of today's plants are hybrids. Pumpkins, squash, and ornamental gourds can cross-pollinate. The seeds planted from normal-appearing fruit can produce plants which bear fruit that is misshapen and undesirable. Plan to purchase seed each year. Grow cultivars that are recommended for your area.

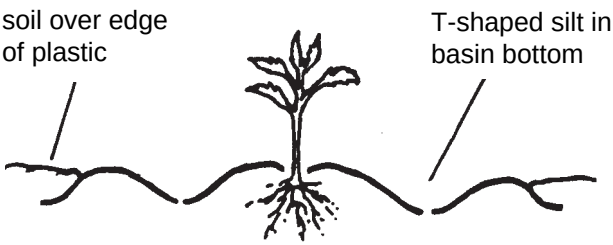
Planting

Plant cucurbits after all danger of frost has passed and when the soil has warmed to 60°F. The last spring frost dates will vary in different locations around the state.

Seeds

Cucurbit seeds require very warm soil to germinate, at least 60°F. Seeds will rot if the temperatures are under 60°F. Dust seed with thiram or captan before planting to help prevent disease. If the seeds are colored, they have already been treated. Soils can be warmed to get a head start on the growing season. Methods used to warm the soil include the use of black plastic and the practice of

mounding or hilling the soil. Lay black plastic on the soil surface as early as possible in the spring. To plant cucurbit seeds or transplants, simply slit the plastic in the area where you want the plants located. Follow the normal planting procedure.



Install plastic anytime prior to planting. Mound the soil and form a 3-6 inch trench around the mound. Place the plastic cover over the mound. Edges of the plastic should fall into the trench. Fill in the trench with soil to cover the edges of the plastic and hold it in place.

To form a hill, mound soil to make a low, broad hill about 8-10 inches high. Plant 4-6 seeds in a circle in 5 inch intervals for each hill. Each hill should be 4-8 feet apart, depending on the variety you select.

Plant cucurbit seeds 1 inch deep. Cover and lightly tamp the soil but not so firmly as to create a crust.

Thin when seedlings have 2 or 3 leaves. Remove all but 2-3 large, healthy, well-spaced plants per hill. More than 3 plants per hill will lead to crowding, greater chance of disease, and lower yields.

Transplants

When purchasing transplants, look for stocky plants free of diseases, pests, and yellow leaves, which are a sign of stress. Transplant cucurbits when plants have developed two adult or “true” leaves.

Purchase transplants in individual peat pots or containers, rather than unsectioned flats. This prevents roots from being disturbed in the transplant process. If you sow seeds to be transplanted outside at a later time, plant 2 seeds per peat pot, peat pellet or individualized pot. When they are 2 inches tall, thin to one strong plant. Two to three weeks are needed for seedlings to grow to transplant size.

Set plants out during the late afternoon or early evening, when the wind has died down, to avoid stress from the hot summer sun. First, make the rows as you would for seed or prepared hills. Then dig a hole for each plant roughly twice as wide and twice as deep as the soil ball. Keep in mind the proper planting distance as noted earlier.

Next, set each plant slightly deeper than it grew before; place soil around the roots; and add 1 cup of starter solution to help roots become established. Make starter solution by dissolving 1 tablespoon of water soluble, high phosphate fertilizer, such as 10-52-17 or 11-48-0 or similar analysis, in a gallon of water. Finish by filling the hole with soil, leaving a small basin around each plant.

Often, the lip of the peat pot acts like a wick, allowing the moisture to escape from the pot. Therefore, be sure to tear or break down the lip and cover it with soil. In sandy soil, the peat pot should be carefully removed.

If the next 2-3 days are sunny, cover the new transplants with newspaper “tents” to prevent wilting. Water as needed, and water thoroughly each time.

Watering

Cucurbits are deeply rooted, so water slowly with 1 inch of water per week. Allow it to completely soak the soil 6-8 inches deep. Water in the morning or early afternoon so the foliage dries by evening. This helps prevent the spread of leaf diseases. Decrease watering later in the season to encourage fruit to mature. At this time, the root systems will be more extensive and able to withstand drier conditions.

Furrow irrigation is best, but soaker hoses also work well. Overhead sprinklers can be used although wet foliage increases the chance of disease.

Weed Control

If planting is done in a well-prepared seedbed, weeds will seldom be a problem and can be controlled by hand-weeding or hoeing. Continue to remove weeds until the vines cover the ground. At this time, the dense foliage will shade out weeds.

Black plastic mulch is very effective when used with cucurbits because it absorbs heat, warms the soil, and maintains good soil moisture levels. The plastic can be installed when the soil is in good planting condition, any time from a few days to 2-3 weeks before planting. This will speed harvest since the soil will be very warm when the seeds and transplants are planted.

If you do not use plastic, cucurbits will benefit from organic mulches applied in the summer after the soil has warmed. Apply peat moss, compost, untreated lawn clippings or weathered straw to a depth of three inches.

When summer mulching materials are used, such as straw or peat moss, additional nitrogen is recommended. Mix 1 tablespoon of ammonium sulfate, calcium nitrate, or nitrate of soda per 1 bushel of mulch. Apply once or twice during the early growing season. A complete fertilizer that is high in nitrogen may be substituted for any one of the above. Apply the fertilizer when the mulch

is moist.

Insects and Diseases

Cucurbits require regular spray programs to prevent insect and disease organisms from reducing yields or killing plants. Contact your local county extension office for insect and disease control recommendations.

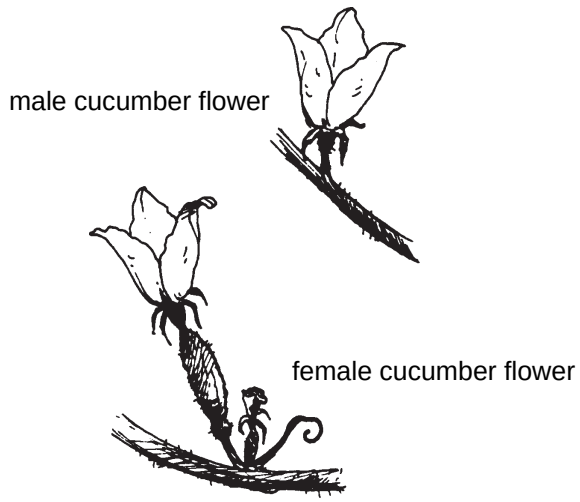
Crop Rotation

Rotation is the practice of changing the location of vegetable crops in a garden each year. Cucurbits are generally attacked by the same pests so they should be rotated on a 3 year schedule. An example might be to grow muskmelon the first year, then grow tomatoes in the same location the second year, and beans the third year. This can then be repeated. Rotate cucurbits on a 3 year schedule with any vegetable other than those from the cucurbit family.

Pollination

Insecticides should be used in late afternoon or early evening to avoid injury to pollinating bees.

The first flowers that appear on cucurbits are usually male. Male blossoms do not bear an immature fruit or ovary directly behind the petals as do female flowers. They furnish pollen for bees to pollinate the female flowers, and then drop off the plant naturally without fruit production. The female flowers have an ovary directly behind the flower, which looks like a tiny fruit. When pollinated, it swells to form a fruit.



If the female flowers bloom before there are male flowers to supply pollen, they will dry up or produce small fruits that drop off and die.

If cucumbers tend to be misshapen, it is due to incomplete pollination. The next fruits will probably be the proper shape.

Specific Information

Muskmelons and Other Melons

Muskmelon is a popular fruit that is eaten fresh or can be frozen. Muskmelon is frequently called cantaloupe. However, the true cantaloupe has a hard, rough, warty, or scaly rind and is not commercially available. Muskmelons have orange flesh and a netted rind.

Other melons include casaba, honeydew, Christmas and Persian melon. Honeydew fruit is large and mildly scented. The flesh is crisp and white or green in color; the rind is smooth. Casaba is similar, except it has a wrinkled rind. Persian is similar to muskmelon, but the fruit is larger. Christmas melon has lightly colored flesh. The fruit is oblong with green and yellow stripes. To grow muskmelon, choose early cultivars for direct sowing outdoors, or start main and late season cultivars indoors to insure adequate time for melons to ripen.

Harvest muskmelon early in the day, after the plants are dry. Be careful not to damage the vines. Pick melons every other day at the start of the season and every day at peak season. At maturity, the stem appears cracked at the point of attachment to the fruit. Check for maturity by gently lifting the melon. If it is ripe it should easily separate from the vine. When ripe, the muskmelon rind changes from green to tan or yellow between the netting.

To harvest Casaba and honeydew, cut them off the vine after they turn completely yellow. They will continue to ripen (become soft and mellow) if kept at room temperature for a few days. When they are completely ripe, the blossom end yields to pressure.

Persian melons are ripe when they have a sweet, fruity aroma at the blossom end. If melons are not yet ripe in September and a hard frost is predicted, cover the foliage and immature fruit with newspaper.

Problems—Muskmelons may crack during periods of high humidity which is common during the summer's rainy period.

Poor flavor and/or smooth rind is due to cool temperatures; wet, cloudy weather; poorly adapted cultivars; poor soil fertility (especially low potassium) and picking the melons before they are ripe.

Herbicide drift can cause leaves to appear mottled and discolored. Check if herbicides have been sprayed the last 10-14 days. If herbicides are not the cause, viruses can show similar symptoms.

Cucumbers

Choose cucumber cultivars according to their intended use. Slicing cucumbers (6-8 inches), pickling cucumbers (2-6 inches), burpless cucumbers (6-15) and novelty cultivars are available. For small gardens, use trellis, wire cages, or bush types such as Patio Pik or Pot Luck.

Planting, fertilization, and other problems are similar to other cucurbits. Refer to general information on cucurbits.

Summer Squash

Summer squash is available in many different shapes and colors. Popular types include scallop or patty pan types (green or white); crookneck or straight neck (usually yellow with a constricted neck); and Italian marrows (club shaped such as zucchini, cocozell and caserta).

Bush types are available for small gardens.

Follow the general planting, fertilization, and care as outlined for cucurbits.

Harvest zucchinis when they are 2 inches in diameter or 6-10 inches long. Pick yellow types at 4-7 inches and patty pan or scallop types when they are 3-5 inches in diameter. They are usually ready to pick 4-8 days after flowering.

Winter Squash

Winter squash can be stored in a cool dry area for many months. They are available in many shapes, colors, and sizes. Small types (14 pounds) include acorn, butternut, and buttercup. Intermediate (6-12 pounds) and large (15-40 pounds) include banana and hubbard. There are a few bush types for small gardens.

Follow the general planting, fertilization, and care as outlined for cucurbits.

Harvest winter squash when stems are greyish and starting to shrivel. Spaghetti squash should turn a golden yellow and banana squash a golden orange when ready to harvest. Cold weather increases the sugar content of winter squash; so if a frost is expected, cover the fruit and vines with newspaper.

Pumpkins

Pumpkins are available in several sizes: small (4-6 pounds), for cooking and pies; medium (8-15 pounds) and large (15-25 pounds), for cooking and jack-o-lanterns; and jumbo (50-100 pounds), for showing at fairs and exhibits. There are also naked seeded or hull-less cultivars for roasting seed. Bush and semi-vining cultivars are used for small gardens.

Follow the general guidelines for planting and maintenance of cucurbits for growing pumpkins.

Pumpkins should be harvested when they have a deep, solid color and the rind is hard. The vines will usually be dying back at this time. Cover during a light frost and avoid leaving pumpkins out during a hard frost to prevent softening.

Watermelons

Watermelons require a long growing season. Gardeners in northern Indiana should choose early cultivars and use transplants. If you grow seedless melons, you must plant a row of a standard seeded cultivar alongside for pollination. Watermelon fruit may be large (20-30 pounds), medium (10-15 pounds), or small (5 pounds). In small gardens, use bush types. The larger the fruit the longer the growing season.

Follow the general guidelines for cucurbits when growing watermelons.

Use a combination of the following four indicators to determine when watermelons are ripe:

1. The light green, curly tendrils on the stem near the point of attachment turn brown and dry. Some varieties may do this 5-10 days before the fruit is fully ripe.

2. The surface color of the fruit loses its slick appearance and turns dull.

3. The skin becomes rough and you can penetrate it with your thumbnail.

4. The cultivars that are predominantly dark green will turn a buttery yellow on the ground side. Lighter melons will also turn yellow, but not as deep as darker melons.

Gourds

The gourds most commonly grown belong to two genera: Cucurbita and Lagenaria.

The Cucurbita types are the most common, as they are the most colorful and contain unusual shapes. The surface may be smooth or warty, plain or colored, and sometimes ridged, or with stripes. In the *C. pepe* var. *ovifera,* there are several shape variations such as the apple, bell, egg, or pear. Colors may be orange or bicolor.

The Lagenaria types are commonly called the bottle or dipper gourds. The fruit may be smooth, knobby or ridged. Some are only three inches long, while others may be more than three feet long. Shapes vary from globe, dish, bottle, dumbbell, club, crookneck, or coiled.

Planting, fertilizing, and care are similar to other cucurbits. Fruits of gourds are picked for eating about 1 week after flowering.

Harvest gourds before frost except for the Luffa or sponge gourd. Luffa should be left on the vines until mature or the vines are killed by frost. To prepare a sponge from the luffa gourds, peel the brown skin from the fibrous interior. It will separate quite readily if the fibrous interior is still moist. After peeling, remove the seeds by shaking, then wash the “sponge” in warm, soapy water. If the fibers are to be whitened, place the sponge in a solution of bleach, rinse, and dry in the sun. It can be used as is or moistened and dried again between papers with weights on top.

Greenhouse Cucumber Production

Greenhouse cucumber production is very popular in many areas of the world (Fig. 1). The cucumber is a warm season crop with required growing conditions of 80 to 85 ^{o}F and plenty of sunlight. The primary type of cucumber grown in Florida greenhouses is the European seedless type. The fruits are mild in flavor, seedless, and have a thin edible skin that requires no peeling. Harvested fruit generally range from 12 to 14 inches in length and weigh about 1 pound each. However, smaller fruits of mini cucumbers have become more popular and commercial production has increased. European greenhouse cultivars are parthenocarpic (produce fruit without pollination). Gynoecious cultivars, i.e., those producing only female flowers or predominately gynoecious cultivars should be grown. If pollination does occur, the fruit will form seeds, the shape of the fruit will be distorted and a bitter tasting fruit will develop. It is therefore essential to prevent bees and other pollinators from entering the greenhouse and carrying pollen from outdoor gardens or field cucumber plantings. Cucumber plants are indeterminate in growth, continually producing fruit on new growth, similar to greenhouse tomatoes.

Greenhouse cucumbers are more sensitive to low temperatures than tomatoes. Minimum temperatures should be no lower than 65F for sustained production. Prolonged temperatures above 95F should also be avoided as fruit production and quality are reduced at extremely high temperatures.

Establishment

Several different types of production systems and substrates can be used to grow greenhouse cucumbers. Possible production systems include: trough, NFT, bag culture, and rockwool. For further information, readers are referred to the earlier discussion in this manual on production systems.

Greenhouse cucumbers are ordinarily established in the greenhouse as transplants using rockwool or foam blocks. Seed costs are very high; a typical cost is 25 to 30 cents per seed. Germination is generally close to 100%, so one seed per transplant container is sufficient. Producers may choose to over-plant the number of containers by 10% to 15% to make up for those few seeds that do not germinate and those plants

Figure 1. Slender Eurpoean greenhouse cucumbers.

lost during or shortly after transplanting. Some growers have successfully direct seeded cucumber into perlite bags and at the same time seeded a few transplants to use as replacement plants. Transplant production should be confined to a small transplant production area of the greenhouse or a separate greenhouse entirely to make efficient use of space and energy and to assist in sanitation practices for disease control.

Cucumber seed germinates rapidly (2 to 3 days) at an optimum germinating temperature of 84F in the germination room. Once the seed has germinated, the temperature should be lowered to 77F. During the seeding and transplant production stage, the plants must never become stressed for water or nutrients. A plant with three or four true leaves is ready to be transplanted. The transplants should maintain an upright growth habit (no curves in the stem) to aid in successful transplanting.

Selecting Cultivars

There are many cultivars available for greenhouse cucumber production. The cultivars available are generally produced by European seed companies, however, a few of the companies have sales and technical support representatives in North America. Cultivars change frequently and, as a result, growers should consult current recommendations through local Extension agents and industry representatives. Several factors should be considered when selecting a cultivar, including disease resistance, plant vigor, early and total yields, fruit size and color, and general fruit quality. Disease resistance is an especially important factor when selecting a cultivar. Diseases can be severe in Florida greenhouses, and fungicide options are limited in the greenhouse. Diseases that can be problems in greenhouse cucumbers in Florida include: gummy stem blight, gray mold, downy mildew, powdery mildew, cucumber mosaic, watermelon mosaic, and Pythium root rot in NFT. Growers must determine the levels of resistance or tolerance in the cultivars considered for production. Selection of a resistant cultivar may be the only practical method of control for some diseases.

Two evaluations of twelve cultivars were conducted in the fall of 1995 and the spring of 1996 at Live Oak. Several cultivars performed well in that trial including 'Kalunga', 'Bellissma', 'Millagon', 'Discover', 'Marianna', 'Fitness', 'Aramon', and 'Fidelio'. in the trial that were most susceptible to mildew were '90-0048', E1828', 'Futurea', and 'B-1157'. 'Fidelio', a long-time popular cultivar produced well in the trial, and had especially smooth fruit, however, it had the shortest fruit length of the twelve cultivars. The longest fruits were consistently produced by '90-0048'. The darkest fruit color was found 'Kalunga', 'Bellissima', and 'E1828'. The lightest green fruit color was found in Futura. The cultivar 'Tyria' has been especially susceptible to gummy stem blight lesions inside the fruit in Florida growers trials and is not recommended in Florida. 'Bologna' has also been very popular among Florida producers since the late 1990s.

In addition to the standard long European cucumbers, special markets may also be developed for shorter miniature or "beit-alpha" types. Some miniature cucumber cultivars are especially susceptible to powdery mildew and the tolerance level of each cultivar should be checked.

Spacing and Training

Greenhouse cucumber plants have very large leaves, grow vigorously, and require large amounts of sunlight (Fig. 2). Under good sunlight conditions, each plant should be provided 5 to 7 square feet of greenhouse space. More space is often required in the northern United States, where light conditions are poor. Exact spacing between rows and between plants within a row will depend upon the type of training and production system to be used.

Several training systems exist for greenhouse cucumber. The basic principle in developing a training system is to uniformly maximize the leaf interception of sunlight throughout the house. The selection of a system will largely depend on the greenhouse facility, the production system, and grower preference.

A vertical cordon system trains plants vertically to an overhead wire. Once the plants reach the wire they are topped and then pruned using an umbrella system (to be described later). Single, evenly spaced rows can be used, however, double-row production is very popular. Typical spacings for this double-row system would be approximately 5 to 6 feet between the centers of each pair of rows. The distance between the two rows within a pair is approximately 2 feet. The spacing of plants in the row for such a double-row system would be 18 to 24 inches. Single, evenly spaced rows in a vertical cordon system would be approximately 4 to 5 feet between rows and 12 to 18 inches between plants within the row.

Figure 2. Young cucumber crop.

A second popular training system is the V-cordon. Single rows are evenly spaced approximately 5 feet apart and plants are distanced approximately 12 inches apart within each row, and the 2 wires are spaced approximately 30 inches apart from each other. The support strings are then tied alternately to each wire. In this manner the plants are trained up the string and will grow at an incline away from the row center. The plants form a V-arrangement down the row.

Pruning

The most common pruning system for either vertical cordon or V-cordon trained plants is known as the umbrella system. In this system, all lateral branches are pruned out as they appear until the main stem reaches the overhead wire. The growing point of the main stem is removed when one or two leaves have developed above the wire. Two lateral branches near the top of the plant are allowed to grow and are trained over the overhead wire resulting in these two branches growing downward. The growing point of each lateral is removed when nearly to the ground. Fruits are developed at the node of each leaf. The fruits on the base 30 inches of the main stem should be pruned off as soon as they appear. This allows the plant to vigorously produce early vegetative growth which is essential for maximum fruit production. Fruits above the basal 30 inches of the main stem are then allowed to develop. The productivity of the laterals is generally less than the main stem.

A comparison of two pruning systems was made in 1995 and 1996 at Live Oak. A drape system allowed the main stem to drape over the trellis cable and grow down to the floor. In the drape system, the apical meristem was not removed. The pinch system required the apical meristem to be removed once reaching the trellis cable. One side branch was then allowed to grow over the trellis cable and back down to the floor. In both

systems, all other side branches were removed. In the two trials, the drape system produced higher yield and quality in most instances. The pinch system resulted in a delay in new growth before the side branch began producing fruit.

Fruit Development

A fruit may be developed at each node and more than one fruit may begin to develop at some nodes (Fig. 3). It is usually best to thin these multiple-fruit clusters to a single fruit, however, vigorous plants can sometimes mature more than one cucumber at a node. Miniature and beit-alpha types will support several fruit per node. Any distorted fruit should be removed immediately. The greatest growth of the fruit occurs between day 6 and 14 after the bloom opens (anthesis). Maximum fruit length occurs at day 14 followed by diameter increase. The shape of the fruit is somewhat tapered being largest at the stem end prior to day 10 after bloom, however, the fruit becomes uniformly cylindrical by day 14. During the spring season, commercially acceptable fruit size is usually reached by the 11th day after the bloom opens.

Figure 3. Parthenocarpic greenhouse cucumber flower and young fruit.

Nutrient Programs

Greenhouse seedless cucumbers have a high nutrient requirement and grow very rapidly when supplied with sufficient nutrients. As a result, growers must plan for an optimum nutrient program making adjustments in the program as the crop demands change. The greatest demand for nutrients is during the peak fruit production period. Nitrogen and potassium are required in the greatest amounts, however, a complete nutrition program including essential minor elements is required. Fertilizer recipes are presented in the chapter on fertilization in this volume. Designing a fertility program varies depending on the production system desired and extreme caution must be used when interpreting or comparing research or articles from one production system to another.

Florida greenhouse producers are using soilless production systems. In these systems, a complete nutrient solution is used to supply the needed nutrients to the crop. Soilless culture increases the grower's ability to control the growth of the plant, but it also requires management to achieve success. Many of the guidelines for soilless culture of tomato, presented earlier in this handbook, also apply to cucumber.

One concern of the soilless system grower is the supply of micronutrients or trace elements (those needed only in trace amounts). Soilless growers not only must supply their crop with the six macronutrients (nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur), but also the 7 micronutrients (iron, manganese, copper, zinc, molybdenum, boron, and chlorine). It is especially important in a soilless system to test the source of water prior to developing a nutrient program. The raw water will have some amounts of many of the essential plant nutrients. These may need to be considered when developing a fertility program. The pH of the water is also critical and may need to be adjusted. Frequently groundwater in Florida has a high pH of 7.0 or above. The target pH of the nutrient solution supplied to the plants should be between 5.5 and 6.0.

Generally, either nitric, sulfuric, or phosphoric acid is recommended for pH control. If it is necessary to raise the pH, potassium hydroxide is usually used. If the source water is alkaline due to high bicarbonate concentrations, the pH should be adjusted before the fertilizer salts are added to prevent precipitation. Plant tissue testing can be a useful tool in addition to a good soil testing or nutrient solution program to monitor the fertility. Cucumber leaf-nutrient ranges are presented in the chapter on fertilizer management elsewhere in this volume. The reported ranges should be used as a guide to assist in avoiding major problems, both toxicities and deficiencies.

Several research articles report a sudden temporary wilt of greenhouse cucumber plants when using NFT. Cucumber roots have a greater oxygen requirement when compared with roots of tomatoes. Cucumbers develop a large root system in the growing tubes and as a result may become stressed for oxygen. Because of this concern, measures may need to be taken to provide improved oxygen supplies to the root zone. Continuous aeration of the nutrient solution and increasing the slope of the tubes to 2 feet or more in height for every 30 feet in length are reported to help. High solution temperatures also reduce the amount of dissolved oxygen in the solution. Growers must avoid high temperatures in the solution.

Figure 4. Greenhouse cucumbers ready for harvest.

Managing Pests

Several diseases, insects, and nematodes can potentially be pests of greenhouse cucumbers. Cultivar selection, greenhouse sanitation, and well-timed applications of properly selected pesticides are all important in managing these pests in the greenhouse. The pest control portion of this handbook has details for managing pests of greenhouse cucumbers.

Harvesting

Fruits are harvested when uniform length, shape, and diameter is reached and before any yellowing appears on the blossom end (Fig. 4). Typical fruit length is 12 to 14 inches and current USDA Grade standards require a minimum of 11 inches in length. Updated copies of the U.S. Grade standards for greenhouse cucumbers are available through: Agricultural Marketing Service, USDA, Room 2056 South Blvd., Washington, D.C. 20250.

Frequent harvests are required because the fruits quickly become overmature. Fruits are harvested as soon as they are marketable to avoid retarding the development of any younger fruit on the plant. Continued, timely harvest keeps the plants in a productive mode since cucumber plants have a limit to the number of fruits they can support any instance. Harvest is usually required three or four times per week.

Total expected yield will depend directly on length of harvest period. Yields range from 1 to 3 pounds of fruit per plant per week during the peak harvest period. A normal harvest period of 12 weeks in a well managed crop can yield a total of 20 to 25 pounds of fruit per plant.

Packing and Storage

European greenhouse cucumbers have a very thin skin resulting in high susceptibility to water loss and softening of harvested fruit. Immediately after harvest, containers should be covered to avoid exposure to direct sunlight. Each fruit is individually wrapped in a shrink-wrap film before packaging. Shrink-wrapping will minimize moisture loss and extend shelf life by several days. Since each cucumber has to be shrink wrapped, this crop is very labor-intensive and time consuming. Growers often mention they were not aware of the considerable time needed to properly shrink-wrap greenhouse cucumbers. Growers should invest in a commercial shrink-wrapping machine designed for cucumbers so that the shrink wrapping is done in a professional manner. There are several types and sizes of shrink wrapping machines available to meet the needs of all sizes of growers.

European greenhouse cucumbers are considered highly susceptible to chilling injury caused by exposure to low, but nonfreezing temperatures. Chilling injury can occur at temperatures below 50F for most vegetables. Chilling injury on cucumber fruit results in a pitting of the fruit surface and a tendency for more rapid loss of green color. Fungal decay often follows chilling injury. Optimum fruit holding conditions are approximately 55F and 95% relative humidity.

Cucumbers are also sensitive to ethylene gas. When cucumber fruits are exposed to ethylene, they lose cholorophyll and rapidly become yellow. Exposure to levels of 1 ppm ethylene for 1 day at 59F will result in a noticeable yellowing of the fruit. Chilling injury to cucumber fruit, even for a short duration, will increase the production of ethylene by the fruit. It is very important that cucumbers not be held or shipped in the same compartment with moderate to high ethylene producing fruits or vegetables such as tomatoes, cantaloupes, apples, and peaches. Consult IFAS Vegetable Crop Fact Sheet VC-34 Ethylene in Post harvest Horticulture for further information on ethylene.

Vegetables

Growing Sweet Corn in Home Gardens

Corn is one of the most popular and diverse vegetables. Many types are grown, including field corn, ornamental corn, popcorn, sweet corn, several different supersweet corns and even broomcorn. Corn may be white, yellow, bicolor and many shades of red, blue or even black. Most home gardeners grow white, yellow or bicolor corn or supersweet corn, so this factsheet will be restricted to these.

The yield and quality of home-grown corn also vary more widely than the yield and quality of most other vegetables. The type of corn grown, cultural conditions of growth, harvest and post-harvest treatment all affect yield and quality. Each of these will be considered in this factsheet.

Type

There are three main types of sweet or supersweet corn marketed to home gardeners.

The traditional type is referred to as "sugary" and is denoted in many seed sources by the letters "su."

The second type of supersweet corn has a very high sugar content and extremely shrunken seeds due to a small, weak embryo. This type is often marketed as "extra sweet" or "ultrasweet" and is usually referred to by the letters "sh_2" for shrunken. Many of the older sh_2 varieties perform poorly under Tennessee growing conditions.

The third type is also a supersweet corn. It tends to have a higher sugar content and to maintain or extend this sugar content longer on the plant and also after harvest. It is usually referred to as "se" for "sugar extended." Se corn tends to be very sweet, tender, crisp and usually retains these qualities after harvest. However, its requirements for warm soil temperatures at germination and isolation from some other corn types at pollination make it more difficult to grow.

Some gardeners also grow and consume various specialty field corns, such as "Trucker's Favorite" or "Hickory King." These are not included in this factsheet.

Varieties

There are several hundred good varieties of sweet and supersweet corn available to homeowners. Many of them do well in Tennessee. Table 1 lists some of the better varieties for home gardeners and their characteristics.

Table 1. Recommended Corn Varieties in Home Gardens

Variety	Color	Type	Approximate Days to Maturity	Comments
Kandy Korn	Yellow	SE	80	Excellent sugar
Honey ‘n Pearl	Bi-colored	SH_2	78	Sweet. All-American Winner.
Silverado	White	SE	88	Silver Queen-type, but slightly earlier. Very good sugar.
Merit	Yellow	SU	88	Large ear, but may produce starchy texture.
Incredible	Yellow	SE	90	Large ears. Excellent flavor.
Bi-Queen	Bi-colored	SU	92	Both yellow and white kernels. Excellent quality.
Golden Queen	Yellow	SU	93	Standard of the yellow su varieties.
Silver Queen	White	SU	93	Standard of the white su varieties.

Seed

Seed germinates less well as it gets older. All seed keeps best under cool, dry conditions. Reseal seed packages with tape, place them in a closed container and refrigerate or freeze the seed to keep it more than one year. If seed is allowed to remain in hot, humid conditions from one year to the next, it is unlikely that the seed will germinate satisfactorily.

Seed from hybrid corn should never be saved for planting, as yields will decrease by 25 percent or more compared to new hybrid seed. Most purchased corn seed has been treated with insecticide and fungicide to protect it during germination. Treated seed must never be eaten or fed to livestock. Treated seed is more likely to produce good plant stands than untreated seed.

Planting

Sweet corn is a warm-season crop that germinates and grows poorly during cool weather. It may be killed by frost. The supersweet and extra sweet varieties are even more sensitive to cool weather and are not normally planted until the soil temperature reaches 60 F.

The recommended first planting date will vary across the state and from year to year.Approximate dates for the various areas of the state are given in Table 2.

Table 2. Recommended Planting Dates for Corn in the Home Garden

Area	Sugary(su)Varieties	Shrunken(sh_2)or se Varieties
West	April 10 April 20	
Middle		
a. Low elevations	April 20	May 1
b. High elevations	April 25	May 5
East		
a. Low elevations	April 25	May 5
b. High elevations	May 1	May 10

To extend the harvest season, make more than one planting. A second planting should not be made until the first planting has three fully developed leaves. This may require more than three weeks in the early spring, but only two weeks later in the season. It should be noted that the later sweet corn matures, the more difficult insect control will be.

The seeding rate should be about 1 1/3 ounces of large-seeded varieties or 9/10 ounce of shrunken gene types per 100 feet of row. With large-seeded varieties, this will provide 155-235 seed and should provide 170-300 seed of the smaller-seeded varieties. Seeding at this rate will provide a good plant population if growing conditions are favorable.

The optimum planting depth varies with soil types and with the time of planting. Plant deeper in light soils and shallower in heavy soils. Early plantings should be shallower than later plantings because better moisture and warmer temperatures exist near the surface. If late plantings are shallow (1/2 inch), there is less likelihood that seed will germinate. A good rule of thumb is to plant seed two to three times deeper than their average diameter.

Plant Spacing

In areas with unlimited space, sweet corn is usually spaced 10-15 inches in the row, with 36 to 42 inches between rows. A common mistake made by home gardeners is to plant sweet corn in only one or two rows at a time. This usually results in poor pollination and low yields. Plant sweet corn in blocks consisting of a minimum of three rows per block.

In small areas having limited space, but with good soil moisture and organic matter, it is possible to plant in double rows that are 10 to 12 inches apart with 30 to 42 inches between each double row. Plants within each row are spaced about 12 inches apart. Planting at these spacings will provide good pollination and good yields as long as the blocks are no more than three or four sets of double rows wide and proper moisture, nitrogen and weed control are provided. The double-row concept is illustrated in Figure 1.

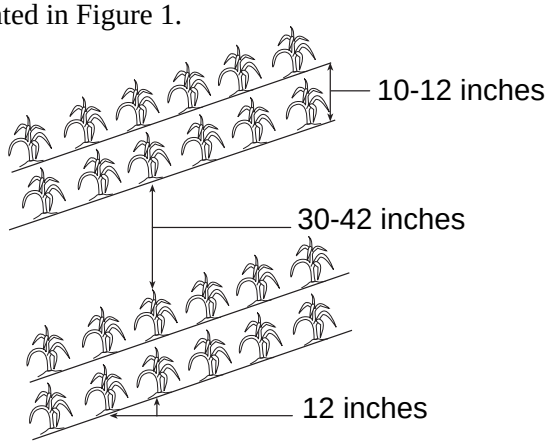


Figure 1. Sweet corn planted in double rows. Use this concept in small areas where space is a problem.

There is no need to remove suckers from sweet corn and no advantage to doing so.

Isolation

Most gardeners know that sweet corn may not be as sweet if it crosses with field corn. Likewise, some of the supersweet or extrasweet corns may not be as sweet if they cross with other types of corn or even with other supersweet corn varieties. Corn varieties can be prevented from crossing by isolating them from each other. They can be isolated either by planting them 100 yards or more apart or by timing plantings so each sheds pollen at a different time. It is a good idea to isolate different sweet corn types from each other unless it is known that crossing will not affect them.

Fertilization

Fertilization should be consistent with current UT soil recommendations. Sweet corn is a heavy user of nitrogen, so good yields depend upon adequate levels being present. Apply recommended fertilizer applications at planting or soon after seedling emergence. When sweet corn is 8 to 12 inches tall, sidedress with 1.5 pounds of ammonium nitrate per 100 foot of row. Proper nitrogen fertilization is very important to developing a strong, tall stalk with the se or sh_2 types.

Weed Control

Control weeds by preventing them from becoming established. This means that weeds should be removed while both corn and weeds are small. If double rows are grown, a rototiller can be used between each set of double rows and hand tools can be used between the double rows. If weeds are removed while they are small, corn will grow at a rapid rate and will reduce weed seed emergence as the corn gradually shades the soil.

Insect Control

European corn borer, corn earworms, Japanese beetles and flea beetles are the major insects affecting sweet corn in home gardens. Corn borers feed on the foliage and internal portions of the stalk. They are usually identified by insect holes bored into the stalk and droppings on the foliage. The corn earworm usually feeds on the tip of the ear. Japanese beetles normally congregate on the tip of the ear and feed on the silks. This may reduce pollination and yields.

European corn borer control is difficult for home gardeners because sprays are effective only during the two-to-three day period after eggs hatch and before larvae bore into the stalks. Pay close attention to the presence of eggs. Eggs are white and one-half the size of a pinhead. They are laid in masses that overlap like fish scales. Eggs

darken just before hatching.

The corn earworm and Japanese beetles can usually be effectively controlled by applying recommended insecticides as a foliar spray directly to the silk when it first appears, and continuing weekly until harvest.

Irrigation

Sweet corn is a high user of water and requires adequate moisture throughout the growing season, especially if the double-row technique is used. Water may be applied by trickle or sprinkler irrigation. It should be provided throughout the season, but is most important during germination and tassel and silk formation.

Water for irrigation can be applied with a sprinkler. A common mistake of home gardeners is to assume that wetting the surface is all that is needed when using a sprinkler. It is important to wet the effective root zone of the plant. This means that the depth of soil containing the larger percentage of active roots should be moistened. Usually, this is the top 8 to 12 inches. An easy way to do this is physically check the depth of wetting after the system has run for a period oftime. When the soil is moist to the required depth, shut the system off.

A trickle system can also be connected directly to the household watering system through hose and filter connections. It only requires 8-10 pounds of inline pressure to operate a trickle system. Plastic hose with properly spaced emitters can be laid down each row to deliver water to the base of each plant. This places water where it is most needed and is most efficiently used. Trickle systems require considerably less water than sprinkler systems, but are more laborious and costly to install and manage.

A typical system is shown in Figure 2.

A trickle system requires relatively level land to operate efficiently. Evaporation can be reduced by applying water in late afternoon or at night. The depth to moisten is the effective root zone of the plants, as mentioned with the sprinkler system.

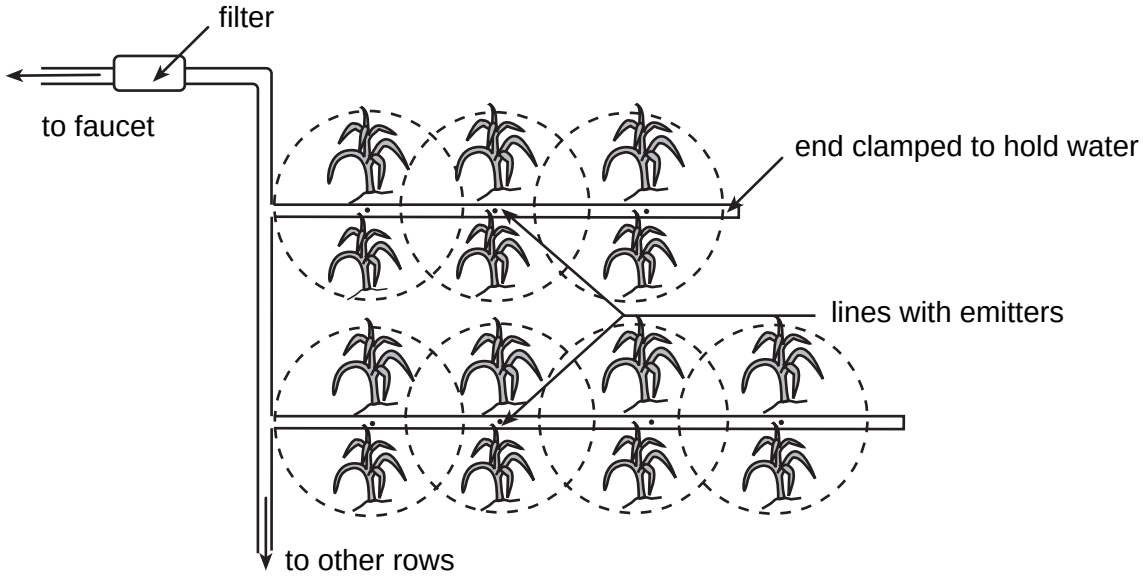
Harvesting

Harvest sweet corn when the silk end of the ear is completely filled out, the silk has turned brown and the kernels are firm but in the milk stage. If the kernels are firm, but can be punctured by applying pressure with the thumb nail, the ear should be in the proper stage to harvest. It usually requires 17 to 21 days from full silking until harvest.

Sweet corn will have its highest sugar and best flavor if it is cooked and eaten immediately after harvest.

Handling

If sweet corn in to be frozen or canned, it should be shucked, de-silked and brought to a boil for a period of three minutes immediately after harvest. Cool it as rapidly as possible after boiling. It may then be either frozen or canned. Immediate processing in this manner reduces sugar loss and greatly improves flavor. Avoid holding sweet corn for long periods at ambient temperatures after it is harvested.



Growing Shiitake Mushrooms

Introduction

Shiitake is an edible mushroom that grows on wood from a variety of tree species. Due to its ease of cultivation and its pungent flavor, Shiitake is being considered as an alternative crop in many areas of the United States. Shiitake have been used in the Orient for about 2000 years, but have only been commercially cultivated since 1940. About 160,000 metric tons are produced annually in Japan, half of which is dried and exported. It represents a two billion dollar industry which employs about 200,000 people.

In the United States, shiitake is used in oriental restaurants and is often sold in oriental, gourmet and health food stores. Over $15 million of Japan's shiitake mushroom production during 1984 was exported to the U.S. The demand for Shiitake is increasing as consumers are being introduced to the mushroom which is more chewy, aromatic and flavorful than the common button mushroom. Over 2.1 million pounds of shiitake was produced in this country during 1986 and nearly 3 million pounds in 1987.

As an alternative enterprise in the United States, Shiitake represents a way to utilize a forest resource that, in many cases, is considered a weed. Growing Shiitake involves utilization of low quality hardwoods; trees of small diameter (three to six inches) that normally are either left in the woods after conventional logging, cut and sold as low-value pulpwood, harvested as firewood, removed as competition or left as unproductive land. Utilization of this resource would also present opportunities for small woodlot improvement.

Much of the shiitake production in the U.S. occurs in Virginia, Ohio, Pennsylvania and California. Growers range in size from small operations of a few logs to large corporations with hundreds of thousands of logs. In Oklahoma, low quality hardwoods, suitable for shiitake production, cover millions of acres throughout east and central Oklahoma. Currently, there exists only a few shiitake producers in Oklahoma who are experimenting with different strains and production methods.

The Production Process

Obtaining Suitable Logs

Selecting the best available tree species is the first step to successfully growing shiitake. Shiitake mushrooms have been reported to grow on red and white oaks, chestnut, ironwood or hornbeam, alder, aspen, poplar, cottonwood, beech, birch, sweetgum, and pecan. There is general agreement that oaks work well, especially those in the white oak group. In the U.S., both white oak (*Quercus alba* L.), post oak (*Quercus stellata* Wangenh.) and sweet gum (*Liquidambar styraciflua* L.) represent the preferred species.

Logs should be cut from living trees free of any decay. Trees should be harvested during the dormant or winter season when the wood contains the maximum amount of stored carbohydrates. In the U.S., this would usually be from November to March. Log diameters should be from three to six inches while log lengths should be from three to five feet. During log cutting it is important not to damage the bark layer.

Log length is not a critical concern and should be determined mainly on the basis of the most manageable length. Log diameter is more critical. Logs smaller than three inches in diameter can dry out very quickly. Although smaller dimension logs will produce mushrooms more quickly, they will tend to decompose more rapidly. Logs greater than six inches in diameter can produce mushrooms over a longer period of time but require more inoculations to compensate for the greater diameter. They also may take longer to produce the first crop and have increased chances for becoming contaminated.

There have been many recommendations concerning log storage or curing. In general, if inoculation is not planned soon after making logs, then trees should be left tree length until shortly before inoculation. Traditional log curing has been from one to two months. However, many growers are cutting logs and inoculating as soon as possible to take advantage of the higher moisture content of trees immediately following felling. Generally, inoculation should occur within two weeks of felling a tree.

Obtaining Shiitake Spawn

A mushroom is a reproductive structure of a fungus plant which produces spores. When a spore lands in a favorable environment, such as a log, it will germinate, sending thread-like filaments called hyphae into the log. The hyphae breaks down the log as it grows and after a period of time, usually at least six months, the fungus will begin to produce mushrooms. Spawn, which contains active hyphae, is the way shiitake producers introduce the fungus into the log.

Spawn comes either as wooden plugs made from hardwood dowels or as sawdust. Many strains of shiitake are available and can be classified as cold weather, warm weather, or wide-range depending on when they produce mushrooms. Most growers, unless they have some training in microbiology, purchase new

spawn each time they inoculate logs. When ordering spawn, it is suggested that at least two strains of spawn be used. In the U.S., growers should consider a cold weather strain for growth in the spring or fall and a warm weather or wide-range strain for summer.
Growers should experiment with several different strains of spawn from more than one supplier.

A new type of spawn called "comb spawn" has been developed in Japan but is not generally available in the United States. It is a wafer which has been cultured with spawn and inserted in a thin saw kerf in a log. It is reported to reduce the total time and labor needed for inoculation.

Inoculation of Logs

Inoculation is placing the spawn into the logs so that the shiitake fungus can grow through the wood. Holes are usually drilled into the log, filled with spawn, and then covered with wax or other material to seal in moisture and protect against contamination. Holes for plug spawn should be 5/16 inch in diameter and 3/4 to 1 inch deep (Figure 1). Plugs are inserted into the logs and usually hammered flush with or just below the surface of the log. Sawdust spawn holes are generally wider and deeper being 3/8 inch in diameter and 1 1/4 inch deep. Sawdust spawn is packed by hand or by special injector into the drill holes. Better colonization by the sawdust spawn as compared to the plug spawn may reduce inoculations per log, but the sawdust spawn is more difficult to handle and you must be careful not to let the spawn dry out.

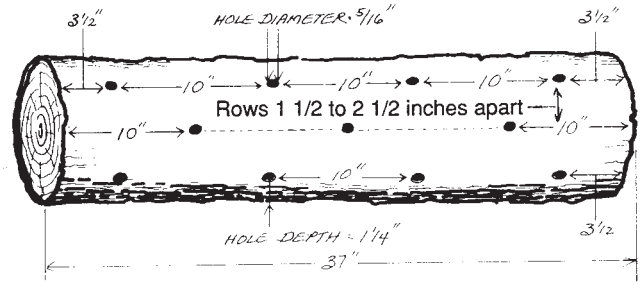


Figure 1. One possible technique for preparing logs for inoculation

Holes should be staggered evenly around the log. Rows running the length of the log are spaced 1 1/2 to 2 1/2 inches apart. The holes within a row should be spaced six to ten inches apart and alternating with the holes in the adjacent row. Heavier inoculation will accelerate the growth of the fungus within the log but also represents additional investment.

Other inoculation techniques include a variety of chain saw cuts. For short logs no more than two feet in length, a 1/2 inch thick wafer can be cut from each end of the log and a layer of sawdust spawn applied to the end. The cut wafer is then nailed back to the log. Another method is to space three to four chainsaw cuts, 1/3 of the way into the log, along each face of the log. The cuts are filled with spawn and sealed with melted paraffin. In combination with this method spawn can also be applied to the end of the log and covered with aluminum foil. Wedge cuts about 1 1/2 inches deep have also been used where spawn is applied to the cut and the wedge replaced and secured by thin plastic tape around the log.

Incubation of Logs

Mushrooms will be produced after the shiitake fungus colonizes the log. The first "fruiting" will normally occur from six to eighteen months after inoculation and will depend on the strain, the inoculation rate, the incubation conditions and tree species. Monitoring and maintaining environmental conditions during the incubation period is a critical point in the production process.

During the first two months logs should be stacked closely to help maintain a high moisture content. Shiitake grows best when the moisture content of the wood is at least 35 to 45 percent. Growth becomes poor when the moisture content falls below 35 percent or rises above 60 percent. When the moisture content becomes low the log should be soaked or continuously watered for 48 hours. Following watering, good air circulation is needed to keep the surface of the logs dry to prevent contamination. The optimum situation is when the bark remains dry but the inside remains moist.

Shiitake spawn will grow between 40 and 90 degrees Fahrenheit but the optimum is 72 to 78 degrees Fahrenheit. Stacking logs under a canopy of trees or shade cloth which provides 60 to 70 percent shade helps to maintain moisture content while preventing the logs from becoming too warm. If the logs dry out or overheat the shiitake fungus can be killed. Common stacking methods include the X pattern and the crisscross pattern (Figure 2). On hill slopes the lean-to pattern can also be used effectively. Logs should be checked periodically and turned or restacked to keep the moisture content evenly distributed. Log moisture content can be monitored by including several logs of known dry weight and periodically weighing them to determine their moisture content.

Mushroom Fruiting

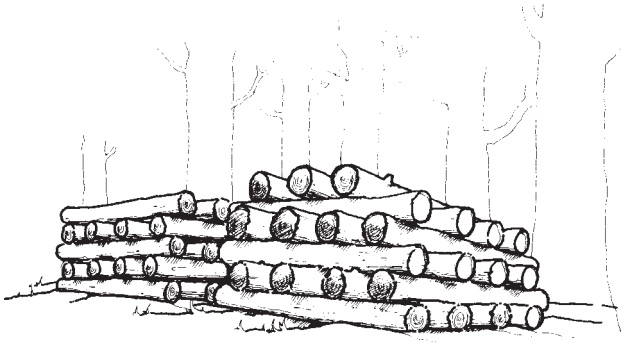
Natural fruiting of shiitake occurs under prolonged cool, moist conditions. It will usually occur within two weeks of a natural rainfall. Fruiting can be induced by soaking the logs in cool water for one to three days. Soaking time will vary depending on the difference between water and air temperatures. In general, the greater the temperature difference, the less soaking time is needed. Soaking temperatures will also vary by strain and growers should check with suppliers for details.

Traditionally, the logs will produce mushrooms in both the spring and the fall, although the fruiting period may be extended in the winter by placing the logs indoors. Many growers restack the logs during the fruiting period using the X pattern. The fruiting area should have slightly more light and air movement than the spawn-run area but still be protected from winds and direct sun. Once logs begin to fruit, they will normally produce mushrooms one to several times a year for up to six years.

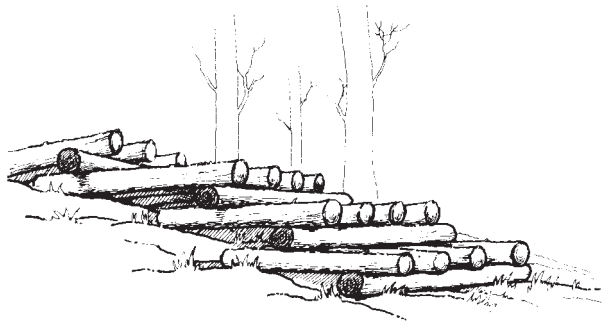
Shiitake can also be grown under greenhouse conditions. By controlling temperature and humidity conditions, logs can be forced to produce during the winter and summer when outside logs are not fruiting. These producers can take advantage of the best markets. Some experienced growers also grow shiitake on substrates other than logs. These include logs made from sawdust and other agricultural waste products such as wheat straw and corn stalks and cobs.

Harvesting, Storage, and Marketing

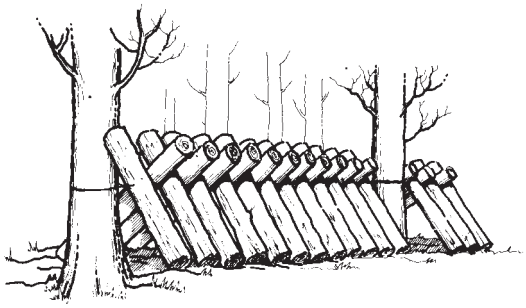
Mushrooms should be harvested on a daily basis, usually in the afternoon when the mushrooms are dry. Mushrooms are removed from the log by twisting or cutting at the base



Criss-Cross Method



Stacking Method on Slope or Hill



X Pattern Method

Figure 2. Common stacking methods.

when they have opened about 60 to 75 percent. They should be put immediately into cardboard boxes and refrigerated. Refrigeration can extend the shelf life of shiitake from four to five days to up to 2 or 3 weeks. Mushrooms should be shipped to market within 5 days of harvest but preferably sooner.

Mushrooms of lower quality or freshness can be dried, packaged and sold in retail and restaurant markets. Shiitake dry easily and reconstitute very well, so marketing by mail is also possible. Drying can be accomplished by placing the mushrooms over dry, warm air, preferably in sunlight which increases their vitamin D content. Under artificial drying, gentle heat of 90°F is gradually increased to 140°F over a 10 to 14 hour period. Seven pounds of fresh shiitake yields about one pound of dried mushrooms.

For most growers, direct, local marketing is probably the best marketing option. Many people are still unaware of this mushroom as a new food option. In most cases, some education about the qualities of shiitake will be required. Marketing cooperatives may be a viable option in the future for smaller producers.

Costs and Returns

Costs can vary greatly depending on raw material, equipment used, efficiency and costs of labor and practices implemented. Potential growers should also carefully consider the possible financial returns and risks in shiitake production. The following is an example of an outdoor operation in which 4,000 logs are inoculated each year (Baughman, 1989). However, growers are reminded that they should perform their own financial analyses to reflect their specific cash-flow situation. Assumptions for the following analyses are as follows. The scenario has a 15 year planning period for which inoculations cease in the twelfth year. Logs were assumed to fruit twice each year starting the year after inoculation. Over a four year period, a 16 percent loss in the number of logs inoculated is assumed (Table 1). Each log produces 3.06 pounds of mushrooms over the four year period.

A detailed description of assumptions for the cash-flow analysis is provided below. All cash flows were assumed to occur at the beginning of the year. The cash flow analysis (Table 2) is provided mainly for the reader to understand the components of an outdoor shiitake operation. Under the assumptions of the example, after-tax yearly net revenue becomes positive in year 3 of the operation, while after tax cumulative net revenue becomes positive in year 5. This reflects the up front equipment costs. Annual profit reaches a maximum in year 13 at $43,279, while the total profit for the 15 year period is $307,309. The reader is reminded that these figures change with any modification of assumptions.

Operating Expenses

Log covers:

Plastic—.25 sq. ft./log @ $0.018/sq. ft., 3 yr. life.

Fabric—1 sq. ft./log @ $0.10/sq. ft., 4 yr. life.

Tools/supplies:

Sawdust spawn inoculation tool— 1/4000 logs inoculated @ $22 ea.

Staple gun—1/12000 logs inoculated @ $20 ea.

Log drilling stands—1/4000 logs inoculated @ $17 ea.

Electric drill—1/6000 logs inoculated @ $210 ea.

Drill bits—$36/4000 logs inoculated.

Electric extension cord—1/8000 logs inoculated @ $18 ea.

Wax melting pot—1/8000 logs inoculated @ $40 ea.

Wax baster—1/4000 logs inoculated @ $34 ea.

Water hose & sprinkler head—1/4000 logs on site @ $35 ea., 4 yr. life.

Scale for weighing logs—60# capacity milk scale@ $100.

Picking & storage baskets for mushrooms—$2/1000 lbs. mushrooms.

Laying yard maintenance materials—5% of original materials cost/yr.

Steel racks for carrying and soaking logs—1/25 logs soaked@ $4 ea.

Office supplies—cost estimated for small tools, paper products, telephone service.

Tractor operation & maintenance—$0.02/log on site/yr.

Utilities:

Outdoor operation—water & electricity @ $0.14/log on site/yr.

Advertising:

$0.30/lb. of mushrooms with expenses weighted to beginning of project. 33% of total expense occurring in first 3 years. Remaining expense spread evenly over next 12 years.

Shipping:

Packaging & labels—$0.25/lb. of mushrooms.
Transportation—$0.50/lb. of mushrooms.

Interest on borrowed money:

11%/yr. based on cumulative net loss.

Capital Expenses

Logs:

Oak logs purchased @ $0.50 ea., 6" diameter by 40" length.
Spawn @ $0.90/log.
Wax @ $0.03/log.
Aluminum identification tags and staples @ $0.05/log.

Soak tank:

Concrete vault, each log being soaked occupies 1.25 cu. ft., total capacity assumes logs to be fruited during one week are all soaked at same time, double capacity provided in case extra logs must be fruited to satisfy short term need.

Laying yard: (for laying and fruiting outdoors)

.8 sq. ft. ground space/log, shade cloth over top and on two sides @ $0.20/sq. ft., wooden poles @ $9 ea. and steel cables @ $0.14/ft. hold up shade cloth, poles 12 feet apart on perimeter and approximately 24 feet apart on interior, perimeter poles held down by cable and buried deadman @ $3.00 ea., cable clamps & thimbles @ $0.70/set and screw eyes @ $0.30 ea. fasten cables to poles and deadman, construction tools @ $100.

Tractor:

Used farm tractor with front end lift @ $5,000, 7 yr. life.
Trailer for transporting logs @ $500, 7 yr. life.

Refrigerator:

.41 cu. ft./lb. of mushrooms, holds all mushrooms fruited in one week.

Scale for weighing mushrooms for sale:

Electronic, digital readout @ $595 ea., 6 to 7 year life.

Revenue

Price:

All mushrooms sold fresh.
$4.50/lb. of mushrooms produced.

Advantages and Disadvantages

Advantages

1. Shiitake can represent a supplemental income source to the landowner with low initial costs compared to other food enterprises.
2. Producing shiitake represents a way to utilize low quality hardwoods, an otherwise under-utilized resource. It can be integrated into conventional timber management practices.
3. The market for shiitake mushrooms is growing.

Disadvantages

1. Similar to other alternative enterprises, shiitake requires some time and effort to produce.
2. Production can be risky due to problems with low quality spawn, competing wood-rotting fungi, molds, termites, insects, and variable weather patterns.
3. The market for shiitake is not well developed and may require some education of the consumer. Price adjustments may be expected as more producers enter the marketplace.

Conclusion

Production of shiitake mushrooms represents a possible alternative enterprise for farmers and landowners in the U.S. As an alternative enterprise it has a high degree of risk. The future market is optimistic although any new producers will have to invest considerable time in developing the market. Very few yield studies have been completed in the United States but attempts to analyze the economics of shiitake production are optimistic about potential profits. Growers should begin on a small scale to experiment with different strains, inoculation techniques and incubation methods.

Table 1. Outdoor production: Log losses and mushroom yields for 4000 logs on a four year cycle.

	Logs		Mushrooms			
Year	Number at Beginning of Year	Percent Loss[1]	Number Fruiting	Percent of Total Yield	Pounds Per Log	Total Pounds
1	4000	10	0	0	0.00	0
2	3600	3	3600	18	.54	1944
3	3492	3	3492	47	1.44	5028
4	3387	0	3387	35	1.08	3658
Total		16		100	3.06	10630

[1] Loss is assumed to occur at end of year.

Table 2. Cash flow for outdoor shiitake production.

ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Costs:[1]															
Tools/supply	1390	1017	980	1508	1613	1352	1770	1817	1600	1909	2041	1710	751	654	542
Utilities	560	1107	1680	2280	2371	2466	2565	2667	2774	2885	3000	3120	2349	1603	821
Advertising	4252	4422	4599	2393	2488	2588	2591	2799	2911	3027	3148	3274	3405	3542	3683
Shipping	0	1516	5656	8969	9327	9700	10088	10492	10912	11348	11802	12274	12765	10848	4752
Interest	2474	4013	2657	0	0	0	0	0	0	0	0	0	0	0	0
Logs	5920	6157	6403	6659	6926	7203	7491	7790	8102	8426	8763	9114	0	0	0
Soak tank	3145	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laying yard	1726	0	1867	0	0	0	0	0	0	0	0	0	0	0	0
Tractor	5500	0	0	0	0	0	0	0	72380	0	0	0	0	0	0
Refrigerator	0	6850	0	0	0	0	0	0	0	0	0	0	0	0	0
Scale	0	619	0	0	0	0	0	7830	0	0	0	0	0	0	0
Revenue	0	9098	33934	53808	55960	53199	60527	62948	65465	68084	70807	73640	76585	65083	28505
Before Taxes:[1]															
PERIOD NET REVS.	-24967	-16604	10092	31999	33235	34890	35921	29361	39167	40489	42052	44147	57315	48435	18707
CUM NET REVENUE	-24967	-41571	-31478	521	33755	68645	104566	133928	17395	213584	255636	299783	357098	405533	424241
After Taxes:[2]															
PERIOD NET REVS.	-21570	-13390	7769	23976	24626	25730	26474	19681	28953	29608	30694	32021	43279	35741	13817
CUM NET REVENUE	-21570	-24960	-27191	-3214	21411	47141	73615	93296	122250	151857	182451	214472	257751	293492	307309

[1] All values are in dollars inflated at 4 percent to year of occurrence, before taxes. Columns may not add due to rounding error.

[2] All values are in dollars inflated at 4 percent of occurrence, after taxes. Columns may not add due to rounding error.

Tabletop Mushroom Cultivation

Making Media and Pouring Plates

Materials Needed

1. Fresh green string beans. Purchased at any grocery store. You will need about 1/8th of a pound.
2. Agar (use soup agar 10 grams per 2 bars) This can be purchases in any Philippine or Japanese grocery store.
3. One cup of tap water (heated to boiling)
4. Blender
5. Strainer
6. Glass or microwave safe containers to hold media
7. Petri plates. Any size will work; however, the easiest to work with are the smaller ones. (50mm X 9mm).
8. Small pot

Procedure

1. Into blender add 1 cup boiling water and green beans. Turn blender on to highest setting and let run for 5 - l0 minutes. The goal is to liquefy all of the beans.


Oster
AGAR

2. Pour the mixture through the strainer. This will remove any of the large pieces of bean.

3. Add more water to make solution 1 cup again.
4. Place mixture in a pot on stove top and bring to a light boil.
5. Add approximately ¾ of a bar of agar (approximately 4 grams) and continue to boil until agar dissolves.
6. Pour the solution into a microwave safe containers, cover and place in microwave. Also place 1 - 2 liters of water in a separate container in the microwave to prevent the solution from boiling over.

7. Bring the media to a boil in microwave. As soon as the media begins to boil turn off the microwave. Let the media cool for 4 hours.

8. Repeat the boiling process after the 4 hours of cooling.

9. Allow media to cool until mixture is warm to touch, however, not solidified. Add 0.5 cc of Gentamicin Sulfate per 10 cc of solution (1.5 cc per cup)
10. After Gentamicin is added and mixed (mixing is accomplished by swirling solution in containers), pour the media into the culture plates. Lift the lid of the culture plate only as much as necessary to all for pouring of solution. Immediately replace lid. Only fill bottom portion of culture plate 2/3 of the way.

11. Stack the culture plates as you go (i.e. place the next plate to be poured on top of the one just finished) This prevents condensation from the warm media to collect on the lid and obscuring the view of the plate.

DO NOT MOVE THE PLATES FOR SEVERAL HOURS, UNTIL THE MEDIA HAS BECOME SOLID!

REMEMBER TO POUR THE MEDIA IN A LOW TRAFFIC AREA TO PREVENT ACCIDENTAL BUMPING OF THE PLATES.

12. Excess media may be discarded, or stored in the refrigerator in airtight containers.

Tabletop Mushroom Cultivation

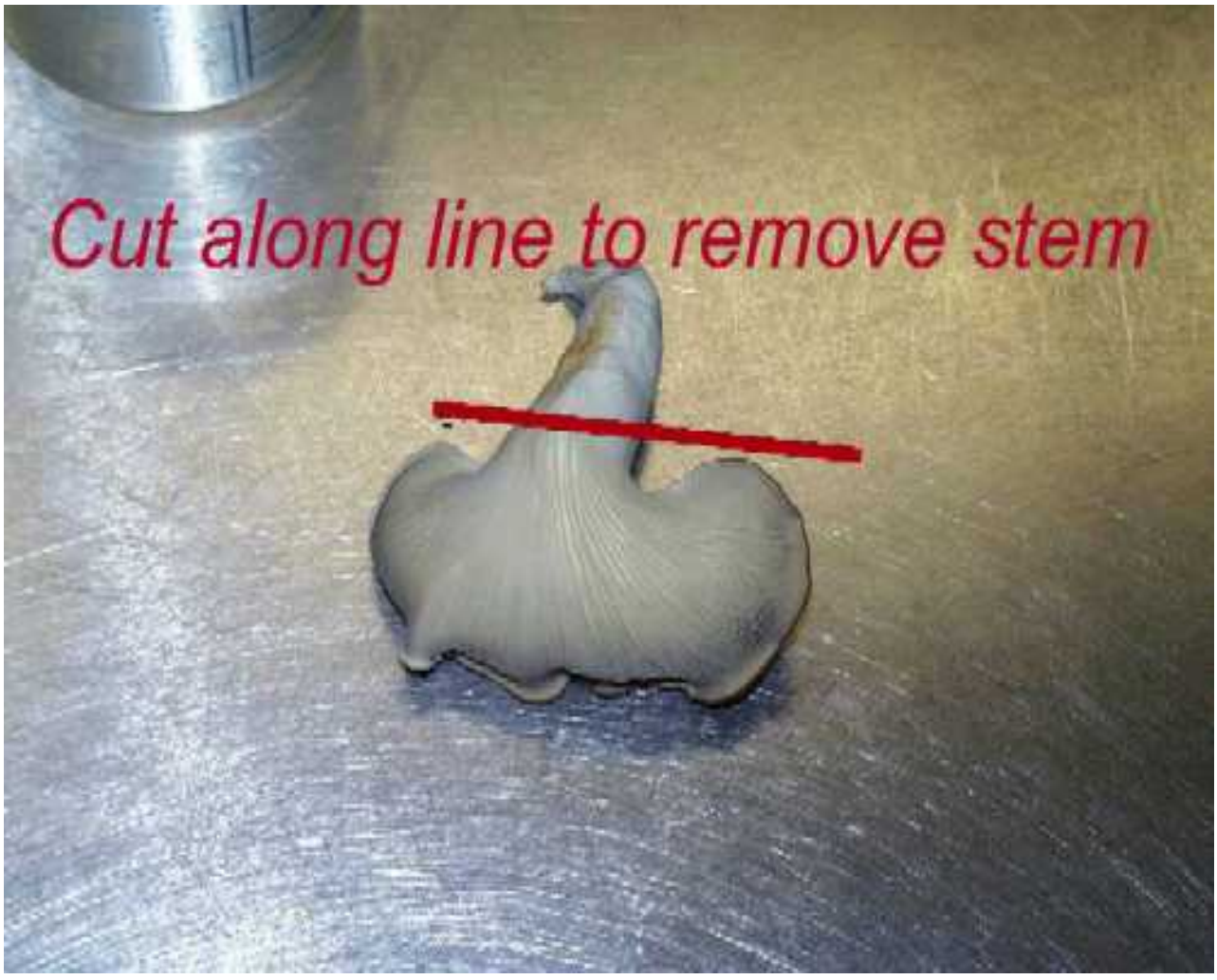
Making the Spore Print

Materials Needed

1. Fresh oyster mushrooms (Pleurotus variety), Can be found at most grocery stores.
2. Dark colored paper.
3. Glass cup or bowl, large enough to cover the mushroom cap.

Procedure

1. Remove the stem from the mushroom, so the mushroom will lie flat on the paper.



2. Place the mushroom with the gills down onto the paper.

3. Cover the mushroom with the glass or bowl.

4. Place the entire setup in an area that will not be disturbed (Or thrown in the garbage by spouses that don't quite understand the fun of mushroom cultivation).
5. Wait 1 - 2 days.
6. Remove the cover from the mushroom and discard the mushroom, there should be a white outline where the mushroom was, this is the spore print of the mushroom.

7. Proceed immediately to placing the spores into culture plate, to avoid increasing the risk of contamination.

Tabletop Mushroom Cultivation

Inoculating Spores on Media

Materials Needed

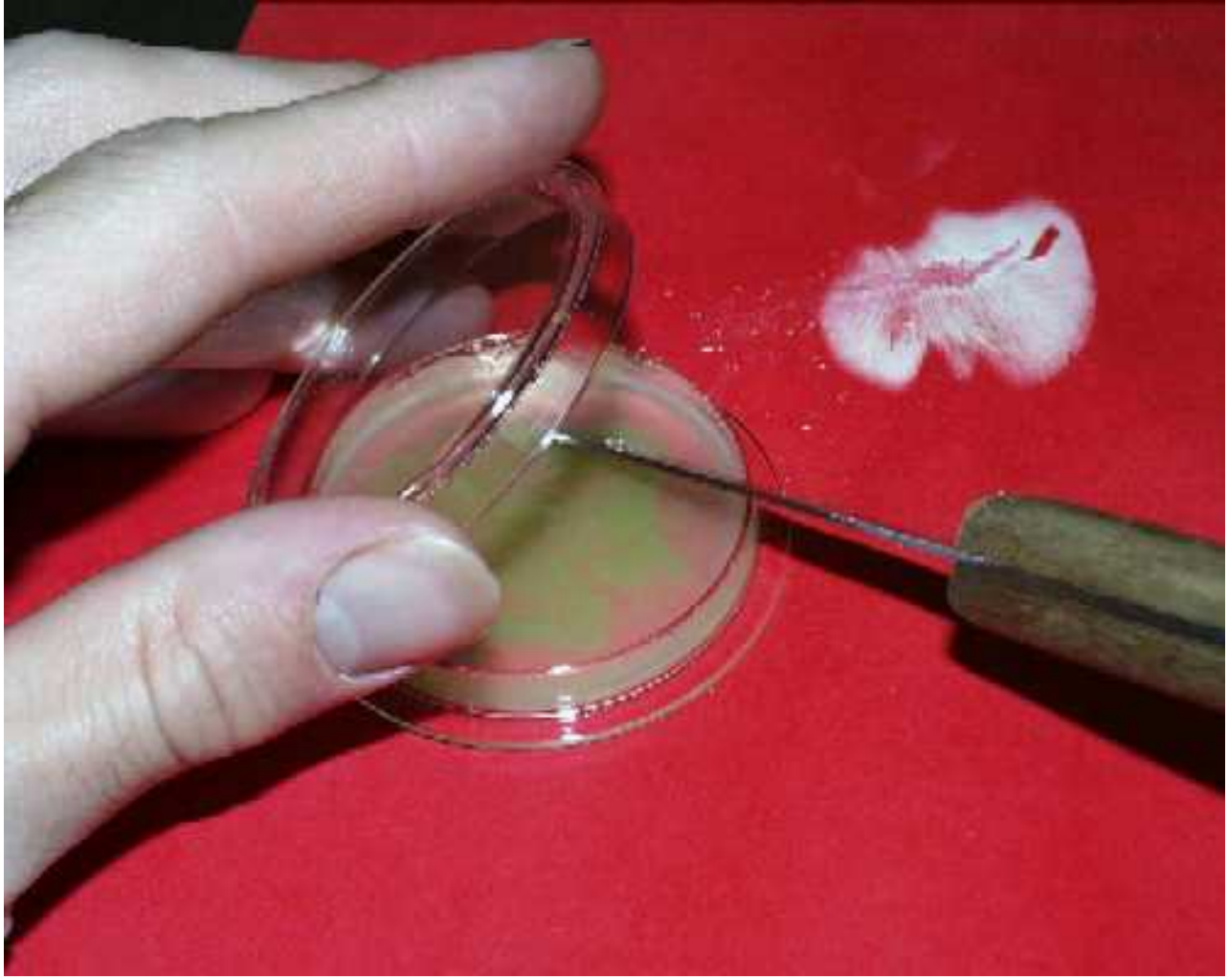
1. Culture plates made earlier.
2. Spore print made earlier.
3. Marking pen.
4. Knife.
5. Propane torch.
6. **Fire Extinguisher**

Procedure

1. Be sure to work in a clean, low traffic area to help prevent contamination.
2.
3. Light the torch and keep it at a low flame. **Extreme care must be taken when working with this. Follow manufacturer's recommendations on safety.**
4.
5. Pass the knife over the flame until the tip becomes red-hot.
6.

7. Allow the tip to cool, this may take a minute or two.
8.
9. Gently scrape one small area of the spore print, try to just pick up the spores of the mushroom on the knife and leave the paper fiber.
10.

11. Carefully open one of the culture plates, just exposing enough of the inside of the plate to enable the knife room to smear the spores over the surface of the media.
12.



13. Promptly close the culture plate tightly to avoid contamination.
14.

15. Label the plate with the mushroom type and the date.
16.

17. Clean any excess materials off of the knife.
18.

19. Repeat this procedure until you have the desired number of plates.
20.

21. Place the plates in a warm dark location where they will not be disturbed
22.

23. In several days, a white, stringy growth should begin to appear on the surface of the media. This material is mushroom mycelium.
24.

Tabletop Mushroom Cultivation

Preparing the Grain

Materials Needed

1. Grain (rye grain works best, however wheat grain has also worked). Grain needs to be fresh and dried. It can be purchased at health food stores and must contain no fungicides. Approximately 8 ounces of grain for each quart jar will be required
2. Seven ounces of bottled water for each quart jar.
3. Quart Mason jars, the number needed will be determined by the amount of mushroom desired.
4. Pressure cooker.
5. Screwdriver and Hammer
6. Cotton Balls
7. Aluminum foil

Procedure

1. To a one-quart Mason jar add 8 ounces of grain, 7 ounces of bottled water.


ALGENE

2. You will need to punch a hole in the top of the lid, do this with the screwdriver and the hammer.

3. Now fill the hole with a cotton ball, this process allows for air exchange, without allowing harmful bacteria into the jar.

4. Place the lid on the Mason jar, and screw the lid down.

5. Shake the bottle to mix the grain and water

6. Cover the jar with a piece of aluminum foil, this will collect any dust that may collect on top of the lid and can then be discarded later without allowing the contaminants to enter the jars.

7. Allow the mixture to set overnight
8. Place the jars in the pressure cooker and cook for one hour at 15 p.s.i.

9. Allow jars to cool and set overnight. Shake the jars to break up any clumps of grain then recook them at 15 p.s.i. for another hour.

10. Jars need to be shaken again, then they will be ready for inoculation with mycelium from culture plates.

IT IS RECOMMENDED THAT ANYTIME THE JARS ARE NOT IN DIRECT USE, THEY BE COVERED WITH FOIL

Tabletop Mushroom Cultivation

Inoculating the Grain

Materials Needed

1. Fully grown culture plate
2. Knife
3. Propane torch
4. Sterilized grain jars
5. Masking tape
6. Marking pen

Procedure

1. It is important that any culture plate or grain jar be opened only enough to allow the necessary task to be completed. The longer the plates or jars are open, the more susceptible to infection they will be.
2. Pass the lid of the grain jar through the flame of the torch. Turn the jar as you move it through the flame so the entire lid is heated.


DFR

3. Loosen the lid of the jar.
4. Heat the knife until it is red-hot. Allow the knife to cool.
5. Transfer approximately ¼ of a culture plate into the jar. Cut the media into pieces then lift each piece out separately and transfer it to the grain jar.

6. Once the transfer is complete, immediately tighten the lids on both the culture plate and the grain jars.

7. Shake the grain jars, the goal is to distribute the pieces of media throughout the jjar and to work them to the bottom of the jar.

8. Label the jar with the type of mushroom you are growing and the date the grain was inoculated with the media.

9. Store the grain in a low traffic, dark, warm area.

Grain Evaluation

1. Grain should have mycelium growing through it in several days. The mycelium will appear white and will take over the entire grain jar.

2. The growth will originate at the areas in direct contact with the culture that was added.
3. Several days after the growth is observed, the grain jars need to be shaken. This is accomplish the same way described earlier, the object is to distribute the grain with the mycelium throughout the entire bottle.

4. Grain bottles are shaken every 2 to 3 days until the entire bottle is colonized.
5. If any growth other than white mycelium appears, the grain is contaminated and needs to be discarded. This contamination may appear as any number of colored growths, (including black, blue, green, gray, or slimy). The jars may be reused, but must first be emptied and cleaned.
6. Completely colonized grain jar

Tabletop Mushroom Cultivation

Preparing Sawdust

Materials Needed

1. Containers that will hold 5 quarts of hot water.
2. Large spoon that has been sterilized by boiling in water for 20 minutes.
3. Large (33 gallon) trash bag.
4. Large strainer or 13 gallon trash bag.
5. 40 ounces of wood pellets (used for wood burning stoves). These pellets can be found in most hardware stores.
6. 1 quart grain jar that has full growth of mycelium.
7. Knife.
8. 5 quarts of water heated to 180 degrees.
9. Aluminum foil.
10. One gallon Ziploc Bags.

Procedure

1. Into the container add the 40 ounces of wood pellets.

2. To the wood pellets, add the 5 quarts of hot water. Cover the container with aluminum foil and let set for one hour.

3. The wood pellets will break down into sawdust. The excess water needs to be removed from the sawdust. This can be accomplished by straining the contents of the container or by dumping the contents into a 13-gallon trash bag, hanging the bag above a sink and cutting small holes in it to allow for water draining. (Using the trash bag makes for easier clean up as they are disposable). Allow the sawdust to drain for about 30 minutes.

4. Cover a working surface with a 33-gallon trash bag. This surface needs to be, as always, in a low traffic area.
5. Place the now strained sawdust on the 33-gallon trashbag and spread the material out. If it is not already cool, allow cooling until the material is room temperature.

6. Open the jar with the mycelium-covered grain. Using the sterilized spoon, scoop out the grain and add it to the cooled sawdust.

7. Break up any large pieces of grain and mix the grain in with the sawdust.

8. Pack the grain/sawdust mixture into a one-gallon Ziploc bag and seal the bag.

9. Puncture four small holes on each side of the bag with the knife.

10. Label the Zipoc bag with the date, and the type of mushroom.
11. Place the Ziploc bag in a dark, warm, low traffic area. (NOTE: The sawdust may continue to drain off excess water, so place the bag someplace where water drainage will not cause a problem, and/or place a towel underneath it to catch any water drainage.)
12. The 33-gallon trashbag can now be disposed of and should have made for easy clean up of the work area. The jar and other materials may be cleaned and reused for other cultures.

Tabletop Mushroom Cultivation

Soaking and Fruiting Mushrooms

Materials Needed

1. Large Bucket
2. Ice
3. Water (Bottled water is best, however do not use distilled water)
4. Completely colonized sawdust block

Procedure

1. Add ice to bottom of bucket.

2. Place colonized sawdust block in bucket.

3. Place more ice on top of colonized block; completely fill bucket with ice.
4. Fill bucket with water.

5. Sawdust block should be soaked in ice water for 2-3 days. Continue to add ice to keep water cold. The bucket may be placed in the refrigerator to aid in cooling.

6. After the colonized sawdust has been chilled for 2 - 3 days, remove it from the ice water and allow it to drain for several hours.

7. At this point, the mushroom block is set to fruit. For fruiting to take place, the sawdust block must maintain certain climate conditions. The temperature should be kept between 70 and 80 degrees. The humidity needs to be between 80 and 90 percent. The mushrooms also need sunlight and fresh air. All of these factors make fruiting very challenging.

8. How you achieve these conditions depends on time and space constraints. If you are only fruiting one or two bags, you may wish to place the bags in a window covered by a larger clear plastic bag with holes cut to allow air exchange. The high humidity can be maintained by misting the block several times a day. The humidity should be high enough that small water drops are always present on the inside of the bag.

9. If you are planning on fruiting larger quantities of mushroom blocks, you may wish to construct a small greenhouse. Depending on the size you construct it, you can use a room humidifier instead of misting bottles. Just remember, fresh air is also important, so allow for plenty of air exchange.

Herbs Indoors

If you have herbs growing outdoors, you can successfully transfer them into an indoor environment for the winter. Here, for example, is a clump of chives (**figure A**). Master gardener Michael Sherman first digs and divides a portion of the chive clump for growing indoors while leaving the rest of the plant in the ground to over-winter and return next year. And the process, drastic as it may appear, is as simple as stabbing into a section of the plant with a sharp trowel or knife. Just be careful to get as many roots as possible when you remove the clump. Plant the chives in a container filled with potting mix (**figure B**). Before you place the container in a south- or west-facing window, there's one more step to consider. Chives, as well as mint, oregano, rosemary, sage and thyme, will rebound much faster if you remove up to two-thirds of their top growth before you put them indoors (**figure C**). If you don't have a south- or west-facing window, you can always grow herbs indoors under fluorescent lights.

Figure A

You can also take cuttings. This technique is best for perennial herbs such as marjoram, mint, oregano, rosemary, sage, tarragon and thyme, and the ideal time of year to do it is at the end of the growing season. Just snip a six-inch section of stem and remove the lower leaves. Ideally, you should have six or eight sets of leaves above the cut. Place the cutting in a container (**figure D**) filled with perlite, coarse sand or a combination of the two. Water the plant well, and cover with a plastic bag to maintain humidity (**figure E**). Place the container in a cool, dimly lit area indoors. You don't need to dip herb cuttings in a rooting hormone because all herbs will root without it, and virtually all herbs will take root between three to six weeks, at which point you can go ahead and remove the humidity tent.

Figure B

The simplest way to grow herbs indoors, however, is from transplants, says Michael. "Transplants are virtually foolproof, and if you're lucky enough to find them this time of year at your local nursery, grab them."

Figure C

You can grow herbs individually or group an assortment in one container. Since they'll be on display in the house, James suggests putting them in a pretty pot. Add a little potting mix to the container, and tease the roots a bit before placing the herb in the soil. Add more potting mix, and tamp it down firmly around the root ball. In a larger container, James groups different herbs such as rosemary, sage and oregano.

Figure D

Figure E

"Shake things up a bit by combining three herbs, in this case, chives, parsley and thyme with a few veggie transplants including some mizuna and mustard (**figure F**)." And to sweeten the pot even more, James adds a small clump of violas (**figure G**). The flowers are gorgeous and edible.

Figure F

Of course, you can always start a number of herbs from seed indoors--in particular, basil and dill--which germinate within a week.

You might be disappointed, however, if you try to move large, container-grown herbs from the patio indoors--especially perennial herbs--because they simply don't adapt well to such an abrupt transition. "This large potted rosemary (**figure H**) looks great now," says James, "but it probably wouldn't last but a few weeks in the house." And of all the herbs that can be grown indoors, James says rosemary is arguably the most difficult. "That's not to say it can't be done, but you've got to baby it by giving it plenty of bright light, cool temperatures--ideally around 60 degrees--and high humidity, which may mean misting as much as three times a day." James leaves his large rosemary container outdoors and takes fresh snippets now and then to flavor whatever he needs as he needs it. "If the plant succumbs to a really hard freeze, I'll use the dried stems and toss them directly on the fire to flavor such dishes as grilled lamb, pork or fish."

Figure H

Aside from rosemary, most culinary herbs adapt well to the indoor environment during the winter months, provided they get bright light, regular watering and routine misting to maintain high humidity levels. Rotate the pots every few days so the herbs don't develop a lopsided look.

Chinese Vegetables

Foreign cuisines are of great interest to the American cook, but high quality, authentic fresh ingredients are sometimes difficult to find. Authentic Chinese cooking demands fresh vegetables which may only be available to you if you grow them yourself. Yet their use is not limited to Chinese cuisine. Many can be used as substitutes in or tasty additions to traditional American dishes.

The culture of most Chinese vegetables is not complicated. Chinese types of beans, squash, cucurbits (cucumber), and cole crops (broccoli, cabbage) are closely related to their "Western" counterparts and have similar cultural requirements (Table 1).

Chinese Water Garden

The Chinese water garden is an exception to the foregoing rule. Chinese lotus, water chestnuts, violet stemmed taro, and arrowhead require a wet growing environment, contrary to the conditions commonplace in American vegetable gardens. In the Orient, these aquatic plants are grown in flooded rice paddies.

You can simulate the conditions that these plants require with a little innovation. A typical, approach is to use a 25-gallon minimum capacity container for water in which smaller plant containers are submerged (except for lotus). The soil should be typical garden soil, not a peat-containing potting mix. You will also need to include some submerged oxygenating plants (SOP) and goldfish. The latter will help keep the water clear and insect free, and will be attractive in the water garden. SOP provide extra oxygen, which otherwise might be a limiting factor in a water environment. Prop the smaller plant containers up on bricks or rocks so the soil line is the proper depth below the water surface. Table 2 gives detailed cultural information on each crop.

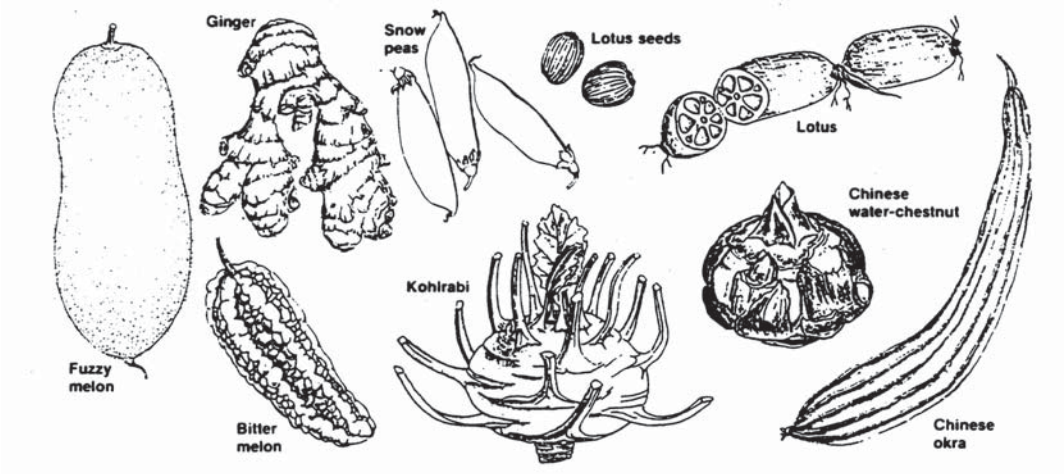


Table 1. Chinese Vegetables Suitable for the Conventional/ American Vegetable Garden.

English Name/ Chinese Name/ Latin Name	Seed Depth (inches)	Distance Between Plants/ Between Rows (inches)	Planting Dates South (Spring range/ Fall range)	Planting Dates North (Spring range/ Fall range)	Days to Maturity	Comments/Use
Azuki Bean Hong dow *Vigna angulans*	1/2-1	2-3/18-30	4-1/6-30 7-l/8-1	5-15/6-15 6-15/6-30	120	May be eaten as sprouts, fresh picked or dried. Edible pods. Beans have slightly sweet flavor. Usually prepared as paste for baking. Highly nutritious (25% protein).
Amaranth Cien choy *Amaranthus tricolor*	1/4	10-18/18	2-15/4-1 8-20/10-10	3-20/4-20 9-1/10-1	30-90	Brilliantly colored leaves usually grown as an ornamental. Use as spinach, raw or cooked. Also called tampala.
Asparagus Pea Bin dow *Psophocarpus tetragonolobus*	1/2	6/18	2-20/3-20 --	3-20/5-1 8-1/9-15	50	Tastes like asparagus. Harvest pods when 1 in. long. Use in stir fry and soups. Whole plant, including flowers, edible. Also called goa bean, princess pea, winged bean.
Bitter Melon Koo gwa *Momordica charantia*	1	36-48/48-60	4-20/6-1 8-15/10-1	5-15/6-15 7-15/9-1	60-75	Ornamental vine that produces bitter quinine containing fruit that must be parboiled to eat. Use in stir fry and soups. Also called balsam pear, la-kwa, and bitter gourd. Extracts of plant have been used for medicinal purposes.
Broccoli, Chinese Gai lan *Brassica oleracea* Alboglabra Group	1/2	6/12	3-15/4-5 7-1/8-15	4-1/5-1 7-1/8-1	60-80	Stalks split and prepared as common broccoli. If peeled and split, stems cook faster. Also called Chinese kale.
Burdock Ngan pong *Arctium lappa*	1/2-1	6/20	3-1/4-1 8-1/9-1	3-15/4-10 7-1/7-20	45	Although roots generally eaten, the young leaves and stems are edible. Scrub or scrape to prevent darkening and remove bitterness. Crisp texture remains even in cooked dishes.
Celery Cabbage, Chinese Pai tsai *Brassica rapa* Pekinensis Group	1/2-1	14-30/30-36	3-1/4-1 8-1/9-1	3-15/4-10 7-1/7-20	70-80	Use as regular heading cabbage stir fried or pickled. Forms tight upright head.
Chives, Chinese, Garlic Gow choy *Allium tuberosum*	1/2	8/12-14	3-15/4-5 --	4-1/5-1 --	24-90	Stronger flavor than ordinary chives. Decorative plant and flowers. Also called oriental garlic.

Cucumbers, Chinese Tseng gwa *Cucumis sativus*	1/2-3/4	36/48	4-20/6-1 6-1/8-1	5-15/6-15 6-1/7-15	60	Small seeded fruit is original "burpless" type. Eat raw, pickled or cooked. Mature fruits are stuffed. Young fruits with flowers attached are eaten as appetizers.
Eggplant, Chinese Ai gwa *Solanum melongena* var. *esculentum*	1/2	18-24/30-36	5-1/6-1 6-1/7-1	5-15/6-10 6-1/7-1	60-75	Small white fruit on some varieties. Good for pickling, sauteeing, or frying.
Fava Beans Fu dow *Vicia faba*	2 1/2	4-6/18-24	4-1/6-30 7-1/8-1	5-15/6-15 6-16/6-30	65-90	Young pods edible, may be shelled like peas or left to produce dry beans.
Flowering Cabbage Hwa choy *Brassica oleracea* Acephela Group	1/2	8-10/t6	3-1/4-1 8-1/9-1	3-15/4-10 7-1/7-20	55-75	Shred, boil, bake, stuff as regular cabbage. Beautiful red, pink, and green combinations of leaves often grown as ornamentals.
Fuzzy Gourd Jiet gwa *Benincasa hispida*	1	36/48	4-20/6-1 6-1/8-1	5-16/6-15 6-1/7-15	75-85	Used in ways similar to zucchini or squash. Fruit must have fuzz and skin removed before being eaten. Also called Chinese watermelon, Chinese preserving melon.
Garland Chrysanthemum Tong how tsai *Chrysanthemum coronarium*	1/4-1/2	6-12/18	2-20/3-20 8-15/10-1	3-20/5-1 7-15/9-1	25-60	Leaves and stems are used as greens for a distinctive flavor, Dried flower petals are used in soups and stir fried dishes.
Giant Garlic Suan *Allium sativum*	2	12/12	2-20/3-20 --	3-15/4-15 --	180	Milder flavor than common garlic. May be eaten raw or blended into butter. Shoots may be used like chives.
Ginger Giang *Zingiber officinale*	3	16/24	5-1/6-1 --	5-15/6-10 --	90-130	Rhizome used in all types of dishes from meats to confections. Added to stir-fry oil before vegetables, it imparts a "warm" flavor.
Hot Peppers La chiao *Capsicum frutescens*	1/4	18-24/24-36	5-1/6-1 6-1/7-20	5-15/6-10 6-1/7-10	65-85	Use with discretion as a seasoning. Very hot fruit is used raw or dried.
Multiplier Onions Chang fa *Allium fistulosum*	1/2	10/18	3-1/4-1 --	3-10/4-10 --	55-120	Use as scallions in stir fry or raw on relish tray. Mild onion flavor. Hollow leaves may reach 3 ft.
Mung Beans Nga choy *Vigna radiata*	1/2	6-8/24	4-1/6-30 7-1/8-1	5-15/6-15 6-15/6-30	90-120	May be eaten as sprouts (Yah tsai) or in a later stage such as edible green pods. Beans will be sticky if boiled.

Mustard, Chinese Gai choy *Brasslca juncea*	1/4	4-10/12	3-15/5-15 8-15/10-1	4-1/6-1 7-15/9-1	35-50	Use as salad green. Commonly pickled, but may be stir-fried.
Muslard Cabbage, Chinese Bok choy *Brassica rapa* Chinensis Group	1/4	6/18	3-1/4-1 8-1/9-15	3-15/4-10 7-15/8-15	35-50	Leaves cooked as spinach, stalks used like asparagus. Growth habit similar to celery or chard.
Okra, Chinese (Luffa) Shuh gwa *Luffa acutangula*	1	36-48/48-60	4-20/6-1 6-1/8-1	5-15/6-15 6-1/7-15	115	Prepare immature fruit as squash or cucumber. Pare off ridges, but leave other skin intact. Mature fruit can be dried and used as sponges. Highly prolific, vigorous vine.
Parsley, Chinese Yjen tsai *Coriandrum sativum*	1/4	4-6/18	3-10/4-10 8-1 /9-15	4-1/5-1 7-15/8-15	60	Seeds have citrus-spice flavor, Add leaves as a seasoning . Plant is also called coriander. Chopped leaves especially fine with poached fish.
Pickling Melon Chung choy *Cucumis melo* Conomon Group	1/2	36-48/60-120	4-20/6-1 6-1/8-1	5-15/6-15 6-1/7-15	65	Use in any standard pickling recipe. Can also be cooked or eaten raw as a vegetable.
Polherb Muslard, Chinese Mizuna (Japanese name) *Brassica juncea* var. *crispifolia*	1/4	12/18	3-15/5-15 8-15/10-1	4-1/6-1 7-15/9-1	30-60	Leafy foliage attractive in salads. Rich in vitamins.
Pumpkins, Chinese Nang gwa *Cucurbita pepo*	1	18-36/60-90	4-20/6-1 6-1/8-1	5-1/5-30 6-1/7-15	130	Used in some ways as squash and pumpkins in soups, pies, baked or fried. Can be stored all winter.
Radish, Chinese Luo buo *Raphanus sativus* 'Longipinnatus'	1	2-10/12-30	3-1/5-1 3-15/10-15	3-20/5-10 8-1/10-1	60-80	Grate, steam, stir fry, pickle, boil or sculpture fleshy root. Leafy tops edible also. Large and very long root. Also called Japanese daikon. Many cultivars are available.
Sesame Chih ma *Sesamum indicum*	1/2	9/36	4-20/6-1 7-1/7-15	5-15/6-15 6-15/7-20	30-45	Seeds eaten raw or roasted. Oil from seed has nutty flavor and is the oil of stir-frying or deep frying.
Snow Peas Ho lan dow *Pisum sativum* var. *macrocarpon*	2	2-3/18-30	2-20/3-20 --	3-20/5-1 --	50-85	Use as soon as picked. Combines well with fish dishes. Add to stir-fry only in last few seconds of cooking.
Soybeans Huang dow *Glycine max*	1/2	2-3/24-30	5-1/6-30 6-1/7-15	5-15/6-15 6-1/7-5	75-115	Mildly nutty flavor. May be served as sprouts, roasted or dried. Harvest green or dry.

Sweet Melons Chung Gwa *Cucumis melo*	1	18-36/60-72	4-20/6-1 7-1/7-15	5-15/6-15 6-15/7-20	115-130	Similar to cantaloupe or honeydew.
Winter Melon Doong gwa *Benincasa hispida*	1	18-36/48-60	4-20/6-1 6-1/8-1	5-15/6-15 6-l/7-15	150	All parts (young leaves, flower buds, both immature and mature fruit) may be used.
Yard-Long Beans Gauk dow *Vigna unguiculata* spp. *sesquipedalis*	1/2-1	48-60/24	4-20/6-30 7-1/8-15	5-10/6-30 7-l/8-1	60-90	12 to 16-inch beans can be used as common green beans. Grow on trellis or teepee supports to 8 ft. high.

Table 2. Chinese Water Garden Vegetables.

English Name/ Chinese Name/ Latin Name/	Minimum Pot Size (inches)	Depth to Plant in Soil (inches)	Water Depth Over Soil (inches)	When to Plant	What to Plant	What/When to Harvest	Comments/Use
Arrowhead Chee koo *Sagittaria sagittifolia*	7 diam 5 deep	1	3-6	after danger of frost	tuber	tuber/all year	Tubers are not edible raw. Like a slightly nutty sweet potato, eat roasted or boiled. Also called swamp potato.
Chinese Lotus Lien ou *Nelumbo nucifera*	25 gal	2 (with growing tip visible on soil surface	10	after danger of frost	rhizome or by seeds	buds, flowers, seed pods/as soon as formed/ rhizomes (or root)	All plant parts can be used, raw or cooked, as greens, in soups, etc. The “roots” (swollen stems which grow in the mud) are most often used in fried, baked, or raw form. They resemble huge sausage links, reddish brown in color.
Violet Stemmed Taro Yu tou *Xanthosoma violaceum*	7 diam 5 deep	1	3-6	after danger of frost	tuber	roots/end of season after foliage dies	Root similar to potato with rough skin. skin. Use like potato. Alsocalled blue taro. Can be confused with Taro (*Colocasia esculenta*) which is also used in Chinese cuisine.
Water Chestnuts Boh chi *Eleocharis dulcis*	7 diam 5 deep	1	3-5	after danger of frost	tubers or corms	“nuts” (corms)/ after 6 months of growth	“Chestnuts” form in mud at base of stem. Walnut size or smaller. Peel tough skin, eat raw or cooked.

GROW BAMBOO

USES: Mention “Bamboo” and you will get a varying array of responses. Anyone who has ever had to dig out unwanted Bamboo will scowl and cuss at the very mention of it. Yet, anyone who has ever had the opportunity to spend time in a Bamboo garden will fondly recall the sheer beauty and tranquility that it has to offer. Bamboo is a remarkable resource that, when used properly, offers many possibilities in the home garden. Need a quick screen? Want to create a windbreak? Like to add subtle noise to your garden? Have a hill that has erosion problems? Need some shoots to harvest for your next stir-fry? Bamboo provides solutions to all of these scenarios.

There are many myths to Bamboo that, unfortunately, lead to its bad reputation. A truly beautiful plant that is tough, resilient and easy to care for, Bamboo deserves to be used more in the home landscape. There are over 1200 species of Bamboo throughout the world, ranging from small, grass-like ground covers to 90-foot tall timbers so there is certain to be one to suit your needs. This guide will take you through the care and culture of successfully growing Bamboo in your landscape and, hopefully, aid in putting some of these myths to rest.

TERMS: Before delving into Bamboo care and culture there are a few terms related to Bamboo that one should be familiar with:

Culm: This is the “stalk” of the Bamboo. Usually hollow, except at the nodes, culms do not thicken but emerge from the ground at their final girth. Node: The solid, swelling ring on the culm where branches originate. Internode: The area of the culm between nodes. Sulcus: A pronounced groove throughout the length of an internode caused by the presence of a developing branch bud at the base of the internode, grooving the culm as it elongates. Branch: Emerging from the nodes on alternate sides, branches are usually formed from a single bud. Sheath: The protective wrapping around newly forming culms. They provide structural rigidity and protect against impact, disease and pest attack. Shoot: The new, leafless culm that emerges from the soil. Rhizome: The underground stems from which new shoots originate.

RUNNING vs. CLUMPING: There are two primary types of bamboo: running and clumping.

Running bamboo has a very aggressive root system that, if not controlled properly, can become a problem. It spreads rapidly through the soil sending up shoots at varying distances away from the parent plant. It is this type of Bamboo for which the bad reputation exists. Running Bamboo should always be planted within a barrier (see CONTROLLING SPREAD below).

Clumping bamboo does not send out the long runners, instead sending up shoots in a fairly compact manner. Be advised, though, that clumping Bamboo is still very strong and will continue to expand it’s clump in all directions, so for this reason should not be planted alongside a fence as it can eventually push the fence over.

CONTROLLING SPREAD: The ability of Bamboo to spread rapidly has, unfortunately, led to a bad

reputation for the plant. Running types of bamboo should always be planted with a root barrier installed. The barrier is made of a high density black plastic 2' in depth and is inserted into the ground around the desired perimeter of the Bamboo grove, overlapping a few feet at the seam. It is advisable to keep the overlap portion at a spot where it can be easily monitored in the event a rhizome should escape. When installing the barrier it should be left 2" above the soil level and should tilt outward slightly so that any rhizomes colliding with the barrier will be directed upward. Each spring the barrier should be examined to ensure no rhizome has escaped. In the rare event a rhizomes leaps the barrier it should be cut off or rerouted within the barrier.

SHOOTING: The true excitement of growing Bamboo is the period when they begin "shooting". Shooting is when the shoots begin to emerge from the ground at full diameter of the new culm. Yes, a mature culm that is 4 inches in diameter will emerge from the ground 4 inches in diameter. The culms then thrust skyward at an astonishing rate – more than 3 ft. in a 24-hour period for some species! The branchless, elongating culms continue skyward until they have reached their mature height, at which point the branching begins. Warm weather and moisture encourage shooting. Running types will do the majority of their shooting in spring and early summer while clumpers start in mid-summer and continue to fall. In both cases shooting could occur at any time if the conditions are right, although late season shoots will remain branches until the following spring.

THINNING: Thinning is essential for a healthy and attractive Bamboo grove. Thinning is the process of removing culms to allow for sunlight to penetrate the grove and should be performed in late fall or early winter. Once the grove or clump has become fairly dense, start with removing damaged culms and then move on to the older culms, those that are 3-5 years in age. Culms should be cut clean at ground level. In clumping types, culms will need to be removed from the middle of the clump to keep the clump from becoming impacted at their centers and also to remove old growth making way for healthy new growth. It is best to clear clumping types before they become too large to manage.

LIMITING HEIGHT: Ideally Bamboo should be selected for its specific height and be allowed to grow unlimited. In the instance where height needs to be controlled there are two methods, either by modifying growing conditions or by manual pruning. The amount of water and fertilization that plants receive directly affect their growth. Minimal water and little to no fertilizer will limit growth, especially in poor soils. Height may also be controlled by cutting the tips off of the shoots once they reach the desired height. At this point the shoots will stop growing and push out their branches and leaves.

WATER: Bamboo can be fairly drought tolerant, but looks its best when given ample water. The soil should be kept moist, but not soggy and should drain well. When using drip irrigation on running types of Bamboo, be aware that heads will also need to be placed away from the original planting to encourage rhizome spread and development.

SOIL & PLANTING: Although Bamboo will survive under adverse conditions and is not particularly fussy, the best soils promote rapid growth and the most attractive plants. Bamboo prefers fertile soil rich in organic materials. It should be loose and well-drained and slightly acidic. Clay soils should be amended well to improve drainage. A mixture of 1 part Master Nursery Azalea, Camellia Gardenia Mix with 1 part Master Nursery Top Soil Plus with 1 part native soil will suffice.

When planting a hole should be dug twice as wide and the same depth as the container. Amend your soil as described above and be sure to add the recommended amount of Master Nursery Master Start fertilizer. The plants

should be planted such that they are slightly above the original soil line and watered thoroughly immediately after planting. Spacing of running types will be determined by how fast the coverage is desired for that particular location. Clumping types should be spaced to allow for their mature height and spread.

FERTILIZING: According to a 19th-century Bamboo cultivation book it is recommended to use "the dead bodies of sheep, dogs, cats and rats as well as the skins, bones and hoofs of cattle and horses". It's a good bet your neighbors may not appreciate this approach so it's best to stick to the packaged fertilizers of the 21st-century.

Keep in mind the Bamboo is a form of grass. Therefore, to encourage quick growth and spread, feed in early spring as shoots are developing with a good lawn food such as Master Nursery Master Green Lawn Food (never use a "weed and feed" type of fertilizer) and continue periodic feedings throughout the growing period. This will provide the nitrogen necessary to promote strong shooting. In the fall switch to Master Nursery Master Bloom 0-10-10 as fall is when the plant is storing up nutrients for spring. Master Bloom will supply the necessary nutrients to ensure strong root development during this period.

MULCH: Bamboo benefits greatly from a layer of mulch. Placing a 3-6 inch layer of mulch helps keep the rhizomes warm and moist and protects them from temperature extremes as well as adding much needed organic material back into the soil. Materials used for mulching include bark, pine needles, straw, leaf humus, fully composed manures and, most commonly, the natural leaf drop associated with Bamboo. One caution with mulch, though, it that if it covers the root barrier (see CONTROLLING SPREAD) you still must check the barrier each spring for errant rhizomes.

PESTS: Fortunately there are relatively few pests that attack Bamboo. One of the most common will be aphids in the spring. Although they are not a real threat to the plant, they leave behind a sticky excretion that fosters an unsightly black, sooty mold. Aphids can be controlled a number of ways including releasing ladybugs or spraying with horticultural oils or soaps. Another pest that may occur on occasion are mites. These tiny spiders appear when the weather turns warm and suck the juice from the leaf cells, leaving behind a stippled look to the leaf. Again, they are not a real threat to the plant and can be controlled with a miticide. And, of course, deer, rabbits and squirrels may go after the tasty new shoots as they emerge so repellents will need to be in place during the shooting season.

CONTAINER GROWING: Bamboo makes for an excellent choice for containers. Because the culms (stalks) are hollow they are actually much lighter in weight than most container grown plants thus making them easy to move. Strategically placed, bamboo in a container can instantly make a much needed privacy screen. They can also play a transitional role providing a temporary screen until a new tree or shrub grows to size, or as a supplemental screen in the winter months when deciduous trees lose their leaves.

When potting bamboo, use a 50-50 mix of Master Nursery Camellia, Azalea, Gardenia Planting Mix and Master Nursery Top Soil Plus. This will give you a rich, acidic soil but will also provide the drainage bamboo requires. Feed monthly from March thru October with Master Nursery Formula 49 organic fertilizer to ensure strong shoot growth and to provide essential micronutrients.

Home Fruit Planting Guide

A home fruit planting carefully selected, properly located, and well managed can enhance the home landscape, provide high-quality fruits and serve as a satisfying hobby.

The home fruit garden requires considerable care. Thus, people not willing or able to devote some time to a fruit planting will be disappointed in its harvest.

Some fruits require more care than others do. Tree fruits and grapes usually require more protection from insects and diseases than strawberries and blackberries. Generally speaking, flowers and fruits of fruit trees must be protected by pesticide sprays from before blossom-time until harvest. In addition, sprays may be required to protect leaves, the trunk, and branches.

Small fruits are perhaps the most desirable of all fruits in the home garden since they come into bearing in a shorter time and usually require few or no insecticide or fungicide sprays.

Fresh fruits can be available throughout the growing season with proper selection of types and cultivars (varieties).

Soils and Sites

Avoid poorly drained areas. Deep, sandy loam soils, ranging from sandy clay loams to coarse sands or gravel mixtures, are good fruit soils. On heavier soils, plant in raised beds or on soil berms to improve drainage.

All fruit crops are subject to damage from late spring freezes. Hills, slopes or elevated areas provide better air drainage and reduce frost damages. Make certain that the air can move freely throughout the planting site and is not “boxed” in with surrounding terrain or tree borders.

Heat from houses, factories, and other structures in urban areas frequently keep the temperature 4 or 5 degrees warmer than surrounding rural areas.

Fruits do best in full sun. They can tolerate partial shade, but fruit quality will be lowered.

Size of Planting Area

Plan the planting to fit the area involved as well as family needs. A smaller planting, well cared for, will usually return more quality fruit and enjoyment to the grower than a larger neglected one. One-half acre or less planted to adapted cultivars of the best kinds of fruit is usually adequate for the average family.

Plan Your Planting

Develop a planting plan well in advance of the planting season. Determine the kinds of fruits, cultivars, and quantities of each needed. Locate a source of plants and make arrangements for plants to be available at the desired time of planting.

Perennial weeds such as bermudagrass and johnsongrass compete heavily with young plantings and should be eliminated before planting. This can be done by spraying with a post-emergence herbicide such as glyphosate (Roundup‰) in late summer the year before planting or by shading out weeds by growing hybrid sudangrass for the year prior to planting.

Strawberries especially should not be planted in newly turned under bermudagrass sod. Not only will the bermudagrass regrow and cause extreme competition problems because of the short height of the strawberry plants, but the white grubs that frequently infest bermudagrass sod can destroy the strawberry roots.

For best survival and production, supplemental water should be provided in the summer. Locate your plantings near a water source.

Planting

If possible, set the plants immediately after arrival. If roots are dry, completely immerse the roots in water for a few minutes or overnight before planting. Always water plants immediately after planting.

Never allow the roots to dry out or freeze. When planting is delayed several days, heel in trees by forming a mound of loose soil or mulching material. Place the roots into this mound, cover them, and moisten. The trees may be vertical or horizontal as long as the roots are covered. This protects them from drying or freezing.

Set trees about the same depth that they grew in the nursery row. Trim off broken and dried roots. Place topsoil around the roots and firm the soil to exclude air. Settle the soil with water and make sure the roots are left in a natural outward position. Leave a small basin one or two inches deep around the tree to aid in watering. Prune back about one-third of the tree top. Wrap the trunk from the soil line up to the first branches (or 18 inches above the ground) to protect the trunk from sunscald, rodent injury, insect damage, and drying out.

Cultural Practices

During the first summer, cultivate or mulch around the fruit plants to reduce competition from other plants and to conserve moisture and fertility. Irrigation is especially important in the first few years while the planting becomes established.

Pollination

Pay close attention to the pollination requirements of the different fruits to avoid disappointment. Many fruits require that the flower is pollinated with pollen from a different cultivar of the same fruit or the fruit will not develop. Planting only one cultivar of these fruits often results in masses of blooms in the spring, but few or no fruits. Different strains of the same cultivar (e.g. two spur strains of 'Delicious') will not provide proper cross-pollination.

There are a few cultivars of apple and pear that do not produce viable pollen. If one of these cultivars is planted, two other cultivars will need to be planted (a total of 3) to provide adequate pollen for all. Sometimes some apple cultivars are listed as self-fertile in nursery catalogs, but for consistent production of the best quality fruit, cross-pollination with another cultivar should always be provided.

Duke cherries are hybrids between sweet and sour cherries. They can be cross-pollinated by either sweet or sour cherries, but Duke cherries should not be counted on to cross-pollinate sweet cherries.

All fruits in the accompanying table that are not marked as requiring cross-pollination are self-fertile, meaning that a cultivar of those fruits can set fruit with its own pollen.
Highbush blueberries will set much better crops if cross-pollination is provided. Rabbiteye blueberries require cross-pollination. Highbush and rabbiteye blueberries will not pollinate each other.

Dwarf Trees

Dwarfing rootstocks enable fruit trees to be grown in much smaller areas than standard-sized trees. The term 'dwarfing' refers to a tree smaller than when grown on seedling rootstocks, even if only 10 to 15 percent smaller. The degree of dwarfing varies with the rootstock. In general, semi-vigorous rootstocks will produce a tree about 3/4 the size of a standard tree, semi-dwarf about 1/2 sized, and fully dwarfing rootstocks produce trees 1/3 of standard size or smaller.
Genetic dwarf fruit trees are available but generally are not satisfactory. 'North Star' sour cherry is an exception.

Types of Fruit

Apples—M.9 and M.27 rootstocks produce fully dwarfed trees (6-8' tall and 4-6' tall respectively). Both produce shallow, weak root systems and require staking or trellising, and regular watering. Dozens of other size-reducing apple rootstocks exist, but the best for the U.S. is MM.111. MM.111 will produce a tree that is 25 percent smaller than on seedling rootstock, but very well anchored and drought resistant.

Interstem trees, with a MM.111 root system, 8 to 10 inches of trunk of M.9 or M.26 and with the fruiting cultivar grafted on top combine the anchorage of the MM.111 with the dwarfing of M.9 or M.26 to produce a tree 8 to 10 feet tall that will not need support. Interstem trees are more costly and less available than single graft trees.

Spur-type strains of apple cultivars have more spurs and fewer long branches than the non-spur strains. They are smaller growing and preferred where available.

Pear—Quince is the standard dwarfing rootstock for pears, but will require support. Quince rootstocks are less cold hardy than pear, and are very susceptible to fireblight. Quince C is the most dwarfing, producing a 1/4 to 1/3 size tree. A new series of pear rootstocks, the OHXF series (from a cross between 'Old Home' and 'Farmingdale'), is entering the nursery trade, and offers a variety of tree sizes from 1/4 to 3/4 standard size.

Pears are very susceptible to the bacterial disease, fireblight. Only cultivars with known resistance to this disease should be planted. Even with blight resistant cultivars, pruning out infected shoots 12-18 inches below the infection as soon as they appear will be necessary to prevent disease buildup. Pruning shears should be sterilized between cuts. More information on fire blight control is available at your local county Extension office. The 'Magness' cultivar should be planted with two additional cultivars since it does not produce viable pollen.

Peach—There are no satisfactory dwarfing rootstocks for peach at present; however, 'Halford' or 'Lovell' are good choices. *Many nurseries use Prunus besseyi seedlings*, but often there is delayed graft incompatibility and tree death. Tree height on peaches can be kept to 6-8' by judicious annual pruning. Well-drained, deep, open-type soils of reasonable fertility are preferred. A spray program for insects and diseases beginning with a dormant application and continuing through fruit growth is required to produce clean fruit. Peach tree borer control is a necessity.

Plum—There are no satisfactory dwarfing rootstocks at present for plums. General cultural requirements are similar to peaches. The Japanese plums bloom earlier than the European types and are more subject to late spring frost damage. European and Japanese plums should not be depended upon to pollinate each other.

Cherry—There are no satisfactory dwarfing rootstocks at present for cherries. Many sweet cherries are not adapted to a hot, dry climate. Cherry leaf spot, plum curculio and poorly drained soils are the major obstacles to successful cherry production in the U.S. The diseases and insects can be controlled successfully with a series of sprays. Sour cherries are generally better adapted than sweet cherries. Sweet cherries in general require cross-pollination; but two cultivars, 'Stella' and 'Lapins', are self-fertile.

Apricot—There are no satisfactory dwarfing rootstocks at present for apricot. Apricots bloom early and are usually killed by late spring frosts. The tree is very ornamental when in bloom, and tree-ripened apricots are delicious, but do not expect consistent production.

Strawberry—Strawberry roots are usually found in the 12 to 18 inch top layer of the soil. Most of the root system is in the first 6 to 8 inches of soil. This stresses the importance of

supplemental irrigation and mulching for this crop. For continued good production, strawberry plantings should be renovated each year after harvest. Purchase virus-tested plants only. A production of one to two quarts of berries per three foot section of row should be possible each year.

Blueberries—Blueberries require a soil pH of 5.0 to 5.2. Highbush blueberries are best adapted to northeastern U.S. They will do best when protected from hot, drying winds. Rabbiteye blueberries are best adapted to southeastern U.S. Highbush blueberries must have supplemental irrigation and mulch of woodchips, sawdust or pecan shells to survive. Rabbiteye blueberries also need irrigation and will benefit from mulch.

Raspberries—Raspberries, generally, are not too productive because of the fluctuating temperatures during winter. Black raspberries, if well watered and mulched, can be successful.

Blackberries—Erect thorny blackberries are the most commonly grown and do not require trellis support. Care must be taken to maintain the rows no more than one to two feet wide to facilitate harvesting. Sucker plants that come up between the rows may be dug and moved into the row or merely removed as soon as they emerge.

Trailing thornless blackberries have smooth, arching canes, and require support on a trellis. Fruit quality is improved if the fruit are allowed to ripen to a dull black rather than a glossy black color.

Grapes—Grapevines will require support on a trellis, arbor or fence. Planting in north-south rows will increase production. Some protection from southwestern winds is desirable. Occasional supplemental watering during the fruit ripening period will improve fruit quality. Annual pruning is necessary to maintain a balance between plant growth and fruit production. It is common to remove 95 percent of the previous season's growth when pruning.

Persimmon—Oriental persimmon trees will bear fruit without pollination. Oriental and American persimmon trees will not cross-pollinate. Oriental persimmons may not be winter hardy in northern parts of the U.S.

HOME FRUIT PLANTING GUIDE

Kind	*Suggested Varieties* **	*Season of Harvest*	*Remarks*	*Suggested Planting Distance In Feet*	*What to Buy*	*When to Plant*
APPLES	* Lodi	June 25-July 6	Yellow, soft, cooking only.	Standard 25 to 30 or Semi-Standard 18 to 25 or Semi-dwarf 15 to 20 Spur-Types 15 to 22 or	One year old trees	Fall or Spring
	* McLemore	July 10-July 25	Red, dessert and cooking			
	* Gala	Aug 10-20	Orange-red, dessert only.			
	* Jonathan	Aug 25-Sept 10	Red, dessert & cooking. Very susceptible to fireblight and cedar-apple rust.			
	* Delicious (red)	Sept 1-10	Red, dessert only.			
	Liberty	Sept 1 -10	Red, dessert and cooking very disease tolerant			
	Freedom	Sept 1 -10	Red, dessert and cooking very disease tolerant			
	Arkansas Black	Sept 10-20	Purplish-red with yellow flesh, dessert and cooking, tolerant to cedar apple rust			
	* Golden Delicious	Sept 10-20	Yellow, dessert & cooking. Well adapted.	Dwarf 8 to 14		
	* Braeburn	Sept 10-20	Orange/red blush over yellow, dessert and cooking			
	* Fuji	Sept 10-20	Yellow, dessert and cooking			
PEACHES	Candor	June 18-24	Yellow, semi-cling	20x20	June bud trees from the south or dormant bud (one yr.) trees from the north	Fall or Spring
	Sentinel	June 28-July 3	Yellow, freestone			
	Redhaven	July 2-7	Yellow, freestone			
	Reliance	July 4-9	Yellow, freestone			
	Ranger	July 8-13	Yellow, freestone			
	Glohaven	July 15-20	Yellow, freestone			
	Nectar	July 15-20	Yellow, freestone			
	Jayhaven	July 21-27	Yellow, freestone			
	Cresthaven	July 28-Aug 3	Yellow, freestone			
	Autumnglo	Aug 6-10	Yellow, freestone			
	Quachita Gold	Aug 13-17	Yellow, freestone			
	White Hale	Aug 13-17	Yellow, freestone			
	Starks Encore	Aug 20-25	Yellow, freestone			
	Fairtime	Sept 13-20	Yellow, freestone			
NECTARINES	EarliBlaze	July 3-9	Yellow, semi-freestone	20x20	June bud trees from the south or dormant bud (one yr.) trees from the north	Fall or Spring
	Redchief	July 15-20	White, freestone			
	Cavalier	July 21-27	Yellow, freestone			
	Sunglo	July 27-Aug 2	Yellow, freestone			
	RedGold	Aug 6-11	Yellow, freestone			

PLUMS							
(European)		Stanley	Aug. 20-Sept. 10	A prune plum, self-fruitful	20x20	One year old	Fall
	*	Bluefre	Sept 1-15	Stanley x President cross		trees	or Spring
	*	President	Sept 10-20	Large, late ripening			
(Japanese)	*	Methley	June 15-25	Red flesh, partly self-fruitful	20x20	One year old	Fall
		Bruce	June 15-25	Very productive, self-fruitful		trees	or Spring
	*	Ozark Premier	Aug. 10-20	Large, yellow flesh			
CHERRIES		Early Richmond	May 20-June 1	The standard of sour or pie cherry,very consistent	20x20	One or two year old trees	Fall or Spring
	*	Kansas Sweet	May 22-June 5	Duke cherry (semi-sweet)			
		Montmorency	June 3-15	The standard of sour or pie cherry, very consistent			
		Northstar	June 5-20	Sour or pie			
		Meteor	June 5-20	Sour or pie (resistant to leaf spot)			
		Stella	June 5-20	Sweet (self-fertile)			
APRICOTS		Tilton	June 25-July 5	Commercial production should not be attempted	20x20	One year old trees	Fall or Spring
PEARS	*	Moonglow	Aug 10-Aug 25	Fireblight resistant	25x25	One year	Fall
	*	Maxine	Aug 25-Sept 5	Fireblight resistant		old trees	or Spring
	**	Magness	Sept 5-Sept 15	Fireblight resistant			
STRAWBERRIES		Earliglow	May 5-June 5	Incorporate organic matter	2x4	One year	Fall
		Sunrise	May 5-June 5	ahead of planting strawberries;		old plants	or Spring
		Atlas	May 10-June 10	select virus indexed plants			
		Allstar	May 10-June 10				
		Cardinal	May 10-June 10				
		Delite	May 15-June 15				
		Marlate	May 15-June 15				
BLACKBERRIES							
(Erect)		Choctaw	July 1-10	Very sweet	3x8	One year old	Fall or
		Womack	July 1-10	Very sweet		root cuttings	early spring
		Cheyenne	July 10-30	Large very sweet			
		Cherokee	July 10-30	Medium large, very sweet			
		Shawnee	July 10-30	Latest ripening, high yields			
		Brazos	July 10-30	Good flavor. Southern Oklahoma only.			
(Erect Thornless)		Navaho	July 20-Aug 5	Sweet	3x8	One year old	Fall or Spring
		Arapaho	July 20-Aug 5	Sweet	3x8	root cuttings	
(Trailing)		Boysen	July 10-30	Trellis or other support	8x12	Tip layers	Early Spring
		Young	July 1-20	required			
(Trailing Thornless)		Hull	July 20-Aug 5	Trellis or other support required6x10		One year old	Fall or Spring
		Chester	July 20-Aug 5	Trellis or other support required		plants	

GRAPES	Venus	July 15	Red, table-seedless			
(Bunch)	Aurora (S 5279)	Aug 1	White, wine type	8x10	One or two	Spring
	Seyval Blanc (SV 5276)	Aug 8	White, wine type			
	Villard Blanc (SV 12-375)	Aug 18	White, wine type			
	Rougeon (S 58908)	Aug 10	Blue, wine and juice			
	Delaware	Aug 15	Red, wine and table			
	Catawba	Sept 1	Red, wine and table			
	Verdelet (S 9110)	Aug 10	White, table			
	J.S. 16-104	Aug 1	Red, table			
	Romulus	Aug 20	White, table-seedless			
	Himrod	Aug 15	White, seedless			
	Fredonia	Aug 8	Blue, table and juice			
	Niagara	Aug 20	White. table and juice			
	Carman	Aug 22	Blue, juice, for southwest Okla.			
	Saturn	Aug 15	Red, table seedless			
	Reliance	Aug 15	Red, juice, jam, seedless			
	Mars	Aug 15	Blue, table, juice, jam, wine, seedless			
	(Muscadine)	Adapted for McCurtain and Choctaw counties only.		14x10	One year old vines	Fall or Spring
BLUEBERRIES	* (highbush)					
	Collins	June 5-June 19	Soil must be quite acid (pH 5.0). May require sulfur to change	4x6	12" to 18" well rooted plants	Early Spring
	Spartan	June 7-June 21				
	Blueray	June 12-June 28				
	Bluecrop	June 15-July 1				
	* (Rabbiteye)					
	Premier	July 5-July 19				
	Climax	July 10-July 30				
	Tifblue	July 20-Aug 3				
PERSIMMON						
(American)	Early Golden	September	For pollination, a male tree (pollen bearing) should be included in the planting or graft a male branch into a female tree	15 to 18	One or two year old trees	Spring
(Oriental)	Huchiya	November	Non-astringent when fully ripe	12 to 15	One or two year old trees	Spring
	Fuyugaki	November	Non-astringent			
	Tamopan	November	Astringent			
	Tanenashi	November	Astringent			
FIG	Ramsey (Texas Everbearing)	July to frost	For milder southern counties; have been grown in protected areas of Tulsa and Okla. City	8 to 10	One year old trees	Spring
	Brown Turkey	Aug. to frost				
JUJUBE						
(Chinese Date)	Lang	September	Used as sweet pickles, preserves, dried confections and fruit butter	18 to 20	One or two year old trees	Fall or Spring
	Li	September				
CRABAPPLES	Florence	August	Jelly and spice	20 to 25	One or two year old trees	Fall or Spring
	Dolgo	August	Jelly and spice			

*Needs cross pollinator. Those cultivars not marked with an asterisk are self-fertile.
**Pollen sterile
***Space does not permit listing of other satisfactory varieties.

Strawberries

The strawberry cultivated today has resulted from the interbreeding of a number of *Fragaria* species, principally the North American *F. virginiana* as well as the South American *F. chiloensis.* This intermingling of genetic characteristics has resulted in a fruit of great variety in taste and color, with a cropping ability and season of such versatility that it can be grown from the Tropics to the cool temperate regions of the world. It is no wonder the strawberry is the most popular soft fruit.

For the purposes of cultivation the strawberry is divided into three categories: the ordinary June-fruiting strawberry; the so-called ever-bearing strawberry that produces one crop in the spring and a second crop in the fall; and the alpine strawberry *(Fragaria vesca,* subspecies *alpina),* a mountain form of wild strawberry (see page 23).

Standard strawberries

The ordinary, or June-bearing strawberry, crops once only in the early summer. A few do crop again in fall and these are called "two crop" varieties, but they are cultivated in the same way as the others. The expected yield per strawberry plant is about 8-10 oz.

Cultivation

Some gardeners prefer to grow strawberries as an annual crop, planting new runners each year. This method produces high quality fruits but a lower yield than that of larger two- or three-year-old plants.

Soil and situation Most soils are suitable for strawberries, but they should be well drained. On waterlogged land, if a drainage system is not practicable, grow strawberries on ridges 2-3 in high. They prefer a slightly acid (pH 6.0-6.5) light loam in a frost-free, sunny situation. They will, however, tolerate some shade and because many varieties flower over a long period, the later flowers should escape spring frosts. Strawberries are readily attacked by soil-borne pests and diseases and a system of soil rotation should be practiced. Do not grow them for more than three or four years in any one site. For this reason, strawberries are best grown with the vegetables rather than with the more permanent fruit plants.

Soil preparation A strawberry bed will be down for three or four years, and the initial preparations should be thorough so that the land is made fertile and free from perennial weeds. In July dig in well-rotted manure or compost at about the rate of 14 lb to the square yard. Rake off any surplus because bulky organics on the surface encourage slugs, snails and millipedes. Once applied, no more organics should be needed for the life of the bed. Just before planting, lightly fork in a balanced fertilizer such as 10-10-10 at 3 oz per square yard.

Planting and spacing The earlier the planting, the better the maiden crop in the following year. Plant in early spring after the ground has started to warm up. It is not necessary to wait until frost danger has passed. In the warmest American climates, however, it is better to plant in October. Plant the runners in moist soil with the crown of the strawberry just level with the soil surface; planting too deep may result in the rotting of the buds and planting too shallow may cause drying out. Plant with a trowel or hand fork, spreading out the roots well. Replace the soil and firm it. Space the plants 18 in apart in rows 3 ft apart. On a light soil they can be 15 in apart with *2k* ft between the rows. Plants to be grown for two years need only 12 in spacing.

Pollination The flowers are pollinated by bees and such crawling insects as pollen beetles. Imperfect pollination results in malformed fruits. All modern varieties are self-fertile.

Watering and feeding Water regularly for the first few weeks after planting and whenever dry conditions occur during the growing season, but try to keep water away from the ripening berries because this encourages gray mold *{Botrytis cinerea).* The risk is less with trickle or drip irrigation because only the soil is wetted. Damp conditions overnight also encourage botrytis; water in the morning so that the plants are dry by nightfall. In mid-August each year, apply a balanced fertilizer at 1/2 oz per square yard along each side of the row. No other feeding is necessary unless growth has been poor. In this case apply sulfate of ammonia at 1/2 oz per square yard in April, taking care to prevent fertilizer touching the foliage because it will scorch it.

Weed control Weeds compete for nutrients and water. Keep the rows clean by shallow hoeing and tuck any runners into the row to fill gaps. Pay particular attention to cleaning up between the rows before mulching. Weedkillers may be used (see page 17).

In general, shallow cultivation of strawberries keeps weed growth in check. But care should be taken to weed strawberry beds each fall, and particular attention should be paid to the removal of all weeds.

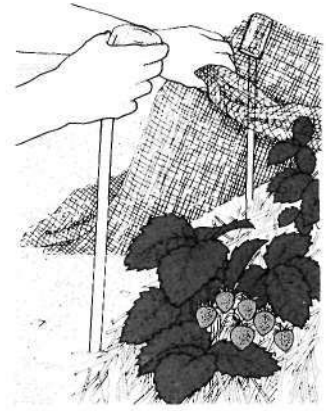
1 In late winter or the preceding fall, dig in well-rotted manure or compost at a rate of 14 lb per square yard. Rake off any surplus manure.

2 About April, plant the strawberries 18 in apart in rows 3 ft apart. Spread out the roots, keeping the crowns level with the soil surface. Firm the soil.

3 For the first few weeks after planting and during all succeeding dry spells in the growing season, water regularly. Keep water away from ripening berries.

4 Up to July 15 in the first year, pick off all blossoms to force strength into the plants for a big crop next year.

5 **When the fruits begin to swell,** scatter slug pellets along the rows. Cover the ground beneath the berries and between rows with barley or wheat straw.



6 Protect the fruit from birds. Support nets with posts at least 18 in tall. Cover posts with jars or pots first.

Strawberries

Disbudding During the first season, remove all flowers until mid-July. If the plants are allowed to set fruit in the first few months, vegetative growth will be retarded and the next year's crop will be small. In succeeding years, of course, disbudding is unnecessary.

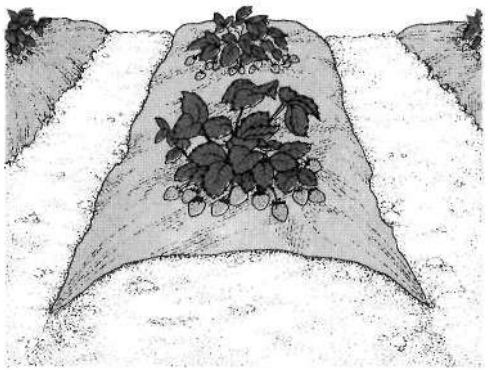
Mulching When the fruits of two-year-old plants begin to swell and weigh down the trusses, scatter slug pellets along the rows. Then put straw down around the plants. This is to keep the fruits clean, so tuck the straw right under the berries and also cover the ground between the rows to help to keep down weeds. Do not straw down earlier than this because the straw prevents the heat from the earth reaching the flowers, which may then be damaged by frost at night. Preferably use barley straw which is soft or, as a second choice, wheat straw.

Protection from birds The best method of protection is to cover the strawberry bed with a large cage, using 3/4 in or 1 in plastic netting, supported by posts and wire or string. The height should be at least 18in; about 4 ft is the ideal height for picking in comfort. Put glass jars or plastic plant pots over the posts to prevent them from tearing the netting. A simpler method is to spread lightweight plastic directly over the plants. It can be folded back when picking is to be done.

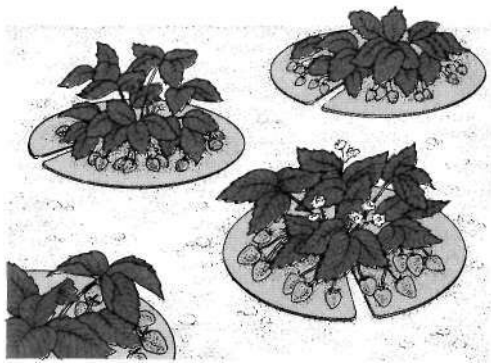
Harvesting
The best time to pick strawberries is in the morning when the berries are still cool. Pick them complete with stalks; try not to handle the flesh because it bruises easily.

At the end of the season
Immediately after cropping, remove the straw and cut off the old plant leaves (about 3 in above the crown) and unwanted runners using shears or a sickle. Alternatively, a rotary lawn mower can be run directly over the entire bed. Tuck in runners needed to fill in any gaps in the row. In the second year, a matted row can be grown by allowing runners to root in the row and reducing the space available, so that the quantity of fruit is greater but the quality suffers. The space between the rows is kept clear. Defoliation is good horticultural practice because it rejuvenates the plant and removes leaves and stems, which may be a source of pests and diseases. But it must be done as soon as cropping is over to avoid damaging fresh growth and reducing the crop the next year.

Alternatives to mulching



If straw is not available, strawberries can also be grown through black polyethylene. First, prepare the bed by raising a 3 in high ridge of soil. Water it well. Lay plastic over the ridge, tucking in the edges under the soil. Plant the strawberries



through slits in the plastic at 15-18 in intervals. Leave a 6 in bare strip between plastic strips to enable rain to permeate to the roots. Black polyethylene sheeting does slow down evaporation, but the soil under it will eventually become dry.

Winter protection
In zones 3-7, as soon as the fall temperature drops to 20*C/68*F, spread straw or salt or marsh hay over the entire bed. The covering should be at least 3 in deep between rows; and enough to conceal the plants themselves. The purpose of the covering is to protect the plants against frost and other winter injuries. If the temperature does not drop to 20°C/ 68°F before the end of November, the plants should be covered at that time in any case.

The covering is removed in the spring after growth is well started. If it is left on too long, the foliage will yellow.

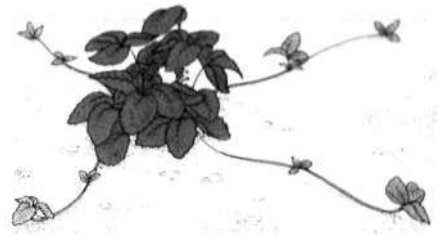
Propagation
Strawberries are easily propagated from runners which the parent plant begins to produce as the crop is coming to an end. The aim is to obtain well-rooted runners for early planting and it is achieved by pegging down the strongest runners so that they make good contact with the soil. In June or July choose healthy parent plants which have cropped well. From each select four or five strong runners. Peg them down either into moist open ground or into 3 in pots buried level with the soil. Pot-grown runners are best because they are easier to transplant. Fill the pots with a seed-starting mixture or a 50-50 mixture of loam and peat. Peg close to the embryo plant but do not sever it from the parent at this stage. For the pegs, use 4 in pieces of thin galvanized wire bent to a U-shape. Straightened out paper clips are ideal.

In four to six weeks there should be a good root system. Sever from the parent, lift and plant out into the new bed. Keep them well watered.

Planting under mist or in a closed propagating case are other useful ways of obtaining very early runners. With these, sever the embryo plants from the parents at the first sign of roots—root initials—and peg them into 11/2-2 in peat pots.

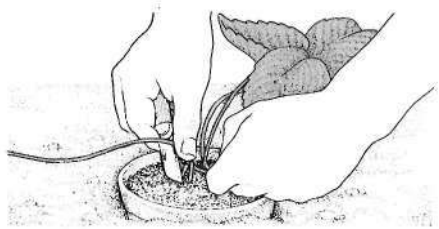
Varieties
Strawberries soon become infected with virus diseases, so it is important to plant only virus-free stock. It is best to obtain plants from a specialist propagator who guarantees healthy stock.

PROPAGATION

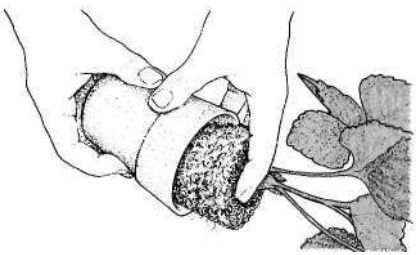


1 In June to August, select four or five runners from healthy, cropping plants.

2 With U-shaped wires, peg runners into open ground or into 3 in pots buried level and filled with a potting compost.



3 **In four to six weeks** they should have rooted. Sever from parents close to plants.



4 Lift out the potted runners and knock out from the pot. Plant out into the new bed and water well.

Strawberries

Ever-bearing strawberries
Ever-bearing strawberries have the characteristic of producing fruit in the spring and again in the fall. It is useful to cover the fall crop with cloches to extend the season, possibly in late October. It is best to grow ever-bearers for one year only because the size and weight of the crop deteriorate in the second year. Replant with new runners each year.

Cultivation
The basic requirements of soil, spacing, mulching and feeding are the same as for June-bearing strawberries. The soil should be highly fertile and moisture-retentive. Be sure to water well in late summer and fall.

Plant in the early spring and remove the first flush of flowers to ensure a good crop later in the season.

In the fall, when cropping is finished, clean up the rows, remove the old straw, surplus runners and one or two of the older leaves, and burn the debris. Cover with straw or hay in the late fall to protect against winter damage.

Do not fertilize the plants in the spring of the following year, but apply a balanced fertilizer immediately after all the spring berries have been picked to encourage a second, smaller, crop in the fall. Then remove plants entirely.

Alpine strawberries
Several varieties have been selected for garden and commercial cultivation. They make an attractive edging plant, having masses of small white flowers. They bear dark red fruits continuously or in flushes from June until November.

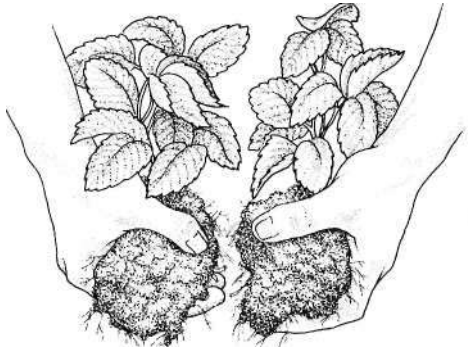
Cultivation
Alpine strawberries are usually grown from seed and kept for no more than two years before re-sowing. There are a few varieties that produce runners, but most do not. Maintaining virus-free stock is difficult.

Sowing Sow the seeds in March under glass. Sow into seed boxes containing a moist seed-starting mixture. Maintain them at a temperature of 18°-20°C/64°-68°F. Cover the boxes with glass and shade until the seeds germinate. When two true leaves appear, prick out the seedlings 1 in apart into flats or peat pots.

Soil preparation, planting and feeding The soil should be rich, well drained and slightly acid (pH 6.0-6.5). Just before planting apply sulfate of potash at 1/2oz per square yard. Once the danger of frosts is over, but by the end of May, plant out the seedlings in the prepared, moist soil. Plant in the open or in light shade. Space the seedlings 1ft apart with 21/2ft between the rows. Water them in dry weather (about 3-4 gal per square yard every 7-10 days). For better cropping, when the flowers appear, feed every two weeks with a liquid fertilizer.

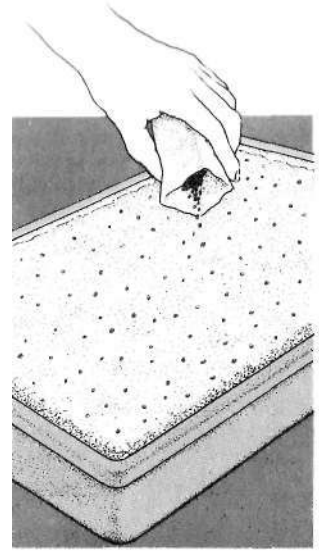
Harvesting
Pick carefully. Slight crushing, sugaring, and overnight soaking brings out the flavor.

PROPAGATION

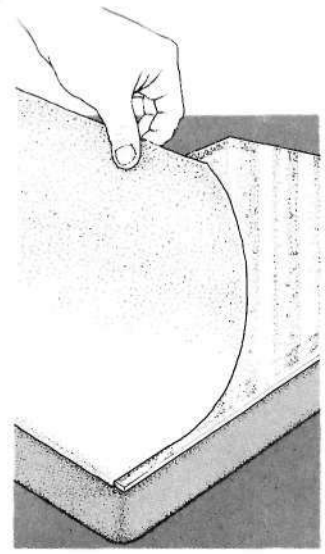


Some ever-bearing strawberries produce runners and are propagated in the same way as are June-bearing strawberries, but a few varieties do not and these are propagated by division.

From late August to early September, dig up a mature plant and break off the new crowns or buds with as many roots as possible. Transfer them to the new strawberry bed and plant them immediately in the usual way. Do not plant the crowns too deep or they will rot.



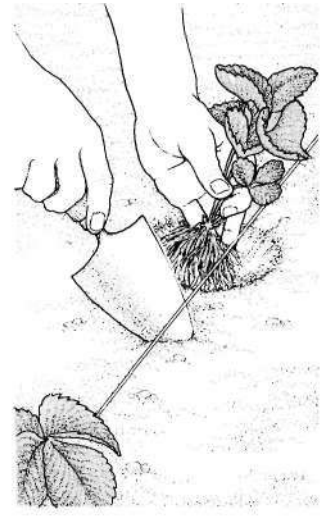
1 In March, sow into seed boxes of moist seed compost.



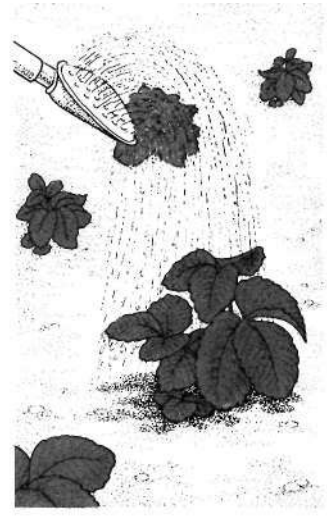
2 Cover with glass and shade until germination. Maintain a temperature of 18°-20°C/64°-68°F.

3 When the seedlings have two true leaves, prick out 1 in apart into flats or individual peat pots.

4 Just before planting, apply sulfate of potash at 1/2 oz per square yard to moist well-dug soil, forking it in lightly.



5 Once the danger of frosts is over, plant out the seedlings in the prepared bed, 1ft apart in rows *21/2*ft apart.



6 In dry periods, water the plants thoroughly every 7-10 days. For better crops, feed every two weeks with liquid manure.

Raspberries

Like the strawberry, the raspberry is one of the quickest fruits to crop, bearing a reasonable amount in the second year and full cropping thereafter. A good average yield is 11/2—2 lb per foot run of row.

Cultivation

Most red raspberries (there are also a few with yellow fruit) flower in late spring and the fruits ripen in early to midsummer, depending upon the variety and the weather: such varieties are called standard or summer-bearing raspberries.

The stems, or canes, are biennial in that they grow vegetatively in their first year, flower and fruit in their second year and then die back to ground level. The root system is perennial and of suckering habit, producing each growing season new replacement canes from adventitious buds on the roots and new buds from old stem bases.

Some raspberry varieties have the characteristic of flowering on the first year's growth on the topmost part. These are called everbearing raspberries as they produce a small crop of fruit in early summer and a larger crop in early fall. All grow in zones 3-7. Because their cultural requirements differ in some respects, they are described separately (see page 26).

Soil and situation Red raspberries grow best on a slightly acid soil of pH 6.0-6.7 that is moisture-retentive but well drained. They can be grown in dry, sandy and limy soils of low fertility, provided plenty of water is given during dry weather and bulky organic manures are liberally applied. Raspberries will not tolerate poor drainage, and even temporary waterlogging can lead to the death of the root system and subsequent death of the canes. In alkaline soils above pH 7.0, iron and manganese deficiencies may occur. See pages 10-11 for reduction of soil alkalinity and correction of iron and/or manganese deficiencies.

The site must be sheltered because strong winds damage the canes and inhibit the movement of pollinating insects. Preferably, they should be planted in full sun, although they grow quite well in partial shade with a minimum of halt a day's sun, provided they are not directly under trees and the soil is not too dry.

Soil preparation Prepare the ground in late fall or late winter by forking out all weeds, particularly perennials. Then dig a trench along the intended row three spades wide by one spade deep. Cover the bottom of the trench with well-rotted manure or compost to a depth of 3-4 in and fork it into the base so that it is thoroughly mixed with the soil. With double-dug grassland there is no need for this operation because the buried turf takes the place of the organic manure. Finally fill in the trench and fork in a balanced fertilizer such as 10-10-10 at the rate of 3 oz per square yard.

Planting and spacing If possible the rows should run north-south so that one row does not shade another too much.

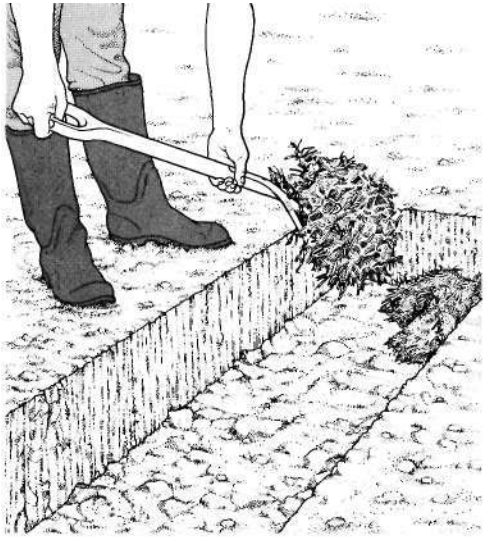
In early spring, plant the canes 18 in apart in the rows. If more than one row is planted, space the rows 6ft apart, or 5 ft apart if using the single fence system. Spread the roots out well and plant them about 3 in deep; deep planting inhibits new canes (suckers).

After planting, cut down the canes to a bud about 9-12 in above the ground. Later, when the new canes appear, cut down the old stump to ground level before it fruits. This means foregoing a crop in the first summer but it ensures good establishment and the production of strong new canes in subsequent years.

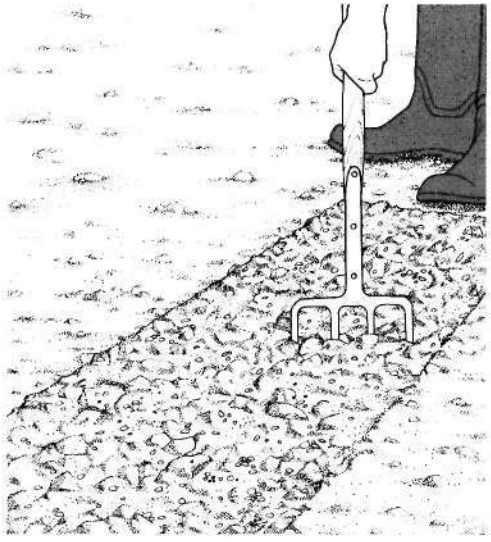
Supporting the canes

To prevent the canes from bowing over when heavy with fruit and to keep the fruits clean it is generally advisable to support the canes. The usual method is a post and wire fence for which there are various alternative systems. It is easier to erect the fence before planting, although it may be left until the end of the first summer.

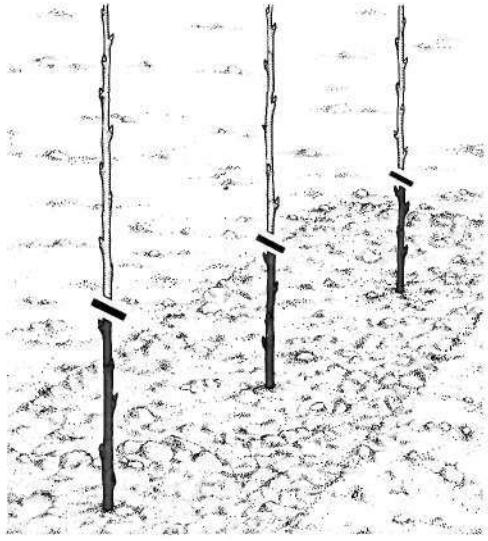
Single fence: vertically trained canes This is the most popular method and consists of single wires stretched horizontally at heights of *21/2,* 31/2 and 51/2ft. It requires the least space of the various fencing systems and is ideal for the small garden. The fruiting canes are tied individually to the wires and thus are secure



1 In early fall, take out a trench in prepared ground three spades wide by one spade deep. Cover the bottom of the trench with a 3-4 in layer of well-rotted manure or compost and fork in thoroughly.



2 Then, fill in the trench and fork in 3 oz per square yard of a balanced fertilizer such as 10-10-10.



3 From March to April, plant the canes at 18 in intervals. Spread the roots out well and plant about 3 in deep. Cut down the canes to a bud about 9-12 in above the ground.

4 In late March, apply sulfate of ammonia at 1/2 oz per square yard. Mulch with a 2 in layer of garden compost, keeping it well clear of the canes.

Raspberries

against winter winds. They are exposed to the sun, which enhances the quality of the fruits and reduces the incidence of fungal disease. The system has the disadvantages that the new canes are at risk of being trampled on during picking and of being damaged by strong winds in July unless temporarily supported by string tied to the lower wires.

Drive in preserved *71/2 ft* posts 18 in into the ground 12-15 ft apart. Use 14 gauge galvanized fence wire.

Erect the end posts first and strut them and then drive in the intermediate posts. Finally fix the wires to the posts using straining bolts at one end and staples on the intermediates and at the opposite end.

Double fence: parallel wires The double fence is erected in a similar way to the single fence but because the top wires are not as high, the posts are only 61/2 ft tall. Cross bars *21/2* ft long by 2 in across to carry the parallel wires are fixed to the end posts and to the intermediate posts. In exposed situations, double posts should be used instead of cross bars. Parallel wires are spaced 2 ft apart at 3 ft and 5 ft from the ground. Stretch wire as cross ties every 2 ft along the wires to prevent the canes falling down in the row.

This method has the advantage of enabling a larger number of canes to be trained in and a greater yield to be obtained from much the same area. Picking the fruits from the center is difficult, however, and there is a higher risk of fungal diseases because of the more crowded conditions.

In an exposed garden the untied canes may be damaged on the wires, so the canes should be tied to the wires.

Scandinavian system (training in a low "V") This is a double fence system with only one set of parallel wires spaced 3 ft apart at 3 ft from the ground.

Drive two sets of posts 41/2 ft long 18 in into the ground, 3 ft apart every 12-15 ft in the row.

The fruiting canes are not tied but woven around the wires to form a "V" when viewed , from the end of the row. The replacement canes are allowed to grow up the center unsupported.

With this method the fruit is presented at a low picking height and the replacement canes are safe within the row. However, there is the risk of fungal troubles because of the crowded conditions of the canes on the wires and in the row. If more than one row is planted, space the rows 6 ft apart.

Single post system This is a method particularly suited to a very small garden. It consists of a single post to which each plant is tied. The posts are *71/2* ft long by 21/2 in top diameter, driven 18 in into the ground.

Initial pruning

In the first two seasons after planting, the number of canes may be few, but thereafter there should be more than enough.

In the second year thin out the weakest canes in the early spring so that the remainder grow more strongly, and pull out unwanted canes growing well away from the row. Allow about 8-10 canes to a plant.

Pruning and training established plants

As soon as fruiting is over, cut down to ground level the old canes which have fruited. Select the healthiest and strongest of the young canes, retaining about four to eight per stool.

If using the single fence system, tie the canes to the wires, 3-4 in apart. Either tie each one separately with a 6 in twist tie or secure them to the wires by continuous lacing using jute or strong string. Tie an occasional knot as a precaution against the string breaking later on.

With the Scandinavian system the canes are laced around a single wire, equally on each side. Gently bend them over at the point they reach the wire and then twist the canes around the wire. No tying is necessary. Do this in late August or early September when the canes are still supple. Depending upon the length of the canes, this could mean four or six canes being twisted around each other and the supporting wires like a rope. The average number of canes from each plant should be about four to six.

For *the* single post system the fruiting canes are tied to the posts and the replacement canes looped in as and when necessary.

Tipping the canes (This is not applicable to the Scandinavian system). In early spring, 'about March, cut the canes to a bud 6 in above the top wire. This removes winter damage to the tips and encourages the lowest buds to break.

For very vigorous varieties grown on the single fence system, where tipping would remove a lot of the cane, loop and tie the canes back on to the top wire and then prune about 6 in off the tips. This method gives extra length of canes, hence more crop, but the top wire must be strong.

Feeding and watering

In early spring each year apply 1 oz of sulfate of potash per square yard. Every third year add 2 oz of superphosphate per square yard. In late March apply sulfate of ammonia at 1/2 oz per square yard. The fertilizers should be applied as a top dressing covering about 18 in each side of the row.

Also, in late March, mulch with a 2 in layer of garden compost, damp peat or manure, keeping the material just clear of the canes. The mulch helps to conserve moisture in the summer and inhibits weed seeds from germinating.

Throughout the growing season keep down weeds and unwanted suckers by shallow hoeing. Be careful not to damage or disturb the roots of the raspberries. If preferred, herbicides can be used (see page 17).

In dry weather water the raspberries regularly but, to minimize the risk of fungal troubles, keep the water off the canes.

Protect the fruit from birds with netting.

Propagation

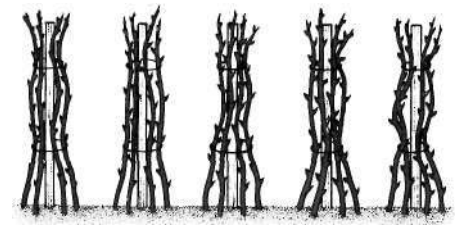
Raspberries are easily propagated by forking up surplus canes with as many roots as possible in early spring. The canes must be healthy and strong. Virus-infected plants should be dug up and burned.

Harvesting

Pick the fruits without the stalk and core, unless the raspberries are required for showing, when they are harvested with the stalk attached, using scissors. Picking of standard varieties continues for about a month. In general, pick raspberries when they are fresh, if possible, for better flavor. Use shallow containers to prevent the fruits from crushing each other.

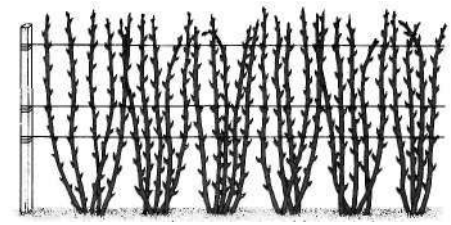
SUPPORT SYSTEMS

Single post system



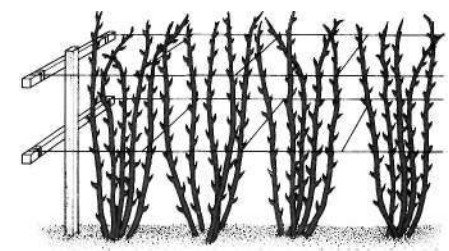
Drive *71/2* ft long *21/2* in dia. posts 18 in into the ground at each planting station.

Single fence system



Drive *71/2* ft posts 18 in into the ground at 12-15 ft intervals. Stretch 14 gauge galvanized wires between the posts at *21/2,* 31/2 and 51/2 ft.

Double fence system



Drive *61/2* ft posts 18 in into the ground 12-15 ft apart. Fix 2 in dia. cross bars *21/2* ft long to the end posts and to each intermediate post. Then, stretch parallel wires 2 ft apart between the posts at 3 ft and 5 ft from the ground. Stretch wires as cross ties every 2 ft along the wires.

Raspberries

Pests and diseases

If aphids are present, spray with dimethoate, formothion or malathion in spring. An oil spray in winter gets rid of the over-wintering eggs. To prevent raspberry beetle grubs feeding on the fruits in summer, spray at dusk with malathion or derris when the first pink berry is seen.

The most serious diseases of raspberries are viruses, which cause the leaves to become mottled or blotched and the canes to be stunted. Seek expert advice before destroying canes because the symptoms are similar to those caused by raspberry leaf mite and bud mite. New canes should be planted elsewhere.

Canes affected by cane blight in summer will wilt, snap off easily and die. If fruiting spurs become blighted, cut out and burn affected canes. Spray new canes with bordeaux mixture.

Cut out and burn canes badly affected by cane spot and prevent it by spraying with liquid copper or thiram at bud burst and pre-blossom time, or with benomyl every two weeks from bud burst to petal fall.

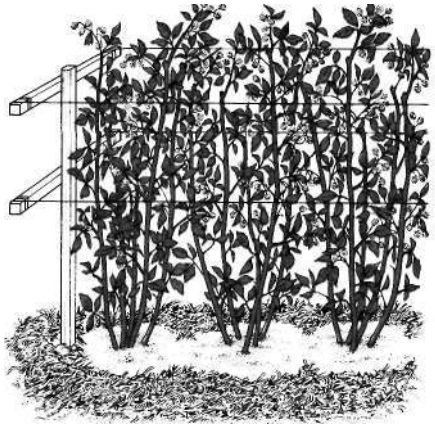
Spur blight causes dark purple blotches around the buds and shoots wither in early spring. Cut out and burn affected canes. Spray new canes when they are a few inches high with benomyl, thiram or captan repeating two, four and six weeks later.

Prevent gray mold *(Botiytis)* on ripening fruit by spraying three times with benomyl at flowering and at two week intervals. Remove and destroy infected fruits.

Selecting healthy plants

It is important to buy only certified stock, wherever possible, to ensure the plants are virus-free and healthy. Healthy plants should last at least ten years before starting to degenerate from virus infection. When this occurs, remove the plants and start a new row in soil that has not grown raspberries or other *Rubus* species before. Alternatively, re-soil over an area 2 ft wide by 1 ft deep.

EVER-BEARING RASPBERRIES

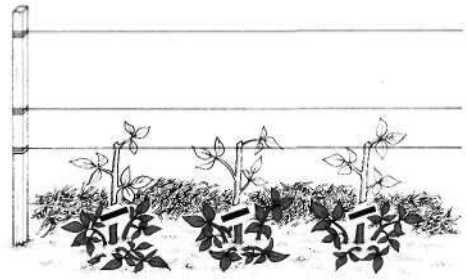


Ever-bearing raspberries bear their fruit on the top part of the current season's canes, extending back from the top over 12 in or more, depending upon the variety. The fruits ripen in early summer a little ahead of standard varieties and again from the beginning of September until stopped by the fall frosts. Ever-bearing raspberries should be picked as soon as ripe and, if necessary, every day. The fall crops can be quite heavy.

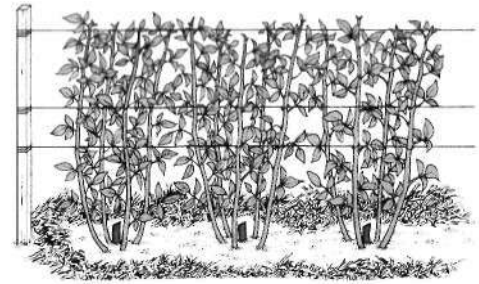
The cultural requirements (soil preparation, planting, spacing, initial pruning and feeding) are the same as for the summer-bearing kind. Use the parallel wire method of support described on page 25. The fruits are produced when the weather is becoming cooler, so they are best planted in the sunniest position possible, otherwise too few raspberries may ripen before the first frosts arrive.

Pruning established plants Such everbearers do not produce a large spring crop. It is better to grow them for fall use only and to put in standard varieties for summer use. Each February cut down all canes in the row to ground level. In the following spring, new canes are produced which crop in the fall. As the canes are not in the row for more than a year, it is not necessary to thin them unless they are particularly crowded. Pull out any which are growing away from the row.

The first year

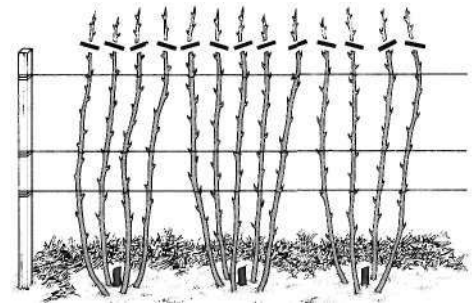


1 In spring, when the new canes appear, cut down the old stumps to ground level.



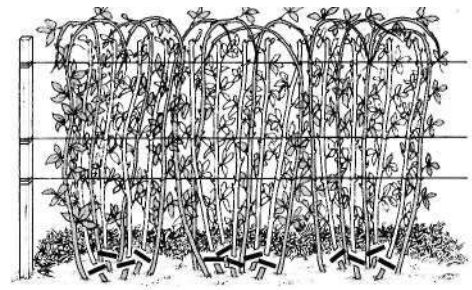
2 In June to September, as new canes develop, tie them 4 in apart on to the wires.

Second and subsequent years

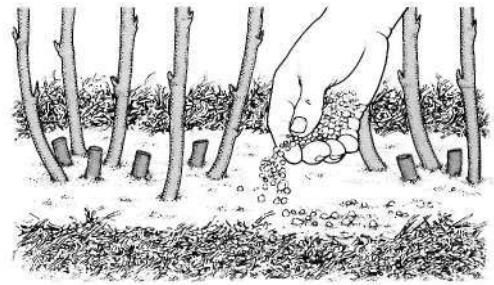


3 **In March,** cut the canes to a bud 6 in above the top wire. Mulch the plants

4 In midsummer, fruit is carried on laterals from last year's canes. Thin out the weakest new growth to leave strong canes 4 in apart. Pull out new shoots growing away from the row.



5 **When fruiting is over,** cut the fruited canes down to ground level. Tie in new canes 4 in apart. If growth is vigorous loop the new canes over to form a series of arches.



6 Each year in early spring, apply 1 oz of sulfate of potash per square yard as a top dressing 18 in each side of the row. Every third year apply 2 oz superphosphate per square yard.

Raspberries

Black and purple raspbemes ,are generally known under the name of black raspberry, just as red *and* yellow raspberries are usually known as red raspberries. They are also closely related to the reds, although they are larger and more productive and greatly tolerant of heat, although less resistant to cold.

Plants with black berries, which are also called blackcaps, ripen earlier than those with purple berries, but purple berries have bigger fruit with a more distinctive flavor. The berries are not as juicy as red raspberries and are used primarily to make appetizing jams and jellies.

Both the black and the purple raspberry grow in zones 4-8.

Culture

Black and purple raspberries are somewhat more susceptible to disease than red raspberries and a little more care should be taken in finding a site for them. Do not plant for several years in soil in which potatoes, tomatoes, peppers, eggplants or a previous crop of raspberries have been grown; and be sure to plant 300—400ft away from all wild brambles and cultivated red and yellow raspberries.

The soil, moisture and fertilization requirements of black raspberries are essentially similar to those needed by the red raspberry.

Propagation

Black and purple raspberries are reproduced by inserting the tips of young canes into the soil to a depth of 4-6 in. Left to their own devices, plants tip-layer themselves but do not produce such good plants as can the gardener. The best time to do this is in midsummer in loose soil with ample moisture.

The plants should be well rooted by late fall and ready for transplanting to the garden in early spring. Cut off the old stem at the ground as soon as new growth starts.

Training and pruning

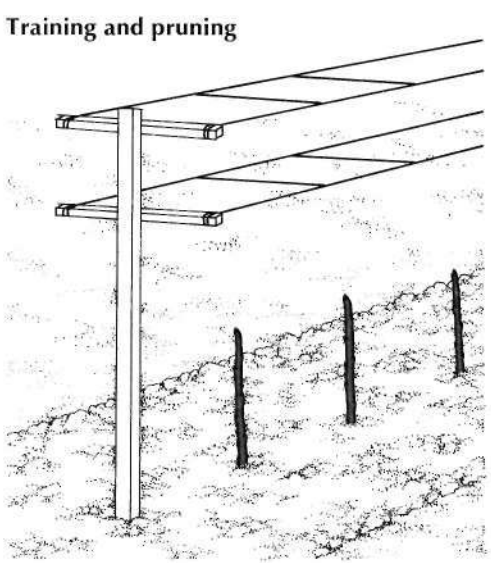
The plants are best grown in a double-fence system similar to that used for red raspberries. II the soil holds moisture well, set the plants 3 ft apart and 1 in deeper than they previously grew. In drier soils, increase spacing between plants to as much as 6 ft.

No pruning is necessary in the first year. Thereafter, in late winter or early spring, cut off all weak canes at the ground, leaving 4-6 good canes per plant. Remove weak and dead laterals, and trim back the remaining laterals on black varieties to 6-8 in; on purple varieties to 10 in. Then in early summer, before berries start to ripen, nip about 3 in off the ends of the upright canes to force the growth of the laterals.

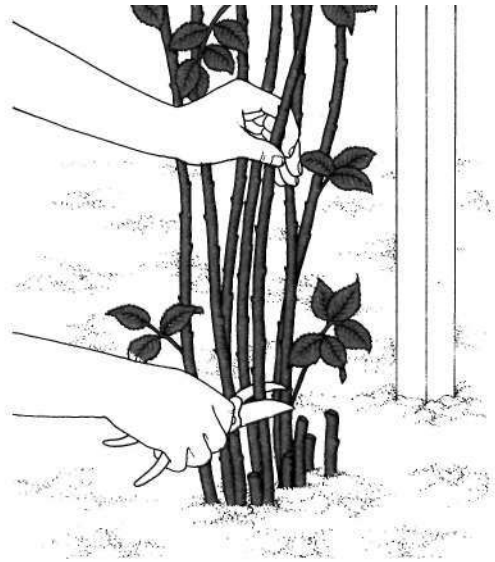
Finally, as soon as all fruit has been picked, prune out all the canes that bore fruit to give more light and room to the new canes. Burn all prunings promptly.

Harvesting

Black raspberries deteriorate more slowly than reds so it is not necessary to pick them so frequently.

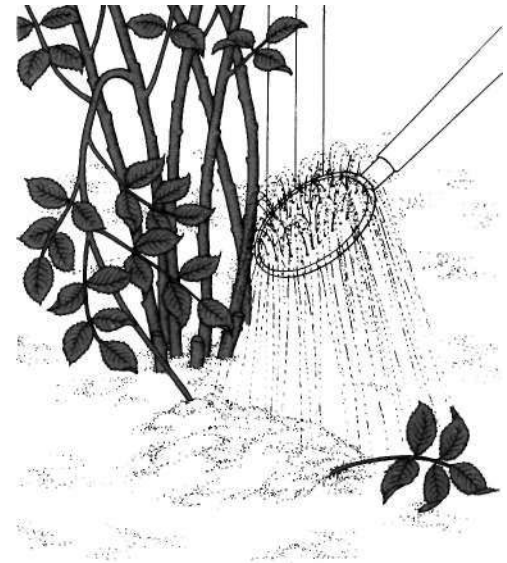


1 Fix two parallel wires between T-shaped supports 5 ft high. The wires should be 18 in apart. Place the canes between the wires.

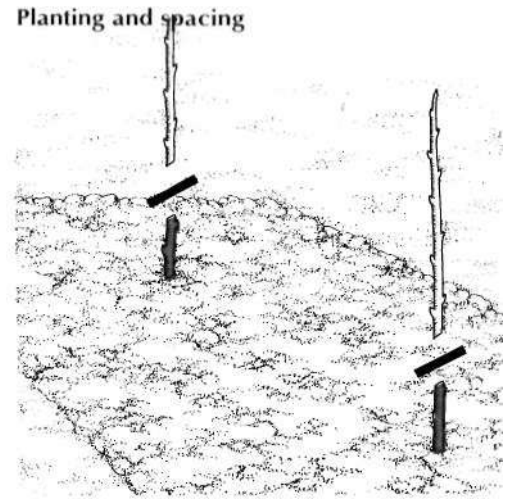


2 After first year, in late winter or early spring, cut off all weak canes at the ground, leaving 4-6 good canes per plant. Remove weak and dead laterals and trim back the remaining laterals.

1 In midsummer, dig a hole 4-6 in deep near the mature raspberries in loose soil with ample moisture. Insert the tip of a young cane into the bottom of the hole and fix with a staple.



2 Fill in the hole, tamp down the soil, and water well. When the tip has rooted, sever from the parent plant with 10 in of stem and plant out.



In spring, place medium-length canes 4ft apart in rows 6 ft apart. Do not plant deeply. Cut the canes down to 6 in above the ground.

Blackberries

The blackberry is a rambling cane fruit found growing wild in many milder parts of the United States. The canes are of arching habit, thick, strong and often aggressively thorned, although there are good thornless cultivated varieties. The plants are usually deciduous, but not always so in mild winters. They grow in zones 5-8.

A good average yield from a well-established blackberry plant is 10-30 lb of fruit, depending upon the size of the plant and the variety.

Cultivation

Cultivated blackberries are much larger and more luscious than wild varieties. They need little preventive spraying and can be planted in a spare corner of the garden to which their wide-spreading roots should be confined.

Soil and situation Blackberries grow in a wide range of soils and will tolerate slightly impeded drainage. If thin dry soils cannot be avoided, improve their moisture retentiveness and fertility with bulky organics.

Blackberries flower relatively late, from May onwards, and bloom over a long period, and so frost is seldom a problem. They are among the few fruits that can be successfully grown in a frost pocket, although this should be avoided if possible. They will also tolerate partial shade but fare better in full sun. Because of their rambling habit, they need some support.

Planting Prepare the ground in the fall. Fork out perennial weeds. Then, if the ground is poor, apply a 2-3 in deep layer of well-rotted manure, compost or peat over an area *2-21/2 ft* square at each planting site and dig it in thoroughly. Rake in 3 oz of a balanced fertilizer such as 10-10-10 over the same area.

Plant while dormant in early spring. Young plants, in the form of rooted tips or one-year-old bedded tips, can be obtained from a nursery. Using a hand trowel or fork, dig a hole wide and deep enough to take the roots spread out well. Plant the canes to the nursery depth. After planting, firm the soil and then cut down each cane to a bud at about 10 in above the ground.

Spacing Plant the canes 4 ft apart in rows 6 ft apart. One plant is often sufficient.

Support Support is generally necessary to keep the canes off the ground for easy picking and to keep the plants tidy. Individual plants can either be tied to sturdy stakes, or a wire fence trellis can be erected with wires every 12 in between 3 and 6 ft. Erect the wires before planting the canes.

Training The fruiting canes should be trained to keep them separate from the young replacement canes to facilitate picking and to reduce the risk of the spread of fungal diseases from the old to the new.

The three methods commonly used are the fan, weaving, and rope system trained one way. The fan is best reserved for less •vigorous berries. The weaving system takes full advantage of the long canes of vigorous kinds but there is much handling at pruning time. The one-way system keeps handling to a minimum, but wastes space because young rods are trained along the wires only to one side of the plant. These fruit the following year. When new rods appear they are trained in the opposite direction.

Initial pruning In the first summer after planting, a number of young canes should spring up from the root system. Tie these securely to the lower wires in a weaving fashion. In the second summer these canes should flower and fruit. At the same time new growth springs from the base of the plant. This young growth should be secured and trained in the adopted method.

When fruiting is over, untie the old canes and cut them down to ground level. With the fan and weaving systems the young canes are then trained in to take their place. With the one-way system, the young canes are already tied in. The young growth will fruit in the next year, and so the cycle is repeated.

Subsequent pruning Pruning in the third and subsequent years consists of cutting out the canes that have fruited and replacing them with the new canes. If the replacement canes are few, the best of the old canes can be used again, but the older growth does not yield the best quality berries. Each April cut back any winter-damaged tips to a healthy bud.

Feeding and watering In early spring apply 2oz of a balanced fertilizer such as 10-10-10 as a top dressing over one square yard around the base of each plant.

A little later, mulch with a 2in layer of garden compost, peat or manure, keeping the material just clear of the canes. In dry weather water the plants but, to minimize the risk of fungal troubles, avoid the canes.

Pollination

All varieties are self-compatible and only one plant is needed.

Harvesting

Blackberries are ready for picking when they are black, plump and sweet. Some varieties turn black before they are fully ripe. Pick all fruit when it is ripe even if not required, because this helps the later fruit to achieve a good size.

Pests and diseases

Blackberries are prone to the same pests and diseases as raspberries (see pages 24-27).

OTHER BERRIES

Boysenberries, dewberries, loganberries and youngberries are all closely related to the blackberry and red raspberry, but generally grow much larger and are of trailing habit. They grow only in warm climates, usually to zone 8, but sometimes to zone 7. All are available in thorny and thornless varieties.

Boysenberries have very large reddish-black fruits with a dusty bloom. They are soft, tartly sweet and have a delicious aroma.

Loganberries have light reddish fruits covered with fine hairs. They are tarter than boysenberries.

Youngberries are very similar to boysenberries, but the fruits are shiny and a little sweeter.

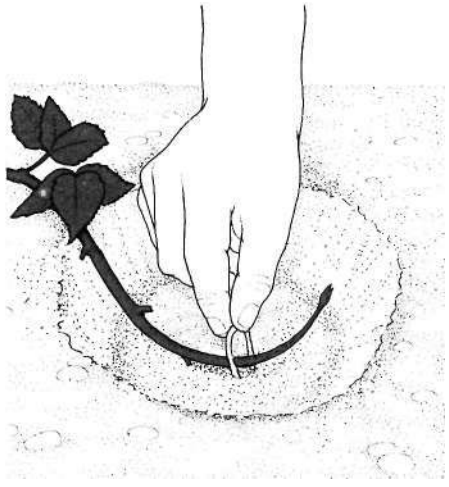
Dewberries are somewhat hardier and have sweet black berries sometimes measuring 11/2 in long. They ripen a week or so earlier than blackberries. 'Lucretia' is generally considered the best variety.

Culture

All of these plants have the same requirements as blackberries. Because the canes run to great length, they should be trained on a trellis. Cut out those that have fruited after harvest in August. Cut back new canes, growing on the trellis, to 6-8ft and remove all but 12-16 of the canes. Early the following spring, cut the laterals to 1 ft.

In areas where the plants are marginally hardy, remove the canes from the trellis in the fall and cover with straw. This should be some protection from frost.

PROPAGATION



Blackberries (like black raspberries) are propagated by tip-rooting. The new canes are tip-rooted in August and September. A 6 in hole is dug with a trowel near the plant, and the tip of a young cane is bent down into it. The soil is then replaced and firmed. As new canes are produced, more tips can be buried. In the following spring, the rooted tips are severed from the parent plant with about 10 in of stem, and then dug up and planted out in a new position. A few varieties produce suckers, which should be lifted with as much root as possible and planted out in the new bed.

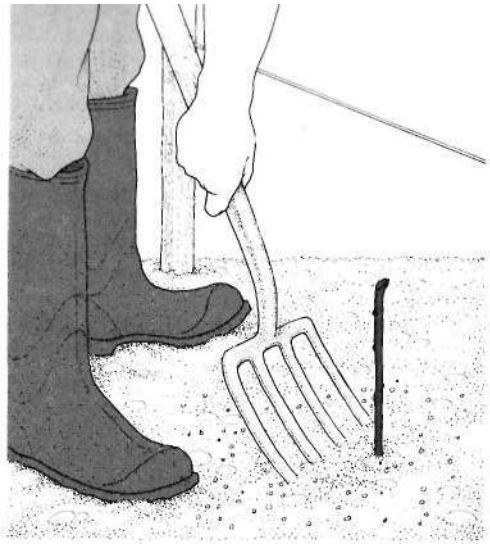
Another method is by leaf bud cuttings taken in July and August and rooted in a cold frame. This method is useful for rapid propagation when stock is limited, and when there are other growing restrictions.

Blackberries

Cultivation

1 In fall, clear the ground of perennial weeds. If the ground is poor, dig in a 2-3 in layer of well-rotted manure over an area 2-21/2-ft square. Fork in 2 oz of balanced fertilizer over the same area.

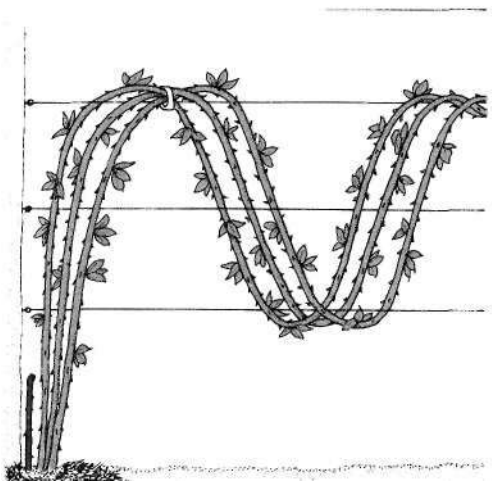
2 In early spring, dig a hole to take the plant with the roots spread out well. Plant to the same depth as it was at the nursery. Firm the soil and cut the cane to a bud 10 in above the ground.



3 **Fork in** 3 oz of a balanced fertilizer such as 10-10-10 per square yard around the base of each plant.

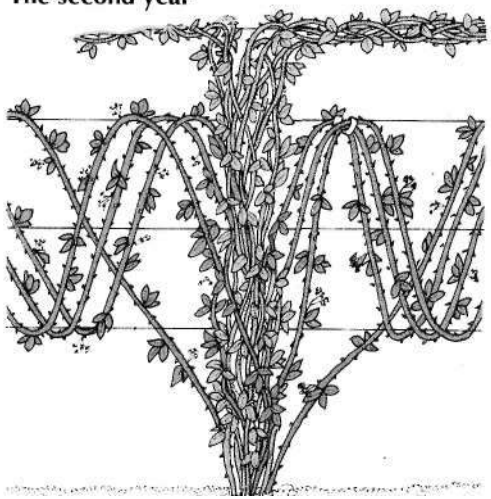
4 Later, apply a 2 in layer of garden compost keeping it just clear of the canes. During dry weather, water the plants but keep the water off the canes.

Weaving system

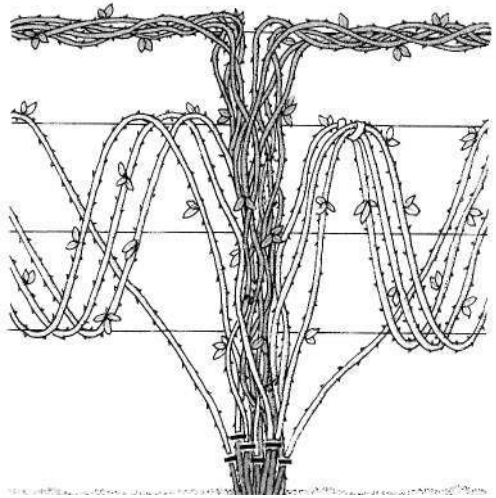


1 In summer, as the young canes appear, tie them to a strong wire support. Weave them in and out of the bottom three wires.

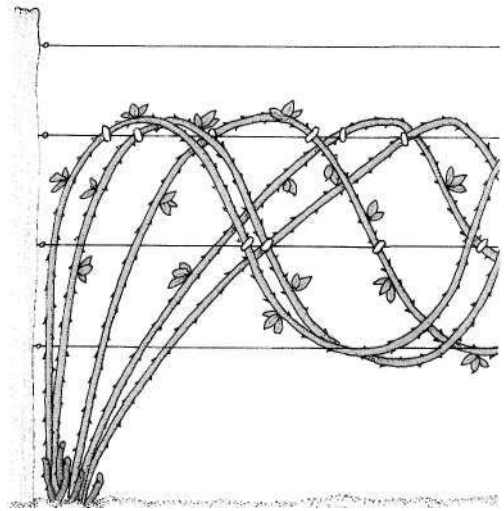
The second year



2 In summer, train the new canes up through the center of the bush and along the top wire. Fruit is carried on laterals of last year's canes.



3 **After fruiting,** cut out all fruited canes to base. If there are few new canes, retain the best of the old.



4 At the same time, untie the current season's canes and weave them round the lower three wires. In fall, remove the weak tips from the young canes.

Black currants

The black currant *(Ribes nigrum)* is a native of central and eastern Europe from Scandinavia to Bulgaria, also northern and central Asia to the Himalayas. It can be found growing wild, generally in damp woody places.

Selection in cultivation has given rise to stronger-growing and highly productive varieties. Black currants are grown on a stool system—that is, many shoots spring from below the ground rather than from a single stem. A well-grown black currant bush may reach 5-6 ft in height and spread and should last 15 years or more before it needs to be replaced. A good average yield from an established black currant is about 10-12 lb.

Cultivation

The black currant is an alternate host for white pine blister rust, a serious pest that kills those trees. Many of the states in which white pine grows forbid the planting of black currants because of the adverse effect on white pine.

Therefore, any gardener considering planting such fruit should first check with the state agricultural extension service or forestry department before ordering. Some nurseries will be able to advise if restrictions exist.

The black currant is the worst of the several alternate host plants of white pine blister rust. Consequently, black currants are difficult to find in American nurseries and only one variety, 'Boskoop Giant', is commonly offered by those nurseries that sell black currants.

Soil and situation Black currants can be grown in a wide range of soils. Ideally it should be slightly acid (about pH 6.5), highly fertile, moisture-retentive and well-drained, although black currants will tolerate slightly impeded drainage. Light soils need plenty of bulky organics. Excessively acid soils should be limed to bring the pH up to 6.5.

The site should be frost-free and sheltered from strong winds so that pollinating insects such as bees are not inhibited. Most varieties bloom early in the spring and the flowers are extremely vulnerable to frost. In frost-prone areas, plant late-flowering or more frost-tolerant varieties and cover the plants on frosty nights. Black currants will tolerate partial shade but prefer a sunny position.

Preparing the soil Prepare the ground in early fall, clearing away all weeds. Apply a 3 in layer of manure or compost over the whole area. If manure and compost are not available, apply a 2 in layer of peat with bonemeal at 3 oz per square yard. If the ground is fairly clean single dig the materials in, but if rough and weedy double dig the area. Rake in a balanced fertilizer such as 10-10-10 at the rate of 3 oz per square yard.

Planting and spacing Buy two-year-old certified bushes. Select plants with not less than three strong shoots.

Plant during dormancy in early spring. Space bushes 5 ft apart in the row (6 ft apart for more vigorous varieties), with 6 ft between rows.

Dig out a hole wide enough to take the roots spread out well. To encourage a strong stool system plant bushes about 2 in deeper than they were in the nursery—the soil mark on the stems gives an indication. Fill in the hole and firm.

Initial pruning After planting, cut all shoots to within 2 in of soil level. This encourages the production of strong young shoots from the base, and creates a good stool system for heavy cropping in the future, although it means foregoing a crop in the first summer. If the plants are certified free of disease, the pruned shoots may be used as cuttings. They root easily, so buy only half the number of bushes required and fill the vacant positions with two to three cuttings to each station.

After the hard initial pruning the young bush should produce three or four strong shoots from the base, each shoot being 18 in or more in length. If growth is poor, they should be cut down again in the winter. Assuming a strong bush has been formed, no pruning is required at the end of the first year; the young shoots are left to fruit in the following summer.

Pruning an established bush Black currants bear the best fruit on the wood produced in the previous summer, although they also crop on the older wood. Prune in early fall "or at any time in the dormant season until early April.

The objective with an established bush is to stimulate a constant succession of strong young shoots to carry fruit in the next season by fairly hard-pruning, cutting at or as near the base as possible, and by heavy feeding.

It is important to be able to distinguish the young wood from the old. This is fairly easy because the bark of the young shoots is much lighter in color than that of three years old or more.

There is no need to limit the number of main branches nor to have the center open. However, about a quarter to a third of the oldest wood should be removed annually. Cut back to a strong young shoot at or near the base or, if there is none, cut out the branch altogether.

Remove any thin mildewed shoots including those suffering from die-back in the center. Leave a working space between one bush and the next.

Feeding and watering Black currants thrive on heavy manuring and high summer moisture. Each March apply a balanced fertilizer such as 10-10-10 over the whole plantation at 3 oz per square yard. Additionally, in April apply sulfate of ammonia at 1 oz per square yard; on acid soils apply an artificial fertilizer containing calcium carbonate and ammonium nitrate. Follow this with a 3 in thick mulch of manure or compost around each bush.

In dry weather apply 41/2 gal of water per square yard every ten days, but keep the water off the stems as much as possible to lessen the risk of fungal trouble.

Weed control The bushes are shallow-rooted. Do not dig around the plant but keep the weeds down by shallow hoeing or by hand weeding or by using herbicides.

Pollination

Black currants are self-compatible and are pollinated mainly by bees.

Frost and bird protection

The flowers are extremely vulnerable to spring frosts which cause the fruitlets to drop. On nights when frosts are likely, drape the bushes with burlap or a few layers of bird netting (see pages 6-7); remove the cover in the mornings. Net the fruits against birds when the first fruits begin to color.

Harvesting

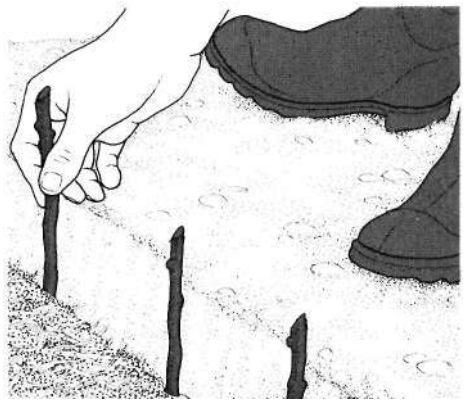
Pick selectively when the currants ripen but before they begin to fall or shrivel.

Pests and diseases

The most serious pests of black currants are aphids, the black currant gall mite, and red spider mite. Use a systemic insecticide against aphids, benomyl for gall mite, and malathion, dimethoate or derris to control red spider mite.

Of the diseases, the most troublesome are reversion disease, gooseberry mildew, leaf spot and botrytis. Bushes affected by reversion should be dug up and burned. Mildew can be controlled by regular spraying with benomyl; this will also control leaf spot. Alternative fungicides are zineb or thiram. For botrytis use benomyl at flowering time.

PROPAGATION



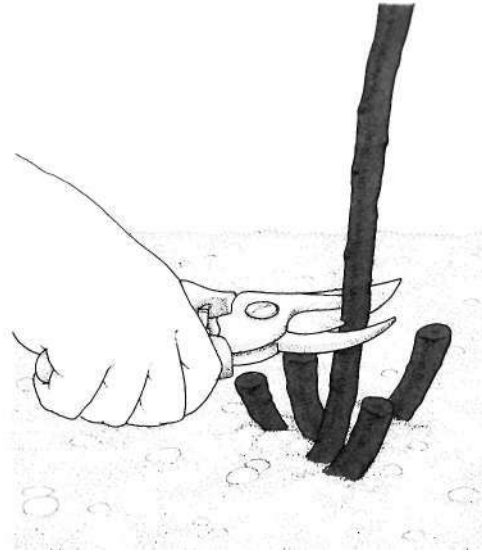
Black currants are propagated from cuttings 8-10 in long and about a pencil's width thick, from well-budded healthy wood of the current year's growth. Take the cuttings in October or November. Make a sloping cut just above a bud at the top and a straight cut just below a bud at the base. Insert the cuttings deeply with only two buds showing above the surface in well-drained light soil. Space the cuttings 6 in apart and firm them in the row.

At the end of the first growing season dig up and plant the rooted cuttings 12 in apart. Cut them down to within 1 in of the ground. This hard pruning should create a stooled bush.

Black currants

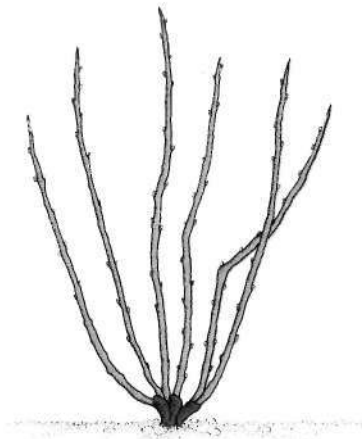
1 In early spring, clear the ground of weeds. Dig in a 3 in layer of manure or compost. Rake in a balanced fertilizer such as 10-10-10 at 3 oz per square yard.

2 Dig a hole wide and deep enough to take the roots spread out well. Plant the bush 2 in deeper than it was at the nursery. Fill in the hole and firm the soil.



3 After planting, cut down all shoots to within 2 in of soil level.

The second year

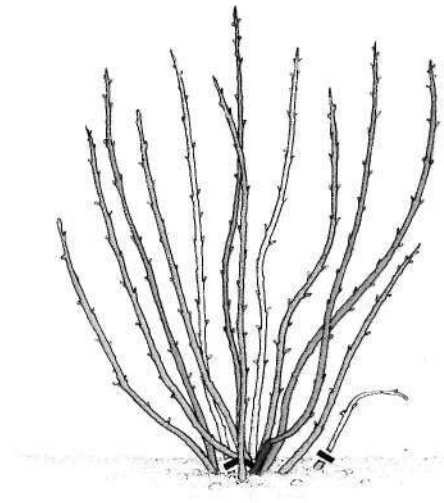


4 In the fall, the severe pruning has resulted in strong new shoots appearing from the base. These will fruit the following year. No pruning is required.

5 **In March,** apply a balanced fertilizer such as 10-10-10 at 3 oz per square yard. A month later, apply 1 oz sulfate of ammonia per square yard

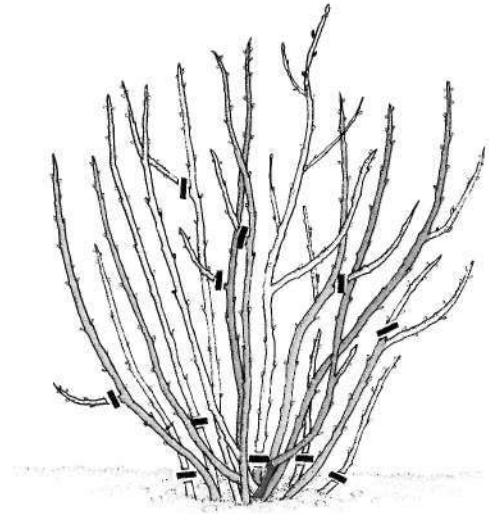
6 In July, the bush fruits best on last year's wood. New basal growths develop.

The third year



7 **In winter,** thin out weak shoots and any branches that are too low, broken or mildewed.

In subsequent years



8 Every winter, remove about one-third of the bush. Cut out badly-placed, damaged wood. Cut back fruited branches to a strong shoot.

Red and white currants

Red and white currants are basically derived from two European species, *Ribes rubrum* and R. *spicatum.* Red currants sometimes occur as garden escapes from bird-sown seed and R. *rubrum* is also found naturalized in many areas.

Cultivation

The fruit buds are produced in clusters at the base of the one-year-old shoots and on short spurs on the older wood. Because of this fruiting habit there is a permanent framework of branches, unlike the black currant for which a succession of young wood is needed.

The red currant is usually grown as an open-centered bush on a 4-6 in stem or leg, rather like a miniature apple tree, with a height and spread of about 5-6 ft. This method of growth makes cultivation around the plant easier and keeps the fruit clear of the ground. The red currant is also grown as a single or multiple cordon, and, more rarely, as a standard or fan. A well-grown bush should yield at least 8-10 lb of fruit and a single cordon about 2-3 lb. Plants should bear well for at least ten years.

The smooth-skinned, glistening red berries are attractive and ideal for jelly, pies, juice and for wine making.

Red and white currants are, like black currants, alternate hosts to white pine blister rust, and so have planting restrictions in many states. The state agricultural extension service or forestry department should be consulted before ordering.

The white currant is a mutation or sport of the red currant and for cultural purposes is treated in exactly the same way. The berries, of somewhat milder flavor than the red, are also useful for jelly and for wine making.

Soil and situation Ideally, the soil should be neutral to slightly acid (about pH 6.7). Red and white currants are less tolerant of poor drainage than the black currant but, provided the soil is reasonably well drained and not deficient in potash, they are tolerant of a wide range of conditions.

The flowers of the red and white currants are hardier than those of the black currant, so it is a useful plant for north-facing walls and fences and for shaded areas, provided the soil is not dry and over-hanging trees do not drip on the plants. They grow in zones , 3-8. A sunny position is best if the berries are to acquire their full flavor. The site should be sheltered but not a frost pocket.

Soil preparation Prepare the soil in the fall or late winter by clearing away all weeds. Apply a light dressing of well-rotted manure or compost about 11/2 in thick over the whole area. If farmyard manure or compost are not available, apply a 1 in layer of damp peat. If the ground is fairly clean, single dig the dressing in; but if weedy, double dig the area. Rake in a balanced fertilizer, such as 10-10-10, at the rate of 2 oz per square yard and sulfate of potash at 1/2 oz per yard.

Selection of plants Buy plants from a reliable source because certified stock is not available. One- or two-year-old bushes are usually supplied by the grower. Select a plant with a clear stem, or leg, of about 4-6 in with a head of about 3-6 evenly balanced shoots. The single (or multiple) cordon may be two or three years old and should consist of one (or more) straight stems with sideshoots.

Planting and spacing Plant during the dormant season in March or April, unless the plants are container-grown, when they can be planted at any time.

Space bushes 5 ft x 5 ft (5 ft x 6 ft on fertile land) and single cordons 15 in apart, or 12 in apart on light soils. Allow 12 in between each stem of a multiple cordon; for example, double cordons should be planted 24 in apart from the main stem at ground level. Cordons should be trained up a vertical cane for straight growth and support. If planting cordons in the open, before planting erect a wire fence with horizontal wires at 2 ft and 4 ft and tie canes to the wires at each planting station.

Next, take out a hole large enough to contain the roots well spread out, and plant the bush or cordon to the same depth as it was in the nursery. Fill in and firm the soil.

Feeding and watering Each March apply a balanced fertilizer, such as 10-10-10, over the whole planting at 2 oz per square yard and sulfate of potash at joz per square yard. On light soils also apply a mulch of rotted manure, compost or peat 2 in thick around each bush. If manure, compost or peat are not available, apply sulfate of ammonia at 1 oz per square yard. Water copiously in dry weather.

1 In late winter, dig in a 11/2 in layer of well-rotted manure. Then, rake in a balanced fertilizer, such as 10-10-10, at 2 oz per square yard and sulfate of potash at 1/2oz per square yard.

2 In early spring, dig a hole large enough to take the roots well spread out and plant the bush to the same depth as it was at the nursery. Delay planting if the ground is very wet or frozen.

3 **Each March,** apply 10-10-10 at 2 oz per square yard and sulfate of potash at 1/2oz per square yard. On light soils also apply a 2 in mulch of rotted manure, compost or peat around each bush.

4 During the winter, protect the fruit buds with netting against attack by birds and frost at blossom time. Remove it during the day at flowering time.

Red and white currants

Pruning bush currants
The objective is to create a goblet-shaped bush with about 8-10 main branches growing upwards and outwards on a 4-6 in clear stem with an open center. Prune in the same way as the gooseberry bush (see pages 36-7) except that the leaders are pruned to outward-facing buds, unless the branches are drooping, when they are pruned to upward-facing buds.

Pruning the single cordon: initial pruning
On planting a one-year-old rooted cutting, shorten the central leader by about one-half to an outward-facing bud. Cut back all other laterals to about 1 in at a bud, and remove any buds lower than 4 in to create a short clear stem. If planting an older pre-shaped cordon, shorten the leader by one-third and prune maiden laterals to one bud.

In late June to early July cut back the current season's side-shoots to 4-5 leaves. Tie the leader to the cane as and when necessary throughout the growing season, but do not prune it.

Second and subsequent years A cordon is pruned in much the same way as a bush. Each summer at the end of June or early in July prune the current season's side-shoots to 4-5 leaves. Do not carry out summer pruning earlier than this or secondary growth may be stimulated. The leader is trained and tied to the cane, but not pruned in the summer until it has reached the required height, usually about 5-6 ft. From then on it is summer-pruned to 4-5 leaves.

Each winter, cut all the previously summer-pruned laterals to about 1 in at a bud. Prune the leader to a bud leaving 6 in of new growth. Once the leader has reached the required height, it is also pruned to leave one bud of the previous summer's growth. This helps to maintain the cordon at approximately the same height for some years.

Multiple cordons, such as the double- and triple-stemmed cordon, are pruned in exactly the same way as the single, except that in the early formative years suitably low placed laterals are used to form the main stems of each goblet-shaped bush.

Weed control
Red and white currants are shallow rooted. Do not dig around the plants but keep the weeds down by shallow hoeing or by using herbicides.

Pollination
Red currants are self-fertile and insect pollinated, so pollination is not a problem.

Frost and bird protection
Red and white currant flowers are fairly hardy, although they will not tolerate hard frosts. Cover them with burlap or two or three layers of bird netting on frosty nights.

The berries are extremely attractive to birds in the summer, as are the fruit buds in the winter. Net the bushes in the winter and at fruit ripening time. Remove the netting at flowering time, because it inhibits insect pollination.

Harvesting
Red and white currants are ripe in July or August and should be picked as soon as they are clear in color. Pick whole clusters to avoid injury to the delicate fruit.

Propagation
Propagate new red and white currant plants in the fall from hardwood cuttings, which should be 12 in long or more. Before planting the cuttings, remove all the buds except the top three or four. Insert into the soil with the third bud within 2 in of the soil surface and label the cuttings. After they have rooted (in about a year's time) plant out the cuttings. This method produces rooted cuttings with four good branches and a short leg.

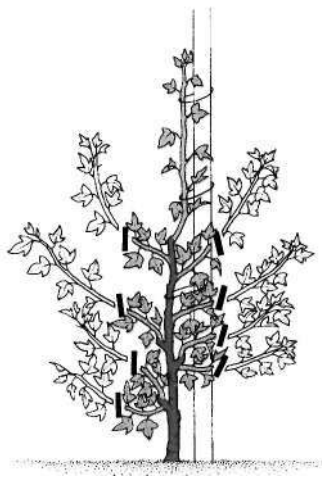
Pests and diseases

The most serious pests are aphids and, to a lesser extent, sawflies and currant fruit flies. Control aphids with a systemic insecticide rotenone.

Occasionally anthracnose and cane blight can be troublesome. Early season sprays of ferbam give satisfactory control of anthracnose. If the canes are blighted, cut back to healthy wood and burn the prunings.

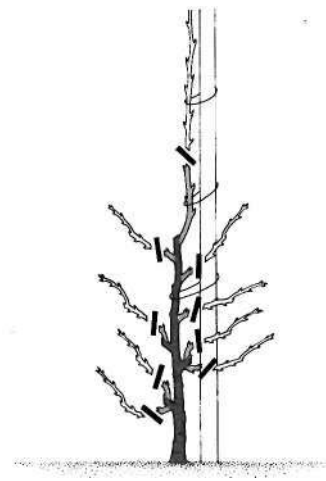
The first year: Cordon

1 In winter, when planting a one-year-old shorten the central leader by about one-half to an outward-facing bud. Cut back all laterals to 1 in at a bud and remove any lower than 4 in.

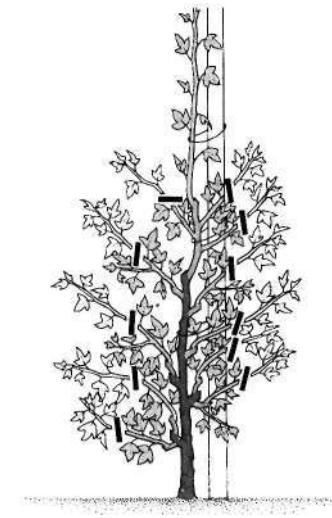


2 From late June to early July, cut back the current season's side-shoots to 4-5 leaves. Tie the leader to the cane as it extends but do not prune it.

Second and subsequent years

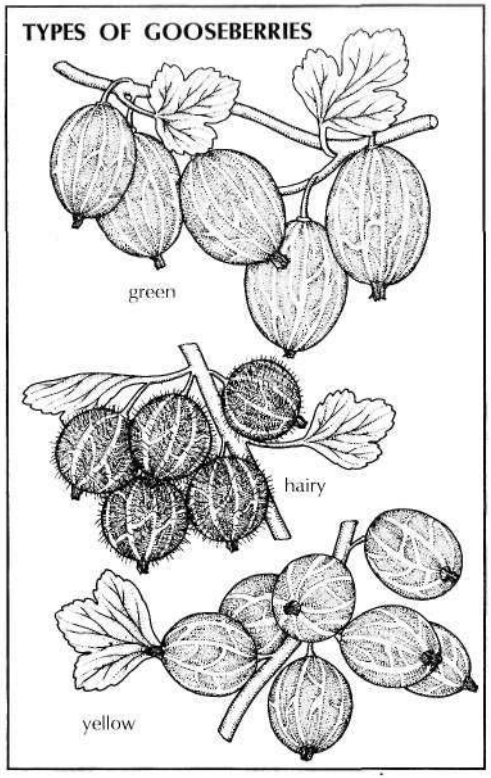


3 In winter, prune the leader to a bud leaving 6 in of new growth. Cut all previously summer-pruned laterals to 1 in at a bud. In later years, cut the leader back to one bud.



4 From late June to early July, prune the current season's side-shoots to 4-5 leaves. Tie the leader to the cane as it extends.

Gooseberries



The gooseberry *{Ribes uva-crispa)* is a deciduous thorny shrub growing in zones 3-8.

Like the red currant, the gooseberry bears its fruit on spurs on the older wood and at the base of the previous summer's lateral growth. For this reason it is grown with a permanent framework of branches, usually in the form of an open-centered bush on a short stem, or led, of about 4-6 in. It is also widely grown as a cordon in single or multiple form and occasionally as a standard on a 31/2 ft stem or as a fan.

The fruits may be smooth or hairy, yellow, white, green or red according to variety.

A well-grown bush should reach a height and spread of 5 ft and crop well for 12 years or more. A good average yield *from* a bush is 5-6 lb, and from a cordon 1-2 lb.

Like currants, gooseberries are alternate hosts of white pine blister rust and can be planted only in areas where this disease is not a problem. The local state agricultural extension service or forestry department should be contacted before ordering plants.

Cultivation

One-, two-, or three-year-old bushes' can be bought from a grower. A one-year-old bush should have about 3-5 shoots evenly placed around the stem, a two-year-old about 5-7 and a three-year-old 6-8 primary and secondary branches. Gooseberries are self-fertile, so they can be planted singly.

Soil and situation The soil requirements of the gooseberry are similar to those of the red currant. The soil should not be allowed to become potash-deficient The plant tolerates a little impeded drainage, provided it occurs below 18 in. The ideal soil, however, is a slightly acid (pH 6.7), well-drained medium loam.

The gooseberry is tolerant of cool, partial shade, but grows best in an open sunny site, which should be sheltered against strong winds, especially at flowering time in early April. Do not plant it in a frost pocket.

Soil preparation Prepare the soil in the fall or late winter. It is essential to eliminate perennial weeds because the gooseberry is thorny and not easy to weed around. On light soils, dig in a 11/2-2 in layer of well-rotted manure or compost over the whole area. On rich soils there is less need for bulky organics because too much of them encourages soft growth, which is prone to snapping and to mildew. Rake in a balanced fertilizer such as 10-10-10 at 2 oz per square yard and sulfate of potash at 1/2 oz per square yard.

Planting and spacing Plant during the dormant season in March or April, preferably when the soil is warm.

Dig a hole wide and deep enough to contain the root system with the roots well spread out. Before planting, clean off any suckers at the base of the plants and any shoots too near the ground, then plant it to leave a clear stem of 4-6 in. Fill in the hole and firm the soil.

Space the bushes 5 ft apart, or on highly fertile ground 5 ft by 6 ft apart, and single cordons 1ft apart. Allow 1ft space for each stem of a multiple cordon. For straight growth and support, train a cordon up a cane. If growing cordons in the open, erect a wire fence with horizontal wires at 2 ft and 4 ft and tie the canes to it.

Feeding and watering Each March apply a balanced fertilizer such as 10-10-10 over the whole plot at 2 oz per square yard and sulfate of potash at 1/2 oz per square yard. Mulch around the base of the plant with a 2 in layer of well-rotted manure, compost or peat on light soils, but less on medium or fertile soils. In the absence of bulky organics apply sulfate of ammonia at 1 oz per square yard.

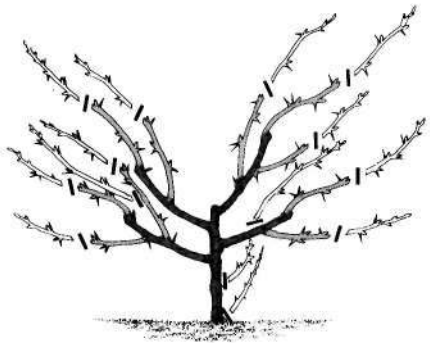
Water copiously in dry weather but do not water irregularly or heavily at the ripening stage because this causes the fruit to split.

The second year

1 Clear the soil of perennial weeds. Rake in a balanced fertilizer such as 10-10-10 at 2 oz per square yard and sulfate of potash at 1/2 oz per square yard.

2 In early spring, dig a hole wide and deep enough to take the roots spread out well. Plant the bush so that there is a clear stem of 4-6 in above ground.

3 At the same time, cut back each framework branch by one-half to an inward- and upward-pointing bud. Clean off the suckers at the base and any shoots too near the ground.



4 In winter, shorten the leaders by one-half to inward- and upward-facing buds. Select well-placed shoots to form further permanent branches and cut back by one-half. Remove suckers and low stems.

Gooseberries

Formative pruning: Bush

Most varieties have a tendency to form drooping growth and, in order to maintain an erect bush, counteract this habit by pruning the leaders to inward- or upward-facing buds or back to upright laterals. The center of the plant is kept open to make picking and spraying easier, to ripen the wood and fruits, and to improve air circulation (which lessens the risk of mildew).

When planting a one-year-old bush, cut back each framework branch by one-half to an outward-facing bud if the shoot is upright. Cut back to an inward-facing bud if the shoot is weeping.

The second year (or a two-year-old bush)

In late winter, shorten the leaders by one-half. Select well-placed shoots to form further permanent branches and cut back by one-half. Remove any suckers or low-growing shoots growing from the stem.

The third year (or a three-year-old bush)

The bush should have developed a main framework of about 6-8 branches with well-spaced leading shoots; it is at the start of its cropping life. In winter, shorten the leaders by one-half to a bud facing in the required growth direction. Cut out shoots crowding the center and shorten those not required In the framework to about 2in. thereafter, prune the bush both in the- summer and in the winter.

Pruning an established bush

Each summer, in late June to early July, prune all laterals (that is, the current season's growth) back to five leaves. This opens up the bush and removes any mildew and aphids at the tips of the shoots. Do not prune gooseberries earlier because this might induce secondary growth. Do not prune the leaders unless they are affected by aphids or mildew.

Each winter, cut back the leaders by one-half to a bud facing in the required direction. If the branch is weeping badly and there is a suitably placed upright lateral on it, then cut back to this.

Next deal with the laterals that were pruned the previous summer. Where smaller quantities of large high-quality dessert fruits are required, cut all of these laterals back to about two buds. Where a large amount of fruit is required, pruning should be moderated accordingly. Vigorous varieties should be pruned less severely because this could encourage excessive growth. Cut out dead and diseased wood, and any growth crowding the center of the bush.

As the bushes become older and branches less productive or too spreading, leave in some suitably placed strong, young shoots to replace the old which are then cut out.

The third year

Pruning a single cordon Prune in the same way as the red currant cordon (see page 33).

Weed control

As with most bush fruits, the gooseberry is shallow rooted. Keep the weeds down by light hoeing or with herbicides.

Protection against frost and birds

The gooseberry flowers early, during April, and spring frosts can substantially reduce the crop. On frosty nights protect the plants when they are in flower. Cover with burlap or two or three layers of bird netting, but remove it during the day to allow in light and give access for pollinating insects.

The fruit buds are attractive to bullfinches and sparrows in the winter and the ripening fruits to blackbirds and thrushes in the summer. Net the bushes in the winter and when the fruits begin to ripen. For further information on netting against birds, see under separate headings (page 17).

Thinning and harvesting the fruits

For large dessert fruits start thinning the fruits in June, removing every other one, and use the thinnings for cooking.

For small or medium dessert fruits, do not thin the fruits but leave them to ripen and develop their full flavor. Pick gooseberries for cooking when they are a good size, but still green, from late June.

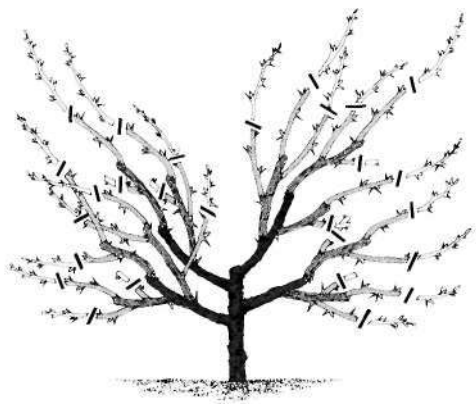
Propagation

Propagate gooseberries using 12 in hardwood cuttings taken from healthy shoots in late September. First remove the weak tip and all but four buds from the upper part of the cutting. This produces a miniature, open-centered bush on a short leg. Dip the base of the cuttings in a hormone rooting powder. Insert the cuttings in the open ground with their lowest buds 2 in above the soil surface. Leave the cuttings in the nursery bed for the growing season. Lift and replant, exposing more of the stem.

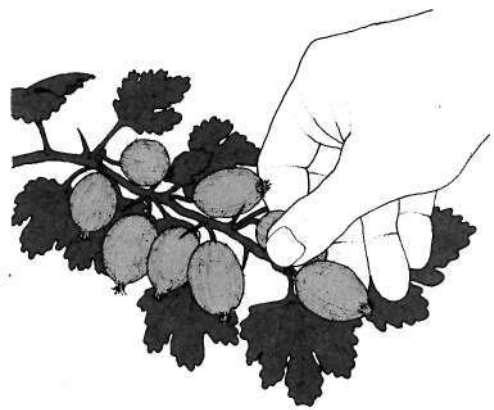
Pests and diseases

The pests and diseases that plague the gooseberry are similar to those that attack the currants. For example, aphids and anthracnose (see page 33).

The third year

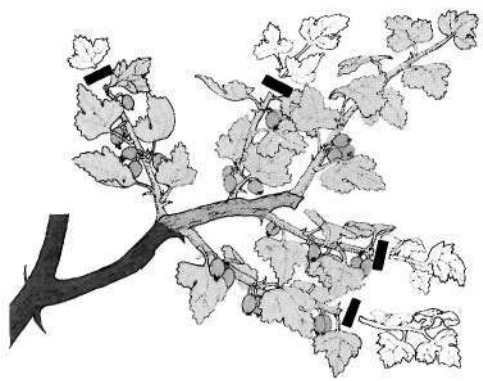


5 In winter, shorten the leaders by one-half to a bud facing in the required growth direction. Cut out shoots crowding the center. Shorten laterals not required for the framework to about 2 in.

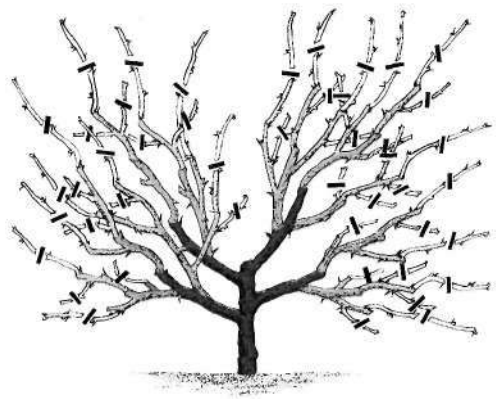


6 When the fruits are large enough for cooking, thin the fruits by removing every other one. Cover the bush with burlap or bird netting to protect the fruits from birds.

The established bush



1 In late June to early July, prune all the laterals produced that season to five leaves. This opens up the bush and removes aphids at the tips of the shoots. Do not prune the leaders.



2 In winter, cut back the leaders by one-half. Cut back laterals pruned in the previous summer to about two buds. Cut out diseased and dead wood and growth that crowds the center.

Grapes

The art of growing grapes, or viticulture, has a long and illustrious history. The vine grows wild in the temperate regions of North America, western Asia, southern Europe and parts of North Africa and it is thought to have originated in Asia Minor.

The vine is a perennial deciduous climber that clings to supports by tendrils. The leaves are hand- or heart-shaped and 4-8 in in size.

The grapes most commonly grown by home gardeners in the northern part of the United States are the so-called American, or bunch, grapes, descendants of wild grapes. The blue, black, green, red and yellow berries usually have slip-skins (separable from the pulp) and ripen from mid-summer on. They are largely self-fruitful. Although American bunch grapes can be grown from zones 3-10, they do best in zones 5-7.

Muscadine grapes are generally grown in the South (zones 7-9). These form much larger vines up to 90 ft long and produce fruits singly or in loose clusters. Several self-fruitful varieties are available but most varieties are self-unfruitful. Since the fruit of self-fruitful varieties is inferior to that of the self-unfruitful varieties, self-fruitful varieties are best used to pollinate the self-unfruitful varieties.

Vinifera, or wine, grapes are descended from European grapes and are best employed in wine-making. A number of varieties, all with skins inseparable from the pulp, are eaten at table and are considered among the best grapes for this purpose. Some varieties are also used for raisins. All vinifera grapes are self-fruitful, producing berries in extremely large clusters. They grow best in California, but there are numerous hardy varieties that can be grown as far north as zone 6. There are also many new hybrid varieties resulting from crosses of American and vinifera grapes. These combine characteristics of the parents and are therefore difficult to classify.

Cultivation

Grapes are sun-loving plants and must be grown where they will be exposed to the sun all day or at least for the greater part of the day. But the base of the plant need not be in full sun although it is essential that the upper part of the plant catches as much strong sunlight as possible. (Grapes growing wild in forests often take root at the foot of trees and soon clamber above the trees).

The location selected for the vines should have good air drainage. In colder areas, protection from winter winds is necessary.

Soil

The vines are fairly tolerant of a wide range of soils, although the soils must be deep and well drained, and not too sandy. The plants require a soil pH of 5.5-7.0. If there is any possibility that the soil may become badly waterlogged, a good drainage system should be installed.

Two or three weeks before actual planting, prepare the soil by double-digging to break up any hard layers and to clear away perennial weeds. Dig in leafmold or well-rotted manure at the rate of about one wheelbarrow load per 20 square feet. Also rake in a balanced fertilizer such as 10-10-10 at the rate of 3 oz per square yard.

Planting

Plant one-year-old vines in early spring before they start to leaf out. Dig large, deep holes; spread out the roots; firm them well; and water thoroughly. Then cut off all but one strong cane and trim this back to eight buds.

Maintenance

Except for pruning and training, grapes do not demand a great deal of attention.

In dry spells, they should be watered deeply, but, as the fruit begins to mature, the water supply should be reduced somewhat. This helps the maturation process and also inhibits succulent growth. In the fall, however, after the fruit has been picked, one heavy watering is necessary to help protect the vines from winter injury.

Unless the plants are doing poorly, they need little fertilizer. Give each plant 2-4 oz of ammonium nitrate or a somewhat more balanced fertilizer in early spring. This should carry them through the growing season.

Keep encroaching weeds pulled. An application of an organic mulch around the plants discourages weed growth in addition to supplying the necessary nutrients for healthy growth.

Training and pruning

the training and pruning of grapes are matters of critical importance. The main purposes of training are to keep the large, fast-growing vines under control, to facilitate care and harvesting, and to expose all parts of the plants to the sun. The purposes of pruning are to maintain vigorous growth, to provide new canes for the next year, and to limit the number of fruit-producing buds so that the vines do not produce too much small fruit of inferior quality.

Various training systems are used for all three types of grapes.

American bunch grapes

Four-Arm Kniffin system This is the most popular method of training American bunch grapes since it gives good production and requires little summer tying of the vines.

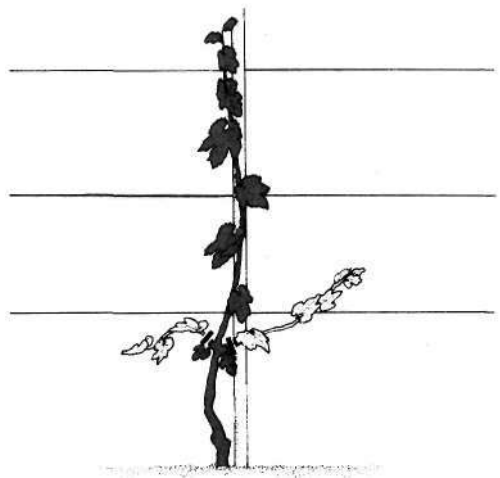
The trellis required consists of 4-6 in posts and galvanized steel wires. Space the posts 16 ft apart. Sink the end posts 3 ft into the ground and brace them with diagonal struts or guy wires. Sink the intermediate posts 2 ft. The posts normally extend 5 ft above ground,

Staking and planting

1 Bore or dig holes and drive 8 ft posts 3 ft into the ground, spaced according to the pruning system to be followed. Stretch wires between the posts, spaced according to the pruning system.

2 In early spring, plant the vine to the nursery depth between posts in prepared ground. Firm the soil and water well. Cut back the vine to one cane and eight good buds.

The first year



3 For both pruning systems, allow one rod to develop. Pinch back to one leaf any other shoots. Leave two good buds (Kniffen) or three (Guyot).

Grapes

but increasing the height to 6 ft exposes the vines to more sunlight and is especially recommended for short-season areas.

Use 9-gauge wire at the tops of the posts and 11-gauge at 30 in above ground. The wires can be stapled to the posts or run through holes drilled in the posts. Drilled holes give greater security. If staples are used, do not drive them down tight because it may be necessary to tighten the wires when they sag under the weight of the vines.

Plant the grape vines between posts. If planted at the base of posts, they may be injured by any wood preservative in the treated posts, and would undoubtedly be damaged when the posts had to be replaced.

The first year When the two top shoots on the young plant are about 1 in long, rub off all other shoots.

The second year Select the strongest cane for the trunk and tie it to the top wire. Cut the cane just above the wire and remove all other canes. If no cane reaches the top wire, tie the strongest one to the bottom wire and extend it to the top wire the next year. If no cane reaches either wire, reduce the vine to a single stem with two or three buds and start all over again.

The third year Pick four good canes for the arms; cut them back to approximately 10 buds in length; stretch them out along the top and bottom wires in both directions from the trunk; and tie them. Cut four other canes back to two or three buds for renewal spurs and remove all other canes.

Subsequent years Each year cut off the 10-bud fruit-bearing canes of the previous year and replace them with the renewal spurs (which are shortened to approximately 10 buds). The renewal spurs are replaced with new renewal spurs cut back to two or three buds. All other canes are removed.

The actual number of buds that should be left on fruit-bearing canes each year depends on the variety of grape and the growing conditions. Until the home gardener has raised grapes for some time, the best way to determine how hard to prune is as follows. First rough-prune the vine, leaving a few more buds than needed. Weigh the wood removed. For the first pound of wood, leave 30-40 buds, more or less equally divided between the four fuit bearing canes, on the plant. For each additional pound of wood removed, leave eight more buds on vine vine. (This weighing plan is used not only for the Four-Arm Kniffin training system, but also for all other training systems).

All pruning is done in early spring while the vines are dormant and after danger of severe freezes has passed. If pruning is done too early, heavy frost can compound the winter injury already suffered by the plant, and the gardener cannot be certain which canes are alive and which are dead. Pruning late does no serious damage, but there is a good chance that some of the buds meant to be saved will be destroyed. If the cut canes "bleed", there is no need for worry as this does no great harm.

Munson system This is an excellent system for humid climates because the grapes are carried well above ground where they are exposed to more air currents.

The trellis consists of sturdy and large posts (4 x 6s are recommended) with stout 24 in crossarms 5 ft above ground. Brace the cross-arm. Staple two No 9 wires to the ends of the crossarms on the top edge. Run a third wire through the posts 6-8 in lower.

Train the new vine, as above, to a single trunk extending to the bottom wire. In the third year, prune it to two fruit-bearing canes and two renewal spurs. Tie the canes along the lower wire, and as the young shoots develop, drape them over the upper wires, allowing them to hang down.

Each year thereafter replace the arms with the canes from the renewal spurs and replace the spurs.

Modified Chautauqua system This system is used where tender grape varieties need winter protection. The trellis is made with 4-in posts and three No 9 wires spaced 12, 28 and 44 in above ground.

In the first year, simply let the vine grow upward and tie it to the wires. In the fall of the same year, select the best cane for the trunk, reduce it to 30 in long, and remove all other canes. Lay the trunk on the ground and cover it with about 8 in of soil for a measure of protection.

In the spring, pull the cane out along the bottom wire at an angle and tie it. As new growth develops, tie to the other wires.

Prune the new growth to short two-bud spurs in the fall. Keep the cane closest to the end of the trunk to form an extension of the trunk. Remove the vine from the trellis and bury it as before.

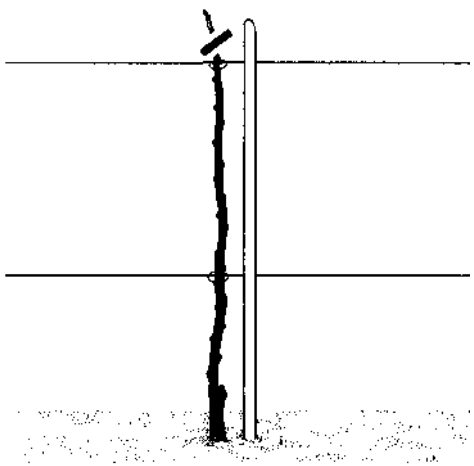
In following years, repeat this procedure. Let the trunk grow to a maximum length of about 7 ft.

Muscadine grapes

Muscadines can be trained by any of the systems described, but the vine is such a strong, rampant grower that it is often cultivated on arbors. In this case, train the young vine to a trunk 6-7ft long before allowing it to branch out to the sides along wires, spaced about 2 ft apart, forming the arbor roof.

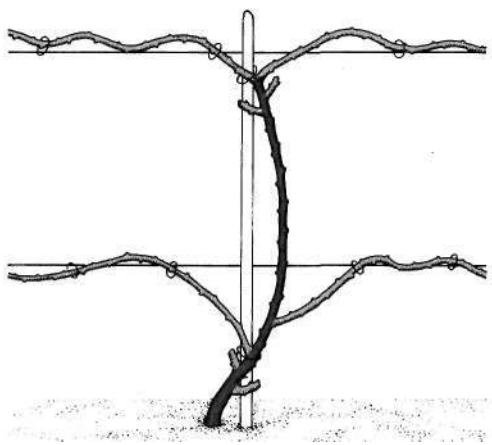
In the Four-Arm Kniffin system, train and prune the vine to form a trunk and four strong arms. Do not cut the arms back until they meet those of the neighbouring vines. Thereafter, annually prune out deadwood, weak canes, and side growth on the trunk and the tendrils. Cut the remaining canes back to two or three buds.

Kniffen system—The second year



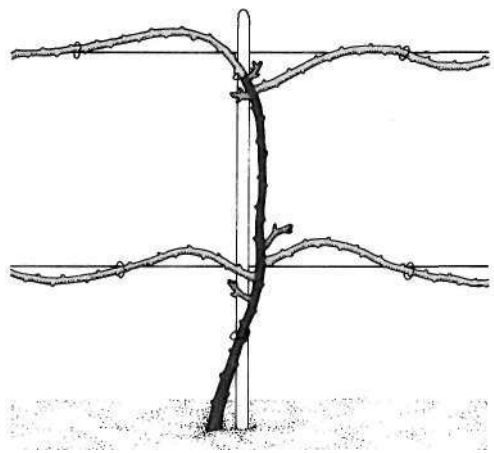
1 In spring, select the strongest cane, tie it in and cut off just above the top wire. Remove all other canes.

The third year



2 In spring, select four vigorous canes and tie them in to form arms. Prune them to ten buds each. Prune four other canes to form four renewal spurs for the next year.

Fourth and subsequent years



3 In spring, cut off the old fruiting arms. Tie in four new canes chosen from the renewal spurs. Cut each new cane back to six buds. Cut four new canes back to two buds to form renewal spurs.

Grapes

In the warmest regions, pruning should be done after the first killing frost in the fall or early winter. Further north, prune in early spring. Muscadines pruned at this time bleed great deal, but there is no damage to the plants.

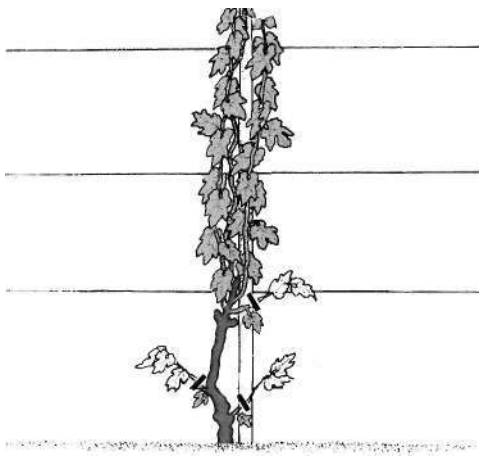
Vinifera grapes

The Four-Arm Kniffin system is the method generally chosen in warm climates, but a modification called the Spur system is used for varieties such as 'Csaba' and 'Cardinal'. The Spur system allows the fruit-bearing arms to be permanent, that is they are not renewed annually. Each arm has 6-8 vertical fruiting spurs and each spur has 2-3 buds that produce fruit shoots.

In cold climates, where tender varieties need winter protection, the Modified Chautauqua system can be used.

Guyot system This is actually two systems. In the single Guyot system there is one fruit-carrying arm while in the double Guyot system there are two fruit-carrying arms. The double Guyot system is the more popular and is described below.

Double Guyot system—The second year



1 In spring, cut the vine down to within 15 in of the ground, leaving three buds. Train the resulting shoots vertically. Pinch back any laterals to one leaf as they develop.

Each year, allow three new main stems to develop. Retain two for fruiting and cut back the others to produce replacement stems for the next year. The fruiting canes are trained close to the ground to take advantage of its radiated warmth.

The trellis consists of 4-in posts spaced 8-10 ft apart. Brace the end posts. Attach a No 12 wire to the posts 15 in above the ground and two No 14 wires so they cross at each post.

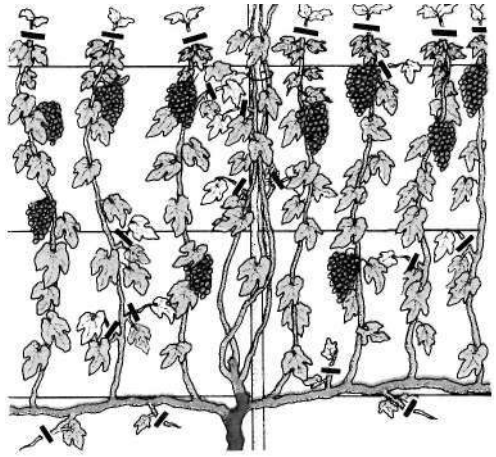
The first year At planting, cut the vine down to about 6 in from ground level if the vine is on its own roots or, if it is a grafted plant, 6 in above the graft union, leaving at least two good buds. During the summer following planting, train one shoot up the post and pinch out all others to one leaf.

The second year In the spring, cut the vine down to within 15 in of ground level, leaving three good buds. During the summer, train in three shoots vertically. Pinch back any laterals to one leaf as they develop. In the next spring, the vine should be pruned as for an established vine (below).

Pruning an established vine Each spring (except the first) cut back the arms that bore fruit the previous summer to the replacement spurs. Do not allow fruit on the plants in the second year after planting, but allow them in the third. Tie down on to the lowest wire one replacement shoot to the left and one to the right. Cut down the remaining spur to three or four buds to provide replacement spurs for the following year. Cut back the immature wood on the replacement spur, leaving about 2-21/2 ft of strong growth either side.

Third and subsequent years From April to August, tuck in the vertical fruit-carrying laterals between the double wires. Cut them back to two or three leaves above the top wires, as necessary, and remove any sub-laterals. Train the three replacement spurs from the center for the following year up the post. Pinch back any sub-laterals on the replacement spurs to one leaf and remove any blossom. Remove any surplus spurs coming off the main stem.

Third and subsequent years

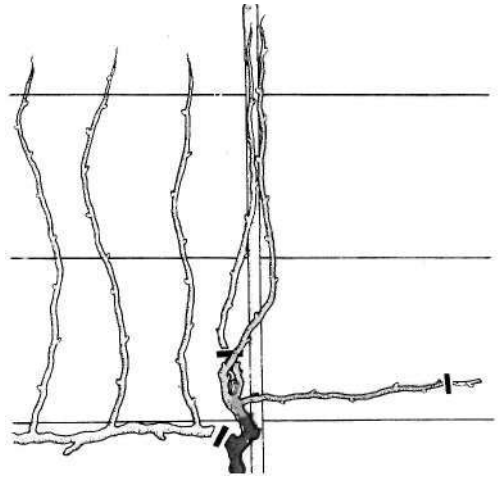


2 **From April to August,** train three shoots vertically from the center. Pinch back any laterals produced on them to 1 in as they develop. Tuck in the vertical fruit-carrying laterals through the double wires. Cut them back to three leaves.

Thinning

Thinning of the fruit is recommended for vinifera grapes, but not for American and **Muscadine grapes. Viniferas are very** heavy producers, and thinning is needed to improve fruit size, thinning of **varieties with very** large or compact fruit clusters is done by removing individual berries immediately after fruit set. On varieties with loose or straggly clusters, remove some of the immature flower clusters appearing with the new growth in the spring.

In addition, with all vinifera varieties, it helps to remove entire fruit clusters soon after fruit set. The number of clusters left depends on the size and vigor of the vine. Keep about 20-30.



3 In November, cut out the two arms that bore fruit in summer to the replacements. Tie down one replacement shoot to the left and one to the right. Cut back each to leave 2-21/2 ft of strong shoot. Cut down the remaining shoot to three buds.

Harvesting

Even when grapes are fully colored, they are not ripe because they need a finishing period for sugars to form. This period can vary from 4-8 weeks. Once picked, grapes do not continue to ripen.

Pests and diseases

Grapes are not greatly bothered by pest and disease problems. But it is advisable to spray the plants in late winter with dormant oil. A general-purpose fruit spray should be applied when the new growth is about 8 in long, just before bloom and two weeks thereafter.

Mildew should be sprayed with a fungicide whenever it appears. Spraying with carbaryl takes care of Japanese beetles, which have a particular liking for grape vines. Repeat treatment as necessary.

It is almost impossible to cover grape vines securely with nets to protect them from birds. But the individual fruit clusters can be enclosed in mesh or with paper bags.

In some years, wasps are even worse than birds, attacking the fruit just as it is ready to harvest and quickly destroying entire bunches. Only paper bags can keep wasps in check.

Disease or pest infestation should not prove a hindrance in viticulture if the grape vines are tended so that they remain in a healthy condition. Soil balance is the greatest determinant influencing grapevine health while weather is the most unpredictable factor. Wet, humid weather usually means mildewed grape vines.

Melons

Gray-green or ochre-colored melons with rough, netted skins are known to most Americans as cantaloupes, but the true cantaloupe is a hard-shelled European fruit that is rarely grown in the United States. Gardeners wishing to attempt to grow it usually have to order seeds from a foreign supplier.

Melons Americans grow fall into two categories: Muskmelons and Winter or late melons. Muskmelons mature in roughly 90 days and can be grown in zones 5-10 and even into zones 3 and 4, if the quick-maturing varieties are chosen. Winter melons, including the 'Casaba', 'Crenshaw', 'Honeydew', and 'Persian' varieties, are larger fruits with variously colored skins and most of them take about four months to mature, so they are grown primarily in warmer climates.

Cultivation

A popular misconception about melons is that they cannot be planted with cucumbers, squashes or other members of the cucurbit family because they are cross-pollinated and this changes the flavor and aroma of the melons. This does happen if seeds from melons grown the year before are used. But the use of fresh seed every year eliminates the problem.

Melons are tender and vulnerable and cannot be sown outdoors until the soil is warm and all danger of frost is past. In short-season areas, this makes melon-growing by this common method impossible.

Soil The soil for melons should be reasonably fertile but not too rich, with a pH of 6.7-7.0. Good drainage is essential. Dig the soil well before planting and mix in considerable humus to improve fertility and moisture retention. Also mix in about 24 oz of 5-10-10 fertilizer per 50 square feet.

Sowing the seed In the North, therefore, seeds are sown in flats or peat pots indoors about 3-4 weeks before the mean date of the spring freeze. When the plants have two or three true leaves, they are moved into the garden and grown under cloches or polyethylene tunnels, usually about two weeks after the last frost.

Planting Further south, however, direct sowing in the garden is a simpler and better method. Sow the seeds in 1/2 in deep drills about 6 in apart and thin them to stand 2ft apart. In setting out transplants, space them 2 ft apart. The rows should be 5-6 ft wide. The alternative is to sow seeds or plant seedlings in gently rounded mounds (hills) 6 ft wide and a few inches high at the center spaced 4 ft apart. Allow two or three plants per hill.

Furrows about 10 in wide can be dug on the south side of the hills to a depth of about 6 in to allow watering without wetting the foliage. Water well, especially during dry spells, but do not keep the soil soaked.

If nematodes are a problem in the garden, the soil should be fumigated before planting. **Watering and feeding** Melons need plenty of moisture throughout the growing season and this should be provided by deep weekly watering in dry spells. Pull out weeds as they appear. Mulching the plants with organic matter or black polyethylene film is a good idea to hold in moisture and keep down weeds. When the vines begin to run, side-dress them lightly with balanced fertilizer or nitrate of soda.

For example, apply 4-8-4 balanced fertilizer carefully at 1/2oz to each mound in a circle around each mound after thinning the plants. Keep the fertilizer well clear of the plants and cover the dressing with nearby soil. The dressing should ideally be applied 4-6 in away from each plant.

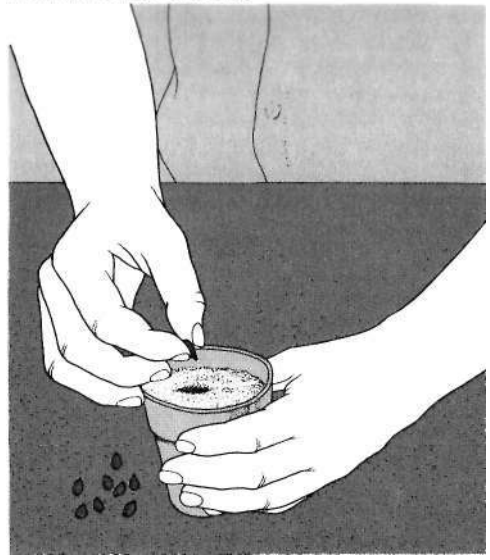
Harvesting

When melons start to turn their characteristic mature color, they are ripening and will soon be ready for picking. In the home garden, however, actual harvest should not start until the fruits pull away from the stem easily. At this time they are in prime eating condition. Do not leave them on the vine any longer, because they begin to deteriorate within a couple of days. Ripe melons have a strong, fruity scent.

Pests and diseases

Melons are attacked by a few insects, but these are not generally very troublesome and can usually be controlled by spraying with malathion or carbaryl when they appear. But diseases can be difficult, especially in warm, humid weather. The best protection against disease is to plant resistant varieties.

Melons under cloches

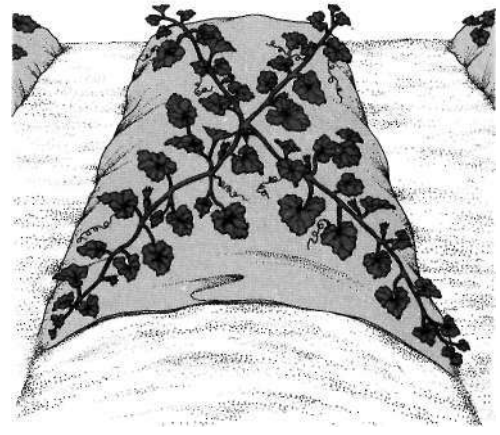


1 About four weeks before the expected date of the last spring frost, sow melon seeds in peat pots indoors. Harden off gradually before removal to the garden.

2 Plant out under cloches when the danger of frost is past. Make a hole wide and deep enough for the root ball to fit into comfortably.

Melons in the open

1 Dig soil well before planting and incorporate humus and 5-10-10 balanced fertilizer at 24 oz per 50 square foot. Mound up the soil.



2 Mulch the plants with black polyethylene and water well. Train as usual. Check for dryness at regular intervals thereafter. Mulching will help to warm cold soil.

Tree fruits

Introduction

Tree fruits (also sometimes referred to as top fruits) form a group comprising all the larger growing fruits which, in the natural state at least, attain tree form. The exceptions to this are the fig, elderberry, mulberry and quince, which may have several main stems and be more shrub-like in appearance; they are, however, still generally classified as tree fruits.

Botanically, the most familiar' tree fruits are members of the rose family *(Rosaceae),* including the apple, pear, plum, cherry, peach, apricot and quince; the mulberry and fig are outsiders belonging to the mainly tropical family Moraceae. Also included in the tree fruit section are some of the most popular nuts, such as almonds, chestnuts, filberts, hazelnuts and walnuts.

Tree fruits are not difficult to grow provided the soil is well drained but moisture-retentive and of a moderate to good depth (see pages 10-11). The site must be sunny and not prone to severe late spring frosts (see pages 6-7).

Unlike growing soft fruits, cultivating tree fruits in the garden is a long-term project. Full fruiting capacity is reached by the tree only after several years, but with care it will then continue for a lifetime. However, the fruit grower is compensated by the fact that the fruiting season for tree fruits is much longer than that of soft fruits. Furthermore, if fruits such as peaches or figs are grown in a greenhouse the season can be prolonged.

Rootstocks

Apples, pears, cherries and plums can all eventually make sizeable trees if grown on their own roots; some even become too large for most gardens. For this reason they are grafted on to rootstocks which control their eventual size. Usually apples are grafted on to a range of apple rootstocks to produce dwarf or less vigorous trees which are ideal for the small garden (see page 45). Pears are traditionally grafted on to quince rootstocks and this lessens their vigor and ultimate size. A dwarfing rootstock for cherries has proved harder to find but a less vigorous one has now been produced, although it is not as dwarfing as some of the apple stocks that are now widely available.

Pruning and training

For all tree fruits, initial training and subsequent pruning is necessary to keep them in good shape and productive throughout their lives. Methods of training, particularly pruning, can seem daunting to an amateur but this need not be so if the instructions with each fruit entry in this book are followed closely. There is also a companion volume on pruning in this series.

Pruning terms The terms used frequently in fruit tree pruning are defined as follows. Maiden describes a one-year-old, for example, a maiden tree. A scion is a variety grafted on to a rootstock of another tree; the union is where the two join. A branch is a limb that arises from the trunk. Primary branches are the first formed, and secondary branches arise from the primary ones. A leader is a main central stem of a tree or a shoot selected to extend a main branch; a lateral is a side-shoot. Spurs are short laterals that bear flower buds and which can occur naturally or be induced by selective pruning of the laterals. Flower buds, or blossom buds, are unopened flowers, often referred to as fruit buds. Wood buds open to give rise to a shoot, as opposed to a flower. Suckers are shoots that grow from below the ground or below the union.

Choice of site

The site should be chosen with care and the soil cleared of perennial weeds either with a selective herbicide (see page 17) or by hand weeding during digging. If some weeds still persist, herbicide treatment can be given again after the tree is planted, but take care to choose one which will not damage the tree.

Protection against birds

In areas where bird damage is expected (and few rural or suburban districts are exempt), protection is necessary. For small tree forms, such as dwarf bush trees, cordons or espaliers, this can be provided by a fruit cage, ideally one with tubular steel or metal alloy poles and netting, although 7 ft headroom is a minimum (see page 17). It is generally impracticable to protect larger tree fruits against bird damage.

Wall- and fence-trained trees

If there is no room in the open garden for free-standing tree fruits, good use can be made of walls and fences if restricted tree forms such as fans, cordons or espaliers are grown. North-facing walls can be used in this way for Morello cherries. Some plums are even more successful on walls than in the open, ripening well in the sheltered and warmer environment. Figs are often best grown on a warm wall (see pages 8-9).

Pollination

Unlike most soft fruits which will produce an adequate crop even if only one plant is grown, many tree fruits are totally or partially self-incompatible, or self-unfruitful. This means that some varieties cannot produce a good crop of fruit if their flowers are fertilized with their own pollen. In such instances at least two different compatible varieties must be grown close enough for bees to be able to carry pollen from one to the other. Sweet cherries provide the best example of self sterility, but practically all the tree fruits set heavier crops if two or three varieties are planted together. They must, of course, flower at the same time and produce plenty of good pollen.

Storage

If it is decided to plant enough apples and pears to provide fruit for the late fall to winter period, storage facilities are necessary. This can be provided by a cool but frost-free cellar or shed (see page 90). Late apples and pears finish ripening many weeks after they have been picked, and so they should not be stored with mid-season varieties until this ripening has taken place because the gases given off by the earlier varieties shorten the storage life of the later ones. Deep freezing is suitable for these two fruits only if they are to be used in cooking when thawed.

Fruit under glass

Figs, peaches and nectarines produce luscious fruits under glass in cool areas. Artificial heat is not required although ripening can be hastened by its use early in the season. Wall or roof space not less than 10 ft long is needed for a well developed peach or a fig rooted in the floor of the greenhouse. Alternatively, much smaller trees can be grown in large pots and housed in all but the smallest greenhouse. Space outside should be set aside where hardy potted trees can be kept with the roots protected during the winter after the fruit has been picked. For fruit in the greenhouse, see page 19; for fruit in tubs and pots, see pages 80—81.

Pollination

Pollination is the transfer of pollen from the anthers or male parts of the flower to the stigmas or female parts of the flower. This results in fertilization and the eventual production of fruit. It is usually carried out by bees or other insects or by the wind. Occasionally, it is necessary to pollinate by hand.

The flowers of most garden fruits contain both anthers and stigmas. Some fruits, such as melons and hazelnuts, bear separate male and female flowers on the same plant.

Some fruit trees, such as peaches, nectarines, apricots and certain plums, are self-compatible—that is they can be fertilized by their own pollen. Others, such as nearly all sweet cherries, elderberries and many varieties of apples and pears are self-incompatible (self-unfruitful); they must be grown with another variety of the same fruit that flowers at the same time so that the two varieties can fertilize each other.

Pollination groups

Different varieties of plums, apples, pears and cherries are divided into pollination groups according to when their flowers are open and ripe for pollination. Those varieties in the same pollination group will cross-pollinate because their flowers are open at the same time. Those in adjacent groups are also acceptable because in most years their seasons of flowering overlap. However, a plant that blossoms very early cannot be counted on to cross-pollinate another plant that blossoms very late.

Incompatibility groups

Not all varieties of the same fruit can cross-pollinate, even when they are in the same pollination group. This is called cross-incompatibility. These varieties are divided into incompatibility groups and will not set fruit with their own pollen or that of any variety in the same incompatibility group. They will cross-pollinate with varieties in another group or in adjacent groups (provided they flower at the same time).

Ineffective pollinators

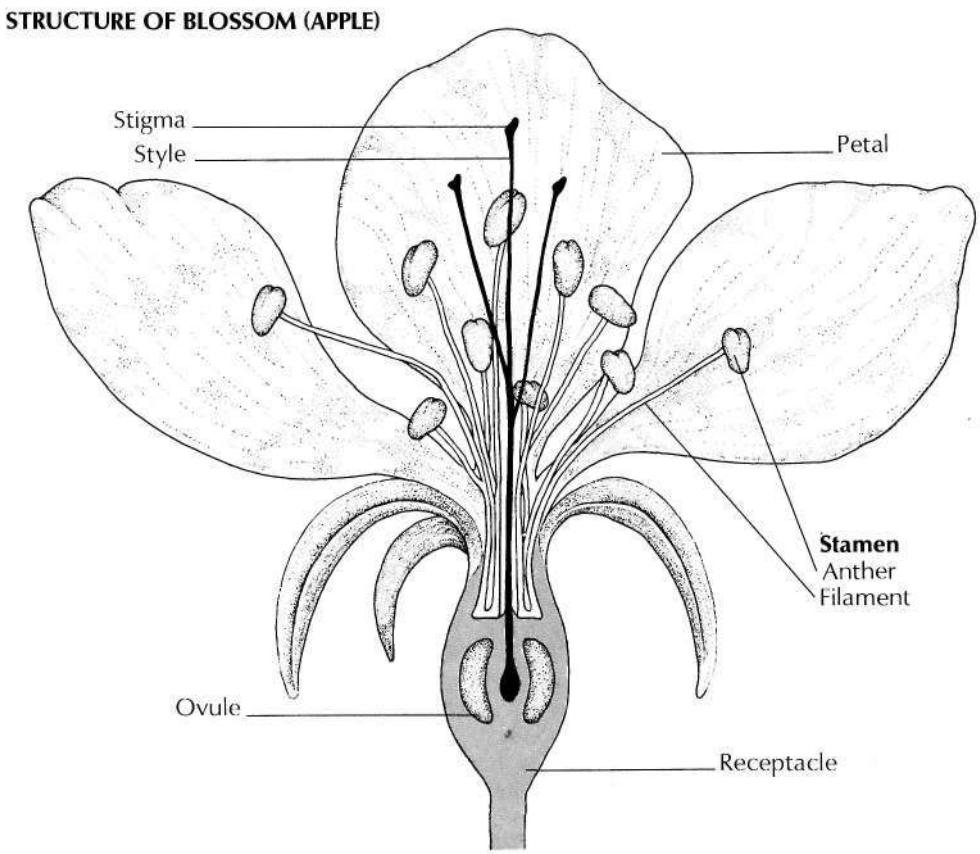
Some varieties of apples and pears, although not strictly cross-incompatible, are ineffective pollinators. This can occur for a number of reasons.

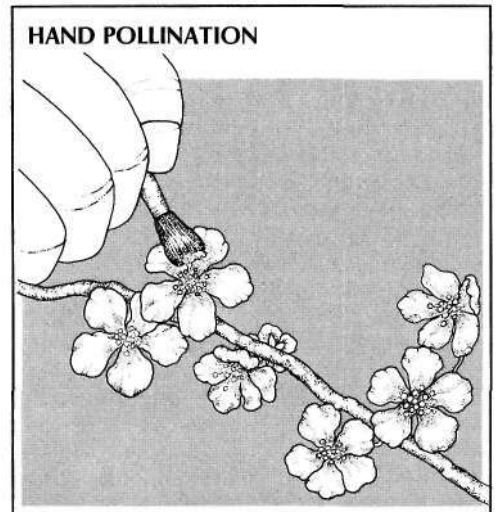
Most varieties are diploid, that is, they have the normal number of chromosomes. A few are triploid, that is they have 11/2 times the normal number. Triploids are poor pollinators and should be grown with two diploid varieties to pollinate each other and the triploid.

Some varieties of pears are known to be ineffective pollinators. Also some varieties of both apples and pears flower only every two years (biennially) or, irregularly. These cannot, therefore, be relied upon to pollinate other varieties.

Many triploids, ineffective pollinators and irregular flowering varieties are good varieties in their own right and popular with gardeners. If planting these varieties, remember to plant other varieties near them to provide the necessary pollen.

The following list gives the specific pollination nature of a selection of popular garden tree fruits from apples to sweet cherries.





Some fruits require hand pollination. First draw the finger-tip over the anthers. A deposit of yellow grains on the finger indicates pollen is being shed. Pollinate at midday and when the weather has been warm and dry for two or three days.

Very gently transfer the pollen from the anthers to the stigmas by using a soft camel-hair brush or a piece of cotton wool on a matchstick.

Carry out hand pollination every day until flowering is over.

Specifics

Apples No variety is completely self-compatible, so more than one variety should be grown.

Apricots Usually self-compatible with a few exceptions (for example, 'Moongold' and 'Sungold' should generally be planted together).

Crabapples Self-compatible.

Nectarines Self-compatible.

Peaches The great majority of varieties are self-compatible.

Pears No variety is fully self-compatible. Plant two or more varieties. Most bloom at about the same time.

Plums Most varieties are self-incompatible, and even those that are self-compatible bear more reliably if planted with another variety. European plums cannot pollinate Japanese plums or vice versa. Native plums are pollinated by other native varieties, sandcherry-plum hybrids or Japanese varieties, if a native variety has been crossed with a Japanese.

Quinces Self-compatible.

Sour cherries Self-compatible. Sweet cherries are not suitable pollinators for sour cherries, but sour cherries can pollinate sweet cherries, although most flower too late.

Sweet cherries Self-incompatible. Two or more varieties are needed. However, some varieties, such as 'Bing', 'Emperor Francis', 'Lambert' and 'Napoleon' do not pollinate one another.

Planting fruit trees

Good establishment, healthy growth and eventual successful cropping of a fruit tree depend a great deal on how well it is planted.

Preparation

Before planting prepare the ground in early fall as described on pages 10-11. Then, for each tree, prepare an area 3 ft square by single digging clean ground and double digging weedy land. Prepare the ground overall for closely planted trees such as those on dwarfing rootstocks. Apply lime if the pH is less than 5.8 (see page 10).

Just before planting, fork in a balanced fertilizer, such as 10-10-10, at a rate of 3 oz per square yard with bonemeal at 2 oz per square yard.

Time to plant

Plant in the dormant season from late October to April; but spring planting is generally recommended. Container-grown trees can be planted at any time. Do not plant when the soil is frozen hard or very wet.

If the tree arrives from the nursery when the soil conditions are not right, heel it in in a sheltered part of the garden. If the ground is too cold and hard to heel in, keep the tree in an unheated, frost-free place such as a cool basement. Unpack the upper parts of the tree but keep the roots in damp straw wrapped in burlap until planting.

Staking

Mark out the planting position and drive in a stake to a depth of 18 in on heavy soils and 24 in on light. Standard trees require 71/2—8 ft posts, semi-dwarfs 6-61/2ft and dwarfs 31/2-4 ft. Central-leader trees need a stake as long as the height of the tree plus the depth into the soil. A large-headed standard, such as a sweet cherry, is best supported by two stakes 18 in apart with a crossbar (to which the tree is tied) nailed just below the stake tops. The top of the stake should be 2-3 in clear of the tree's head to avoid chafing the lowest branches. Stakes come in a variety of materials (see pages 12-13).

Trees on very dwarfing rootstocks, for example apples on Mailing 9, are best staked permanently. But for trees on more vigorous stocks, the stake can usually be removed after four or five years, depending on the vigor. Before removing the stake, check if the anchorage is sound by rocking the tree.

Planting

If the roots are a little dry, soak them for an hour before planting. Keep them covered.

On the day of planting, dig out a hole deep and wide enough to take the roots fully spread out. Mound the soil in the center. Keep the fertile top-soil separate from the lower layers. Fork the bottom and prick the sides of the hole to allow the roots to develop outwards. Dig in into the base rotted-down sods or a bucketful of well-rotted manure, compost or peat. Trim off with shears any broken or long tap roots. If planting a container-grown tree, gently tease out the soil and roots around the edge of the rootball.

Place the tree on the mound with the stem 2-3 in away from the stake. Ensure that the lowest branches clear the top of the stake. Plant the tree to the same depth as it was in the nursery, indicated by the soil mark. Keep the union between scion and rootstock at least 4 in above the soil surface to prevent the scion from rooting.

Fill in the holes; this is easier if one person holds the tree while another fills it in. Sprinkle a little of the fertile top-soil over the roots first then return the remaining soil a spadeful at a time. Occasionally shake the tree gently so that the soil falls among the roots. Finally, firm the soil and level off the surface.

Next, mulch the tree with well-rotted manure compost or peat over an area 18 in in radius to a depth of 2-3 in, keeping the material 1-2 in clear of the trunk to prevent fungal diseases from infecting the base.

Tie the tree to the stake. A one-year old can be secured with plastic chainlock strapping using a figure of eight tie, but older trees need a more substantial tie with a cushion between stake and tree to prevent chafing. There are a number of proprietary makes, or one can be made (see pages 12-13).

Dwarfs require one tie placed 1 in from the top 'of the stake. Semi-dwarfs and standards require two ties, one at the top and one halfway down. Nail the ties to the post to prevent them slipping down.

Where animals are particularly troublesome, protect the trees with wire netting.

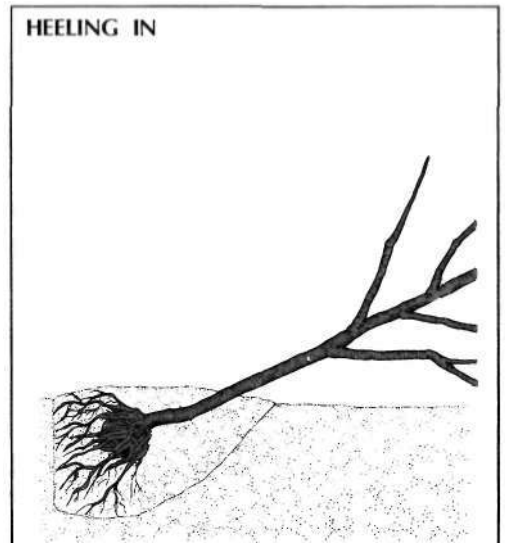
Each year in April, July and October check the tree ties and if necessary loosen to avoid constriction. Re-tie home-made ties.

Planting against a wall

The soil at the foot of a wall can become very dry and poor, especially if it is protected from rain-bearing winds or is sheltered by overhanging eaves.

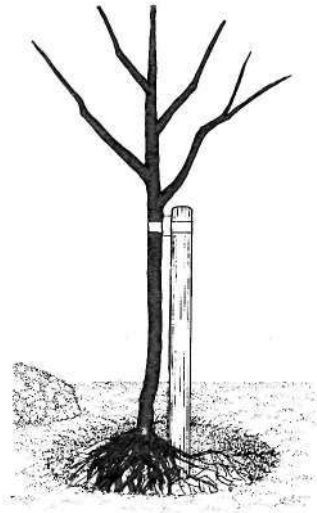
Where the soil is poor and the drainage is bad, construct a drywell or a single line of tiles 3 ft deep to take the water away (see page 10). Re-soil over an area at least 6 ft x 3 ft wide x 2 ft deep with a fibrous, medium chalky loam, if possible made from sods stacked for six months before use. Add rubble to the loam in the ratio ten soil to one rubble. Two weeks before planting thoroughly mix in base fertilizer at the rate of 8 oz per 2 gal bucketful of soil.

The tree should be planted about 9 in from the wall base. During the growing season, water it whenever the soil is dry, applying 4 gal at a time around the base of the tree.

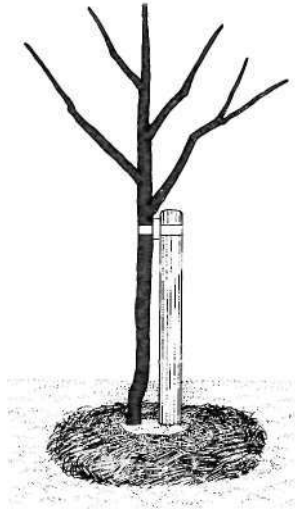


Take out a shallow trench. Unpack the tree and lay it in the trench at an angle. Cover the roots with moist, friable soil.

1 If the roots are dry, soak them for an hour before planting. Trim off broken or long tap roots with shears.



2 Drive in stake. Dig a hole deep and wide enough to take the roots fully spread out. Mound the soil slightly in the center.



3 **Set the plant on the mound** 2-3 in away from the stake with the union at least 4 in above the soil surface. Replace the soil, firming gently. Mulch well.

Apples and pears

Introduction and rootstocks
The domestic apple (Malus *domestical* is of complex hybrid origin but it has evolved, under human influence, from various species, all of them belonging to the series Pumilae. It has been estimated that up to 1980 there were at least 6,000 named varieties of apples in the world.

Like the apple, the pear *{Pyrus communis)* has long been cultivated. It is a native of Northern Europe. In the United States, apples are grown in zones 3-8 and pears in zones 5-8. In both cases, however, a very few varieties will grow further north or further south of these zones.

Site
Ideally, the site should be frost-free, in full sun, and sheltered from strong winds. Pears flower in late April to early May and apples in the first half of May, when they are at risk from spring frosts. The gardener in a frost-prone site should consider growing trees on dwarfing stocks or using the restricted forms whose small size makes it practicable to protect them by covering the trees on frosty nights. With apples, the alternative is to plant varieties that flower late, but this is not applicable to pears because even the later varieties flower in the danger period.

Ample sunshine is important, particularly for pears, if the fruits are to develop their full color and flavor. Apples will tolerate some shade, provided they receive at last half a day's sun in the growing season. Where there is a choice, allocate the sunniest position for pears and dessert apples, and the less sunny positions for cooking apples, for which color and flavor are not so critical.

Shelter is essential because both kinds of fruit are insect pollinated and strong winds inhibit the insects' flight, which results in poor pollination. Wind-breaks, either living or artificial, should be provided on exposed sites or, again, choose apples and pears on dwarfing stocks or in restricted form because they are easier to shelter than are taller trees (see pages 6-7).

Soil
The ideal soil for both apples and pears is a medium well-drained loam, not less than 24 in deep and slightly acid (pH 6.7). They are, however, tolerant or a wide range of soils. Pears and dessert apples require good drainage, whereas cooking varieties can bo grown in heavy soil and marginally poorer drainage, but the soil must never be waterlogged.

Light sandy soils are acceptable provided bulky organics are incorporated and heavy mulching and watering is practiced. Thin soils over limestone are unsuitable because lime-induced chlorosis and lack of water and nutrients generally occur. Deep soils over limestone can support apples and pears quite satisfactorily.

Soil preparation
In late winter, prepare the soil by clearing away perennial weeds over an area 3 ft square. Fork in a compound fertilizer such as 10-10-10 at 3 oz per square yard.

Planting and staking
In early spring, plant the tree to the same depth as it was at the nursery, spreading the roots out well (see page 44).

Standard trees and semi-dwarfs require stakes and tree ties. The restricted forms are supported by wall or fence wiring.

Selecting the rootstock
Apples and pears are not grown on their own roots for a number of reasons. Some will not root easily, some are prone to root troubles, and some make large unproductive trees. To overcome these problems, apple and pear varieties are grafted by the nursery on to various rootstocks.

The rootstock is the most important influence on the eventual size of the tree. An apple grafted on to a dwarfing stock, for example, will stay small, whereas on a vigorous stock it will eventually become large. It can also affect how long it is before the tree will fruit and its cropping capacity, so it is important to know the rootstock on which the tree is grafted or, when ordering a new tree, to indicate to the nursery what size of tree is required so that the appropriate rootstock is selected.

The stocks most widely used are listed right. The size of the tree quoted under the rootstock is an estimate.

ROOTSTOCKS

Apples
M7: Semi-dwarfing tree that can be controlled by training and pruning and grown to a height of about 15 ft.
M9: Very dwarfing One of the most dwarfing stocks, M9 is widely used, making a tree about 6-10 ft in height and spread. It soon bears fruit, usually from the third year onwards, sometimes even in the second year. It requires good soil conditions and will not tolerate neglect, or competition from grass and weeds. The root system is brittle and such a tree requires staking throughout its life. An excellent stock for the small garden. Used for dwarf, dwarf pyramid and cordon.
M26: Dwarfing M26 makes a dwarf tree 8-12 ft in height and spread. It tolerates average soil conditions. It soon bears fruit, usually within three or four years of planting. It requires staking for the first four or five years, longer on exposed sites. Used for dwarf pyramid, and cordon and occasionally espalier and fan. It is a suitable stock for the small garden.
M27: Extremely dwarfing It is too soon to comment about its suitability for garden use but first reports are that it will make an ideal tree for growing in pots and in small gardens. It needs careful feeding and watering.

MM106: Semi-dwarfing MM106 makes a tree 12-18 ft in height and spread. It is tolerant of a wide range of soils. Trees on this stock soon bear fruit—usually within three or four years—and can produce heavily in later years. Such a tree requires staking for the first four or five years. Used for cordon, espalier and fan.
MM111 and M2: Vigorous The trees on these stocks make trees 18-22 ft in height and spread, but their growth varies according to soil and variety. They make large trees on good loamy soils, but only medium-sized trees on poorer sandy soils. Used by nurseries for half-standard and standard trees, espaliers and occasionally cordons and fans. They are slow to fruit in comparison with the more dwarfing stocks, sometimes taking seven to eight years. They are too vigorous for most gardens except where the soil is poor.

Pears
Pears are usually grafted on to quince rootstocks, which make them small to medium-sized trees. Some pears have a weak and spreading habit, and others are vigorous and upright, therefore the sizes given below are only an approximation.

There are three rootstocks: Quince C, Quince A and Pear. Both Quince C and A are suitable for the garden.
Quince C: Moderately vigorous Quince C makes a pear tree about 8-18 ft tall. It bears fruit in four to seven years. It is suitable for highly fertile soils and vigorous varieties, but not where conditions are poor. Used for cordon, dwarf pyramid and espalier.

Old stocks of Quince C may be infected with a virus, so where possible obtain stock certified as virus-free. If in doubt, use Quince A because there is not much difference in vigor between the two.
Quince A: Medium vigor Slightly more vigorous than Quince C, it is the stock upon which most pears are grafted. It bears fruit in four to eight years. Pears on Quince A make trees between 10-20 ft in height and spread. It is used for all forms of pear tree except standards.

Certain pear varieties are not compatible with quince and these have to be double worked by nurseries. This means a piece of pear graftwood compatible with both the quince rootstock and the pear variety, such as 'Beurre Hardy', is used as an intermediate between the two. Varieties requiring double working include 'Bristol Cross', 'Dr Jules Guyot', 'Doyenne d'Ete' and 'William's Bon Chretien'. If this is not done, the pear could eventually separate at the graft union.
Pear stock: Very vigorous Pears grafted on to pear rootstock make very large standard trees, and, consequently, are too big for most gardens.

Apples and pears

Selecting the tree form
Just as important as the correct choice of rootstock is the choice of tree form.

There are two basic types of trees, those that are planted in open ground and pruned in the winter, and those that are grown in restricted form, usually against a wall or fence, and pruned mainly in summer. The restricted form of tree is not widely available in the general market and it may be necessary to seek out a nursery specializing in this form.

Where a gardener has plenty of land and a heavy yield is the main criterion, the unrestricted winter-pruned trees planted in the open are the best choice. Where the gardener has little room, or prefers the neat look of well-trained summer-pruned trees, or wants to fill a blank space on a wall or fence with fruit trees, then the restricted forms should be chosen.

Trees in the open
The tree forms commonly grown in the open are the dwarf, semi-dwarf and standard. These are all open-centered trees and they differ only in the length of stem or trunk before the first permanent branch and in the size of the head, or framework.

Dwarf tree The dwarf tree has an open center and is goblet-shaped with a short stem of about 18-24 in. It is used only for apples because there is as yet no truly dwarfing stock for pears. Dwarf apples are grafted on to a Mailing 9 rootstock or the equivalent and, because of their small size, are suitable for any garden. The soil must be very fertile, however, and the trees have to be fed and watered regularly or they will be stunted. Gardeners with less fertile soils should choose trees on more vigorous rootstocks.

Dwarf trees are easy to prune, spray and pick, and they soon bear fruit, but obviously their cropping capacity is not as great as that of larger trees. It is best not to plant dwarf bush apples in a lawn because they cannot compete with grass but if this is unavoidable, maintain a grass-free area for at least 2 ft around the base by mulching and water the tree regularly.

Semi-dwarfs The semi-dwarf tree has a clear stem or trunk of about 20-30 in before the first primary branch is reached, and its total full-grown height is roughly midway between the height of a dwarf and a standard tree.

Semi-dwarf apples develop into moderately-sized trees which bear fruit in about three to six years, depending on the rootstock used, the variety of the apple, and the growing conditions.

Semi-dwarf apples and pears are suitable for the medium to large garden and can be planted in a lawn provided the grass does not inhibit the young tree's growth. They are not suitable as shade trees because the head is too low.

Standard The standard has a clean stem of 6-7 ft, and, in the case of a few varieties, may reach an ultimate height of 40 ft. But they should be kept much smaller by pruning, about 20ft.at most. The gardener needs a long ladder for picking fruit and a powerful sprayer for pest and disease control. Vigorous trees are slow to bear fruit but, because of their large size, they eventually yield heavy crops.

Restricted tree forms
The restricted tree forms are used where trees have to be contained in some way, for example, against a wall or fence. They are ideal for the small garden or where space is limited. However, because they are restricted, the yield in comparison with trees in the open is relatively small.

The main restricted tree forms for apples and pears are the cordon, the espalier and the dwarf pyramid. The fan is occasionally used.

The cordon is intended for a low fence. If closely planted, many varieties can be grown in a relatively small space and the gardener can more easily meet the cross pollination requirements (see pages 50-1).

The espalier may be planted against a low or high fence, depending upon the number of arms it is intended to have. Its long horizontal arms require more room than the cordon. It is a handsome form (see pages 52-3).

The fan requires a high wall, the height depending on the kind of fruit grown (see pages 8-9). Unlike the cordon or espalier it cannot be planted against a low fence unless the gardiner is prepared to increase the height with trellis work. The fan is used mainly for stone fruits such as peaches, cherries and plums, and for this reason it is described only on those pages.

The dwarf pyramid The dwarf pyramid is a small tree, pyramidal or Christmas tree-like in shape and kept this way by summer pruning. If, like the cordon, it is closely spaced, many trees can be planted in a relatively small area (lose attention to summer pruning is necessary, however, to maintain space between the framework branches and adjoining trees, otherwise a row of dwarf pyramids can soon degenerate into an unproductive hedge.

Although a restricted form, the dwarf pyramid is intended for planting in the open, not against a wall or fence (see pages 54-5).

TREES IN THE OPEN: SPACING AND YIELDS

Dwarf tree
Spacing Plant the trees 8-10 ft apart.
Yield A good average yield from an established tree is about 40-60 lb.

Semi-dwarf tree
Spacing Plant 18-20 ft apart.
Yield 70-90 lb.

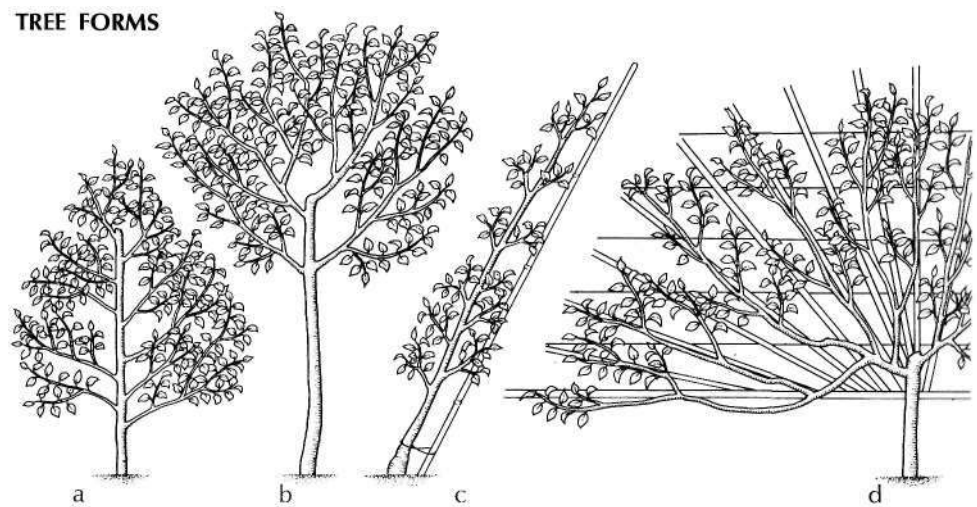
Standard tree
Spacing Plant 30-35 ft apart.
Yield A good average yield from a well grown standard apple is 60-120 lb and from a pear 40-100 lb.

Varieties

The choice of varieties depends upon the personal preferences of the gardener. Nevertheless, when making the final selection, ensure that the varieties will pollinate each other (see page 43).

Many triploid varieties are very vigorous and are not suitable for growing in restricted form unless grafted on to the dwarfing rootstocks Mailing 26 for apples and Quince C for pears.

The description of the apple and pear varieties gives the season when the fruit is mature and fit to eat or cook. The picking date and maturity are not necessarily the same and this varies from locality to locality.



The dwarf tree (a) is made up of the top, an inter-stem of 18-24 in, and the rootstock. The standard tree (b) has a clear stem of 6-7 ft grafted onto a vigorous rootstock. The cordon (c) is planted and trained obliquely. The fan (d) is shaped.

Apples and pears

Trees in the open
The dwarf, semi-dwarf and standard tree forms are commonly grown in the open.

Selecting the tree
A nursery can supply one-year-old, two-year-old or three-year-old trees. Trees older than this are not recommended because they may not establish well.

A one-year-old, or maiden, tree consists of a straight stem with or without laterals. A maiden with laterals, sometimes called a feathered maiden, is a better choice because if the laterals are suitably placed they can be used as primary branches, and a year is saved in the formative pruning stage. The maiden is the least expensive type, but it requires initial shaping and takes longer to bear fruit.

Trees of two and three years old will have already been partly shaped by the nursery and, being older, bear fruit sooner.

Soil preparation and planting
Prepare the soil in the late winter (see page 44). Plant the tree while dormant, in March or April, driving in a stake first.

Pruning

Prune in late winter, but not when the air temperature is below freezing.

The first winter The work of forming the head begins with the maiden tree.

Unfeathered At planting, shorten the maiden tree to 24 in for a dwarf bush or to 30 in if a standard is to be formed. Cut back to just above a bud, making a sloping cut away from the bud and ensuring there are three or four good buds beneath it. This cut stimulates the formation of primary branches the next year.

Feathered Cut back the main stem to a lateral at about 24 in for a dwarf or 30 in for a standard, ensuring there are two or three suitably placed laterals just beneath it. Remove all others flush with the main stem. Shorten the selected laterals by about two-thirds to an outward-facing bud.

The second winter (or the two-year-old tree) In the dormant season, select three or four strong leaders to form the primary branches, taking care to select those that are evenly spaced and have formed wide angles with the main stem. The wide angles ensure a stronger joint; a narrow-angled branch may break off under the weight of the crop later on. Notice the effect of apical dominance, that is, the topmost shoot is the most upright and it is often unsuitable because it is too central and forming a narrow angle with the stem. If this is so, cut it out, heading back to the next branch. Next, shorten the selected primary branches by one-half and shorten the less vigorous ones by two-thirds. Cut each to an outward-facing bud. The remaining shoots are removed altogether. Protect the cuts.

During the summer, the branch growth following the hard pruning should be strong, with secondary branches forming.

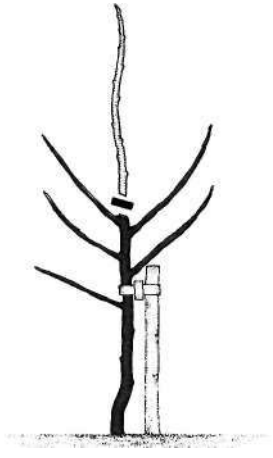
In the third winter (or the three-year-old tree) Select about four more widely-spaced branches. The framework now consists of about eight branches. Shorten these by one-half or, if weak, by two-thirds, cutting back to outward-facing buds. Prune back to about four buds those laterals not required for secondary branches and those competing with the leaders. If the tree is growing vigorously, some laterals on the outer part of the tree can be left unpruned to form flower buds. Shoots crowding the crotch of the tree should be removed. The center should be open, but not completely barren of growth. Growth from the main stem lower than the primary branches should be cut off to maintain the clean leg. Protect the cuts with a tree paint.

The fourth winter The tree is entering the cropping phase of its life, but a little more formative pruning is still necessary, as described for the third winter. Weak varieties may need further formative pruning for the next two or three winters.

Winter pruning the cropping tree By the fourth or fifth year the tree should start bearing fruit. From then the pruning guidelines are flexible, exactly how much is pruned depends on the condition of the tree.

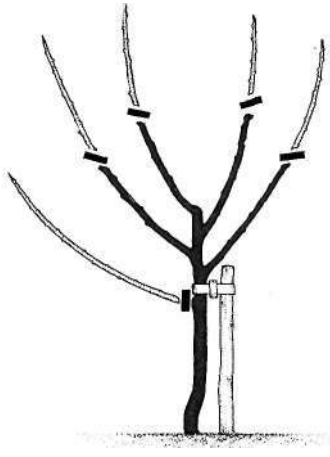
Before pruning an older tree, remember that the harder the tree is pruned, the more growth is obtained, but in consequence the less fruit is produced. Thus, a heavily pruned tree will be vigorous but unfruitful, whereas a lightly pruned tree may crop heavily, but the fruit will be small and the framework weak and badly shaped.

Pruning a feathered maiden



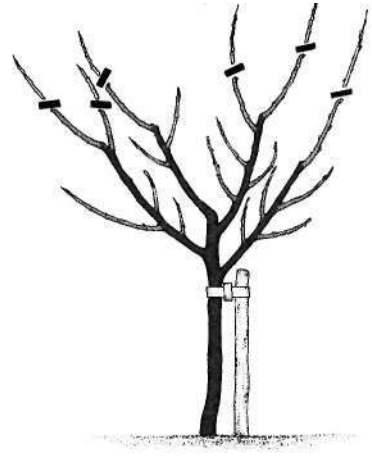
1 **In late winter,** prepare the soil and drive in a stake. Plant a maiden tree to the same depth as it was at the nursery. Tie to the stake. Cut the main stem back to a bud or lateral at about 24 in for a dwarf, 30 in for a standard.

The second year



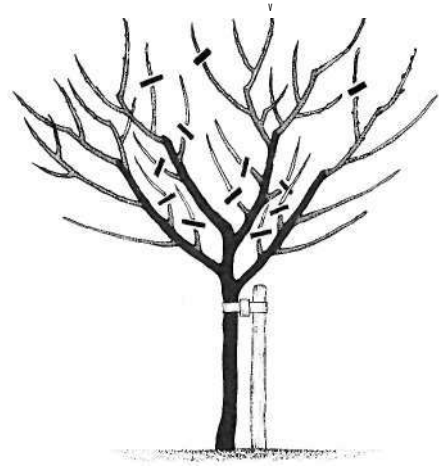
2 **In late winter,** select four of the primary branches that have formed wide angles to the stem. Cut back vigorous ones by one-half and less vigorous ones by two-thirds. Prune to outward-facing buds. Remove unwanted branches.

The third year



3 **In late winter,** select a further four well-placed new growths to form permanent branches. Cut back vigorous ones by two-thirds. Prune to outward-facing buds.

Fourth and subsequent years



4 In late winter, the branch framework has now been formed and leader pruning can cease, unless growth is weak. Leave laterals on the outer parts of the tree unpruned. Cut back laterals on the inside to about 4 in.

Apples and pears

Pruning the cropping tree
Before pruning apple or pear trees that are past the formative stage, it is important to distinguish between the spur-bearing and the tip-bearing varieties. A spur-bearing variety produces fruit buds on the two-year-old as well as on the older wood, where they are carried on short stubby shoots called spurs. Where these shoots become very branched, typically on old wood, they are called spur systems. The spur-bearer is the most common type of apple and pear tree.

A tip-bearing variety produces fruit buds at the tips of slender shoots made in the previous summer. A few spurs are also produced on the older wood, but considerably fewer than on a spur-bearer. The tip-bearer has a more gaunt appearance in comparison. There are also partial tip-bearers, which produce spurs on the older wood as well as fruit buds at their tips. For pruning purposes they are treated as spur-bearers.

There are three basic pruning techniques: spur pruning, renewal pruning, and regulatory pruning.

Spur pruning As mentioned above, spur-bearing varieties form spurs naturally, but they can also be induced to form spurs. Each winter cut back a proportion of maiden laterals to four or five buds. Choose those that have insufficient room to extend as secondary branches.

In the following summer, a lateral so pruned produces one or two shoots from the uppermost buds, but usually the lower buds develop into flower buds by the end of the growing season.

In the second winter, cut back the laterals to the topmost flower bud, thus removing the previous summer's growth. However, where there is room and no risk of the spur overlapping an adjoining branch, extend the spur system by cutting back to three or four wood buds on the previous summer's growth.

After some years, a spur system may become crowded and complicated and, as a result, the fruits are too numerous and therefore small. Then spur thinning is undertaken by reducing the length of the spur systems, cutting away the weakest buds and those buds growing on the undersides of the branches.

Renewal pruning of spur-bearers This also depends upon the tendency of many apple and pear varieties to produce flower buds on unpruned two-year-old laterals. It is best reserved for the strong laterals on the outer part of the tree, where there is room for such growth.

The renewal system of pruning is a method that encourages regular cropping by the removal of fruiting laterals that have passed their peak in growth. Young laterals are trained to take the place of the old laterals. This system is only effective when done by experienced gardeners and so should be practiced with great care.

In the winter, select a proportion of strong, well-placed laterals on the outer part of the tree and leave them unpruned. Prune the others as described in spur pruning. During the following growing season, the terminal bud on each unpruned lateral extends to produce a further maiden shoot, while most of the remaining buds develop into flower buds.

In the second winter, cut back the laterals to the topmost flower bud. In the following summer the cut-back laterals produce fruit.

In the third winter, half the laterals that have fruited can be retained as an elongated spur system. The others are cut back to leave a 1 in stub. This severe shortening stimulates the production of a new lateral from the stub, and so the cycle is repeated.

To sum up, at any one time the tree carries a number of one-year-old laterals unpruned, two-year-old laterals pruned back to a flower bud, and three-year-old laterals which are stubbed back to 1 in after fruiting—or left if there is room.

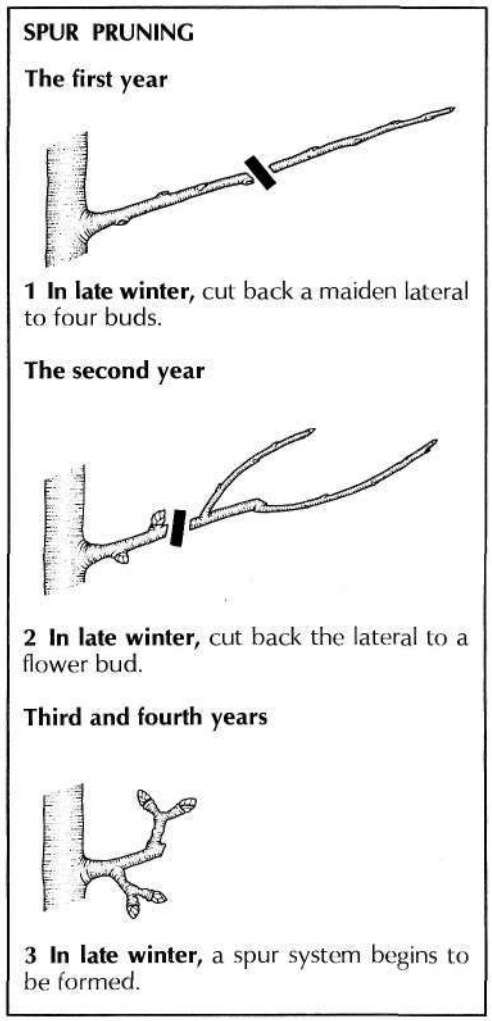
Regulatory pruning This applies to the tree as a whole rather than to specific parts of it as in spur or renewal pruning. Basically it entails keeping the center open by removing crowding and crossing branches and cutting out dead, diseased and broken wood. There is no need to prune the leaders after the early formative years except with poorly growing varieties, which require the stimulus of hard pruning.

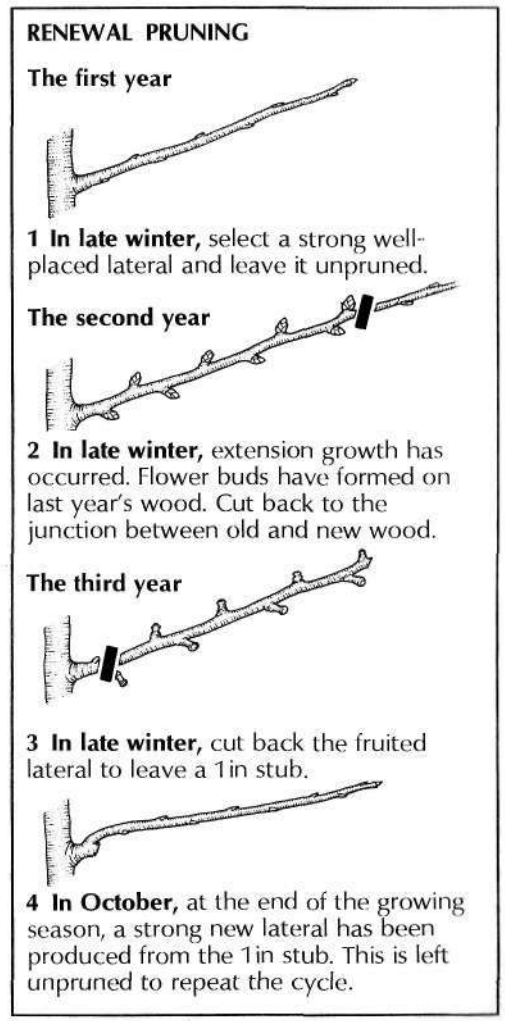
The framework branches, laterals and spurs also should not be crowded. As a rough guide, in an old tree no main branch should directly over-shade another by less than 18 in, nor should branches be closer than 18 in when side by side. Laterals should be spaced about 18 in apart and spurs not less than 9 in along the framework of branches.

If in later years, as a result of light pruning, the tree over-crops (with consequent small fruit) and growth is weak, adopt a policy of harder pruning to reduce the number of flower buds and to stimulate new growth. Simplify some of the over-long spur systems, and where they are crowded cut out some of them altogether. Increase the amount of renewal pruning.

Pruning of tip-bearers In the winter, prune lightly on the regulatory system (see above). Leave any maiden shoots less than 9 in long unpruned because they have fruit buds at their tips. Prune longer laterals back to four buds. This induces short shoots in the following summer with fruit buds at their tips—spur pruning in effect.

Always prune the leaders of tip-bearing varieties because this induces more laterals to bear fruit in the following year.





Apples and pears

The central-leader tree
The success of this form, which is not common in the United States, depends upon producing wide-angled branches off the central leader. Depending on the training method, it is referred to as a vase shape or modified-leader form. Therefore buy a feathered maiden, because the laterals on such a tree are naturally formed at the correct angle. Such a form may be used if the gardener does not desire maximum fruit production, but only wants a specimen of beauty.

Soil preparation and planting
Prepare the soil in the early fall (see page 44). This form requires a long stake to support the central leader. The stake should be 8-81/2| ft long by 11/2—2 in top diameter.

Drive the stake in first, 18 in deep on a heavy soil and 2 ft deep on a light soil. Plant the tree and tie it to the stake.

Pruning and tying down in the first year (or the one-year-old tree)
During the dormant season from November to February, select three or four laterals to form the first tier of branches starting at not less than 24 in from the ground. Choose strong, well placed laterals coming off the main stem at a wide angle. Prune these back by one-half to an outward-facing bud. Remove the rest of the laterals entirely. Cut back the central leader to the third bud above the topmost selected lateral.

By August the original laterals will have extended and possibly new laterals will have been produced. A new central leader will have grown on. Tie the leader to the stake using a figure of eight tie with soft thick string. Choose three or four good laterals that form a wide angle with the main stem and gently tie the extension growth of each down to 30 degrees above the horizontal with soft thick string secured to 9 in long wire pegs pushed into the ground. Remove any upright laterals and those directly beneath the central leader.

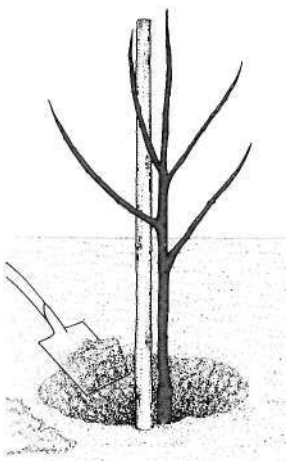
Pruning in the second winter
Cut back the central leader by about one-third of the previous summer's growth to a bud on the opposite side to that of the previous year. The technique of cutting to an opposite bud is called "zig-zagging" and helps to maintain the more or less straight growth essential in the central leader. Remove any upright laterals and those competing with the leader. Prune each remaining lateral by one-quarter to a downward-facing bud. Check the string ties to ensure there is no constriction and remove any where the branch has set at about 30 degrees.

In August, again tie down suitable new laterals to form branches.

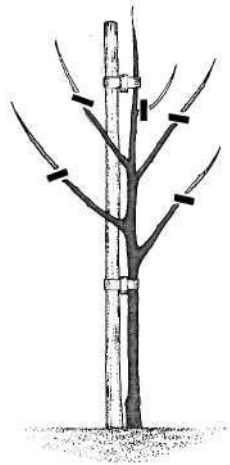
Pruning the cropping tree
In the third and subsequent years a similar procedure is followed. The central leader is pruned by one-quarter (if weak by one-third) to induce the lower buds to produce new laterals. The more vigorous the leader is, the lighter it is pruned. Branches are allowed to grow from the central stem at regular intervals, choosing those with a wide angle. Narrow-angled laterals are removed. The higher placed branches must be kept shorter than those beneath to allow sunlight to reach the lower parts. After the laterals at the very top have fruited, they must be pruned on the renewal system (see page 48). Tying down is discontinued once the branches have set at the required angle.

Each winter cut back the extension growth of the central stem to a weaker side branch once it has reached a height of 7-8 ft. Tie up the side branch to the stake as the new leader.

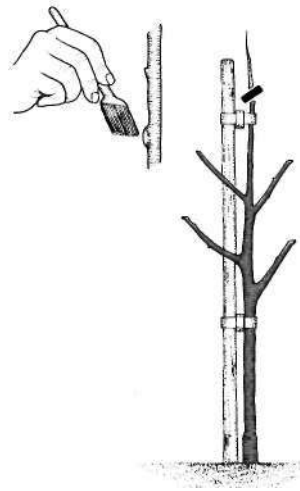
The second year



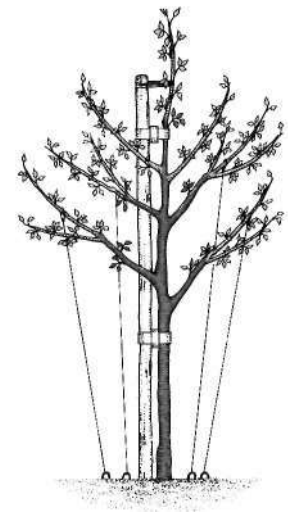
1 In November to March, prepare the ground and drive in a stake. Plant the feathered maiden tree to the same depth as it was at the nursery. Tie it to the stake.



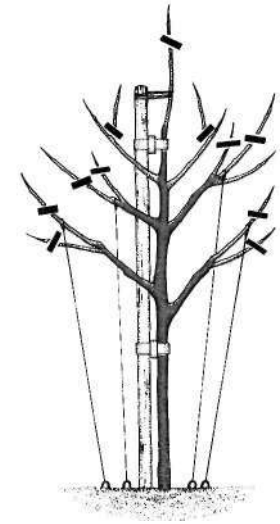
2 At the same time, select three or four laterals to form the first tier of branches at about 24 in from the ground. Prune them back by one-half to an outward-facing bud. Remove remaining laterals entirely.



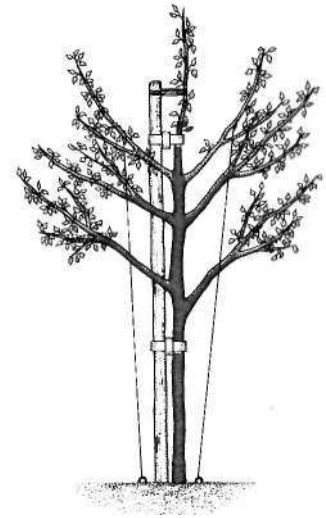
3 **Then,** cut back the central leader to the third bud above the topmost selected lateral. Protect the pruning cuts with a wound paint.



4 By August, the original laterals will have extended and a new central leader will have grown on. Tie the leader to the stake. Tie down the extension growth to 30 degrees above the horizontal using soft string.



5 In winter, cut back the central leader by one-third of the previous year's growth to an opposite-facing bud. Remove any upright laterals. Prune remaining laterals by one-quarter to a bud.



6 Every year, check the string ties. Remove the ties where the branch has set at 30 degrees. In August, tie down new laterals. Cut back the leader to a weaker lateral. Tie it up as the new leader.

Apples and pears

Restricted tree forms: The cordon

A cordon consists of a single straight stem furnished with side-shoots or fruit spurs which are kept short by summer pruning and sometimes by winter pruning. It may be planted and trained vertically or obliquely, usually the latter because it requires less height and its growth is more easily controlled. There are also multiple cordons, with two or more stems.

The single stem apple cordon is not difficult to care for and is an ideal way for the amateur gardener to experiment.

The cordon is a form that, perhaps more than any other, is suited to the small garden. It is closely planted, so many varieties can be grown in a relatively small space and the gardener can more easily meet the cross-pollination requirements of apples and pears. Cordons can be grown against walls and fences or out in the open on a wire fence.

Choice of rootstock

For apple cordons, the dwarfing rootstock Mailing 9 is the most suitable where space is very limited and the cordons are to be kept down to a height of 5-6 ft. The soil must be fertile, however, if in doubt about the soil, obtain trees on a slightly more vigorous stock.

For pears, the cordons must be grafted on to Quince A or C rootstocks.

An apple cordon crops high quality fruit early and heavily because it is raised on dwarfing rootstock. Other fruits that can be grown on the cordon system include gooseberries, red currants, sweet cherries, and white currants.

Selecting the tree

Cordons of one, two or three years old can be planted. If selecting a maiden tree, preferably choose one with plenty of laterals because these are the foundation of the fruit spurs to come. Two- or three-year-old cordons will be quicker to bear fruit, but they must be well furnished with spurs and laterals.

Spacing

Space the cordons *21/2* ft apart on medium to good soils or 3 ft apart on poor, shallow or sandy soils with the rows 6ft apart.

Support system

Cordons may be planted against a wall or fence or out in the open on a wire fence. On walls and wooden fences erect horizontal wires every 2 ft as described on pages 8-9. Out in the open drive in wooden posts every 12 ft to hold the wires. The posts may be *21/2* in x *21/2* in oak or 31/2 in top diameter in other woods. Set the posts 2ft deep or 3 ft in sandy soils. The end posts should be strutted. Alternative materials include iron, steel or concrete posts. Erect the wires at 2 ft, 4 ft and 6 ft and use 10 gauge wire for the upper wire and 12 gauge for the other two. Securely tie 8 ft bamboo canes to the wires at an angle of 45 degrees, with the tops pointing towards the north if the rows run north-south, or to the east if they run east-west. Space the canes at 21/2—3 ft intervals to correspond with the planting stations.

Planting and training oblique cordons

Prepare the soil in the early fall (see page 44). Plant in the dormant season, unless using container-grown plants, which can be planted at any time. Against walls and solid fences, the cordon should be planted 6-9in away from the structure to allow room for the growth of the trunk. Set the cordon at an angle of 45 degrees with the union between stock and scion uppermost, and then securely tie the cordons to the cane using thick soft string or plastic chainlock strapping in a figure of eight. If the one-year-old tree has laterals, shorten those over 6 in long to four buds. Thereafter, prune each summer. Do not prune the leader.

It is not wise to allow a cordon to crop in the first year after planting, so in the spring remove any flowers, taking care not to cut the growing shoot just behind the blossom.

Summer pruning: Modified Lorette System

Summer pruning is necessary to confine the growth to the limited space available. It also induces the production of fruit spurs close to the main stem. The Modified Lorette System is the simplest method.

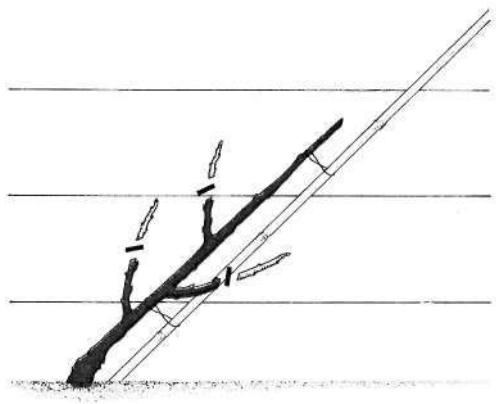
Summer prune in about mid-July for pears and in the third week of July for apples in warm climates. Prune seven to ton days laterals arising from existing side-shoots or all mature shoots of the current season's growth that are growing directly from the main stem. Cut back those mature sub-laterals arising from existing side shoots or spurs to one leaf beyond the basal cluster or rosette of leaves. Mature shoots have a stiff woody base, dark leaves and are 9 in or more long. Leave immature shoots until mid-September. Do not prune shoots that are shorter than 9 in because they usually have fruit buds at their tips.

Pruning the cropping tree

Each May, once the cordon has passed the top wire and reached the required height (usually 7 ft), cut back the extension growth to its origin. Each July subsequently, cut the leader to 1 in. From mid-July onwards the remaining shoots on the cordon are pruned on the Modified Lorette System (see above).

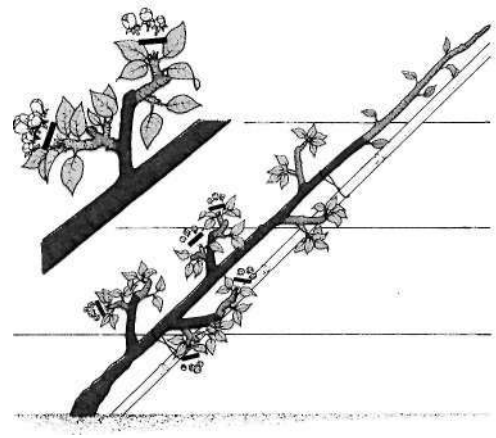
If, later on, there are secondary growths from shoots pruned in July, cut them back to mature wood just before leaf-fall. In areas

The first year

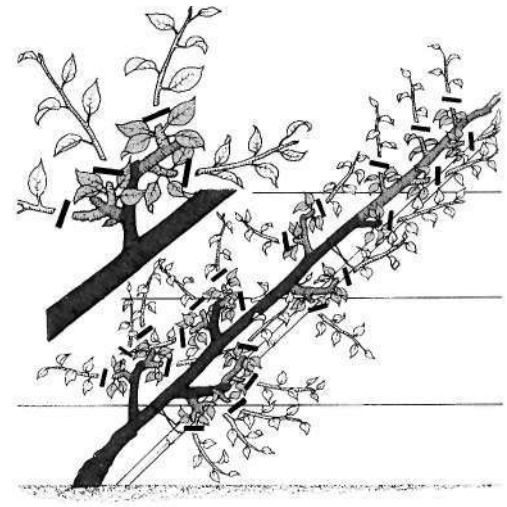


1 In late winter, plant the maiden tree with the union uppermost, against a cane secured to wire supports at about 45 degrees. Do not prune the leader. Cut back any feathers to four buds.

Second and subsequent years



2 In spring, after a further year's growth spurs will have formed on the cut-back feathers. Remove any flowers as they appear, leaving intact the growing shoot behind the blossom.



3 In late July, cut back laterals longer than 9 in arising directly from the main stem to three good leaves from the base, ignoring the basal cluster. Cut back sub-laterals from existing spur systems to one leaf beyond the basal cluster.

Apples and pears

where secondary growth is prolific after pruning, for example in high rainfall regions, delay pruning until later in the summer. If much secondary growth still occurs, then stop summer pruning altogether and prune in the winter instead, pruning to one bud from existing spurs and three buds on laterals arising directly from the main stem.

Winter pruning

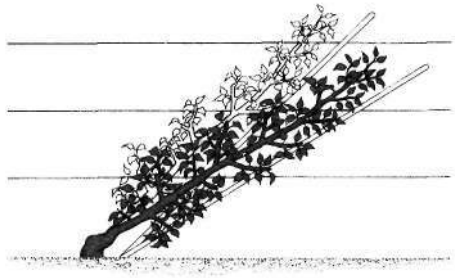
Normally neither the leader nor the side-shoots are pruned in the winter except when a tree makes too much secondary growth, or makes poor growth, or to renovate it.

When a young cordon does not produce sufficient side-shoots, resulting in bare areas of stem, laterals may be induced by pruning the leader (previous summer's growth) by up to one-third of its length. Treat newly planted tip-bearers in the same way.

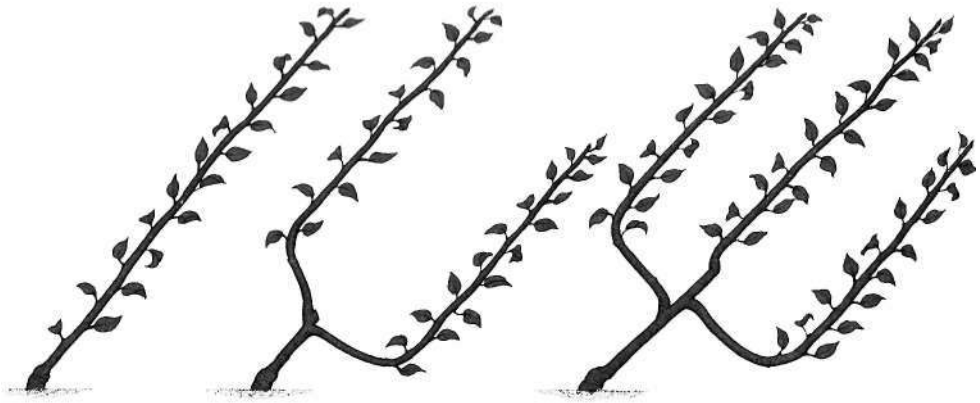
Neglected cordons can be brought back into shape by winter pruning. Thereafter prune them in the summer. Overlong or complicated spur systems should be reduced to two or three fruit buds.

LOWERING THE CORDON

When the cordons reach the top wire they may be lowered to obtain a longer stem. Lowering also helps to check the vigor of an overvigorous cordon. Lower carefully five degrees at a time and not lower than 35 degrees, so that there is no risk of breaking the stem. Lowering the angle slows down the movement of sap and limits extension growth while encouraging fruit bud protection.

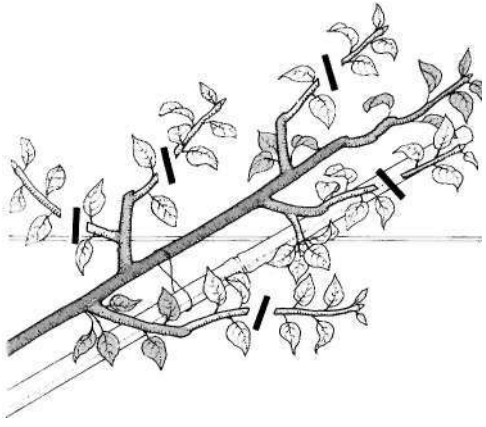


MULTIPLE CORDONS



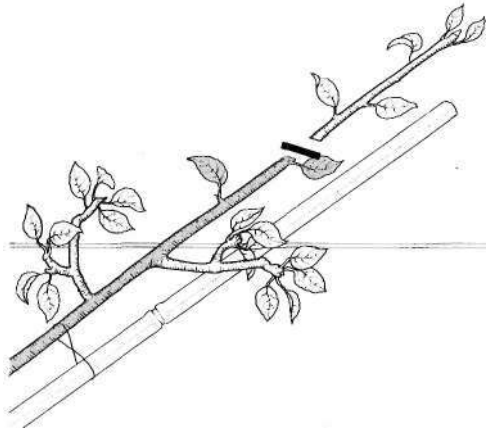
Cordons may also be formed with two, three or more arms, trained either vertically or at an angle. The training of a multiple cordon is initially similar to the formation of the first horizontal arms of an espalier. Thereafter each stem of the multiple cordon is treated as a single cordon. Vertically trained cordons are generally more vigorous and often less fruitful than those trained at an angle of about 45 degrees. The angle can be reduced further (see Lowering the cordon).

Secondary growths

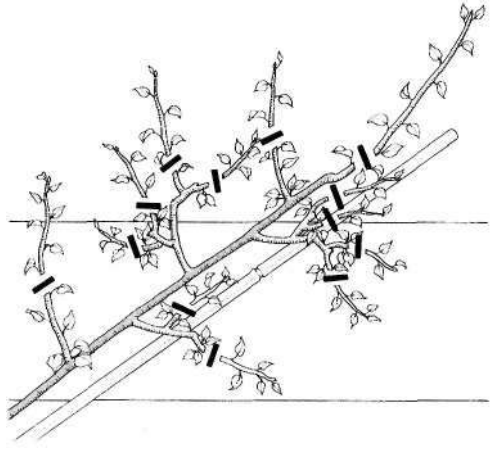


Just before leaf-fall, if further growth has developed from pruned shoots, cut it back to mature wood. In high rainfall areas, where much secondary growth occurs, stop summer pruning and prune from November to March instead.

The fruiting cordon

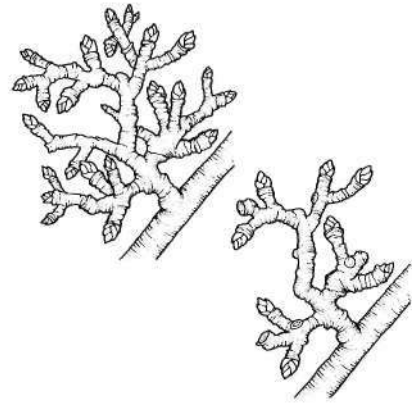


1 **In** May, when the leader has passed the top wire and reached the required height of about 7 ft, cut back the extension growth to its origin.



2 Each July, cut back the leader to 1 in. Cut back to three leaves all mature laterals longer than 9 in growing directly away from the main stem and those from existing side-shoots and spurs to one leaf beyond the basal cluster.

OVERCROWDED SPUR SYSTEMS



As the tree matures thin out in the winter by reducing overlong overlapping or complicated spur systems to two or three fruit buds. Remove buds that are weak on the underside and shaded parts of the branches.

Apples and pears

Restricted tree forms: The espalier
An espalier consists of a central stem from which horizontal fruiting arms (tiers) grow at about 15—18 in intervals. The tree is trained in one plane and makes a handsome boundary marker or can be used to cover walls or fences.

Choice of rootstock and spacing
If a small espalier apple is required, for example, against a low fence, the tree should be on the Mailing 9 rootstock. This means obtaining a maiden tree and shaping it, because pre-formed espaliers on this stock are not usually available. For more than one espalier, plant 10 ft apart.

Where more vigorous trees are required, to clothe a large wall for example, they should be on vigorous rootstock and spaced 15-18 ft apart. Pears should be on Quince A or C rootstock.

Selecting the tree
The number of horizontal arms or tiers required depends upon the height of the wall or fence. Most nurseries that sell trees for espaliering supply two-tier and three-tier espaliers and further arms can be trained in if required. A formed espalier is much more expensive but crops sooner.

Support system
On walls and fences erect the horizontal wires to coincide with the espalier arms (as described on pages 8-9); usually each tier is 15-18 in apart. Out in the open, drive in posts to hold the wires every 12-18 ft, depending upon the spacing of the espaliers. The end posts should be strutted. Plant the espaliers centrally between the posts. Use 10 gauge galvanized wires and strain tight with straining bolts on the end posts.

Soil preparation and planting
In late winter, prepare the soil (see page 45). Plant in March or April. To allow room for the trunk to grow when sited against a wall or fence, the espalier should be planted 6 in away.

Formative pruning
Formed espaliers may be obtained or the gardener may prefer to start off with a maiden tree. The formative pruning steps in the lust, second, and subsequent years are described below in as much detail as possible.

The first year Plant an unfeathered maiden tree in late winter or early spring. Cut back the stem to within 15 in of ground level, making sure that room for a short leg is left, together with three good topmost buds. The two lower ones should point in opposite directions.

In spring carefully direct the shoot from the top bud vertically up a cane and the others to the right and the left. It is difficult to obtain horizontal shoots in the first year without a check to growth and it is best to train the two shoots initially at angles of about 45 degress to the main stem. This can be achieved by tying them to canes secured to the wire framework.

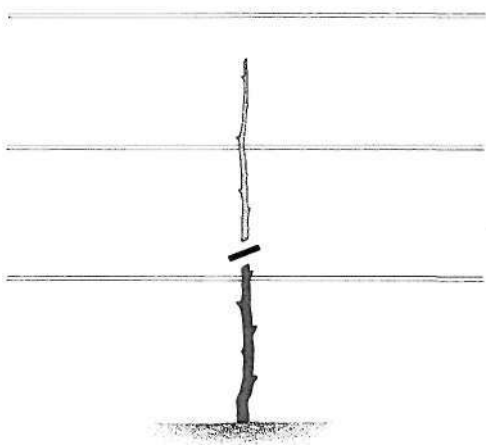
During summer the angle can be varied so that a weaker shoot is encouraged to catch up by raising it a little towards the vertical.

In November, at the end of the first growing season, lower the two side branches to the horizontal and tie them to the wire supports. Prune back the central leader to within 18 in of the junction, with the lower arms to coincide with the next wire, the intention is to promote a further three growths one to continue the central axis and the othet two to form a second tier of side branches Shorten surplus laterals from the main stem to three buds. Prune the two horizontal leaders to downward-pointing buds, removing about one-third of each shoot. If growth has been particularly satisfactory, perhaps because of a good growing season, the leaders can be left unpruned.

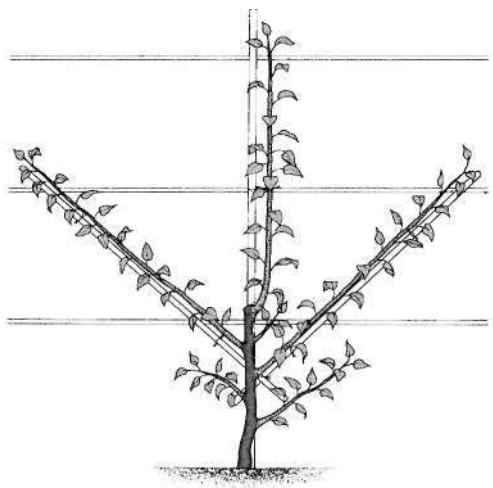
Second and subsequent years The next years are a repetition of the first, with subsequent tiers of branches being trained in. In late winter lower the side branches to the horizon tal and secure them to the wire **support!** Cut back the central leader to within 18 in of the last tier of arms at the next wire Cut back unwanted laterals from the main stem to three buds. The horizontal leaders. should be cut back by one-third, cutting In downward-pointing buds, if growth has been quite poor.

Cut back competing growths from **the** main stem to three leaves during the summer from July to September.

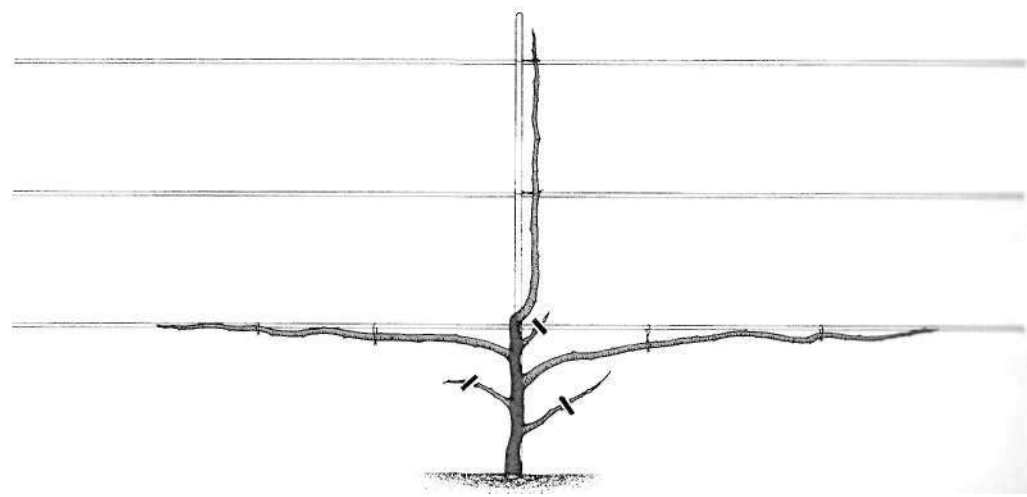
The first year



1 In late winter, plant an unfeathered maiden tree. Cut back the stem to within 15 in of ground level. Leave room for a short leg and select three good upper buds for training.



2 From June to September, train the shoot from the top bud vertically up a cane. Train the shoots from the two lower buds at an angle of 45 degrees to the main stem. Tie them to canes fixed on the wire support.



3 At **the end** of the growing season, lower the two side branches to the horizontal and tie them carefully to the wire supports with soft string. Cut back surplus laterals on the main stem to three buds.

Apples and pears

There is a tendency for vertical shoots to grow from the horizontal arms. These laterals are pruned in summer, cutting each back to three leaves above the basal cluster. Do not tie the extension growth of the horizontal arms until the end of the summer because early tying checks growth. In winter train and prune both the horizontal and vertical leaders in the same way as before. This regime of winter and summer pruning should continue until the desired number of tiers has been built in.

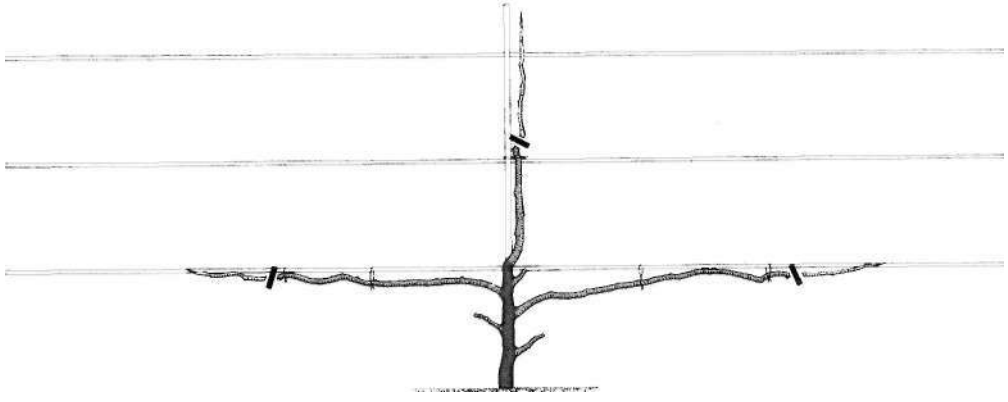
The number of tiers finally achieved depends on soil, site and inherent vigor, but four or five is usual. Eventually both the central axis and the horizontal arms fill their allotted space, from then onwards cut back the new terminal shoots to their origin each May and summer prune subsequent growth.

The fruiting stage

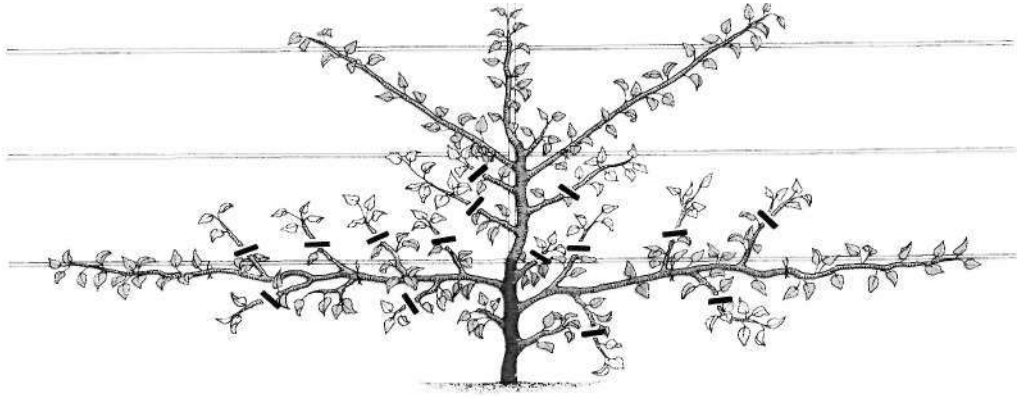
Each summer The fruits are carried on spur systems on the horizontal arms. The spurs are formed by the summer pruning of laterals on the Modified Lorette System in exactly the same way as for cordons. Regard each arms as a horizontal cordon (see pages 50-1).

Winter After a few years of fruiting, the spur systems may become complicated and should be simplified by removing clusters of weak buds and by cutting back some of the spurs to two or three fruit buds.

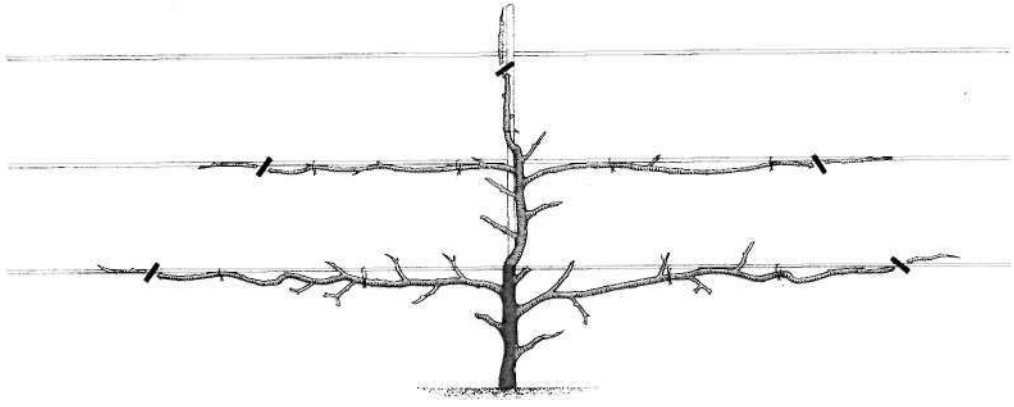
Second and subsequent years



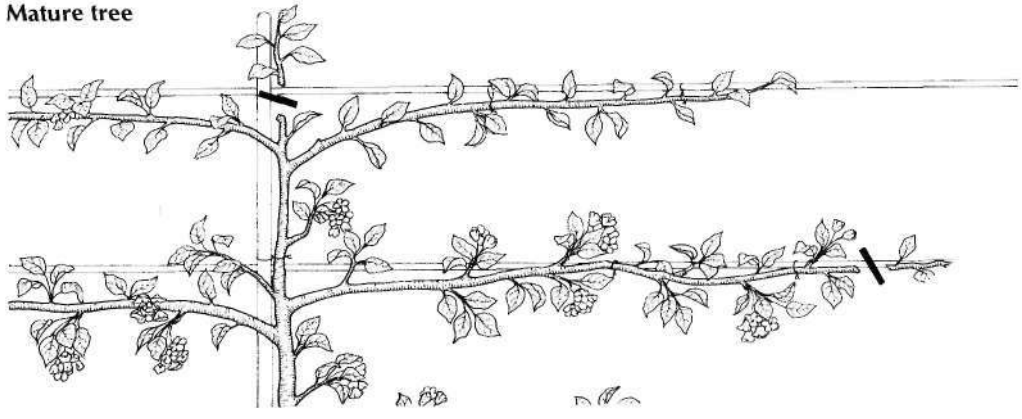
4 At the same time, cut back the central leader to within 18 in of the lower arm at the next wire, leaving three good buds to form the central leader and two new horizontal arms. If growth is weak, prune back the horizontal leaders by one-third, cutting to downward-pointing buds.



5 **From July to September,** train the second tier of branches in the same way as in the previous years (see caption 2). Cut back competing growths from the main stem to three leaves. Cut back laterals from the horizontal arms to three leaves above the basal cluster.



6 In winter, cut back the central leader to within 18 in of the lower arm, leaving three good buds to form the new central leader and two new horizontal arms. Cut back surplus laterals on the main stem to 3 buds. Tie down the extension growth of each arm to the horizontal. If growth is poor, prune back the leaders by one-third.



7 In **May,** when the final number of tiers is produced and the tree has filled its allotted space, cut back the new terminal growths of the vertical and horizontal arms to their origins. From now on prune them each summer as if they were cordons.

Apples and pears

The dwarf pyramid
The dwarf pyramid was evolved by commercial fruit growers as an easier method of producing apples and pears intensively. The pear, in particular, when grown on Quince rootstock, responds well to this method of training and in recent years the technique has been extended to plums. With apples and pears the aim is to produce a central-leader tree some 7ft high with a total branch spread of about 4 ft through the tree, tapering to the top to form a pyramid.

It is essential to keep such a closely planted and compact tree under control. This control is exerted by a combination of summer pruning, early cropping, the complete removal of any vigorous upright shoots, and the choice of a rootstock capable of sustaining the required balance between steady cropping and the renewal of bearing wood.

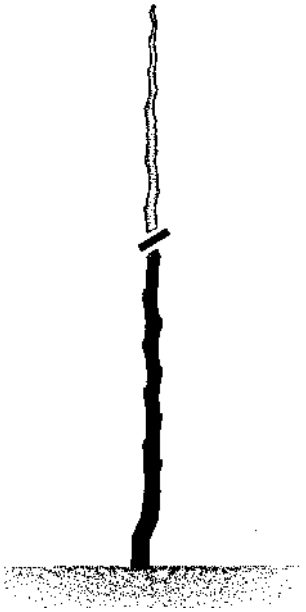
Choice of rootstock
Mailing 9 and Mailing 26 rootstock are suitable for apples in most gardens and either Quince A or the re-cloned Quince C (when generally available) can be used for pears.

Planting and staking
In early fall, prepare the soil (see page 45). Plant in the dormant season from November to March. Individual stakes are not necessary unless planting only one or two trees. With a row of trees, support them by erecting two posts at the ends of the row, and stretch two horizontal wires between them, one at 18 in and the other at 36 in. Tie the trees to these, using string or strapping.

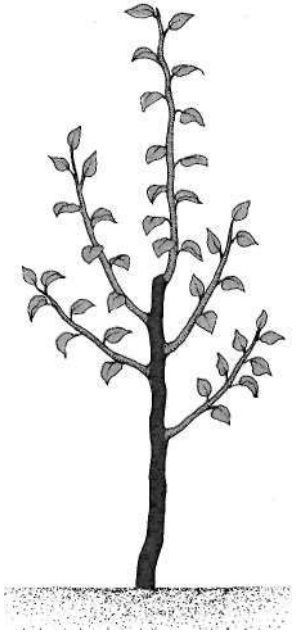
Spacing
Space apples on M9 rootstocks at 4-5 ft apart, and apples on M26 rootstocks and pears 5-6 ft apart. Allow the wider spacing on fertile soils. The rows should be 7ft apart.

Pruning and training
The first year A start is made with a maiden tree, which is cut back to about 20 in on planting during the dormant season in early spring. Prune to a bud on the opposite side to the graft. The result of this initial pruning is the production of four or five strong shoots. The uppermost shoot, which will become the leader, grows vertically.

The first year

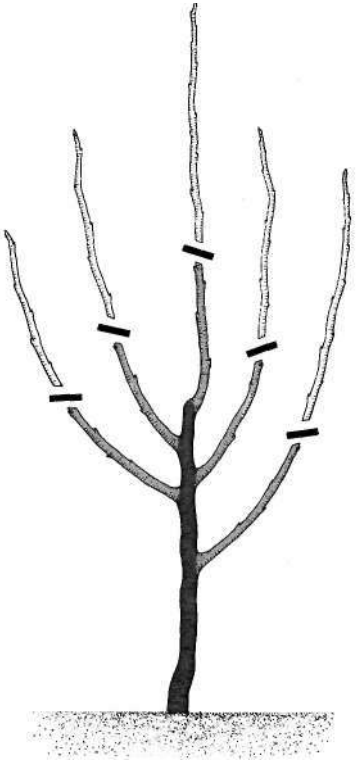


1 In early spring, at planting cut back the maiden to a bud within 20 in of ground level.

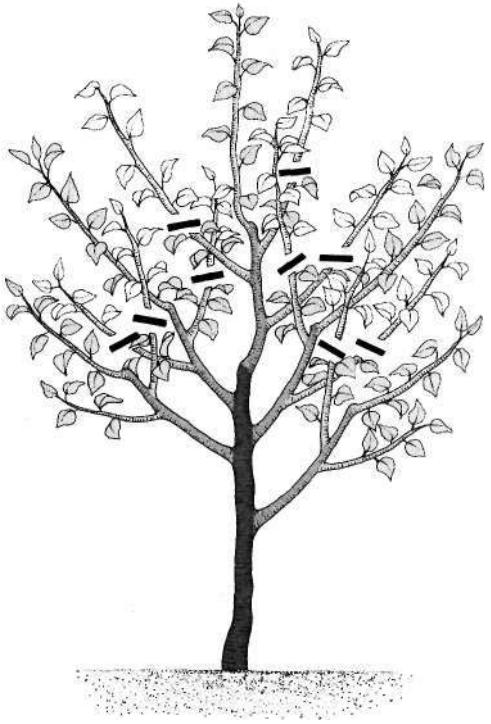


2 From July to August, four or five strong shoots will have been produced. No pruning is necessary.

The second year



3 In late winter, cut back the central leader to leave 9 in of new growth. Cut to a bud that points in the opposite direction to the last pruning. Cut back side branches to downward-pointing buds to leave 8 in of the maiden extension.



4 In late winter, cut back laterals not required for the framework to three leaves or 3-4 in and sub-laterals to one leaf beyond the basal cluster. Leave leaders unpruned.

Apples and pears

The second year In the following winter prune the central leader to leave about 9in new growth, taking care to cut to a bud that points in the opposite direction to the last pruning. This is aimed at keeping the successive stages of the central stem as straight as possible, in a series of zig-zags. It would be easier not to prune the leader at all because the stem would be straighter if left untouched, but such pruning is necessary to stimulate the annual production of side branches during the formative stages. These side branches, perhaps four in number and evenly spaced around the tree, are pinned back to within 8 in of the maiden extension, cutting each to a downward-pointing bud to maintain the horizontal direction.

During the following summer begin summer pruning, starting in mid-July for pears and about the end of July for apples. Cut back laterals (the current season's growth) longer than 9 in arising directly from the side branches to three leaves, and laterals from existing spurs to one leaf beyond the basal cluster. Leave immature shoots until September and then prune them in the same way. Do not prune the leaders in summer.

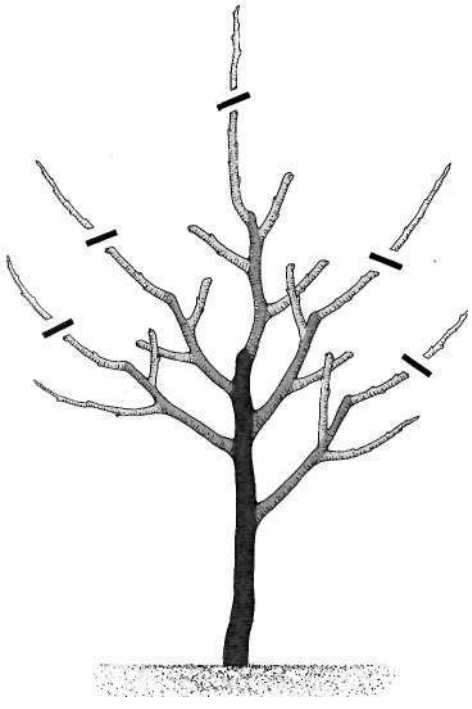
Third and subsequent years Prune the central leader in winter. Aim to leave about 9 in of new growth, cutting to a bud that is pointing in the opposite direction from the bud to which the stem was pruned in the previous winter. This stimulates the production of new side branches. Cut back any secondary growth that may have occurred as a result of summer pruning to a mature bud.

Every summer, prune the current season's growth on the side branches using the Modified Lorette System (see page 56), treating each side branch as if it were a cordon. Prune the branch leaders to six leaves.

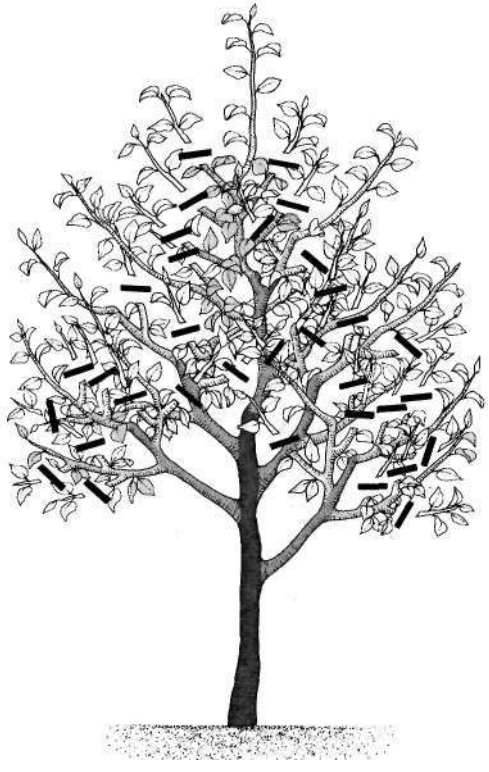
When the tree reaches 7ft, further extension growth should be stopped by cutting back the leader to its origin each May. Prune any other shoots that need restriction, such as vigorous upright shoots at the top or branch leaders growing into adjacent trees.

In winter it is occasionally necessary to shorten branches to a downward-pointing shoot in an attempt to maintain the essential horizontal position of the fruiting arms. Trim overcrowded spurs at the same time.

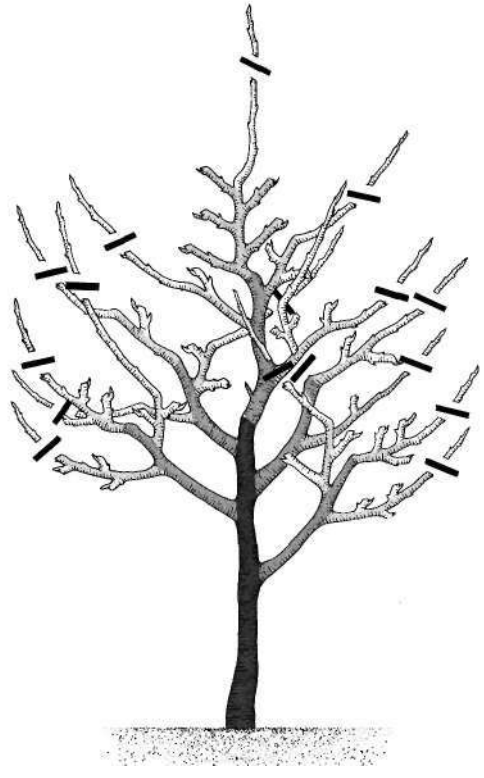
Third and subsequent years



5 From November to February, prune the central leader to leave about 9 in of new growth, cutting to a bud on the opposite side to the previous pruning.

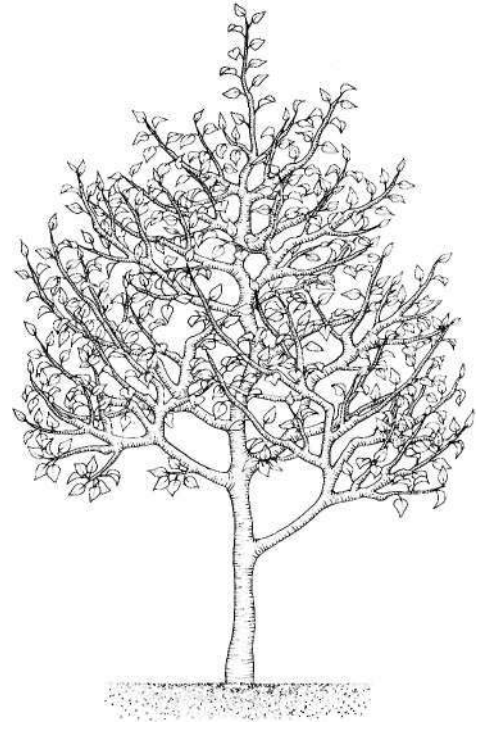


6 From July to August, throughout summer cut back laterals to three leaves or 3-4 in and sub-laterals to one leaf beyond the basal cluster. Prune the leaders of the side branches to six leaves.



7 In late winter, prune the central leader to leave 9 in of new growth. Remove entirely any over-vigorous shoots. Shorten branches to downward-pointing buds as necessary to maintain the horizontal position of the fruiting arms.

THE MATURE TREE



When the tree has reached the required height of about 7 ft, cut back the leader to its origin each May. Thin fruiting spurs as necessary. Maintain the central stem and retain the pyramid shape by close pruning and removal of vigorous shoots.

Apples and pears

Cultivation

Feeding and mulching Apply fertilizers as a top dressing over the rooting area, which is roughly equivalent to the spread of the tree and slightly beyond. Inorganic fertilizers can scorch grass, therefore brush well in and water the grass if the weather is dry. If the soil tends to be acid, with a pH lower than 6.7, sulfate of ammonia should not be applied because it makes the soil more acid. Instead use an artificial fertilizer containing calcium carbonate and ammonium nitrate. It does not affect the pH.

In early March, mulch newly planted and young trees with well-rotted manure, compost or peat to a depth of 2 in over a radius of about 18 in, but keep the mulch just clear of the stem.

Dessert apples In mid-winter apply sulfate of potash at 3/4 oz per square yard. Every three years, in mid-winter apply superphosphate at 2 oz per square yard. In late winter apply sulfate of ammonia or the fertilizer mentioned above, at 1 oz per square yard.

Dessert apples in grass See cooking apples.

Cooking apples The same rates and timings given for dessert apples apply except that extra nitrogen is necessary, so double the application of sulfate of ammonia or the fertilizer mentioned above. This also applies to dessert apples grown in grass.

During heavy rainfall in spring and summer, and in high rainfall areas, some apple varieties suffer from magnesium deficiency (see pages 14-16). At the first signs, apply three foliar sprays at 14-day intervals, using 8 oz magnesium sulfate in 21/2 gal water, plus a spreader (1/4 fl oz washing-up liquid). To avoid a recurrence, apply the magnesium sulfate as a top dressing in April, at 2 oz per square yard over the rooting area.

Pears, dessert and cooking Pears benefit from additional nitrogen, but if too much is given, vigorous growth is encouraged which, in turn, encourages fire blight. In the first year, therefore, apply only a few handfuls of balanced fertilizer such as 10-10-10. From the second year until the tree starts to bear, apply 8 oz of ammonium nitrate. Then increase the application to 16 oz and then, when the tree is about 10 years old, apply 24 oz. Thereafter, apply 32 oz per year.

Watering To ensure good establishment and strong growth, young trees (especially newly planted ones) need to be watered in the growing season whenever the soil is dry. As a guide, apply 4 gal per square yard every ten days throughout dry periods.

Cropping trees also respond to irrigation by producing heavier crops of larger and better quality fruit. Lack of water may induce a biennial bearing pattern (see page 58). The total amount of water needed is about 4 in (18 gal per square yard) in July, 3 in (131/2 gal per square yard) in August and 2 in (9 gal per square yard) in September.

Obviously, in cool wet regions these totals will be met by natural rainfall, but in dry areas some water must be applied, the actual amount depending upon the rainfall. Apply 2 in (9 gal per square yard) at a time under the trees, starting in early July. Use a slow-running hose as a soaker and keep the water on the ground rather than on the foliage, irrigating over the rooting area.

Fruit thinning The main purpose of fruit thinning is to obtain larger and better quality fruits. In heavy cropping years if the fruits are not thinned, the resultant crop will consist of small, medium to poor quality apples or pears and, as with lack of water, the strain imposed upon the tree might put it into a biennial habit. Much depends upon the condition of the trees: trees with healthy foliage and a strong framework can carry more fruit than can weaker trees. Young trees should not be allowed to crop so heavily that the branches are bowed down and the tree cannot make the essential strong growth needed for its framework.

Some varieties naturally shed some of their fruitlets in late June or early July which is called the June drop, but this may not be sufficient. Start lightly thinning before this in mid-June by removing the malformed fruits, and then complete the task after the June drop in about mid-July.

Cooking varieties should be thinned harder than the dessert fruits.

Use sharp scissors or press the fruitlet with the thumb and finger, leaving the stalk behind. In the final thinning, dessert apples should be spaced on average 4-6 in apart with about one fruit per cluster and occasionally two where there is a good show of supporting leaves. Cooking apples should be spaced on average 6-9 in apart.

With apples, sometimes the "king" or "crown" fruit produced in the center of a cluster is virtually stalkless and malformed. If this is the case, remove it, but if the apple is well shaped, leave it because the king fruit can be the best in the cluster.

Pears need less thinning than do apples. Start thinning after the natural drop in late June, but not until the fruitlets turn downwards. Thin to two fruits per cluster and occasionally to one where the foliage is poor or sparse.

Supporting heavily laden branches Prop up heavily laden branches well before there is a risk of the branches breaking. Use forked poles or stakes but place a cushion of soft material such as a piece of rubber tire between the prop and the branch.

Weak branches can be tied to stronger ones with rope or webbing. Small trees can

Manuring

1 In mid-winter, apply sulfate of potash at the recommended rates. In late winter apply sulfate of ammonia.

Mulching

2 In early March, mulch newly planted and young trees with a 2 in layer of well-rotted manure or compost over a radius of 18 in.

Watering

3 **In summer,** apply 4 gal per square yard every ten days in dry periods.

Apples and pears

be supported by "maypoling". This involves driving a tall stake into the ground near the stem of the tree and tying rope or thick string from its top to each branch that will benefit from support.

Protection from wasps and birds

Apples and pears (especially the early varieties) sometimes need protection against wasps and birds. The trees can be netted or collars placed around the fruit stalks against birds (see page 17) but wasps are more difficult to combat. One remedy is to find and destroy the wasps' nests. They can also be trapped in jam jars partly filled with beer and sugar. However, these two methods guarantee only partial control, and the most positive (if tedious) protection against wasps is to enclose each fruit, or cluster of fruits, in a muslin bag or piece of nylon stocking.

Harvesting and storing

The time for picking apples and pears varies according to the season and the locality so it is not possible to give exact picking dates. As a guide, the earliest varieties of apples are ready for picking in late July to early August.

Apples A good test for ripeness is to lift the fruit in the palm of the hand and if it leaves the spur easily with its stalk intact, it is ready. Another sign is the first windfalls (discounting drops from strong winds and codling moth attack). With the later ripening varieties, the color of the pips is an indication. They should be beginning to change color from white to straw-coloured and eventually to brown. With dessert apples in particular the skin of the fruits becomes more brightly colored.

Early varieties are best picked when slightly immature because they soon go mealy. Pick those apples that have colored rather than clearing all the apples in one go. Usually those apples in full sun are ready first and those in the middle of the tree last. Handle the fruits very gently because bruised fruits do not keep. Put the fruits carefully into a picking container lined with soft material and transfer them just as gently into their final container.

Late apples reach maturity in storage sometime after pic king, depending upon the variety. Most should be off the tree by about the third week of October, but there are a few varieties which keep better and acquire more flavor if left on as long as possible, birds and winter gales permitting. These include 'Granny Smith'.

Store only sound fruits (see page 90 for details of storage).

Pears The correct time for picking pears is harder to assess than it is for apples. The best test of readiness is to lift the pear in the palm of the hand and with a slight twist and tug, it should leave the spur with its stalk intact. There is also an almost imperceptible change in the ground color of the skin from dark green to lighter green.

Early and early mid-season pears (August to September) must not be left on the tree until they are fully ripe otherwise they may go "sleepy", that is very soft, mealy and brown at the center. Pick them when they are almost ready but still firm, and then let them mellow in storage. Their storage life can be extended considerably by keeping them under cool conditions (3°-7^{0}C/37°-45°F).

Late pears should be left on the tree until they leave the spur easily; the first sign of windfalls is an indication. The fruits are hard at this stage but will mellow in storage. Keep them under cold conditions and bring the pears into room temperature to finish ripening whenever required. (See page 82 for details of storage).

Pests and diseases

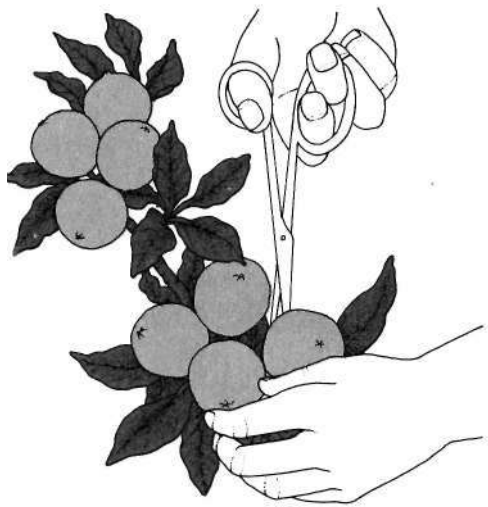
Apples The most troublesome diseases are scab, mildew and canker and the most troublesome pests are aphids, leaf-eating caterpillars, sawfly and codling moth larvae.

Scab and mildew can be controlled by regular spraying with benomyl or captan starting at bud burst and finishing in July. If canker occurs, cut out the rotting wood and paint the clean wounds with a canker paint. In bad attacks also apply liquid copper sprays after harvest and at 50 per cent leaf-fall, and the following year at bud burst. Check that the soil is not badly drained (see pages 10-11).

Use a systemic aphicide against aphids.

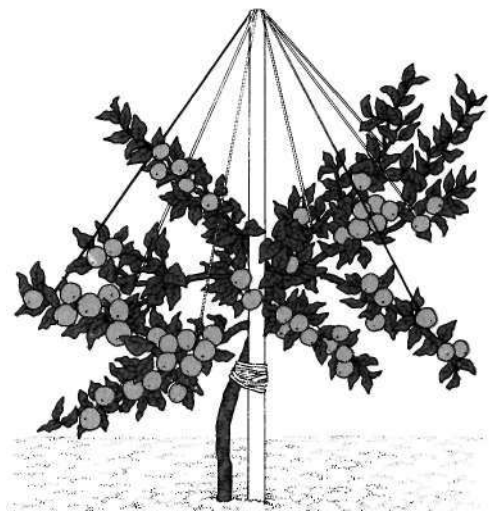
Thinning

4 In mid-June, thin the fruits using sharp scissors or press the fruitlets off with the thumb and finger, leaving the stalk behind



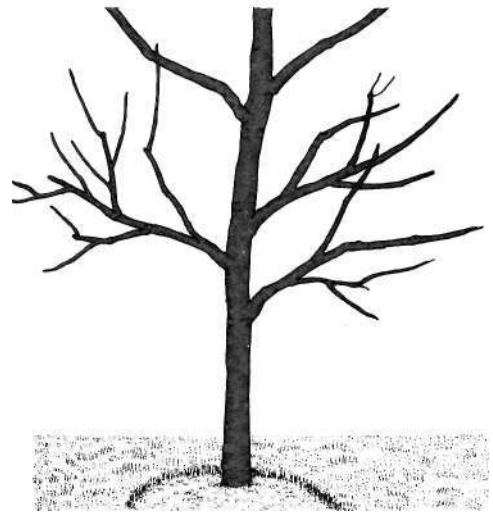
In mid-July, thin again to leave one or two dessert apples per cluster 4-6 in apart, cooking apples 6-9 in apart. Pears need less thinning; leave two fruits per cluster.

Maypoling



5 On small trees, to support branches with a heavy crop, drive a tall stake into the ground near the stem of the tree. Tie a rope from its top to each branch.

Grassing down the orchard



6 After four or five years, sow grass in the orchard. Sow a fine lawn mixture at 2 oz per square yard, leaving a grass-free area of 2 ft radius around the base of each tree.

Apples and pears

Spraying with dimethoate one week after petal fall controls sawfly larvae. Use a general-purpose fruit spray against codling moth caterpillars in mid-June and again at the end of June.

Pears The most troublesome disease of pears is scab and the most troublesome pests are aphids and leaf-eating caterpillars.

For scab spray with captan or benomyl at bud burst, repeating every two weeks as necessary until late July.

The whole business of pest control can be greatly simplified if a general-purpose fruit spray containing an insecticide and fungicide is used on a systematic schedule throughout the growing season.

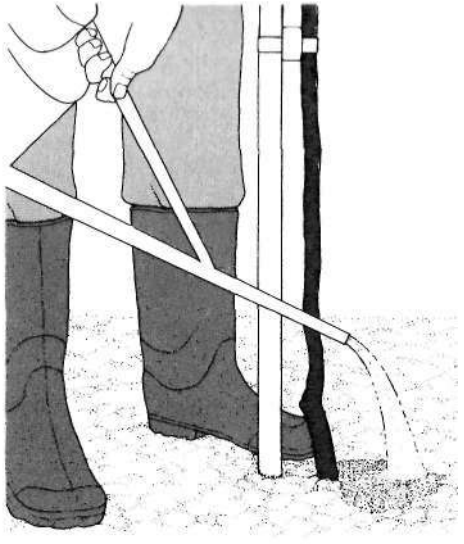
In winter, during dormancy, spray with a dormant oil. Then use the general-purpose spray (1) just before blossoms open, (2) when three-fourths of the flower petals have fallen, (3) two weeks after petal fall, and (4) every 10-14 days thereafter until about three weeks before harvest.

Adding a "sticker" (a gluey liquid) to the spray keeps it from being rapidly diluted by the rain. If the "sticker" is not used, it may be necessary to increase the frequency of spray in wet or very humid weather to every seven days.

BIENNIAL BEARING

1 In spring, before a heavy crop year, rub one-half to three-quarters of the fruit buds from the spurs, leaving one or two per spur.

2 Each March, apply 4 oz per square yard of a balanced fertilizer, such as 10-10-10, and sulfate of ammonia at 2 oz per square yard. Mulch small trees with a 2 in layer of well-rotted manure over a radius of 2 ft.



3 **In late August,** apply a further 2 oz per square yard of sulfate of ammonia. In dry weather water copiously, giving at least 1 in of water (41/2 gal per square yard) over the rooting area every ten days until rain restores the balance.

Propagation

Apples and pears do not come true from seed nor are they satisfactory from cuttings, so they are propagated by budding or grafting on to suitable rootstocks, a task normally performed by the fruit tree nursery.

Biennial bearing

Biennial bearing or the carrying of a heavy crop one year and little or none in the next, is a common problem with apples and pears. Certain varieties are prone to it, although almost any variety can fall into this habit. It is more likely to happen to trees which are starved or receiving insufficient moisture, which makes them unable to carry a heavy crop and at the same time develop fruit buds for the following year. Frost destroying the blossom one spring can sometimes be the start of biennial bearing. Once the tree is into this cropping pattern it is difficult to correct, although there are certain techniques the gardener can try which sometimes improve the situation.

In early spring before an expected heavy crop year, half to three-quarters of the fruit buds are rubbed off the spurs, leaving about one or two per spur. This lessens the burden of too heavy a crop in that year and may enable the tree to develop fruit buds for the next year.

In conjunction with bud rubbing, a policy of more generous feeding and watering should be adopted in "on" and "off" years. But remember the danger of over-feeding pears.

First, clear away grass or weeds from the base of the tree over a radius of at least 2 ft.

Each March apply a balanced fertilizer such as 10-10-10 at 4 oz per square yard and sulfate of ammonia at 2 oz per square yard. Small trees should also be mulched with well-rotted manure or compost to a depth of 2 in over a radius of 2 ft but keep the material clear of the stem.

In late August apply a further 2 oz per square yard of sulfate of ammonia. Throughout the growing season, whenever the conditions are dry, the tree should be irrigated copiously by applying at least 1 in of water (41/2 gal per square yard) over the rooting area every ten days until rain restores the balance.

If bud rubbing does not work, an alternative technique is to induce the tree to crop biennially over half the tree by removing half the blossom. Alternate branches are selected and marked in some way. Half the branches are designated to crop in the even years (1980,1982, and so on) and half the branches are designated to crop in the odd years (1981, 1983, and so on). Each spring, those branches not selected to crop in that particular year must be rigorously deblossomed. At first this deblossoming represents quite a task, especially with a large tree, but after the third or fourth year it should be found that the branches have accepted this alternate pattern and very little blossom removal is necessary. However, a careful watch should be kept to see that the tree does not slip back into the full biennial cropping. As with the first technique, generous feeding is recommended.

Grassing the orchard

After four or five years, sow grass seed throughout the orchard. Grass checks the vigor of the trees and promotes color in the fruits, so grass down dessert fruits, but not cooking apples or cooking pears for which size is more important than color. Delay grassing if the trees are growing poorly.

Plums

A classification of plums

Plums grow in varieties of color, shape, and size and are known by different names in various parts of the world. Understandably, therefore, confusion often occurs among gardeners and botanists over names in the plum family.

The plum is a deciduous tree ranging in height from 15-30 ft when mature. It bears small fruit and is popular with gardeners. For reasons of simplification, the plum can be classified into three broad categories or groups: European, Japanese and native. But there are several other fruits which are also called plums, and these will be described briefly at the end of this section.

The European plum, primarily a blue fruit growing in zones 5-7, is further sub-classified simply as plum, or as, for example, gage, damson, or bullace. These fruits are recognized in the United States as plums, but a varietal name, such as green gage plum, damson plum, or Stanley prune plum, is appended for more precise identification.

The Japanese plum is a red fruit somewhat larger than the European plum, and grows in zones 5-9. Native plums, the best of which are for the most part hybrids, are the results of crosses with Japanese plums. The fruits are red or yellow and fairly small. These trees grow in zones 3-7.

All plums can be canned or made into jams or jellies, but not all are ideal for immediate consumption. The Japanese plum is generally the best of the many plums available for eating when ripe and fresh, but many of the European plums are also excellent eating.

Since the plum does not form a very large tree, it is generally grown as a free-standing tree in the open. Standard, semi-dwarf and dwarf specimens are available. Some of the European varieties can be fan-trained against a warm wall or a fence, or as a pyramid, a very good form for the small garden. It is not suited to such restricted forms as the cordon or espalier.

Pollination

As a rule of thumb, plums are self-unfruitful. The numerous exceptions to this rule are noted in the lists of varieties (above). A general safeguard, however, is to plant any variety of plum in the proximity of another variety to ensure a good set of fruit. But it should be realized that European and Japanese plums cannot pollinate each other. Native plums are pollinated either by other native varieties, by sandcherry-plum hybrids or, in the case of crosses between native and Japanese plums, by Japanese varieties.

Cultivation

The cultivation of all the various types of plums is broadly the same. The major variations are in pruning.

Yield A good average yield from a fully-grown plum tree in the open ranges from 30 to 120 lb.

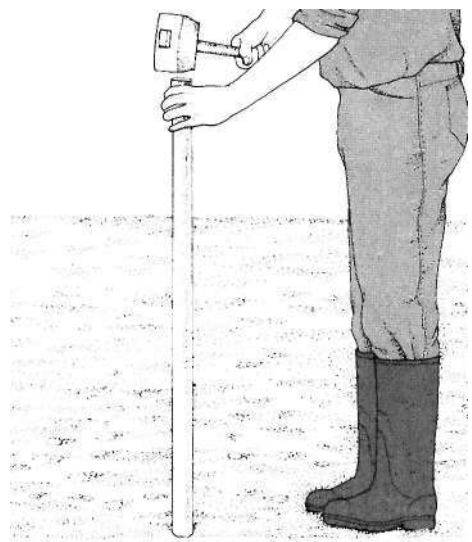
Soil and situation Plums require a deep, moisture-retentive, well-drained soil with a pH from 6.5 to 7.2. Shallow soils over light, sandy subsoils are unsuitable. The plums grow best in clean soil. Control grass and weeds around the tree by shallow hoeing. Avoid too deep cultivation because this encourages suckering. Plum varieties on vigorous rootstocks can be surrounded with grass, but a clean area 2 ft square should be maintained right around the base of the tree.

Plums flower early, and so a sheltered, frost-free site must be chosen because this is essential to avoid irregular cropping. Japanese plums, which bloom very early, should be planted on a north-facing slope or the north side of a building or wall in order to retard blooming and thus protect the plums from late frosts.

Soil preparation In the fall or early spring, prepare the ground by thoroughly clearing away perennial weeds over an area 3 ft square. Fork in a balanced fertilizer such as 10-10-10 at 3 oz per square yard and bonemeal at 2 oz per square yard just before planting. If the soil is light, also fork in well-rotted manure or compost at one 2-gal bucketful per 2 square feet.

Planting and spacing Plant bare-root trees in March or April while the tree is dormant. Container-grown trees can be planted at any

1 In autumn, prepare the ground, clearing away perennial weeds. Lightly fork in 3 oz of a balanced fertilizer and 2 oz of bonemeal per square yard.



2 For trees in the open, drive in a stake. For fan-trained trees construct a system of wires on the wall. Plant the tree and tie it to the stake or to the wall wires.

3 In February, apply a balanced fertilizer at 4 oz per square yard. One month later, apply sulphate of ammonia at 1 oz per square yard. Mulch the tree with a 1-2 in layer of compost or manure.

4 Thin the fruits when they are the size of hazelnuts and once the stones have formed within the fruits. Repeat when the fruits are twice this size to leave them 2-3 in apart on the branches.

Plums

time. Dig a hole wide and deep enough to take the roots fully extended. For trees in the open, before planting drive in a stake to reach just below the lowest branch. For fan-trained trees, construct a system of supporting, horizontal wires spaced 6 in apart (see pages 8-9). Plant the tree to the same depth as it was in the nursery. Return the soil and firm it well. Tie to the stake with a tree tie and cushion or tie in the branches of a fan to the wall wires. Water well. Trees in the open require staking for the first two or three years.

Space trees grown in the open 20 ft apart. Fan-trained trees are spaced 15-20 ft apart.

Pruning

Since Japanese and native plums grow more vigorously than European varieties, they require more pruning. This includes cutting back the head to some extent almost every year.

The first year In late winter, cut back the central stem of the maiden tree to a bud at about 2-3 ft for a dwarf, or 4-5 ft for a standard. It may be necessary to grow the tree on for another year to acquire the needed height for a standard before cutting it back. Shorten all laterals to about 3 in to help thicken the stem.

In July or August, select four to five evenly spaced primary branches around the stem at the top. Pinch out the growing points of all others at four or five leaves, including those lower down the main stem.

The second year In late winter, select four branches that have formed wide angles with the stem. Cut back each leader of those selected by one-half to outward-facing buds. Remove the remainder, including the lower laterals of the last year to thicken the stem.

In the summer, remove any suckers that appear from the ground as well as shoots on the main stem below the head.

The third year Repeat the procedures adopted in the previous spring and summer, but allow more secondary branches to develop to fill the increased space, providing up to eight strong, well-placed outward-growing branches. In late winter, cut these back by one-half to two-thirds of the maiden growth to outward-facing buds. I cave shoots on the outer parts of the head not required for leaders. Prune back unpruned laterals on the inside of the tree to 3-4 in.

Little pruning of European plums is necessary in subsequent years. Generally, all that is needed is to cut out dead, broken, rubbing and crossing branches and to thin out the head when it becomes crowded. Japanese and native plums require the same general treatment, but, as noted above, may need some heading back.

Pruning the fan-trained tree Starting with a maiden tree, the framework of a fan-trained plum is built up in the same way as a fan-trained peach (see pages 67-9). Thereafter, the pruning is different because, unlike the peach, the plum fruits on short spurs on three- and four-year-old wood as well as on growth made in the previous summer. However, the older wood tends to become bare with age and from damage by frost or birds. The aim in pruning is to encourage spur formation and, when necessary, to replace worn-out branches.

In the early years, extend the framework, as with the peach, to fill in the wall space; then follow the steps below.

In the spring of later years, cut out **a** proportion of the old, worn-out wood back to young replacement branches. Paint the wounds.

Feeding and watering

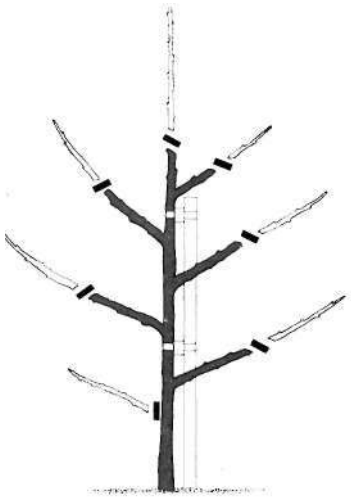
In early spring, apply a balanced fertilizer, such as 10-10-10, at 4 oz per square yard. Mulch young trees with a 1-2 in layer of well-rotted manure or compost over a radius of 18 in, keeping the mulch clear of the stem.

Water well and regularly in dry weather during the growing season, applying 1 in of water (41/2 gal per square yard) every ten days until rain corrects the balance. Avoid irregular heavy watering because this can cause splitting of the fruits, especially near the ripening stage.

Thinning the fruits

Thin the fruits (if the tree carries a heavy crop) after the stones have formed within the fruits

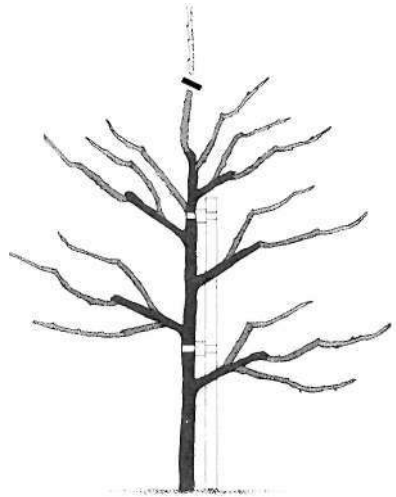
The pyramid plum: the first year



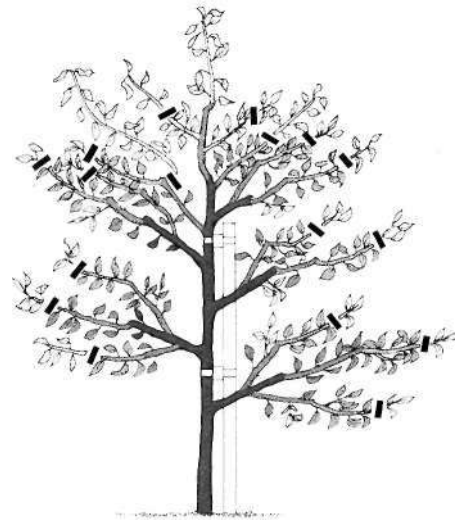
1 In March, cut back the leader to 5 ft. Cut back to the stem all laterals up to 18 in from the ground. Cut back the remaining laterals by one-half.

2 In fate July, shorten the new growth of the branch leaders to 8 in to downward-facing buds. Shorten the current season's laterals on the branches to 6 in. Do not prune the central leader.

Second and subsequent years



3 **In March,** shorten the central leader by two-thirds of the previous summer's growth until the tree has reached about 9ft, then shorten the central leader to 1 in each May to keep the tree at this height.



4 In late July, shorten the current season's growth of each branch leader to eight leaves. Shorten the laterals to six leaves. Cut out any vigorous shoots at the top of the tree.

Plums

to avoid loss of flavor and the possibility of a biennial pattern of bearing. I bin once when the fruits are about the size of hazelnuts, and again when they are twice this size. On most European and native plums, fruits left on the tree to ripen should be 2-3 in apart; however, allow 4 in in the case of very large varieties. Japanese plums should be thinned to 3-4 in apart. Do not tug the fruits off because this may tear away the following year's fruit buds; cut the fruit stalk with scissors or shears.

Supporting the branches

It is essential to support very heavily laden branches because they may break and spoil the shape of the tree. Such wounds also increase the risk of bacterial infection. Support individual branches with a clothes prop or forked stake driven into the ground at an angle. Wrap the branch with burlap where it meets the crotch of the support. Alternatively, the branches of dwarf trees can be supported with ropes tied to a central stake in maypole fashion (see illustration 5 on page 57).

Protection against birds

The fruit buds of the plum are susceptible to bird damage in winter and the ripe fruit is also at risk in the summer. Where necessary and practicable, protect the tree with netting (see page 17).

Harvesting and storing

Plums ripen from midsummer on. They do not ripen simultaneously and it is necessary to go over the tree several times. Pick fruits intended for canning, jam and cooking while still slightly under-ripe. Pick all fruits with the stalks intact.

Plums cannot be stored for prolonged periods, but they will keep for two to three weeks if picked when a little under-ripe and kept in a cool place, at about 6°-7°C/42°-45°F.

Propagation

Plums are propagated by budding or grafting, a task normally carried out by the nursery. For details see the companion volume in this series, *Plant Propagation.*

Pests and diseases

Spray trees with dormant oil in late winter. Then apply a general-purpose fruit tree spray when the petals fall and at 10-14 day intervals until approximately a month before harvest. Brown rot is a problem if the weather is warm and humid at time of bloom or in the three-week period before harvest. To control it, spray with captan at 3-4 day intervals.

Sandcherry-plum hybrids

These small (1/2 in to 11/4 in diameter) plums are also known as cherry plums. They are the result of crossing native sandcherries with plums, usually native but sometimes Japanese. Accordingly, the deciduous plants range from shrubs no more than 4 ft high to trees about 25 ft high. The fruits have purple, red or green skins and yellow to purple flesh. Sandcherry-plum hybrids are most commonly grown in zones 2-6, where true plums do not thrive.

The many varieties all fruit from mid-August to September.

Cultivation

The sandcherry-plums are grown like plums and in dry regions require about as much space. In wetter areas, however, spacing can be reduced considerably. The best fruit is borne on young growth, so the plants must be pruned rather hard every year. A good procedure is to remove entire branches after they have fruited for about three years. The plants are self-unfruitful; plant two or more varieties.

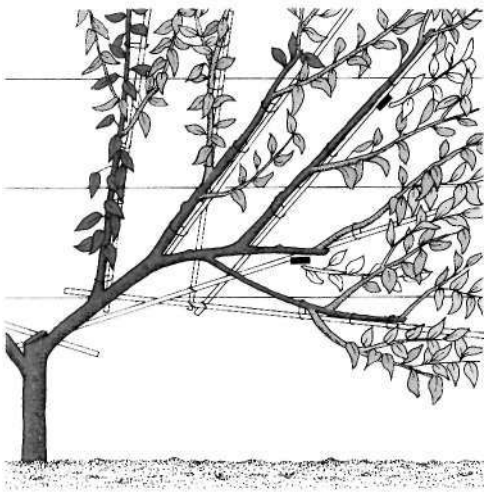
Beach plums

The beach plum is generally associated with Cape Cod, where it grows wild in profusion, but it can be grown throughout zones 6-8 near the ocean.

Cultivation

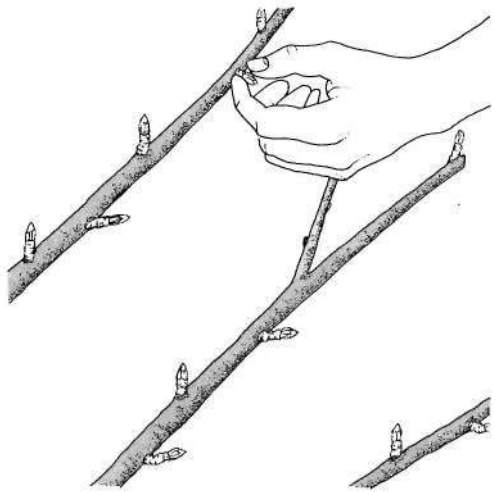
The beach plum grows in indifferent soil so long as it is well-drained, but needs full sun. A little balanced plant food can be applied in early spring, the plants can be mulched with leaves, and then pretty well forgotten. Watering is required only in long dry spells.

The plum fan

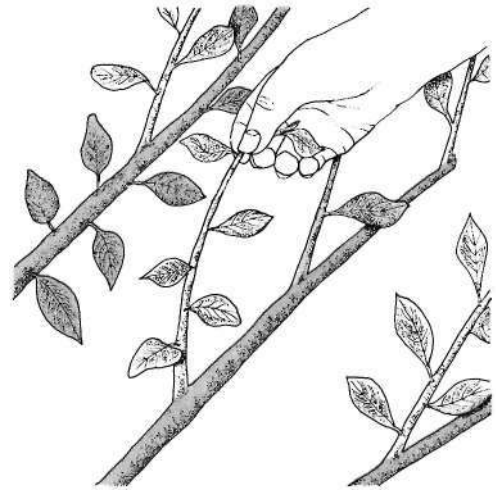


1 For the first three years, follow the formative pruning steps for the peach fan (see pages 69-70), extending the framework to fill in the wall space. Prune only in spring or summer.

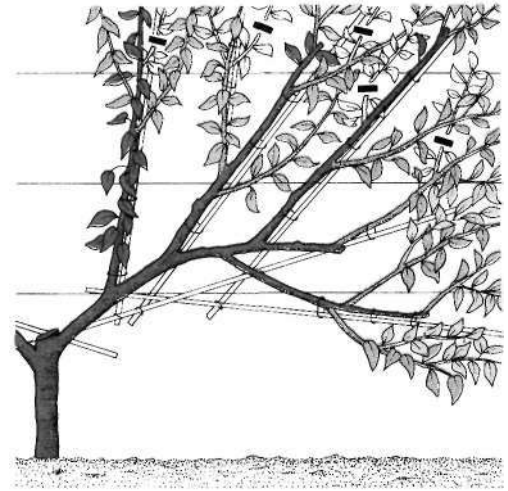
Fourth and subsequent years



2 Each spring, as growth begins, rub out shoots growing directly towards the wall and breastwood.



3 **From late June to late July,** as new shoots are made, pinch out the growing points of shoots not wanted for the framework when they have made six or seven leaves. This begins to form the fruit-bearing spur system.



4 After cropping, between mid-August and mid-September, cut back the pinched-out shoots to three leaves to encourage fruit buds to form at the bases of the pinched-out shoots the following year.

Sweet and Duke cherries

The cultivated sweet, or dessert, cherry is a hybrid between *Prunus avium* and *P. cerasus.* It is a hardy deciduous tree which is cultivated in many areas of Europe and western Asia. It bears clusters of attractive, white flowers in spring and bears fruits, ranging in color from yellow and pink to almost jet black, from June onwards in cool temperate areas. It grows in zones 6 and 7, and in protected locations in zone 5.

The Duke cherry is thought to be a cross between the sweet and sour cherry and it is intermediate in character between the two.

'May Duke', 'Olivet', 'Reine Hortense' and 'Royal Duke' are good varieties, but are difficult to find.

Cultivation

Although this delicious fruit merits a place in any garden, it has one serious drawback—its extreme vigor. Despite the introduction of increasingly dwarfing rootstocks, the cherry remains quite vigorous and is therefore not suitable for a small garden. It is often grown as a fan on a wall, but the wall must be fairly high. In the open it is grown as a standard. By using the less vigorous rootstock Colt, it could be grown as a pyramid. Treat Duke cherries in the same way as sweet cherries.

Yield The yield from the different kinds of cherry can vary enormously depending, of course, on the size, age and form of the tree and the climate. A good average from a fan is about 30 lb and from a well-grown standard 100 lb.

Soil and situation Cherries grow in any good, well-drained soil but it must be deep, ideally more than 21/2 ft. The pH should be between 6.7 and 7.5. Light, sandy and shallow soils are not suitable.

Cherry blossom is susceptible to frost and young trees to wind damage so the site should be sheltered from winds, in full sun and not in a frost pocket.

Soil preparation In the spring clear away weeds over an area 3 ft square, single digging clear ground and double digging weedy ground. Just before planting, fork in a balanced fertilizer such as 10-10-10 at the rate of 3 oz per square yard with bonemeal at 2 oz per square yard.

Planting and spacing Plant when dormant in March or April. Container-grown trees can be planted at any time. Dig a hole wide and deep enough to take the roots fully extended. For trees in the open, before planting drive in a stake to reach just below the lowest branches. Standard cherries require two stakes and a crossbar. For fan-trained trees, erect a system of horizontal wires on the wall using 14 gauge wire and spaced 6 in or two brick courses apart (see pages 8-9).

Plant the tree to the same depth as it was at the nursery. Return the soil and firm it well. Tie to the stake with a tree tie and cushion, or tie in the branches of a fan to the wall wires. Space fan-trees 18-25 ft apart; half-standards and standards at 30-40 ft apart and dwarfs 25-35 ft apart.

Pruning the fan-trained tree

The sweet cherry fan is pruned as shown in the step-by-step instructions below. Prune in spring as the buds burst and not in winter because of the risk of bacterial canker. If the maiden tree is well feathered use two strong laterals, one to the left and one to the right at the first wire to form the initial ribs. Tie these to canes fixed to the wires at 35 degrees.

Pruning dwarf, semi-dwarf or standards

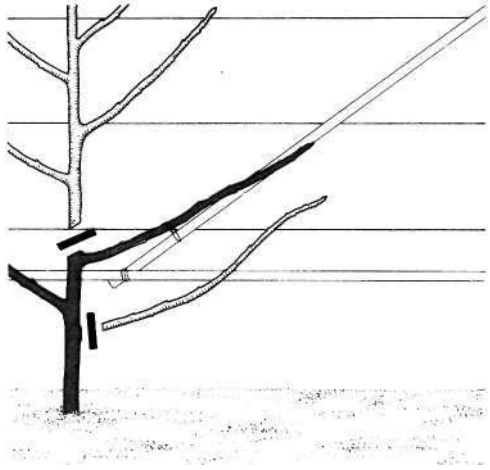
The first year: the maiden tree Prune in the early spring just as the buds begin to open. The head is formed by cutting back to three or four suitably placed buds in the same way as for the apple (see page 47). The objective is to obtain three or four well-placed primary branches by the end of the summer. Pinch out any flowers that are produced. Shoots lower down on the main stem should be pinched back to four leaves. These help to stiffen the stem and should not be removed until the cherry is four years old. Protect the pruning cuts.

The second year In spring, prune each leader by one half to an outward-facing bud. Summer prune the pinched-back shoots on the main stem by pinching out the growing points. Weak or diseased branches should be entirely removed.

1 In spring, prepare the soil. Dig a hole wide and deep enough to take the roots fully extended. Plant the tree against a wired wall for fan-training (or with two stakes and a crossbar for standards).

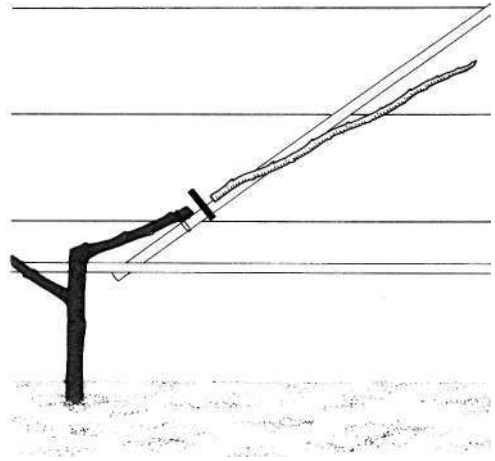
2 Each April, apply a top dressing of balanced fertilizer at a rate of 3 oz per square yard over the rooting area. Mulch with a 2-3 in layer of well-rotted manure over a radius of 18 in.

Pruning the fan-trained tree: the first year



1 In spring, tie two strong laterals to canes fixed to wires at 35 degrees. Head the center stem back to the uppermost of the selected laterals. Remove all other laterals and protect the cuts.

The second year



2 **In spring,** select suitable buds and shorten each leader to about 12 in. This encourages shoots to develop in the summer which are used as the ribs of the fan.

Sweet and Duke cherries

The third year b*y* the third spring six to nine well-spaced leaders should have been formed. Prune them lightly, leaving about 24 in of the previous summer's growth. Prune laterals competing with the leaders back to three buds. Upright laterals in the center should be cut out because these may grow too vigorously and spoil the shape of the tree. Where there is room, leave other laterals unpruned.

Fourth and fifth years No more leader pruning should be necessary. In the fourth spring clean up the trunk by removing the pinched-back shoots. Protect the wounds by sealing them with bituminous paint.

Pruning an established tree

Very little pruning is necessary while the tree is well furnished with cropping wood and of manageable height. Each year cut out dead, broken, crowded or crossing branches, cutting them flush to avoid any snags. Prune in the spring and protect the wounds by sealing them with bituminous paint.

Grassing down For the first four or five years the soil around trained trees must be kept clear by maintaining a 3 ft wide border along the length of the wall over the spread of the tree. The border may then be planted to grass if the tree is developing in a satisfactory manner.

Dwarf and standard trees should also be grassed down after five years. For the grass mixture (see page 57). Keep the grass clear of the trunk of the tree, as not to do so will encourage pests or diseases.

Feeding and watering In March or April apply a balanced general fertilizer, such as 10-10-10, at 3 oz per square yard as a top dressing over the rooting area. Young trees, both fan-trained and in the open, should also be mulched to a depth of 2-3 in over an overall radius of 18 in.

Cherries against walls require watering in dry spells during the growing season. Once a good set of cherries has been achieved, water the border soil copiously in times of drought. Apply 1 in (41/2 gal per square yard) over the rooting area every seven days (ten for the sour cherry) until rain falls. Keep the tree accustomed to moist soil conditions. Do not suddenly give heavy applications of water after the soil has become dry because this may cause the fruits to split and so spoil the subsequent crop.

Pollination

With one exception (the variety 'Stella') sweet cherries are not self-compatible, in fact, cross-incompatibility occurs. Most Duke cherries are self-compatible and can be planted singly but a few are not.

Protection against frost and birds

It is feasible to protect the blossom of a fan-trained tree against frost, but hardly practicable with a tall standard. Drape the fan with burlap or netting (see page 7). Other birds destroy the buds in the winter while starlings and blackbirds eat the ripe fruits. Protect the tree by covering it with adequate netting.

Harvesting

Leave the cherries on the tree until ripe unless they start cracking. Pick with the stalk on using scissors or shears: if fruits are pulled off and the stalk is left hanging it encourages brown rot. Cherries should be eaten as soon as possible after picking as they can deteriorate quite quickly.

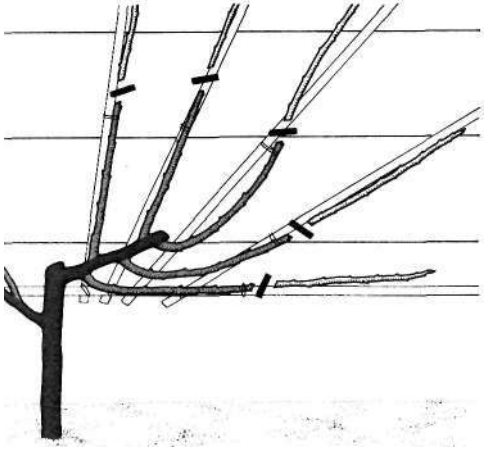
Propagation

Cherries are propagated by budding, or by grafting on to rootstocks, tasks normally carried out by the nursery but which can be done by keen amateurs if great care is taken in the exercise.

Pests and diseases

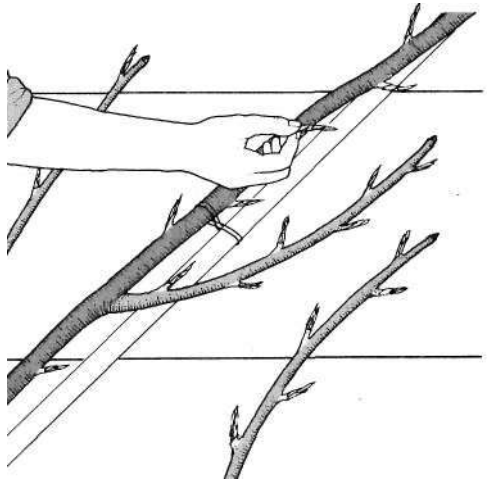
Tent caterpillars, cherry slugs, and brown rot are the most troublesome problems. Cherry slug and tent caterpillar as well as most other problems can be controlled by a regular spray program. The program should include the application of a dormant oil in late winter or early spring followed by consistent use of a general-purpose fruit spray after petal fall. To prevent brown rot, spray the plants with captan during periods of warm and humid weather conditions.

The third year

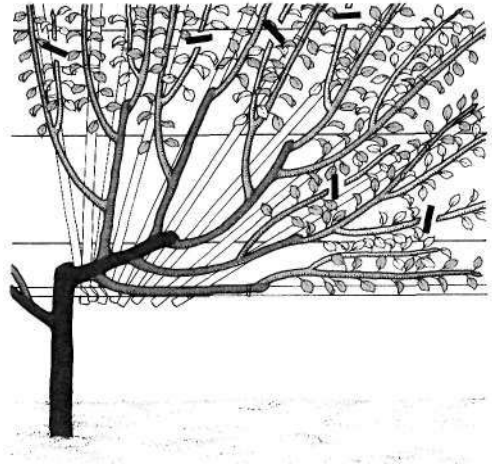


3 In spring, cut back all leaders to suitable buds, leaving 18-21 in of new growth.

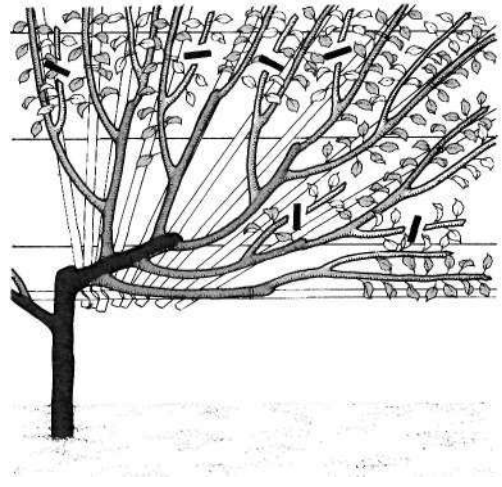
Fourth and subsequent years



'4 In spring, when most of the wall space has been filled, rub or cut out any breastwood or laterals growing directly towards the wall.



5 **In late July,** cut back to six leaves any laterals not wanted for the framework. When growth reaches the top of the wall, cut back to a weak lateral just below. Or, bend and tie down the shoots.



6 At the end of September, cut back to three leaves the laterals that were pinched out in July to encourage fruit buds to form at the base of the shoots in the following year.

Sour cherries

The sour cherry is a culinary fruit derived from *Prunus cerasus.* It is a hardy deciduous tree that is much less vigorous than the sweet cherry and can be grown in a small garden. There are two types of sour cherry: the Morello with dark red, almost black fruits and red juice; and the Amarelle, with red fruits and colorless juice. Both are self-compatible and can be planted singly in zones 4-7.

Cultivation

Usually grown as a small tree in the open, or as a fan on a wall, the sour cherry can also be grown as a central leader tree in pyramid form.

The sour cherry begins to bear fruit in its third or fourth year. A maiden tree can be planted but a few years are gained if a two- or three-year-old tree already partly shaped by the nursery is obtained.

Soil and situation Provided the soil is well drained, the sour cherry is tolerant of a wide range of soils but it prefers one that is neutral to slightly alkaline (pH 7.0).

The sour cherry flowers early in spring and so should not be planted in a frost pocket. It will tolerate partial shade and can be grown as a fan on a north-facing wall.

Planting and spacing Plant the tree when dormant in early spring. Prepare the soil and plant, stake and tie as for the sweet cherry (see page 62). Bush and central-leader trees should be staked for the first four or five years. For fan-trained trees, erect a support system of horizontal wires on the wall before planting. Use 14 gauge wire and stretch the wires at every 6 in or two brick courses (see page 9).

Space trees grown in the open 20-25 ft apart. Fans are spaced 12-15 ft.

Control weeds and grass by shallow hoeing or use weedkillers (see page 17). Leave a border of uncultivated soil around the tree.

Pruning the fan-trained tree

The formative-pruning and training is the same as for a peach fan (see page 67), taking care to cut the leaders back hard in the first three years of training so that a head with plenty of ribs arising close to one another is formed.

Pruning the cropping tree is based on the fact that the sour cherry fruits almost solely on the growth made in the previous summer. As with the peach, the aim is to obtain a constant supply of strong new shoots to carry the next season's cherries.

In spring and early summer, thin out the new shoots to about 4-6 in apart along the framework branches. Leave one replacement shoot at the base of each fruit-carrying lateral. Tie the young shoots to the wires while they are still flexible. Do not pinch out the growing points of the young shoots, but let them extend where there is room.

After harvesting in mid-summer, cut out the laterals that have fruited back to the young replacement shoots.

Some sour cherries are relatively weak growing and the fruiting laterals do not readily produce replacement shoots near the base. If these fruiting laterals are left unpruned and no replacements form, they become extremely long with the base and center of the fan bare and the crop carried only on the perimeter. When this happens, in March, cut out a proportion of the three- and four-year-old branches back to younger laterals to stimulate the development of new growth.

Pruning the bush and pyramid

The initial training for these forms is the same as for the open-centered bush and pyramid plum. The leaders are cut back in early spring as growth begins to establish the framework.

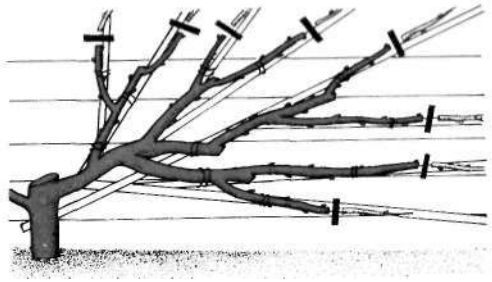
Mature trees bear fruit along young wood formed in the previous season. In March cut back a proportion of the older shoots to one-year-old laterals or young shoots so that the old growth is continually replaced.

As the trees become older, the center may become bare and unproductive. Each year after harvesting, cut back one-third of the main branches to within about 3 ft of the head to produce vigorous young replacement branches. Protect the cuts with a wound paint.

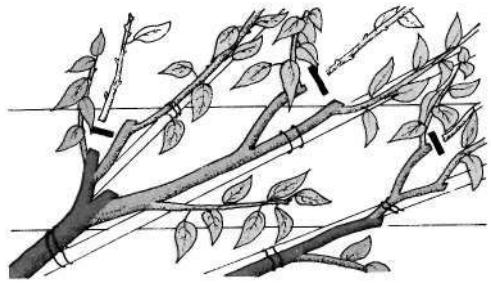
Routine cultivation

For feeding, watering, protection, thinning, harvesting, propagation, pests and diseases see Sweet and Duke cherries (pages 62-3).

Fan-trained tree

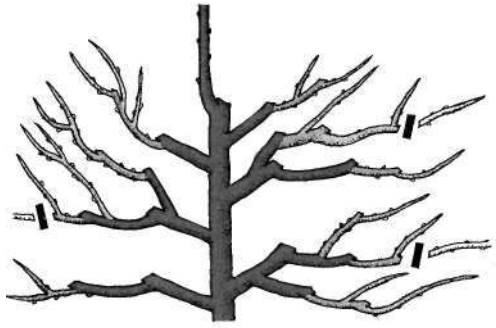


1 For the first three years, follow the eight steps for formative pruning of a peach fan (see pages 67-70), cutting the leaders back hard).



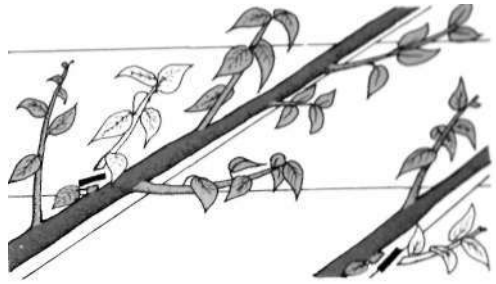
3 After harvesting, cut out the laterals that have fruited back to the young replacement shoots.

The mature tree



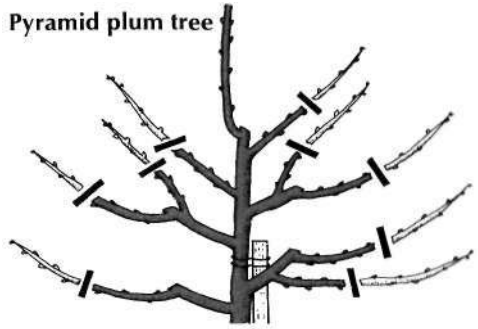
2 In March, cut back some of the older shoots to one-year-old laterals or young shoots to replace the older growth.

Fourth and subsequent years

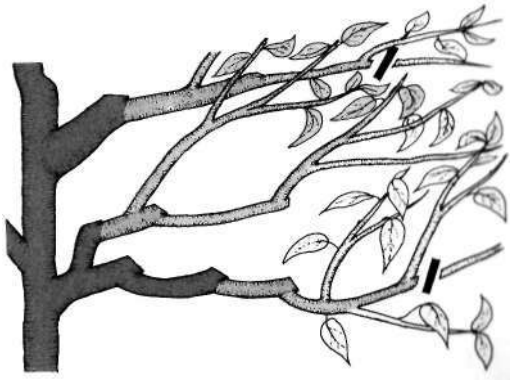


2 In **spring and early summer,** thin out new shoots to 4-6 in apart along the framework branches. Tie in young shoots to the wires.

Pyramid plum tree

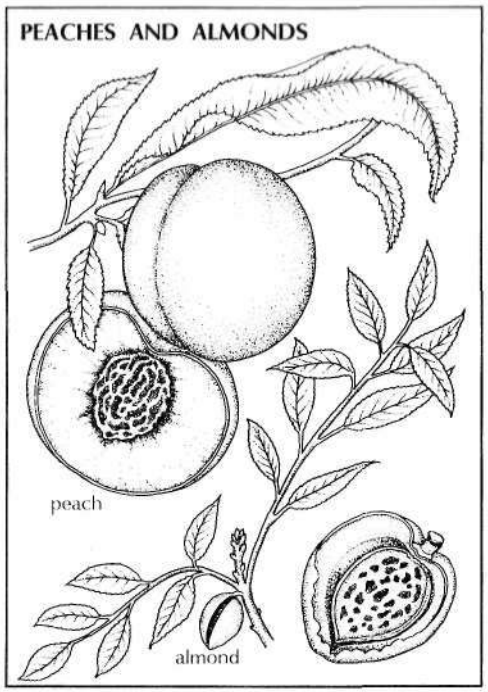


1 For the first three years, follow the steps for the initial pruning of a pyramid plum. **Cut** back the leaders in early spring.



3 After harvesting, if the tree is bare and unproductive, cut back one-third of the main branches to within 3 ft of the head,

Peaches and almonds



Peaches, nectarines and almonds (outdoors) The peach *(Prunus persica)* is a small deciduous tree with long, tapering light green leaves and attractive pink flowers borne singly in the early spring. Despite its name, the peach did not originate in Persia, but almost certainly in China where it was cultivated for many centuries before being introduced to Europe. The peach is grown throughout the warm temperate regions of the world (zones 6-8).

The nectarine is a smooth-skinned sport, or mutation, of the peach. Generally the fruits are smaller than peaches and often considered to have a better flavor. For most cultural purposes, however, it is treated in exactly the same way as the peach.

The almond tree is similar in size, habit, leaf form and flower to the peach, but it blossoms even earlier and therefore in cooler areas the blooms are frequently destroyed by frost or affected by cold. For this reason in northern latitudes (zone 7) it is grown largely for its beautiful blossoms. The almond tree is a reliable producer of nuts in zone 8 and especially in zone 9. It does best in the hot Sacramento and San Joaquin valleys of California.

Cultivation

The peach and the nectarine are self-compatible and single trees can be planted. The almond is only partly self-compatible and two or more varieties should be planted.

Yield The yield from a peach or a nectarine can vary enormously depending upon the size of the tree and the environment. A good average, yield from a fan is about 30 lb and form a bush 30-100 lb.

Soil and situation The peach is tolerant of a wide range of soils but it is essential that they are well drained. To improve the drainage of a heavy soil place brick and stone rubble and chopped sods in the bottom of the planting hole. The ideal soil is a medium to heavy, moderately limey loam, not less than 18 in in depth with a pH of 6.7-7.0.

The peach is quite hardy, preferring a cold winter and a sunny dry spring rather than a warm, wet winter which causes the buds to open only to be damaged by subsequent frosts. The site must be in full sun and sheltered from cold winds and ideally not in a frost pocket. The peach flowers very early so it is ideally grown as a fan on a wall or fence with a southerly aspect where it can be protected against frost at flowering time and benefit from the warmth of the structure. When planted in the open, as it generally is, the peach can be placed on a northern slope or the north side of a building so that it will bloom late after frost danger is past.

Soil preparation Where there are poor soils at the base of a wall, it is worth while preparing the border specially (see page 44).

On good soils, however, it is sufficient to fork in a balanced fertilizer such as 10-10-10 at the rate of 3 oz per square yard with bonemeal at 3 oz per square yard over an , area of two square yards.

Selecting the tree For a tree to grow in the open buy a well-feathered maiden tree. For a fan obtain a fan that is already partly formed. Choose one with 5-12 shoots (depending upon the age of the tree) that are evenly spaced to form the first ribs of the fan.

Planting Plant during the dormant season, usually in March or April. If planting a container-grown tree, it can be planted generally at any time. In the prepared soil, dig a hole wide and deep enough to take the roots fully spread out. Plant the tree to the same depth as it was at the nursery. Give each tree grown in the open a space of about 20 ft in diameter.

A fan must be planted 6-9 in away from the wall or fence to allow for growth, with the stem inclined slightly towards its support structure (see page 44).

After planting, apply a 2-3 in mulch of well-rotted manure, compost, peat or mushroom compost for 18 in around the tree.

A system of horizontal wires is necessary to support the fan. Fix the wires to the wall or fence every 6 in or two brick courses apart, starting at 12 in above the ground (see pages 8-9). Tie canes to the wires where needed with thin wire.

Pruning and training

Stone fruits such as the peach are pruned in late winter or early spring.

The fan-trained tree

The first year In March, starting with the feathered maiden tree, cut back to a lateral at about 24 in above the ground, ensuring that there are two good buds, or laterals, beneath it, one to the left and one to the right. Cut all remaining laterals to one bud. If there is not suitable lateral, cut back to a wood bud which is slender and pointed. If in doubt, cut to a triple bud which consists of two round flower buds and one wood bud.

In the early summer select three strong shoots. Train the topmost shoot vertically and of the other two, train one to the left and one to the right, choosing those that come from just below the bottom wire. Remove all other buds or shoots entirely.

As the two side-shoots lengthen, tie them to canes at an angle of 45 degress. When both these shoots are about 18 in long, in June or July, cut out the central shoot entirely. Protect the wound with a wound paint to prevent disease or pest infection.

The second year In March, cut back the two side-shoots to a wood or triple bud at 12-18 in from the main stem. I his will induce new shoots in the coming summer. Protect the cuts with wound paint.

In summer, select four strong shoots from each arm. One to extend the existing rib, two equally spaced on the upper side and one on the lower side of the branch to give the tree a total of eight ribs by the end of the season. Pinch back all other shoots as they develop to one leaf.

Carefully train each new shoot to a cane to extend the wings of the fan. Keep the center open at this stage.

The third year In March, shorten each leader by about one-third, cutting to a downward-pointing wood bud. Paint the wounds.

In the summer, allow the leading shoot on each of the eight ribs to extend. Also select three more shoots on each branch and train these outwards, tying them to canes on the wires, to fill in the remaining space on the wall or fence. Rub out buds growing directly towards the structure and breastwood. Of the remaining buds, allow young shoots to grow every 4 in on the upper and lower sides of the ribs. Pinch back to one leaf any surplus shoots. Repeat this process as and when necessary throughout the summer. When the selected laterals have made 18 in of growth, pinch out the growing points, unless they are required as part of the framework. In late summer tie them to canes on the wires. Fruit will be borne on these laterals in the following summer.

Fourth and subsequent years From this point onwards the tree must be regarded as a cropping tree. The wall or fence should now be more or less completely covered with framework branches on which every 4 in are fruit-bearing laterals.

The peach carries its fruits on shoots made during the previous summer so pruning is aimed at a constant and annual renewal of young shoots. It follows also that the shoots which have borne fruits are cut out to make room for the new young ones.

Each late spring, about May, remove shoots growing directly towards and away from the wall or fence but leave one or two leaves or shoots which have flower buds at the base. Next deal with the previous summer's laterals which should be carrying both blossom and

Peaches and almonds

side-shoots. Select one side-shoot at the base as the replacement, one in the middle as a reserve and one at the top to extend the fruit-carrying lateral. Pinch back the remaining side-shoots to two leaves. When the basal side-shoot and the reserve lateral are 18 in long and the fruit-carrying lateral has a further six leaves, pinch out the growing points of each.

Pruning the standard tree The formative pruning is the same as for an apple (see page 47).

In the cropping years the objective is to encourage plenty of strong new growth each year to carry fruit in the next summer. This new growth is then cut back 50 per cent or more in the early spring of the year if it is to bear fruit. Long branches at the top of the tree should be removed at the same time. It is occasionally necessary to cut back some of the older wood which has become bare to young healthy replacements. Avoid, however, making large wounds because peaches are susceptible to bacterial canker.

Feeding and watering In early spring each year apply a balanced fertilizer such 10-10-10 at the rate of 3 oz per square yard as a top dressing over the rooting area. Replenish the mulch if necessary.

Trees over the age of three years need nothing more than nitrate of soda or ammonium sulfate unless a soil test indicates the soil has a potassium or phosphorus deficiency.

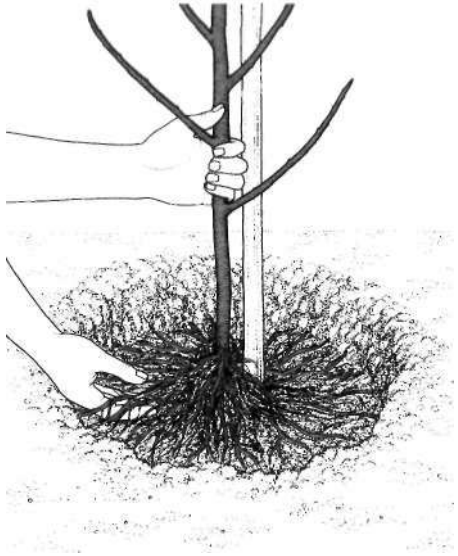
Keep the soil moist at all times until just before the fruit begins to ripen. Ample water is essential to good production. But it is also important to keep the tree accustomed to moist soil conditions at all times. In other words, do not suddenly apply a lot of water near ripening time because there is the risk of splitting the fruits. Because the soil at the base of a wall tends to dry out rapidly, fan-trained peaches must be watered with special care. Direct water at the base of the tree so that moisture gets to the roots. Do not wet the foliage.

Frost protection

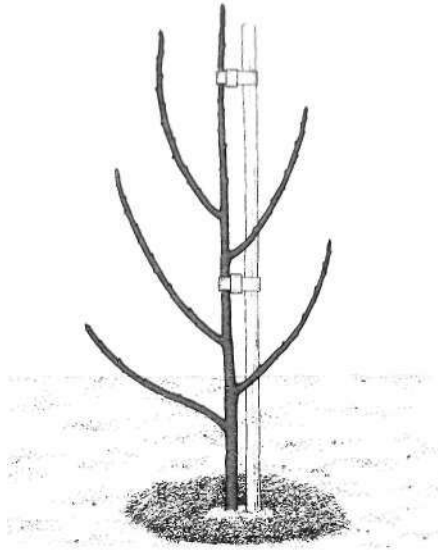
Protection of the blossom against frost is also essential from pink bud stage until the danger of frost has passed. Drape the fan-trained tree with burlap or bird netting (see page 17). Remove during the day.

Planting

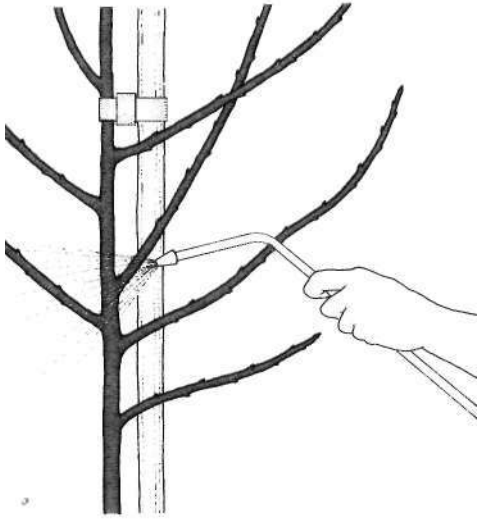
1 Before planting, fork in 3 oz per square yard of a balanced fertilizer, such as 10-10-10, with 3 oz bonemeal. Repeat every March.



2 In March or April, plant during the dormant season. A fan should be 6-9 in away from the wall or fence with the stem inclined towards it.



3 After planting, mulch to a depth of 2-3 in with manure or compost for 18 in around the tree. Replenish every year in late winter.



4 In March, spray with a copper fungicide or Bordeaux mixture against peach leaf curl. Also spray with dormant oil.

Thinning

5 **From early May to July,** thin the fruits, starting when they are the size of large peas.

Harvesting

6 From August onwards, pick the fruit when the flesh feels soft at the stalk end. Hold the fruit in the palm of the hand, lift and twist it slightly.

Peaches and almonds

Thinning

To obtain good-sized fruits it is essential to thin the fruits. Thin over a period, starting when the fruitlets are the size of large peas and stopping when they are the size of walnuts. Peaches should be 9 in apart and nectarines 6 in apart after the final thinning.

Harvesting peaches and nectarines

The fruit is ripe when it has a reddish flush and the flesh feels soft near the stalk end. Hold the peach in the palm of the hand, lift and twist it slightly. It should part easily from the tree. Store the fruits in a cool place until they are to be eaten. They will keep for only up to a week and for long-term storage they must be canned or frozen without the stones.

Pruning the fan-trained tree after harvesting

Immediately after cropping, not later than the end of September, cut out the laterals which carried the fruits back to the replacement shoots. Tie in the young shoots and cut out any dead or broken branches.

Once the peach has reached the required height and spread, remove any unwanted extension growth by cutting to a lateral further back along the branch. Cut out bare wood back to strong young replacements. Protect the wounds with a wound paint.

Harvesting and storage of almonds

Harvest the nuts when the husks split and the nuts fall naturally. Remove the nuts from the husks and dry them thoroughly in well-ventilated conditions: in sunshine is ideal, or in an airing cupboard. Keep the nuts off the ground by laying them on wire netting to allow air circulation. Once dry they should be kept in cool and dry conditions.

If squirrels are troublesome, harvest the nuts slightly earlier and dry both husk and nut initially before splitting them open.

Propagation

Peaches, nectarines and almonds are propagated by budding or grafting, a task normally carried out by the nursery, but it can be performed by the keen amateur.

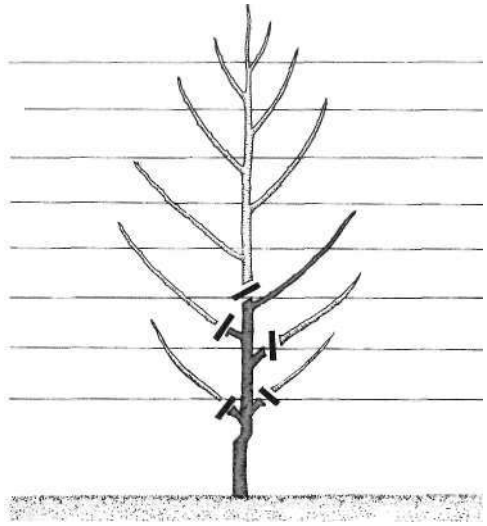
Pests and diseases

Peaches and nectarines are attacked by a number of diseases and insects but this need not cause worry if a consistent spray program is followed faithfully. A dormant oil can be sprayed on in late winter. Then, after about 75 per cent of the petals have fallen, apply a general fruit-tree spray and continue with this at about two-week intervals for the next wo months, or even up to within a month of harvest. Such treatment will take care of most problems.

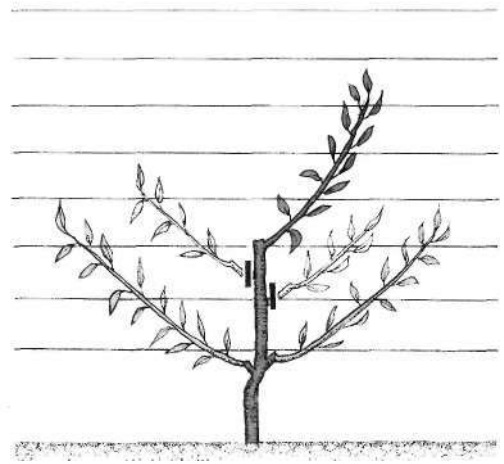
To control brown rot, especially troublesome on nectarines and, in some years, just about as bad on peaches, spray with captan. Do this every three days if there is a spell of hot, humid weather at the time of bloom. Captan spraying can also be carried out in the three-week period prior to harvest as well as during a hot and humid spell.

Leaf curl causes first leaves to thicken and curl as well as tinting them red and yellow. To control this, apply a liquid copper fungicide before the buds open in the spring. Bordeaux mixture can also be employed, and, if so, it is mixed and applied with dormant oil. Almonds require regular spraying with a general-purpose fruit spray.

The fan-trained tree: the first year

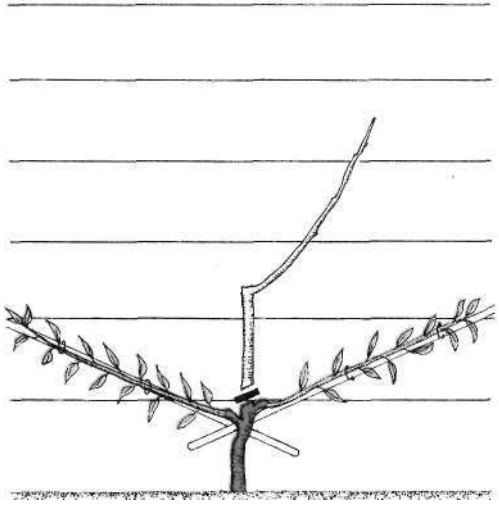


1 In March, cut back a feathered maiden peach to a lateral about 24 in above the ground, leaving one good bud on each side beneath it. Cut remaining laterals to one bud.

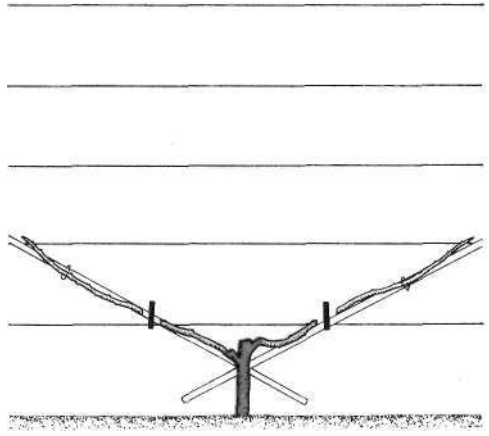


2 In early summer, select three shoots. Train the topmost vertically, and one to the left and one to the right. Remove all other buds or shoots.

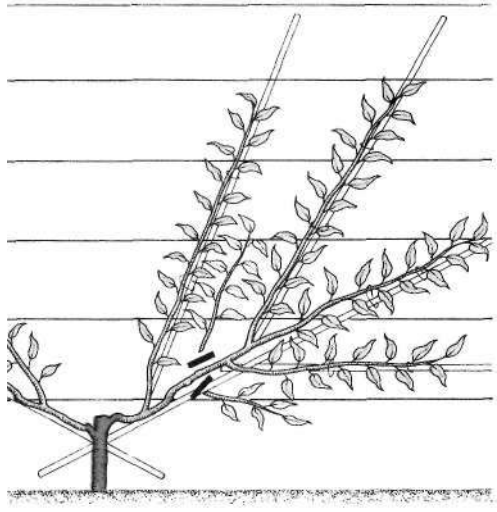
The second year



3 In June or July, tie the lengthening side-shoots to canes set at an angle of 45 degrees. Later that summer, cut out central shoot and protect cut with wound paint.



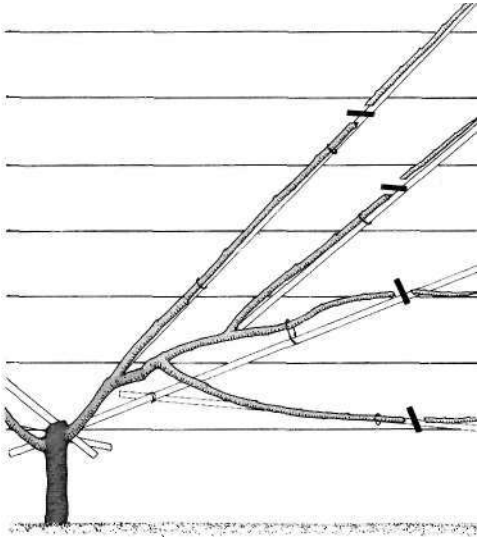
4 In March, cut back the two side-shoots to a wood or triple bud at 12-18 in from the main stem. Protect the cuts with wound paint.



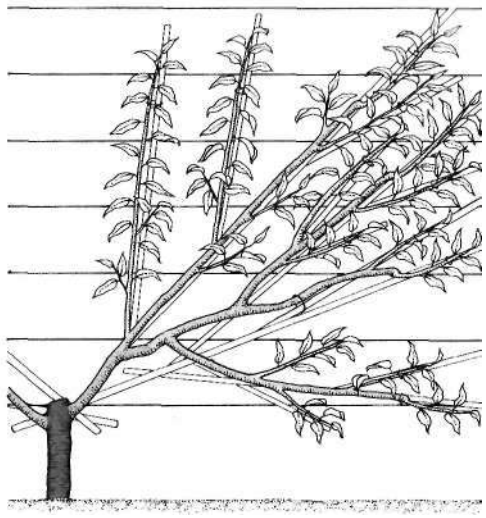
5 In summer, select four shoots on each arm, one to extend the existing rib, two spaced equally on the upper side and one on the lower. Stop other shoots at one leaf.

Peaches and almonds

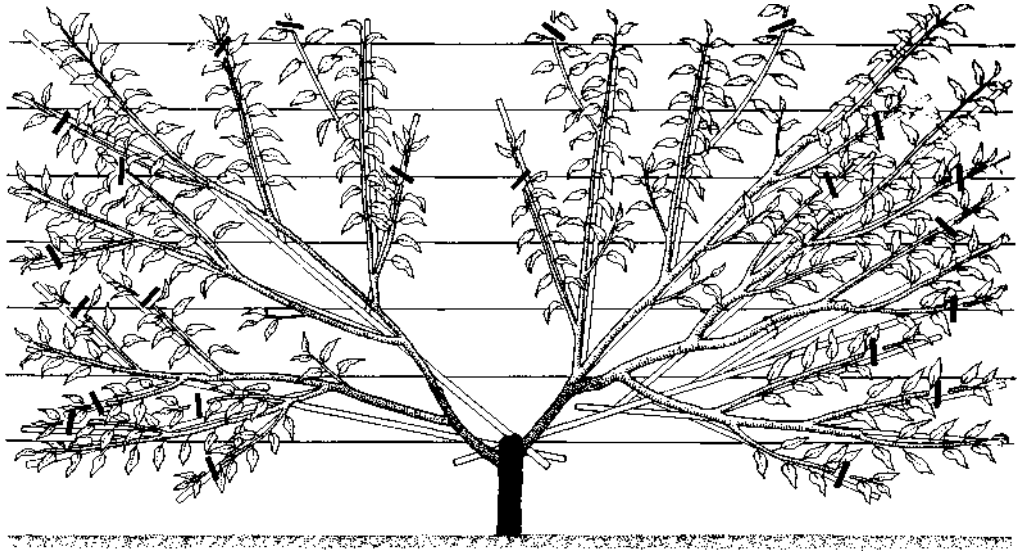
The third year



6 In March, shorten each leader by one-third by cutting to a downward-pointing wood bud. Protect the cuts.

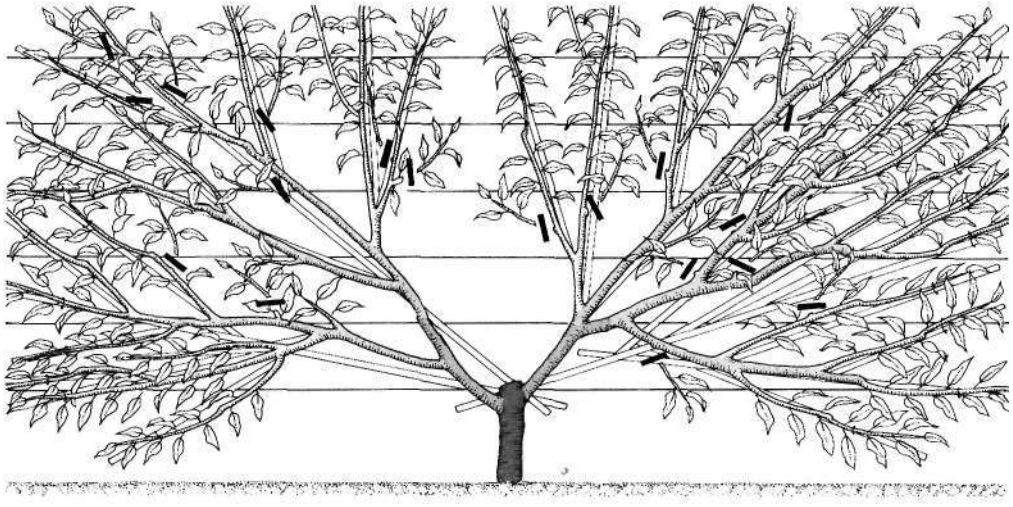


7 In summer, allow the leading shoots on each rib to extend. Train three shoots on each branch outwards, tying them to canes. Allow shoots to grow every 4 in.



8 In late summer, when the selected laterals have made 18 in of new growth, pinch out the growing points of each and tie them to canes on the wires. These laterals will bear fruit the following summer.

Fourth and subsequent years



9 Each year in about May, remove shoots growing directly towards and away from the wall or fence. Leave shoots with flower buds at their base one or two leaves.

10 Select two replacement laterals on each leader: one at the base and a reserve in the middle. Allow a lateral to extend the fruit-carrying lateral. When the basal and reserve laterals are 18 in long and the extension has six leaves, pinch out the growing points. After harvesting, cut the fruited laterals back to their replacements.

Apricots

The apricot *(Prunus armeniaca*) is a hardy deciduous tree. It is a native of China and is widely grown in California and Washington, but can be raised successfully elsewhere in zones 5-8.

Cultivation

A dwarf tree is best for the garden where space is limited. Even this can reach a height of 8 ft and a span of 15 ft. Buy a two- or three-year-old tree.

Soil and situation The apricot needs a well-drained but moisture-retentive and slightly alkaline soil with a pH range of 6.5-8.0. Light, sandy soils are not suitable.

Warmth in summer is essential and, although the apricot can be grown in the open in warm temperate areas, it thrives best fan-trained against a south- or west-facing wall in the cooler regions. It can also be grown successfully in containers.

Shelter the tree from frost and wind to encourage pollinating insects and to protect the ripening fruit. Keep the soil around the tree clear of weeds and grass so that ample moisture can reach the roots.

Planting In all but the mildest climates, where fall planting is safe, apricots should be planted only in the spring. To prepare the ground, clear away perennial weeds over an area 3 ft square. Dig in well-rotted manure or compost at a rate of one 2-gal bucketful per square yard. Plant the tree, water well, and mulch lightly.

Plant fan-trained trees 15 ft apart and 6 in from the wall or fence. Plant bush trees 15-20 ft apart.

Formative pruning and training The formative pruning of the fan-trained apricot is the same as that of the fan-trained peach. The formative pruning of the bush apricot is the same as that of the bush plum, but prune it in early spring before growth begins.

Pruning the croppingtree Mature fan-trained apricots are pruned in the same way as are fan-trained plums. Mature bush apricots are pruned in the same way as sour cherries (see page 64).

The apricot carries the best quality and most abundant crops on short spurs on two- and three-year-old wood. Extensive pruning is not necessary because it results in a poor crop. Every four to six years, cut out the older shoots that have fruited to make room for new young ones. This means cutting out some of the lateral and sub-lateral branches of a fan-trained tree. Retain and tie in the same number of new shoots to replace them. Do not prune or pinch back these shoots until the second season, but only if required.

Thinning Thin the fruits at intervals from the time they are the size of cherries until they are almost full size. First remove misshapen fruits and those growing towards the wall. Later, thin pairs and clusters so that those left to ripen have 3-4 in between them.

Feeding Root dryness is a common problem with wall-trained trees. Water generously until the root area is soaked, especially if the weather is dry when the fruit is setting or when it starts to swell.

In late winter, sprinkle an artificial fertilizer containing calcium carbonate and ammonium nitrate around the tree at a rate of 1 oz per square yard and apply a general fertilizer, such as 10-10-10, at a rate of 2 oz per square yard. Every four years, if necessary, apply ground limestone to maintain the pH at a little above 7.0. In late spring, mulch the root area to 1 in.

Pollination Most apricots are self-compatible but, because the flowers open early in spring when few insects are about, hand pollination is sometimes necessary (see page 43). The new and very hardy 'Moongold' and 'Sungold' are not self-fruitful and must be planted together.

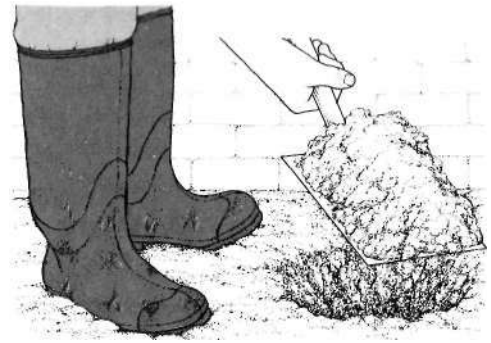
Protecting the blossom The apricot is highly susceptible to frost damage. Protect it with polyethylene or netting (see pages 6-7).

Harvesting

Depending on the variety, apricots ripen from midsummer to early fall. Pick the ripe fruit carefully and try not to break the skin.

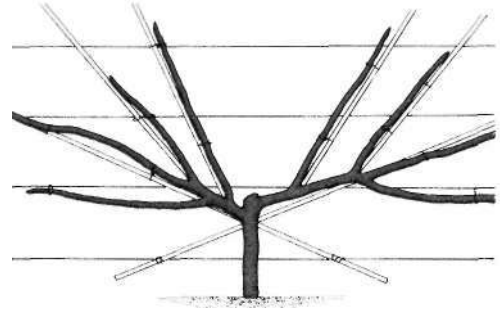
Pests and diseases

Spray trees on the same schedule and with the same materials as peach trees. The trees are very susceptible to brown rot if the weather is humid and warm at the time of bloom and in the three weeks before harvest starts. To control this, spray frequently with captan during these periods.



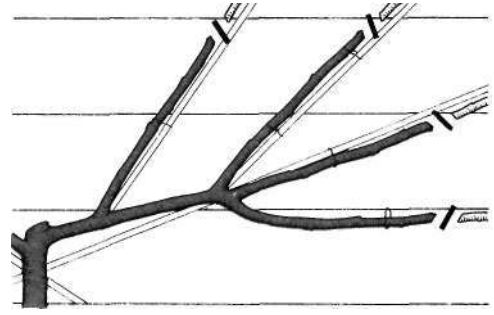
1 In early spring, in prepared ground dig a hole large enough for the roots. Plant at the same depth as at the nursery. Mulch well.

A three-year-old fan-trained tree

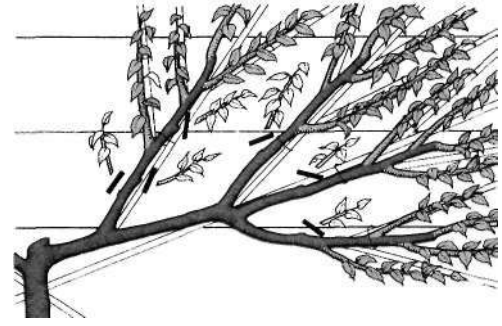


2 Erect supporting horizontal wires 9 in apart on the wall or fence. Tie in the young branches to the canes on the wall wires.

The first year

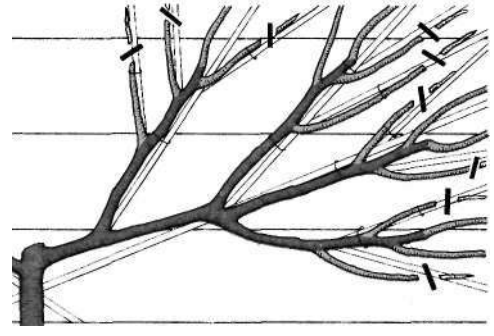


3 In March, shorten each leader by one-third, leaving about 30 in of growth.

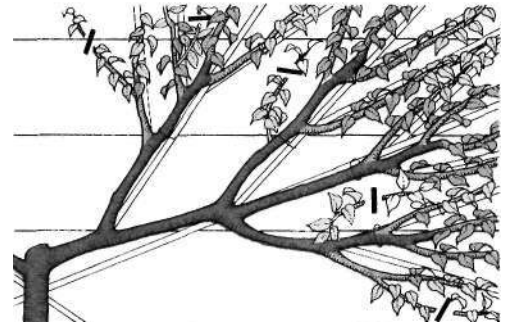


4 In July/August, select and tie in three additional shoots from each pruned leader. Pinch out all remaining shoots.

The second and subsequent years



5 In spring, rub out buds pointing towards or away from the wall or fence. Prune the leaders by one-quarter.



6 Early in July, pinch off the tips of side-shoots at six leaves. After cropping, cut back these laterals by one-half.

Mulberries

The common or large black mulberry *(Morus nigra)* is a deciduous tree native to western Asia. In the United States it grows from zone 6 southward. The red-black fruits resemble loganberries and have a sharp but sweet flavor particularly suitable for cooking.

Cultivation

The mulberry is long-lived and decorative. It is self-compatible and so will fruit if grown as a single plant. When mature it reaches a height of 20-30 ft.

Soil and situation The mulberry is tolerant of a variety of soils but thrives best planted in rich, fertile well-drained but moisture-retentive soil with a pH of 5.5-7.0.

It should be planted in a sheltered, warm and sunny position. In the coldest areas it is best grown against a south-facing wall or fence.

Planting In early spring prepare the ground thoroughly, clearing away perennial weeds over an area 3 ft square. For planting in the open, drive in a stake to reach just below the lowest branches. For wall- or fence-trained trees, construct a system of supporting horizontal wires, spaced every 9 in (see pages 8-9).

Dig a hole wide and deep enough to take the roots fully extended. The roots are brittle and so take care not to damage them at planting. Never dig near a mulberry tree.

Plant the tree to the same depth as in the nursery, spreading the roots out well. Return the soil and firm it carefully. Tie the tree to the stake with a tree tie and cushion. For wall-trained trees, tie in the branches to the wall wires. Water well and mulch with well-rotted manure or compost.

Pruning and training The mulberry is slow growing, taking eight to ten years to begin cropping, so a three- to five-year-old tree already shaped at the nursery is best.

Prune mulberries grown in the open in winter. Cut back to four or five buds any strong laterals longer than 12 in that are not required as framework branches. Remove or shorten any which spoil the shape of the head. Protect the cuts with a wound paint.

Prune wall-trained mulberries in summer. Train in the main branches 15-18 in apart to cover the wall. Tie down the leaders at the end of the summer and once they have reached the required length stop them by cutting back each leader to one bud on the previous year's growth in April. Prune side-shoots to four or five leaves in late July to encourage fruit spurs to form.

The branches of mature trees become crooked and brittle and may need supporting with a forked stake. Wrap the branch with burlap where it meets the crotch.

Watering and feeding Watering is necessary in extremely dry weather.

In April, apply a balanced fertilizer, such as 10-10-10, at a rate of 2 oz per square yard. In spring, mulch with well-rotted manure or compost.

Propagation

Propagate from cuttings. In early October, after leaf-fall, remove a one-year-old stem with all the year's growth. Make a sloping cut just above the proposed top bud and a horizontal cut about 6 in below it. Dip the basal cut only in rooting hormone. Heel in several cuttings, in bundles of ten, into a sandbox almost to their full depth. Label them and leave for the winter.

Just before the dormant buds break in spring, dig the propagation bed thoroughly. Make a furrow 5 in deep. Lift the cuttings and plant vertically 4-6 in apart. Firm back the soil leaving about 1 in of the cutting exposed. The following fall, lift and transplant the rooted cutting.

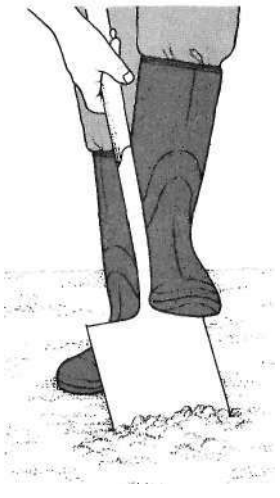
Harvesting

The fruit ripens from late August over a period of about three weeks. Pick fruit for cooking when it is slightly unripe. Fruit for eating is almost black.

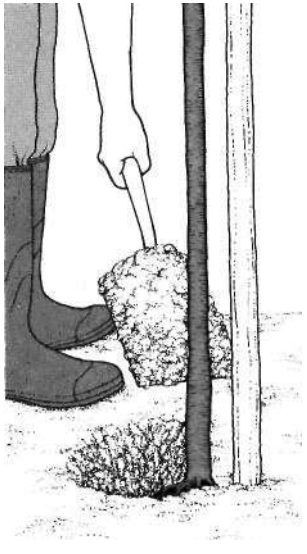
Pests and diseases

The mulberry is generally free of pests and diseases but protect the ripening fruit against birds (see page 17).

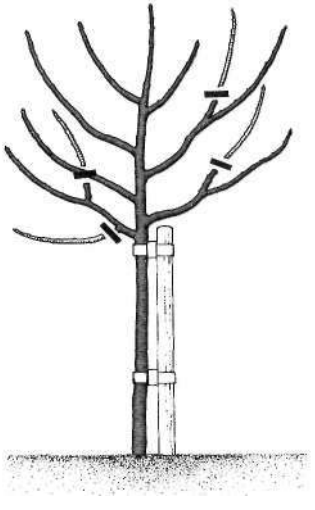
Trees in the open



1 In spring, clear the ground of perennial weeds. Dig a hole wide and deep enough to take the roots. Drive in a stake.

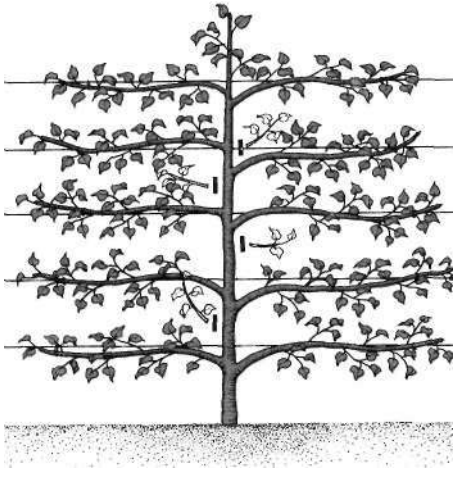


2 Plant the tree, spreading the roots out. Return and firm the soil. Tie the tree to the stake. Water well. Mulch with manure or compost.

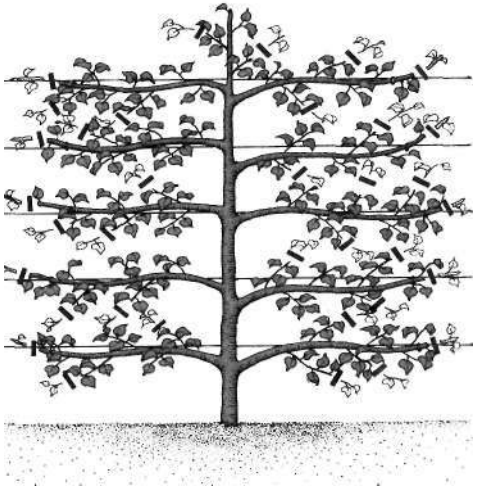


3 **In winter,** cut back to four or five buds laterals longer than 12 in not required for the framework. Cut out branches spoiling the head.

Wall-trained trees



1 In summer, train in the main branches 15-18 in apart. Tie down the leaders at the end of summer. Cut out breastwood and any branches growing into the wall.



2 In April, once the leaders have reached the required length, stop them by cutting back to one bud on the previous year's growth. In late July, prune the side-shoots to four or five leaves.

Elderberries

The common elder (.Sambucus *nigra)* is a deciduous tree native to Europe, western Asia and parts of northern Africa and now grows wild over much of the USA and Canada. The shiny purple-black blue or red berries are widely used in preserves, and both the fruit and flowers are popular for making wine. The plant grows as a large shrub or small tree and is often considered too wild and vigorous for the garden. Its new woody growth gives off an unpleasant smell and was used in the past as a fly-repellent. In the northern USA, the American or sweet elder (5. *canadensis)* is widely grown and several improved clones are available. They have an extremely high Vitamin C content. Depending on the variety, they grow from zones 3-9, but are not common in zones 5-8.

Cultivation

Only elders with black berries are grown for their fruit. The red-fruited kinds are inedible.

Soil and situation The elder is tolerant of a wide variety of soils, including those with bad drainage, and a wide range of soil pH. It is lime-tolerant.

The elder will grow in most situations but it fruits most freely in a sunny position. Common elder is hardy to zone 6; *S. canadensis* in zone 3.

Planting The elder may be grown as a standard on a single stem but it is more usually grown as a large rounded bush with a number of branches from near ground level.

Plant a one- or two-year-old tree in early spring. Four weeks before planting prepare the ground, clearing away perennial weeds over an area 3 ft square. Fork in a balanced fertilizer, such as a brand of 10-10-10 at a rate of 3 oz per square yard.

Dig a hole wide and deep enough to take the roots fully extended. For standards, drive in a stake to reach just below the lowest branches. Place the plant in the hole at the same depth as at the nursery and then fill in the soil gradually, firming it at the same time. Tie the standard to the stake with a tree tie and cushion. The bush does not need staking.

The American elder is not self-compatible. For cross-pollination to occur there should be a minimum of two varieties, planted about 10ft apart.

Pruning After planting, cut out weak and damaged growth and cut back main shoots by a few inches to a good, outward-facing bud. This ensures that during the first growing season the plant's energy is concentrated on producing a strong basic framework of branches. Cut back any unwanted suckers to ground level. Little flower is produced in the first year.

In subsequent years, in late winter, cut out dead and congested branches to maintain a good shape. Cut out about a quarter of the old wood back to base each year to encourage new growth. Cut back unwanted suckers to ground level and protect the cuts with a wound paint.

Feeding In dry spring and summer weather water well and mulch the root area with well-rotted manure or compost. If growth is weak or slow, feed with a balanced fertilizer at a rate of 2 oz per square yard.

A 5-20-10 balanced fertilizer or ammonium nitrate can be applied each spring. Ammonium nitrate may be applied at 1 oz per year of shrub age up to a maximum of 16 oz, and 5-20-10 fertilizer at 16 oz per year up to a maximum of 64 oz.

Propagation

In late October take a 9-12 in cutting from a sturdy one-year-old stem. Plant in open ground 6 in deep. Alternatively, in July, take 4-6 in cuttings of semi-hard wood stems. Insert them 2 in deep in a cold frame 4-6 in apart. In October in the following year, lift the rooted cuttings and re-plant them in a permanent position.

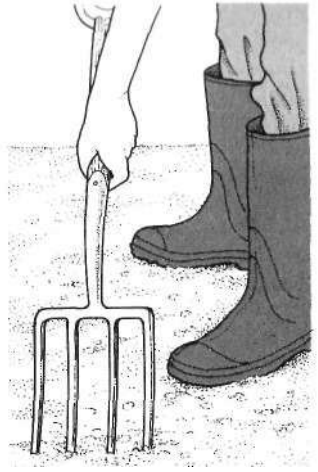
Harvesting

Pick fruits when dark in color with a noticeable bloom. It is preferable to use them as soon as possible, but they will keep in a refrigerator for about two weeks.

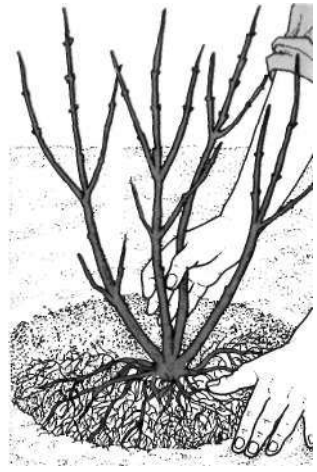
Pests and diseases

The elder is generally free of pests and diseases, except for the elder borer, which deposits its eggs under the bark of old canes. This pest can be controlled by burning annual prunings. If mites become troublesome, spray with a miticide. Plants may need to be netted to keep off birds.

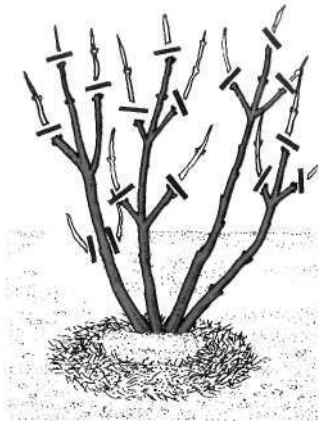
The first year



1 Four weeks before planting, clear away weeds over an area 3 ft square. Fork in a general fertilizer at 3 oz per square yard.



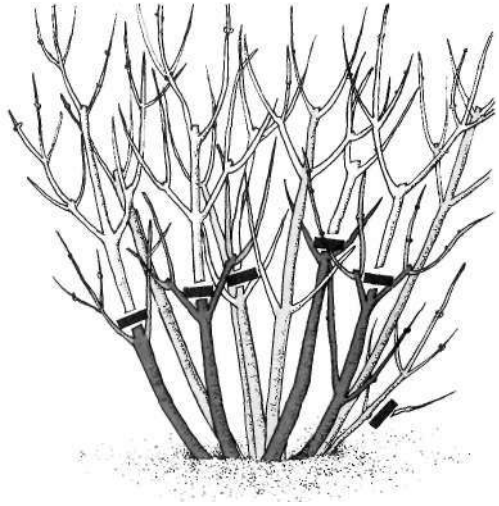
2 In spring, plant the elder at the same depth as it was in the nursery, spreading the roots out. Firm the soil. Water well.



3 **After planting,** cut out all weak growth and cut back the main shoots a few inches to a good outward-facing bud. Mulch well.

Second and subsequent years

4 In April, if growth is slow, feed with a balanced fertilizer at a rate of 2 oz per square yard.



5 **In winter,** cut out dead and congested branches. Cut out about a quarter of the old wood back to base. Seal the cuts with a wound paint.

Quinces

The true quince *(Cydonia oblonga)* is a native of central to south-western Asia. It has been cultivated since ancient times. It is related to the pear, for which it is often used as a rootstock to induce a more dwarfing effect on the vigor of the pear tree. The true quince is often confused with its distant relatives the oriental quinces *(Chaenomeles* spp), referred to as "Japonicas", which are grown as garden shrubs. "Japonicas" have light pink to deep red flowers, spines and edible fruits.

The true quince is a low, deciduous, thornless tree with a crooked irregular mode of growth. When fully grown it is about 15 ft in height and spread, although it can be half as tall again on fertile soils. It may also be grown as a fan against a warm wall in much the same way as a pear. This method is particularly suitable for more northerly areas where it would not thrive in the open.

The tree's natural form is attractive and it can serve an ornamental purpose in the garden. It often lives to a great age and, once established, requires little attention. It comes into cropping in the fourth to fifth year. The flowers are large (1 1/2–2 in), solitary, white to very light pink and most attractive, resembling the wild dog-rose. It has a pale grey bark and dark green oval leaves with downy white undersides.

Quince fruits are apple- or pear-shaped, mostly with a grayish-white down on the skin; when ripe they are pale or deep, clear, golden-yellow. The flavor is acid and astringent, and the texture rather gritty—they are too harsh, in fact, to be eaten raw when grown in northern climates. When grown in warmer, sunnier areas (such as Turkey), the fruits become much sweeter and are eaten raw. Quinces are not grown commercially in cool temperate areas, but they can be cultivated fairly easily by the amateur, providing an interesting alternative to the more conventional tree fruits.

Quinces make a delicious orange-colored jelly, marmalade or preserve; and a slice or two of quince in an apple pie provides a subtle aromatic taste to the dish.

Cultivation

The tree is hardy in zones 5-8, but, as mentioned above, warmth is necessary for the fruits to ripen properly. Quinces can be raised from seed but this is a lengthy process so buy a plant from a nursery or garden centre and ask advice.

Soil and situation The quince succeeds in most soils but grows best in a deep, light fertile and moisture-retentive soil.

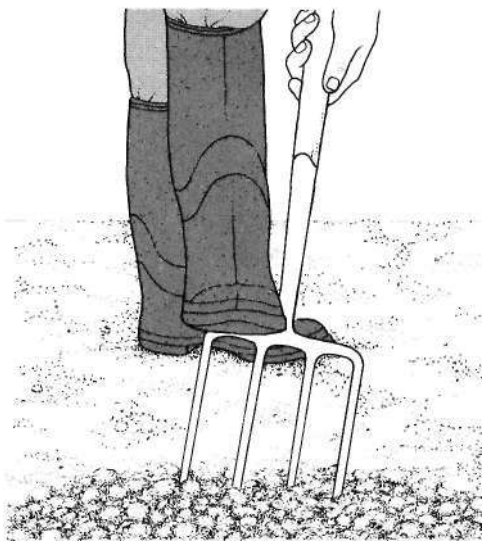
It does well planted near a pond or stream. In warmer areas, it can be grown in the open, but in a sunny, sheltered position. In more northerly areas, extra protection is needed, the best situation being a sunny corner where two walls meet, with the plant grown as a fan or bush tree.

Planting and spacing Since it grows rather crooked, the quince tree needs support for the first three or four years of its life until the stem has acquired sufficient strength to support the head.

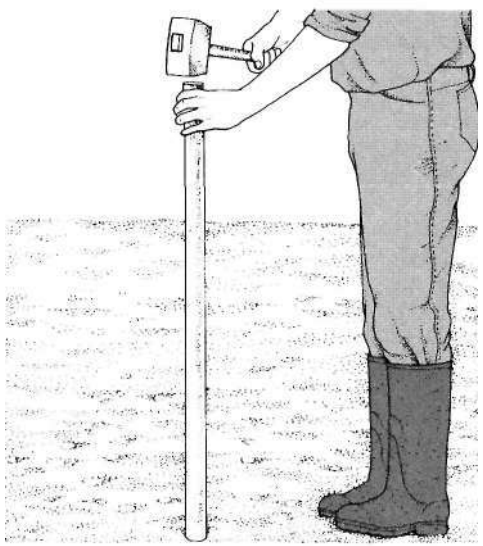
Plant in early spring during the dormant period. Container-grown plants can be planted at any time of the year. Prepare the ground thoroughly in the fall before planting, clearing away perennial weeds over an area 3 ft square. Fork in 4 oz per square yard of a balanced fertilizer such as 10-10-10 and a

Planting the tree

1 Between November and March, prepare the ground, clearing away perennial weeds over an area roughly 3 ft square. Choose the planting position carefully.



2 Fork in 4 oz of a balanced fertilizer such as 10-10-10 and a handful of bonemeal over the area where the tree is to be planted.



3 **Prepare a stake** by coating it with bituminous paint. Drive it about 1 1/2–2 ft into the ground. Be sure it is not loose.

4 Dig the planting hole deep and wide enough to accommodate the tree's whole root system with tendrils well spread out.

Quinces

handful of bonemeal. Drive the supporting stake in first so that it will just clear the lowest branches. Dig a hole deep and wide enough to take the whole root system with the roots spread well out. Plant with the main stem about 2 in away from the stake and the tree at the same depth as it was in the nursery, ensuring that the union between the root-stock and scion (grafted stem) is not less than 4 in above soil level. Firm the soil well. Tie the tree to the stake with a tree tie and cushion.

Dwarf trees should be spaced about 10-12 ft apart, semi-dwarfs at about 15 ft, and standards about 20 ft apart.

Pruning and feeding The quince is a difficult tree to train in the first year, and so it is best to obtain a tree already partly shaped by the nursery. Buy a two-year-old for a dwarf tree or a three-or four-year-old for a standard or semi-dwarf.

The aim is to achieve a goblet-shaped tree with an open but by no means barren center. Prune during winter for the first three or four years by cutting back the leaders of the main framework branches by one-half the previous summer's growth, to an outward-facing bud. Prune back to two or three buds any side shoots that compete with the leaders and those crowding the center. Leave other side shoots unpruned to fill in the framework where there is room. Twist off any suckers around the base and cut off unwanted shoots on the main stem back to their point of origin. After the fourth year, little pruning is necessary apart from the removal of shoots that cause crowding, low-lying branches, or suckers at the base. The quince bears its fruit on spurs and on the tips of the previous summer's growth, therefore prune only to keep the head tidy. Cut back any vigorous or badly placed laterals but do not prune every lateral otherwise a large number of fruit buds will be lost.

Each March apply a general fertilizer such as 10-10-10 at 3 oz per square yard, and in early April apply sulfate of ammonia at 1 oz per square yard. On poor soils, mulch the trees in the early spring with well-rotted manure or compost. Maintain a weed-free area over an 18 in radius around the base of the tree.

Harvesting and storing

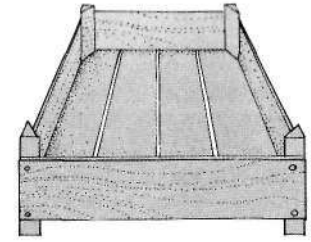
The fruits should be left on the tree as long as possible to develop their full characteristic flavor, provided there is no danger of frosts. They usually ripen from the middle of September on, depending on the locality. Once gathered, they should be stored in trays or apple boxes in a cool dark place and allowed to mellow for about a month before use. Quinces are strongly aromatic and should be stored by themselves because their aroma will affect the taste of any other fruits stored in the same container.

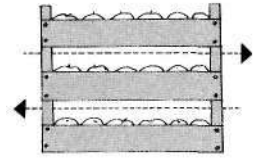
Pests and diseases

Many of the insect pests such as aphids, codling moth, slugworm and various caterpillars that attack apples and pears also attack quinces. If these pests prove troublesome, a spray program similar to that for apples and pears may be used.

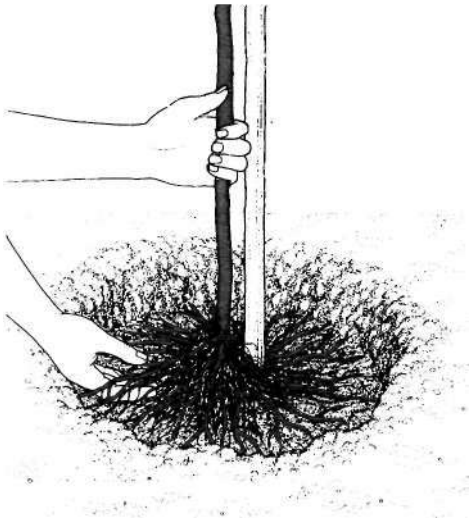
The only diseases that may occur are leaf blight *{Entomosporium maculatum)* and brown rot of the fruit. To prevent them, spray with Bordeaux mixture in mid-June and again two or three weeks later.

STORING

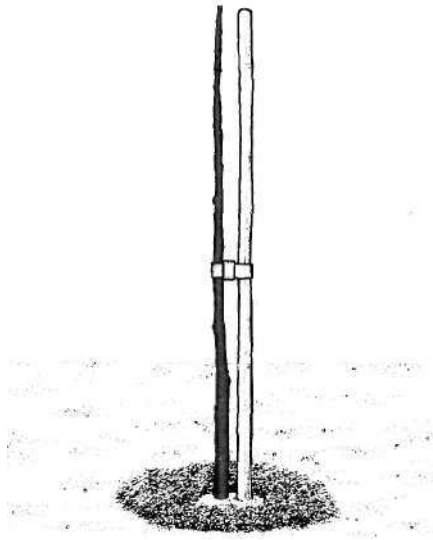




Once the quince fruits are gathered, store them in trays or apple boxes. The receptacle should be put away in a cool and dark storage area so the quinces can mellow.

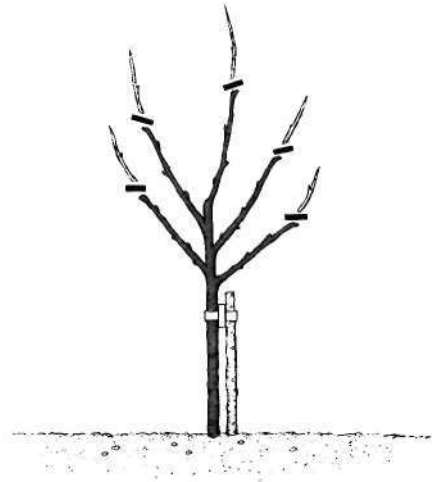


5 **Then, plant the tree** to the same depth as it was at the nursery, about 2 in away from the stake, firming well during planting.



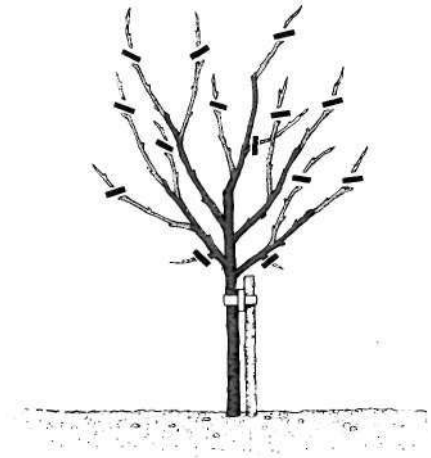
6 Tie the tree to the stake using a tree tie and cushion. In the second year, it may be necessary to prop the tree up if the crop is heavy.

The first winter after planting



7 Cut back the leaders of the main framework branches by about one-third, pruning each to an outward-facing bud. Cut back to 2-3 buds weak lateral shoots.

In the second and third years



8 In winter, cut back the leaders of the main framework branches by about one-third to an outward-facing bud. Cut back weak lateral shoots to 2-3 buds.

Hazelnuts

Botanical authorities have recently decreed that the small shrubby nut trees belonging to the *Corylus* genus should all be called filberts. To many people, however, they are still, and always will be, hazels or hazelnuts. They are frequently found growing wild in the Northeast of the United States. Cultivation is most common in zones 8 and 9 in the Northwest; but the plants do fairly well in zones 6 and 7 more or less everywhere.

In the Northwest, most filberts grown are European varieties. American varieties are hardier, but produce smaller nuts and smaller crops. Consequently, filberts grown in the eastern and central United States are crosses between American and European filberts.

Soil and situation The trees will grow on almost any soil from light gravel to heavy loam, but they require moderately good drainage. They are lime-tolerant and do best on a medium loam over limestone with a pH of 7.5-8.0. Rich soils tend to cause vigorous leafy growth at the expense of the nut yield.

As these are woodland plants by nature, they tolerate light shade but usually produce heavier crops in an open sunny position. Plant them out of the wind.

For good crops, keep the ground clean between the trees. Fork the soil in fall and hoe regularly in spring and summer.

Planting Plant two- to three-year-old trees. In the Northwest, planting is done in early winter; elsewhere in early spring.

Before planting, prepare the ground thoroughly, clearing away perennial weeds over an area 3 ft square. Lightly fork in lime at the rate of 7 oz per square yard.

Dig a hole wide and deep enough to take the roots fully extended. Drive in a stake to reach just below the lowest branch. Plant the tree to the same depth as at the nursery. Return the soil, and firm it in. Tie the tree to the stake with a tree tie and cushion and water well. If planting more than one tree, allow 15 ft between them.

Pruning The filbert is best grown in bush tree form with a 15 in tall stem and six or seven good main branches, giving a cup shape.

Prune during the latter part of flowering (about late February). For the first four to six years, cut back the leaders by about half to an outward-facing bud. Keep the trees at a height of 6-7 ft and, if necessary, cut back to a lateral at the required height. Cut back vigorous laterals to three or four buds. Do not prune the laterals that bear the tiny red female flowers (these are usually carried on the weaker shoots). Pull out suckers.

In August, break off by hand strong lateral growths to about half their length (six to eight leaves from the base) and leave them hanging. This is called brutting and allows air and light into the tree to help ripen fruit buds. It is the brutted side-shoots which are usually shortened back a further 2-3 in in winter.

Feeding In March, apply a balanced fertilizer, such as 10-10-10, at a rate of 3 oz per square yard. In April, apply an artificial fertilizer containing calcium carbonate and ammonium nitrate to old trees making poor growth, at a rate of 1 oz per square yard.

In fall, on light soils, lightly fork in well-rotted manure or compost at the rate of one 2-gal bucketful per square yard.

Every third winter, on acid soils, to keep the soil alkaline, lightly fork in lime at a rate of 7 oz per square yard.

At all times maintain a heavy organic mulch, not only to control weeds and hold in moisture, but also to improve the fertility of the surrounding soil.

Propagation

The most usual methods are by layering or by removing suckers.

For layering, select a young vigorous stem in spring and mark its position on the soil 9 in behind its tip. Dig a hole with one straight side 4-6 in deep. Peg the stem down against the straight side, and return and firm the soil. Keep the soil moist.

In late fall, after leaf-fall, sever the layered stem from the parent plant. In the early spring, cut off the growing tip. Lift and transplant the layered stem.

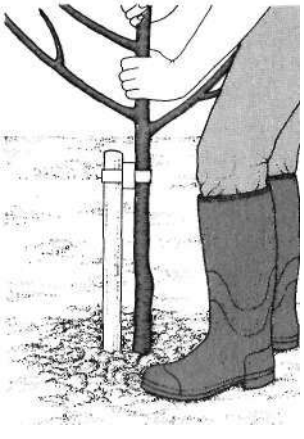
Harvesting

Filberts come into production about three years after planting. Harvest the nuts from the ground after they drop, and remove husks that remain. Spread the nuts out in a cool place to dry.

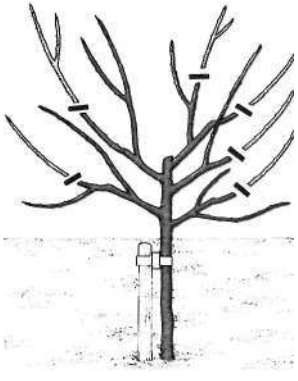
Pests and diseases

Spray with derris to combat nut weevil two or three times in May and early June. Spray in late summer with Bordeaux mixture to control filbert blight. Hazelnut trees are on the whole disease-free.

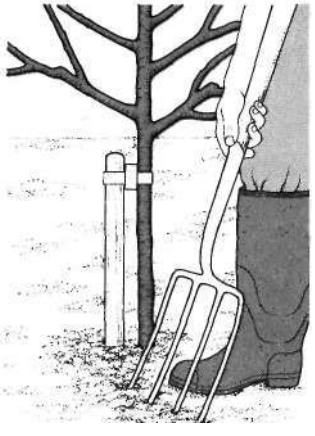
The first four to six years



1 After preparing the soil, dig a hole large enough to take the roots spread out well. Drive in a stake. Plant the tree, firming the soil. Tie the tree to the stake.

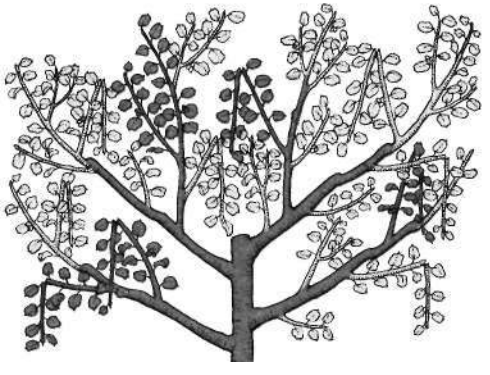


2 In late February, cut back the leaders by about half to an outward-fadng bud. Cut back vigorous laterals to three or four buds. Twist and pull out suckers.

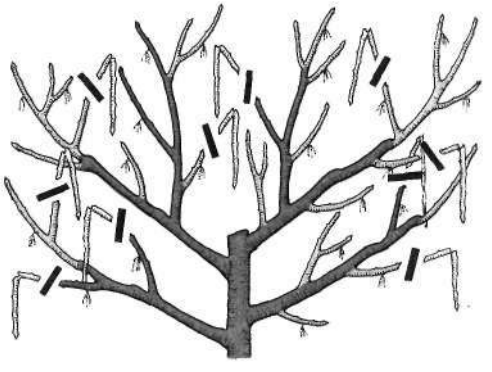


3 In March, apply a balanced fertilizer at a rate of 3 oz per square yard. Every third winter, on acid soils, fork in lime at a rate of 7 oz per square yard.

In subsequent years



4 In August, break off by hand strong lateral growths to about half their length (six to eight leaves from the base) and leave them hanging.



5 In February, cut back previously brutted laterals to three or four buds. Do not prune laterals carrying female flowers. Twist out suckers around the base and cut out dead and crowded growths.

Chestnuts/ Walnuts

Chestnuts

Big, productive American chestnut trees have been wiped out by blight, and although there is some hope that agricultural scientists have finally come up with a solution to the problem, it will undoubtedly be a long time before this once-prized tree is again widely grown.

The sweet Spanish chestnuts that are cultivated throughout Europe for both nuts and timber are equally susceptible to chestnut blight and therefore are not grown in the United States.

This leaves the Oriental varieties. Of these, the Chinese chestnut is the most reliable. An attractive deciduous tree growing to 50 ft and spreading just as wide, it is resistant to the blight and produces masses of good nuts. It grows in zones 5-8. Because it is essentially self-unfruitful, two varieties must be planted together to assure nut production.

Cultivation

Although chestnuts bloom late, the swollen buds may be killed by frost, so locate the trees accordingly. Allow plenty of space for them and, since the branches hang low, do not plant them near a terrace or in other areas where headroom is needed.

The chestnut does well in light, well-drained soils with a pH of 5.5-6.5, but shallow, clay, waterlogged, and alkaline soils are unsuitable.

Planting Prepare the ground thoroughly, clearing away perennial weeds over an area 4-5 ft square. Dig in well-rotted manure or other humus at a rate of about one 2-gai bucketful per square yard. Dig a hole wide and deep enough to take the roots fully extended and drive in a stake to reach just below the lowest branches.

Grafted trees are generally preferred to those grown from seed because they produce bigger nuts at an earlier age. In any case, plant plant the trees to the same depth as at the nursery, spreading the roots out well. Firm the tree to the stake, and water well.

Feeding and pruning

Fertilize the trees after they are established in early spring with about 1 lb of balanced fertilizer per inch of trunk diameter. If grafted specimens are used, however, cut the application in half until it is certain the tree will survive the winters.

Cut back by half the laterals produced during the first growing season when they reach 9-12 in. A few of the upper laterals produced later in the season may be left unpruned. In early winter, cut back the pruned laterals flush with the stem. Repeat this training process each year until the required length of clear trunk has been produced.

Little pruning is required after the main branch system has been formed. Where there is congestion, cut out thin shoots in summer. Prune lightly in winter.

Pests and diseases

To control chestnut weevils, the worst pests, spray three or four times in August with carbaryl.

Harvesting

Nuts are borne in the current season's growth. Crafted specimens start bearing after 4-5 years; seedlings take a little longer. Harvest nuts when they fall to the ground after the burrs surrounding them open. Since the nuts deteriorate if left on the ground in the sun, gather them daily and place them in open trays in a dry, airy place to cure until they feel a little soft. The nuts can be stored for a long time if mixed with slightly damp peat in plastic bags and kept under cover at just above freezing.

Walnuts

Despite its name, the English walnut *(juglans* regia) is native to China, Iran, the Himalayas and south-western Europe and is more properly called the Persian walnut. It is hardy in zones 8-10 and most widely grown in central California valleys.

The rather widely advertised Carpathian walnut is an unusually hardy strain of Persian walnut and grows in zones 5-8. In actual fact, however, it is likely to be a disappointment in all zones except 6.

The eastern black walnut (J. *nigra)* is widely grown in the eastern and central parts of the United States. It is hardier and bigger than the English walnut. It grows in zones 4-8. The nuts have a distinctive rich flavor. All walnuts are self-fruitful, but nut production is more reliable if two different varieties of the same species are planted together.

Cultivation

Usually grown as a central-leader standard, the walnut reaches a height of about 25 ft in 20 years and a final height of 60-70 It. It is therefore suited only to large gardens. It is slow to crop, taking five to ten years before beginning to bear fruit.

Soil and situation The walnut grows well on a wide variety of soils provided they are deep, fertile and well-drained. The ideal soil is a heavy loam, at least 2 ft deep, over limestone, with a pH of about 7.0.

An open position with shelter from spring frosts is best because both the young growths and flowers are prone to frost damage.

Planting For fruiting purposes, it is best to obtain a three- or four-year-old grafted tree of a named variety. Before planting, lightly fork in ground lime at a rate of 7 oz per square yard on acid soils. Clear away perennial weeds over an area 4-5 ft square. Fork in a balanced fertilizer, such as 10-10-10, at the rate of 3 oz per square yard.

Dig a hole wide and deep enough to take the roots fully extended. Drive in a stake to reach just below the lowest branches. Plant the tree at the same depth as at the nursery. Return the soil. Tie the tree to the stake with a tree tie and cushion. Water well.

If planting more than one tree, allow a space of 40-50 ft between them.

Pruning Once the head of the tree has formed, very little pruning is required. Cut out any dead or awkwardly placed branches in August. Protect the cuts with a wound paint.

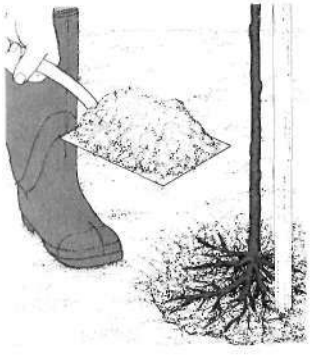
Pests and diseases

To control walnut blight on English and Carpathian walnuts spray with Bordeaux mixture when leaves begin to develop, after pollination and during spells of wet weather. For anthracnose on black walnut, spray with zineb when leaves are 12 in long and three times after that at two week intervals. Use malathion or carbaryl to discourage such insect pests as may appear.

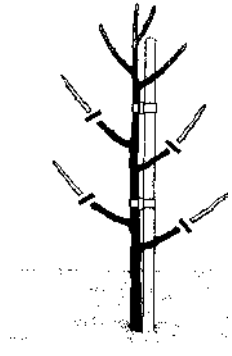
Harvesting

English and Carpathian walnuts start bearing in 4-5 years; black walnuts take a little longer. Harvest the nuts as they drop. Remove the husks (wear rubber gloves so the hands are not indelibly stained); wash the nuts; and spread out in a dry place to dry for a few days before storing.

The first year

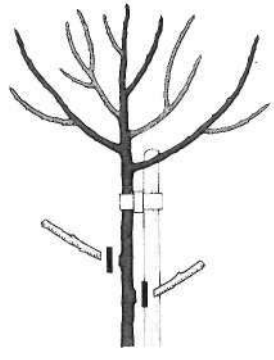


1 In prepared ground, dig a hole large enough for the extended roots. Drive in a stake and plant the tree. Tie to the stake.



2 Cut back by half all lower laterals produced during the first growing season when they reach 9-12 in.

Second and third years



3 In late fall or early winter, cut back the pruned laterals flush with the stem.

Insects

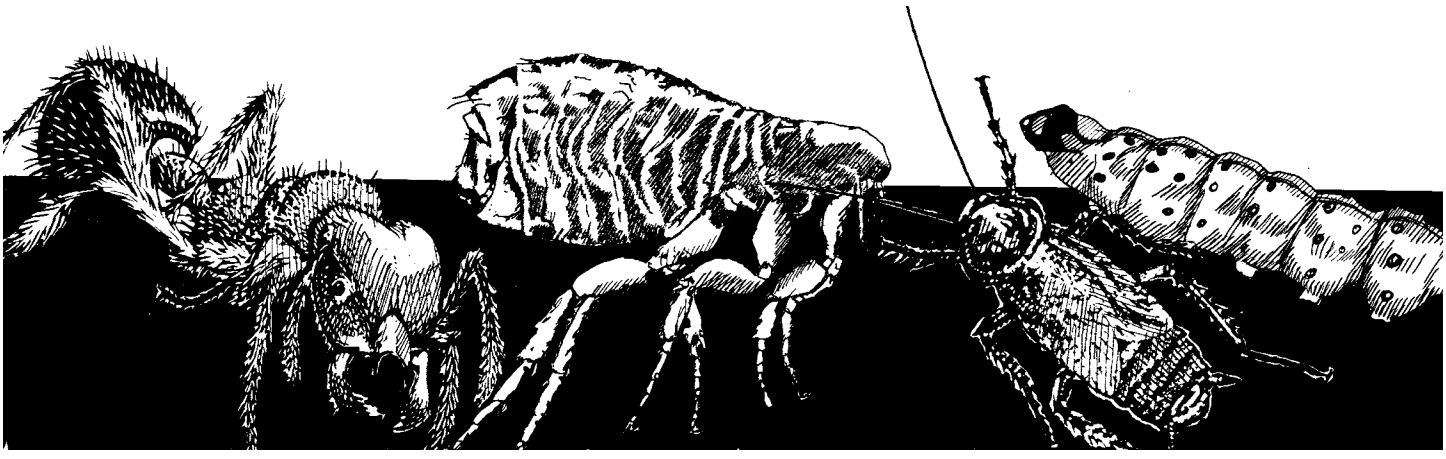
Commercial Sources of Predators, Parasitoids and Pathogens

The Agricultural Extension Service receives numerous inquiries for information about where insect predators and parasitoids can be purchased. These insects are intended for use by both homeowners and commercial growers as biological control agents.

Biological control uses beneficial organisms rather than insecticides to reduce insect populations. Almost all insect groups include some beneficial members. The use of beneficial organisms is particularly important where chemical residues are undesirable. Beneficial organisms can be predators, such as ladybugs, lacewings and praying mantids that feed on other insects. Others, such as some species of nematodes and wasps, including *Trichogramma*, are parasitoids with an immature stage that lives on or inside a host, which the parasitoid eventually kills. *Trichogramma* wasps lay their eggs into the eggs of caterpillars, where they develop by feeding inside the host's egg. An example of a beneficial pathogen is *Bacillus thuringiensis*, which is used as a microbial insecticide.

The Tennessee Department of Agriculture does not list the decollate snail, *Rumina decollata*, as a biological control organism suitable to be brought into Tennessee.

The Agricultural Extension Service is not in the business of advertising, selling or buying beneficial organisms. This list of sources was compiled as a response to public requests for information. This listing and general description of beneficial organisms are not recommendations and do not imply effectiveness in controlling any pest.



Commercially Available Biological Control Agents

1	*Aphidoletes aphidimyza*: A predatory midge that feeds on aphids.
2	*Anisopteromalus calandre*: A wasp that is a parasitoid of weevil larvae in stored grain.
3	*Aphelinus abdominalis*: A parasitoid wasp of aphids.
4	Predatory ladybird beetles.
5	*Bracon hebetor*: A wasp that is a parasitoid of lepidopteran pests of stored grain such as the Indian meal moth and the Mediterranean flour moth.
6	*Bacillus thuringiensis*: Microbial insecticide for control of lepidopteran pests (butterfly and moth caterpillars).
7	*Macrocentrus ancylivorus*: Parasitoid wasp of oriental fruit moth.
8	Mealybug destroyer, *Cryptolaemus montrouzieri*: A predatory lady beetle that feeds on mealybugs.
9	*Diadegma insulare*: An ichneumonid parasitoid wasp of diamondback moth larvae.
10	*Diaeretiella rapae*: This wasp is a parasitoid of aphids such as the cabbage aphid and the green peach aphid.
11	*Aphidius matricariae* and/or *Aphidius colemani* and/or *aphidius ervi*: Parasitic wasps of aphids.
12	*Eretmocerus eremicus*: (=*californicus*): A parasitoid wasp of whiteflies.
13	Fly parasites and predators: For fly control in poultry manure, etc.
14	Greenhouse whitefly parasitoid wasps (*Encarsia sp*).
15	*Goniozus legneri* and/or *Pentalitomastix* sp.: Navel orange worm parasitoids for almond and walnut crops.
16	Gnatrol or other brand names of *Bacillus thuringiensis* subsp. *israelensis*: Used as a soil drench for fungus gnat larvae in soil mixes.
17	*Neoseiulus (=Amblyseius) cucumeris*: A predatory mite of thrips.
18	*Bacillus thuringiensis* Berliner var. *israelensis*, Serotype H-14: For control of mosquitoes and black fly, Mosquito Dunks, Vectobac or other brands.
19	*Neoseiulus (=Amblyseius) barkeri (= mckenziei)*: A predatory mite of thrips.
20	*Dacnusa sibirica* and/or *Diglyphus isaea*: Parasitoid wasps of leafminers on tomatoes and other plants.
21	Predatory lacewings, *Chrysoperla (= Chrysopa)* spp.
22	Predatory mites.
23	*Macrolophus caliginosus*: A predatory mirid bug that feeds on whiteflies.
24	Mosquito-fish, *Gambusia affinis*: Feed on the aquatic life stages of mosquitoes.
25	Parasitic nematodes. BioVector and Millenium are brand names.
26	*Iphiseius (=Amblyseius) degenerans*: A predatory mite of thrips.
27	*Orius* spp.: The predatory minute pirate bugs.
28	Pheromone and/or lures.
29	Praying mantids.
30	*Pyemotes tritici:* Fire mite, a mite that feeds on the eggs of stored-grain pests and ants (including imported fire ants).
31	NPV specific to *Spodoptera exigua* (beet armyworm): Spod-X is the brand name.
32	*Leptomastix dactylopii*: A wasp parasitoid of citrus mealybugs.
33	Scale parasitoids and predators.
34	*Bacillus thuringiensis* var. san diego: Used on Colorado potato beetle larvae and the larvae of elm leaf beetles.
35	Spined soldier bug: A predatory bug.
36	Traps.
37	*Thripobius semiluteus*: A wasp parasitoid of banded greenhouse thrips on citrus and avocadoes.
38	*Pediobius foveolatus:* A wasp parasitoid of the Mexican bean beetle.
39	*Delphastus catalinae: (=pusillus)*: A predatory beetle that feeds on greenhouse and silverleaf whiteflies.

40	*Trichogramma* spp., wasps: Egg parasitoids of caterpillars.
41	Warehouse pirate bug, *Xylocoris flavipes*: This predaceous bug feeds on the eggs and larvae of beetle and moth pests in stored grains.
42	*Hypoaspsis* sp: A predatory mite that feeds on fungus gnat larvae and thrips pupae in the soil.
43	*Nosema locustae*: A biological insecticide for use on grasshoppers and some species of crickets.
44	*Cotesia marginiventris* and/or *Cotesia plutellae*: A braconid wasp parasitoid of several caterpillar pests.
45	*Atheta coriaria*: A rove beetle that preys on fungus gnats and shore flies.
46	Nuclear polyhedrosis virus (NPV) specific to *Heliothsis/Helicoverpa* spp. (tobacco budworm and cotton bollworm): Gemstar is the brand name.
47	Microbial fungicide, *Gliocladium virens*: SoilGard 12 G is one brand name. For control of "damping off" and root rot pathogens of ornamental and food crop plants grown in greenhouses, nurseries and interiorscapes.
48	Microbial fungicide, *Trichoderma harzionum* strain T-22: Root shield granules or drench. For control of some root pathogens.
49	Other microbial fungicides or root inoculants.
50	Other parasitic wasps.
51	*Feltiella acarisuga*: A predaceous cecidomyiid midge that feeds on twospotted spider mites.
52	Nuclear polyhedrosis virus (NPV) specific to codling moth. Cyd-X is the brand name.
53	*Beauveria bassiana*: BotaniGard ES, Mycotrol O and Naturalis H&G are brand names of this biological (fungal) insecticide.
54	Spinosad: Montery Garden Insect Spray, Conserve SC and SpinTor are brand names of this mixture of spinosyn A and D, a biological insecticide derived from the soil actinomycete, *saccharoployspora spinosa*.
55	Granulovirus specific to codling moth. Virosoft Cp4 is the brand name.
56	*Carcinops pumilio*: A hister beetle predator of fly eggs for poultry manure fly control.

Commercial Sources

A-1 Unique Insect Control
5504 Sperry Dr.
Citrus Heights, CA 95621
916-961-7945
Fax: 916-967-7082
4, 13, 14, 21, 22, 25, 29, 40

American Lake Doctors and Queen of the River Fish Co., Inc.
3810 N. 115th St.
Longmont, CO 80501
303-651-2514
800-422-2514
Fax: 303-651-2224
24 also grass carp/white amur for aquatic vegetation control

Applied Bio-Control
P.O. Box 118
Waterford, CA 95386
209-874-1862
Fax: 209-974-1808
e-mail: appbio@netfeed.com
4, 13, 15, 21, 22, 40

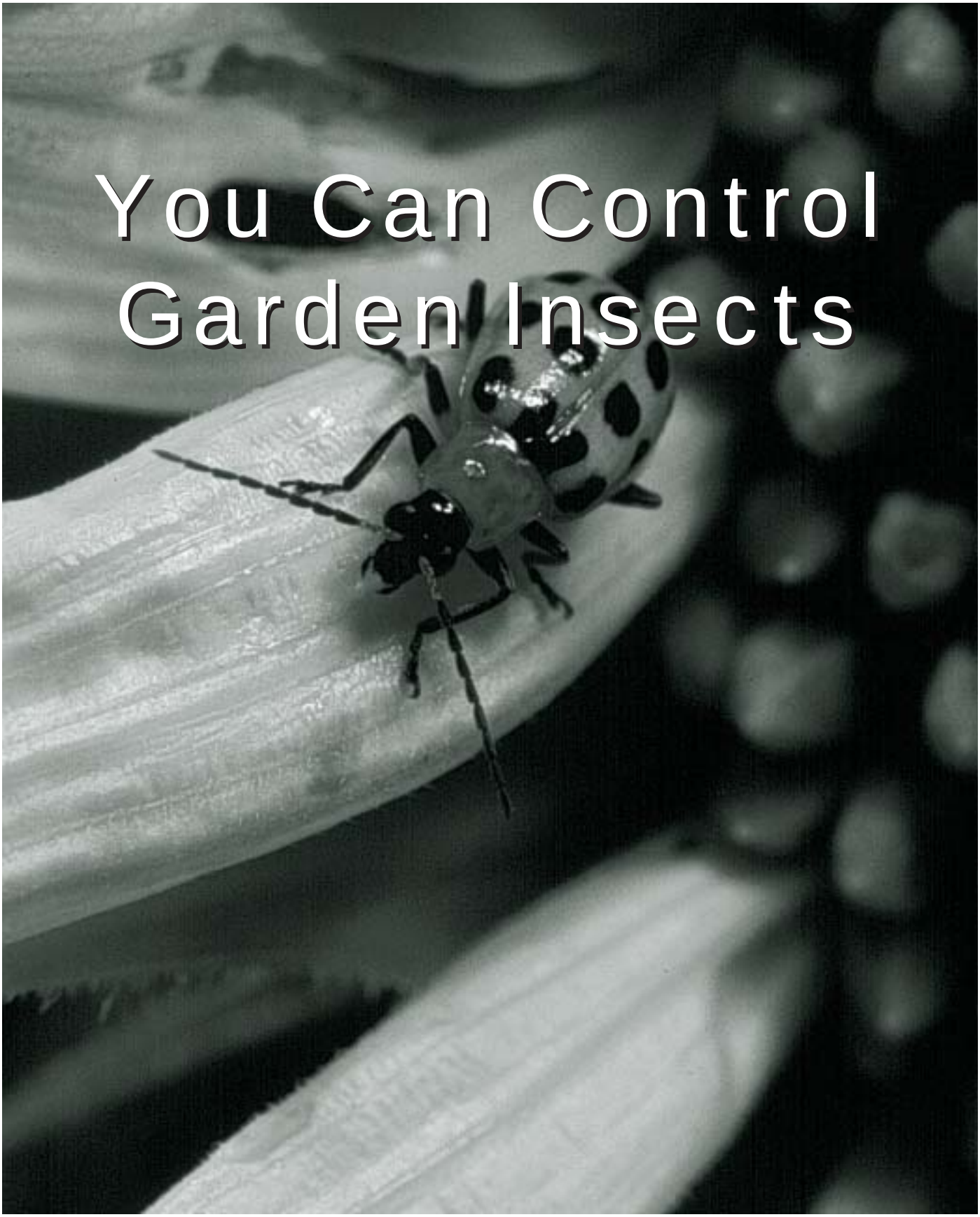
ARBICO Environmentals
P.O. Box 8910
Tucson, AZ 85738
800-827-2847
602-825-9785 (consultant)
1, 4, 5, 6, 8, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 24, 25, 27, 28, 29, 32, 33, 34, 35, 36, 37, 38, 39, 40, 42, 43

Beneficial Insectary
9664 Tanqueray Ct.
Redding, CA 96003
530-226-6300
800-477-3715
Fax: 530-226-6310
http://www.insectary.com
13, 15, 21, 40

Beneficial Insectary Canada
60 Taggart St.
Guelph, Ontario, Canada N1H6H8
519-763-8653
Fax: 519-763-9103
13, 21, 40

Better Yield Insects
44 Bristol Rd.
Narragansett, RI 02882
401-792-3416
800-662-6562
Fax: 401-792-8058
1, 4, 6, 8, 13, 14, 17, 18, 19, 21, 22, 25, 27, 29, 33, 36, 39, 40

Biocontrol Network
5116 Williamsburg Rd.
Brentwood, TN 37027
615-370-4301
1-800-441-2847
Fax: 615-370-0662
e-mail: ebugs@biconet.com
orders@biconet.com
http://www.biocontrolnetwork.com
http://www.biconet.com
1, 4, 6, 8, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 25, 27, 28, 29, 32, 33, 34, 36, 37, 38, 39, 40, 42, 43



You Can Control Garden Insects

You Can Control Garden Insects

Insect Infestations

Insect infestations reduce yields and lower the quality of harvested garden vegetables. Three to seven generations of many insect pests attack garden vegetables during the growing season. All plant parts may be injured by insects. Some insects bore into roots, seeds or stems. Many suck large quantities of plant sap. Others destroy crops by chewing on the succulent foliage, stems or fruits. Plant diseases are carried by certain insects.

Safe, effective and economical control measures can minimize the loss from insects. Control can be maintained all season by a combination of cultural practices, mechanical control, biological control and chemical applications. To maintain control, follow these practices, as they apply to the vegetables in your garden:

- Anticipate insect pest problems.
- Remove other vegetation and debris that harbor insects from vegetable garden beds.
- Turn under spent plants when the vegetables have been harvested.
- Inspect plants regularly for insect infestations and spray when needed.
- Apply sprays when the young, most vulnerable stages of insect pests are beginning to hatch or emerge.
- Observe use restrictions and avoid applying insecticide on garden vegetables within the minimum number of days between last application and harvest.
- Select insecticides that take a short time to control insects during the harvest period.

Insect Reproduction, Growth and Development

How Insects Grow

Most insects develop from an egg and, upon hatching, have a form different from that of the adult. The series of form changes as an insect develops from egg to adult is called **metamorphosis**. The young insect is covered with a more or less firm skin called the **exoskeleton**. As the insect feeds, it grows inside this skin, but it cannot increase in volume because it is restricted by its exoskeleton. A new elastic exoskeleton then forms under the old rigid exoskeleton. The old exoskeleton splits along the back and the insect crawls out of its old skin and expands to its new size. After exposure to air for a short time, the new exoskeleton becomes hardened and the insect is ready to resume activity and grow some more. The process of shedding the old skin is called **molting**. Molting occurs several times over varying periods of time until the final stage is reached.

With each molt insects change their form to varying degrees, depending on the kind of metamorphosis that insects may have. Most vegetable garden insect pests have either gradual (Figure 1) or complete metamorphosis (Figure 2). Examples of gradual or incomplete metemorphosis, in which the very young resemble the adults, include plantbugs, grasshoppers, stink bugs, squash bugs, aphids and leafhoppers. Examples of pests with complete metamorphosis are Mexican bean beetles, cabbage loopers, hornworms, flies, June beetles, cutworms and armyworms.

Gradual metamorphosis (Figure 1). Generally these young insects resemble the adults. In proportion to the rest of the body, the legs and head become relatively smaller in each instar. This is because the head and legs do not grow as fast as the rest of the body. In insects which are winged, there is also a gradual development of the wings with each molt. There are no more molts after the fully developed, winged, adult emerges. Not all of these insects develop wings. The young are called nymphs. Nymphs and adults inhabit the same places and eat the same kind of food.

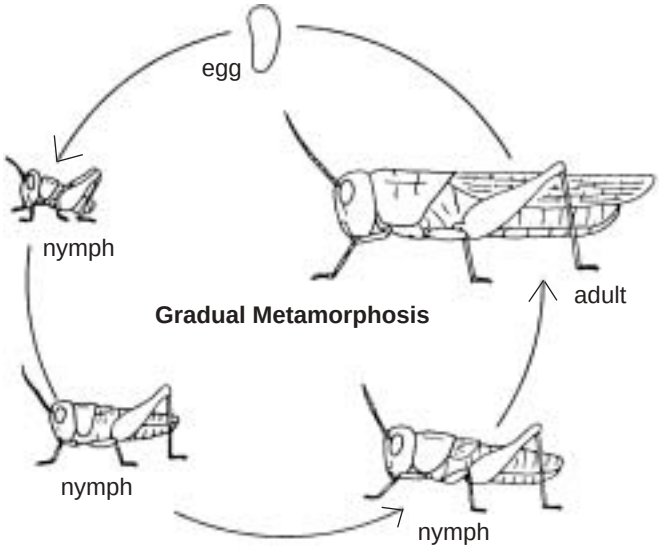


Figure 1

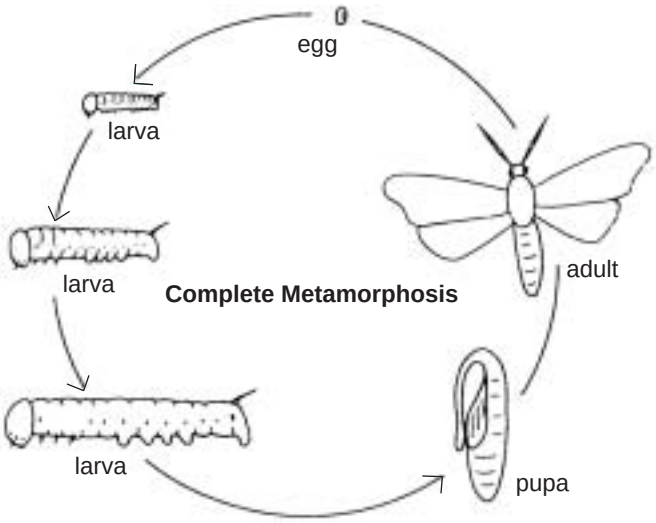


Figure 2

Complete metamorphosis (Figure 2). All four stages of development - egg, larva, pupa and adult - are present. All increases in size occur during the larval stage. Some people erroneously think that small flies will grow to be big flies. At the end of the larval stage, the insect transforms into a pupa which does not feed or move about. It is sometimes called a resting stage, but inside the pupal skin drastic changes are taking place. More alteration of form is going on during the pupal stage than during any other period of the insect's development. Out of the pupa emerges the fully formed adult, complete with wings. No further molts occur. The larvae and adults of these insects may live in different habitats, eat different food, have different kinds of mouthparts and have many other differences. The larval stage of some orders of insects are called maggots, grubs or caterpillars.

Soil Insects

Many garden insect pests live in the soil during one or more stages of their life cycle. These insects are adapted to feeding in or on the planted seeds, roots or lower stems of plants.

The length of time the individual insect lives in the soil varies from two to three weeks for some flies, to three years for some wireworm species.

These insects may either occur as large numbers of newly hatched larvae or as partially grown overwintered larvae with a ravenous appetite at the time you plant your garden. The plants can be severely damaged or even killed overnight following planting.

Anticipate problems with soil insects. Inspect the plant bed soil thoroughly as you cultivate the bed.

Seed Corn Maggot

Description: Small, white maggots without legs or a distinct head, about 1/3 inch long, that feed externally and internally on roots and seeds.

Damage: Death of small plants may result from maggots feeding on roots.

What to do: Avoid planting spring turnips and radishes in soil that is high in partially decomposed organic matter. Do not plant in wet soil.

Onion Maggot

Description: Small white maggots without legs or distinct head, about 1/3 inch long, that bore through underground stems and bulbs.

Damage: Thinning of stands often results from plant death caused by the maggots tunneling in small bulbs. Even if they are not totally destroyed in the garden, damaged bulbs will rot in storage.

What to do: Avoid planting onions in an area high in partially decomposed organic matter. Cull onions should be removed from the garden after harvest.

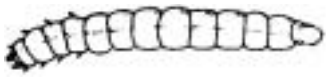
Cabbage Maggot

Description: Yellowish white; legless larva; blunt at the rear end and pointed at the front; about 1/4 to 1/3 inch long. The adult fly lays eggs in the soil around the base of the plant, and the eggs hatch into maggots that burrow down to adjacent roots.

Damage: The maggots are destructive in seed beds and in young transplants. They feed on the roots and stems just below the surface; seedlings wilt, turn yellow and die. Infested cabbage rarely produces a head. Maggots are also reported to introduce a fungus causing blackleg and to spread bacterial soft rot.

What to do: Protect seedlings from egg-laying adults with a square of tar paper laid flat on the ground around the stem or cover with mesh or screening to exclude the fly. Don't plant in cold, damp soil. In the spring, wait until the soil warms up and is sufficiently dry. Add organic matter to the soil in the fall to reduce soil's attractiveness to egg-laying spring cabbage maggot flies.

Wireworm



Description: Shiny, slick, reddish-brown, tough, 6-legged worms up to 1 1/2 inches long.

Damage: The wireworm tunnels through tubers, making deep, more or less cylindrical burrows.

What to do: Avoid planting potatoes in an area that has been in sod for the past two or three years.

White Grub

Description: Several species. White or light yellow; hard brown heads; curved; 1/2 inch to 1 1/2 inches long when full grown. White grubs live in soil and are larvae of May and June beetles. They require three years to mature. Adult lays eggs in grassy areas.

Potato Tuberworm

Description: White caterpillars up to 3/4 inch long with a pinkish or greenish tinge and brown at both ends.

Damage: Larvae burrow into stems and petioles and mine the leaves of plants. The tubers of potatoes in the field and in storage are riddled with slender, dirty-looking, silk-lined burrows.

What to do: Keep potatoes well cultivated and deeply buried in hills during growth. Infested vines should be removed before digging to avoid larval movement to tubers.

Early-Season Insect Pests

Early-season insect pests infest and damage seedling plants early in the growing season. They feed on leaves and stems of young seedling plants.

Cutworm

Description: Plump, smooth-skinned, greasy-looking caterpillars up to 1 inch long often found curled up at base of plants.

Damage: Young transplants may be cut down at ground level, or branches may be removed from larger plants. Some damage to small tomato fruit may occur on older plants.

What to do: Physical barriers, such as aluminum foil wrapped around a 4-inch length of stem between leaves and roots may be used to protect newly set transplants. Baits, sprays or recommended insecticides may be needed. Avoid planting tomatoes in soil recently in grass or sod.

Thrips

Description: Adult - extremely small (1/25 inch long), yellow or brown winged insects; very active. Nymph - similar to adult but smaller and wingless. Thrips often feed on weeds in and around the garden.

Damage: Adults and larvae suck plant juices and cause whitish blotches. Tips of leaves may become distorted and die. Entire plants may wither and fall over with severe infestations.

What to do: Set onions should not be grown near seed onions. Weeds in and around the garden should be removed to reduce build-up of thrips. Beginning when thrips are numerous enough to cause scarring of leaves, two or three applications of a recommended insecticide should be made at weekly intervals or as directed by label. Certain varieties of sweet Spanish onions possess considerable resistance to injury.

Flea Beetle

Description: Adult - many species; very small, black or striped shiny beetles 1/16 to 1/8 inch long that jump readily when disturbed. Adults overwinter under leaves, grass and trash in and around the garden.

Damage: Adults chew tiny holes in the leaves.

What to do: Removal of weed hosts will reduce flea beetle populations. When extremely heavy populations are observed on weeds surrounding the garden, insecticide treatment of garden margins may prevent entry by the pest. When beetles and damage are seen on eggplant or beets, apply a recommended insecticide before serious damage results.

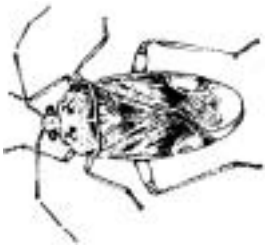
Aphids

Description: Adult and nymphs - small, soft-bodied, yellow, pale green or powdery grey; about 1/8 inch long with two “tail pipes.” Usually occur in colonies or clusters on the undersides of leaves and in broccoli heads.

Damage: Adults and nymphs suck plant juices, leaves thicken, wrinkle and turn yellow or brown; small plants may be severely weakened. Broccoli is very sensitive to aphids, which are difficult to remove from the heads in preparation for eating.

What to do: Observe small plants closely after rapid growth begins in the spring. Wash the aphids from the plants daily with a forceful stream of water until the population is no longer a problem or apply a recommended insecticide when colonies are found in the absence of enemies such as lady beetles.

Lygus Bugs



Description: Several related species including tarnished plant bug are included in this group. They are flat, oval, mottled with white, yellow and black splotches that give it a tarnished appearance; 1/4 inch long. When disturbed, these active insects fly or move to opposite side of stems; they are seldom seen.

Damage: Adults and nymphs pierce and suck juices from the pods, stems and blossoms. This feeding causes blossoms and young pods to drop from the plants. Feeding on the older pods causes the pods and seed to be pitted and undesirable for food. The pods may also be deformed.

What to do: Dust or spray with an insecticide labeled for the specific crop. Clean up and destroy weeds and trash in the fall to prevent overwintering.

Insect Pests Infesting Plant Foliage, Pods and Fruits. These Pests Continue Feeding on Garden Plants Throughout the Season.

Mexican Bean Beetle

Description: Adult - coppery-brown rounded beetles; about 1/4 inch long, with 16 black spots on the back. Adult spends the winter in rubbish and weeds. Larva - yellowish, soft-bodied and fuzzy. Clusters of yellow eggs are laid under the leaves.

Damage: Leaves appear lacy from adults and larvae chewing on the undersides.

What to do: Apply a recommended insecticide, or hand pick adults and larva and crush the eggs. Clean up plant debris after harvest to reduce overwintering adults. Plant early and pick mature pods promptly.

Stink Bug

Description: Adult is shield-shaped, flat, bright green or brown, 5/8 inch long with wings and a narrow head; bad-smelling when crushed. The nymph resembles adult in shape, but is somewhat more rounded than shield-shaped, wingless, and green, orange and black. Adults overwinter in weeds.

Damage: Adults and nymphs suck juices and cause pods to fall and cause distortion of seeds. Brown spots form on the pods from the feeding.

What to do: Apply a recommended insecticide; keep the weeds down both in and around the garden.

Whitefly

Description: Adults - very small sucking insects with two pairs of broadly rounded wings covered with a snow white waxy powder. They look like tiny moths and fly out in a cloud when disturbed. Larvae are very small flat, scale-like insects, difficult to see. All stages feed on the undersides of leaves and excrete honeydew.

Damage: The flies suck plant juices, causing leaf discoloration leaf drop and stunting of plants. A sooty mold grows on the honeydew, causing a black unsightly appearance on the leaves.

What to do: Use a recommended insecticide.

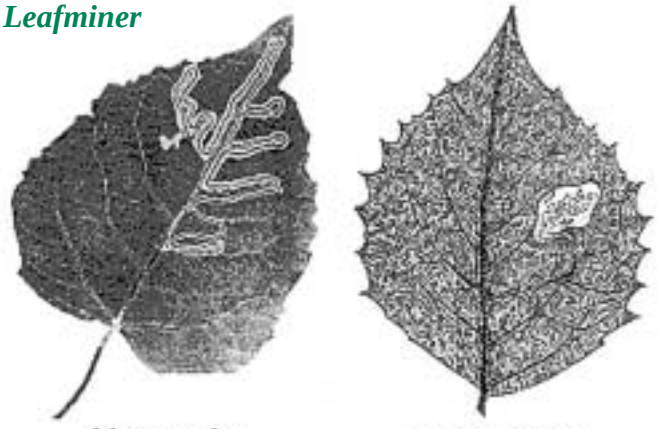
Hornworms (Tobacco and Tomato)

Description: Large, green caterpillars with white bars; up to 3 or 4 inches long with a slender horn projecting from near the rear end.

Damage: Hornworms feeds on leaves, consuming large amount of foliage. Leaf loss may result in stunting and fruit scald.

What to do: Handpicking and destruction are often easily accomplished because of size. If large numbers of hornworms or plants are involved, use a recommended insecticide.

Leafminer

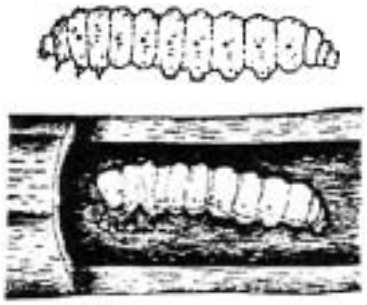


Description: Winding white trails or broad white spots appear on leaves, made by small white or yellow legless maggots feeding between upper and lower surfaces of the leaf.

Damage: The leaves may be weakened, and the mines or tunnels may serve as points where disease and decay may start.

What to do: Handpick infested leaves, if practical, before the larvae pupate and begin another generation, or use a recommended insecticide when large numbers of mines are found.

Squash Vine Borer



Description: Thick, white, wrinkled, brown-headed caterpillars, up to 1 inch long. Produces yellowish, sawdust-like excrement from holes in the vines.

Damage: Infested vines are often completely girdled and usually become rotten and die beyond the point of attack. Late in the season, some tunneling in and damage to fruit may occur.

What to do: Plant as early as the weather will allow. With few infested plants, stems can be split and larvae removed. A spade-full of moist soil should be placed over damaged stems to encourage new root growth. Apply a recommended insecticide weekly or as directed by label during the fruiting period.

Stalk Borer

Description: Slender, up to 1 1/2 inches long. Young borer: creamy white, dark purple band around the body, several brown or purple stripes running lengthwise down the body. Full-grown borer: creamy white to light purple without band and stripes.

Damage: Eats tunnel in stem, causing plant to wither and die. Tunnel usually has opening up to 1/4 inch in diameter at its lower end. Attacks pepper, corn, potato and rhubarb.

Distribution: East of Rocky Mountains.

What to do: Remove and destroy weeds; the insect breeds in weeds, especially dock and ragweed. Plant may be saved by puncturing the insect. To locate the borer, split the stems lengthwise above opening to tunnel. Bind split stem and keep plant watered.

Blister Beetle

Description: Soft, slender beetles with long legs; 1 1/2 - 1 3/4 inches long; either black, grayish or black with narrow gray or yellow stripes on margins of the wing covers.

Damage: Leaf removal from large members of beetles feeding on the foliage may cause fruit injury by sun (sun scald).

What to do: Apply a recommended insecticide.

Harlequin Bug

Description: Adult - red and black, shiny, flat, shield-shaped; about 3/8 inch long. Nymph - red and black, oval, no wings. Eggs - white with black rings, barrel-shaped; laid in double rows under the leaves. Adults overwinter around trash and old plants in and around the garden. This bug has a disagreeable odor.

Damage: Sucking adults and nymphs cause yellow splotches; leaves wilt, turn brown and die.

What to do: Handpick bugs and crush their eggs as they appear; if necessary, apply a recommended insecticide; keep weeds and trash down in and around the garden to reduce overwintering adults.

Squash Bug

Description: Adult - the winged adult is dingy gray-black and nearly an inch long with a narrow head. Adults and nymphs have a very disagreeable odor when crushed. Nymph resembles adult in general shape. Newly hatched nymphs have reddish heads and legs and green bodies. Later they become darker, the head and legs turning black and the body light to dark gray.

Damage: Adults and nymphs suck plant juices. Young plants can be severely weakened or killed. Older plants often have one or more runners damaged. Leaves on damaged runners wilt and become crisp and dark brown.

What to do: If only a few vines are involved, the easiest control method is hand collection of eggs and bugs. The eggs are 1/6 inch long, elliptical, yellowish-brown to bronze, and usually in clusters on the underside of leaves. Garden sanitation reduces overwintering populations. Apply a recommended insecticide to control the young nymphs, because the adults are very difficult to control with insecticides.

Colorado Potato Beetle

Description: Adult - yellow and black striped, hard-shelled beetle about 3/8 inch long. Larva - brick-red, humpbacked, soft-bodied larva with rows of black spots along each side of the body. Eggs - orange, elongated eggs laid on the leaves.

Damage: Adults and larvae eat holes in leaves, especially damaging to small plants.

What to do: The Colorado potato beetle is notorious for its ability to develop resistance to insecticides. Applying a recommended insecticide as soon as adult beetles are observed may provide control. If the initial application is made before egg-laying, repeat treatments may be unnecessary. Adults, larvae and the eggs may be hand-picked from plants and destroyed.

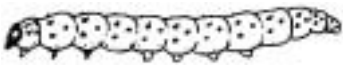
Leafhopper

Description: Small, very active, greenish, slender, wedge-shaped jumping insects up to 1/8 inch long.

Damage: The leafhopper sucks sap from undersides of leaves causing leaf tops to turn brown, followed by the browning and curling of entire leaf margins.

What to do: Apply a recommended insecticide.

European Corn Borer



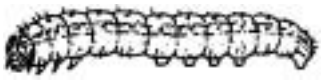
Description: Flesh-colored; rows of small, round, dark-brown spots; dark-brown head; up to 1 inch long. Overwinters as a caterpillar in the stalk.

Damage: Larvae bore into the stems of plants and cause breakage. Heaviest damage occurs late in the season. In addition, larvae may enter the fruit by boring under the calyx (small green leaves under the flower). Larvae feed in tassels and young leaves in the

whorl, soon moving to tunnel in the stalks and the ear; may enter the ear at the base, side or tip. Broken tassels and stalks, shredded leaves, sawdust castings outside small holes in the stalk and ear are signs of the borer. Tunneling in fruit often causes premature fruit drop.

What to do: Plant as early as the weather permits; apply a recommended insecticide when larvae are first found. Apply a recommended insecticide when the corn borers are first seen in the whorl, and before they enter the stalk and ear. Remove old plants after harvest to reduce borer numbers.

Fall Armyworm



Description: Light green to black, striped; black head with inverted white Y on the front of the head; about 1 1/2 inches long. Feeds at night.

Damage: Attacks the young emerging corn leaves in the whorl and the ear in a manner similar to the corn earworm. Fall armyworms will chew through the husks to attack the kernels, whereas corn earworms enter the tip. Often several fall armyworms are found in an ear.

What to do: Apply a recommended insecticide. Plant early.

Corn Earworm or Tomato Fruitworm

Description: Fully-grown larvae are up to 1 3/4 inches long; variable in color from light green to pink to brown to nearly black, marked with alternating light to dark stripes running lengthwise on the body. The head is yellow and unspotted, and the legs are dark or nearly black. The skin of the larvae is coarse with short black hairs (like on a 2-day old beard).

Damage: Earworms chew buds and leaves in the whorl resulting in large ragged holes as the leaves unfold and may cause plants to be stunted; they later feed on the silk and the kernels from the tip of the ear downward; seldom more than one corn earworm per ear. Chewed-off silk prevents pollination; various mold fungi are introduced into the ear. Holes are eaten in tomatoes, causing them to rot.

What to do: Plant as early as the weather permits; apply a recommended insecticide when larvae are first noticed, or when damage is first observed.

Cowpea Curculio

Description: Adult - black, hump-backed, hard-shelled beetle, nearly 1/4 inch long, with a slender snout and prominent round punctures (dimples) on the back. Larva - whitish, legless grub inside the pods.

Damage: Adults cause black wart-like stings on surface of pods by feeding and egg-laying activities. Larvae develop from eggs deposited inside pods. Larvae feed on one or more peas during their course of development.

What to do: Where feasible, remove broomsedge and bluestem from garden edge to reduce overwintering sites.

Cucumber Beetles - Spotted Cucumber Beetle

Description: Adult - greenish-yellow, 12 black spots on wings, black heads, slender, about 1/4 inch long. Adult overwinters at the base of plants which are not entirely killed down by the frost.

Damage: The beetles eat holes in the leaves and flowers and carry bacterial wilt. May attack young seedlings even before they emerge. Larvae tunnel roots and stems of beans, corn and grasses.

What to do: Protect young plants by cone-shaped netting or screen protectors until runners develop; apply a recommended insecticide; clean up weeds to reduce overwintering adults.

Cucumber Beetles - Striped Cucumber Beetle

Description: Adult - pale yellow to orange, three black stripes on wings, black heads, about 1/4 inch long. Larvae - white, brownish at the ends; slender.

Damage: Adults feed on the leaves, stems, and fruit and transmit bacterial wilt. Larvae sometimes feed on underground stems and roots of cucumbers and related plants.

What to do: Cover seedlings with netting or cone-shaped screens until runners form; or apply a recommended insecticide.

Cabbage Looper

Description: Pale green, smooth-skinned worms up to 1 1/4 inches long, which make a loop in the middle portion of the body as they move along the plant. Brown pupae are attached to one side of a plant leaf during the growing season.

Damage: Large holes are eaten in leaves. So much leaf tissue may be consumed that plant growth is interfered with. Larvae may be present in the heads and go unnoticed until cooking.

What to do: It is very important to control these larvae while small, as the larger ones are quite difficult to control. Conventional chemical insecticides often fail. Applications of Bacillus thuringiensis (Dipel or Thuricide) are usually effective in keeping populations under control.

Diamondback Moth Caterpillar

Description: Greenish-yellow with black hairs; slightly pointed at both ends; wiggles rapidly when disturbed and hangs from a silk thread; about 1/3 inch long. Overwinters as a pupa in the leaves of the host plant.

Damage: Larvae chew holes in all parts of the plant, but prefer areas around the bud. Larvae may be present in the heads and go unnoticed until cooking.

What to do: Apply a recommended insecticide. Clean up old plants after harvest to remove pupae.

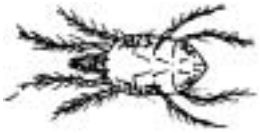
Imported Cabbageworm

Description: Velvety green with a narrow orange stripe down the middle of the back and a broken yellowish stripe along each side; about 1 1/4 inches long. Overwinters as pupae in the leaves of the host plant or other objects nearby.

Damage: The larvae chew holes in the leaves and are more likely to feed near the center of the plant. Larvae may be present in the head and go unnoticed until cooking.

What to do: Apply a recommended insecticide. Clean up old plants after harvest to remove pupae.

Spider Mites

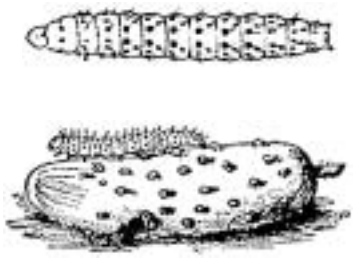


Description: Tiny (barely visible) red, orange, yellow or green mites that suck juice from the undersides of leaves. Fine webs on the leaves.

Damage: Yellow spots on leaves; leaves turn yellowish brown and drop; plants are stunted.

What to do: Frequent high pressure syringing with water will tend to reduce populations; wait for natural predators to reduce the mites if the population doesn't get too high or apply a recommended miticide.

Pickleworm



Description: Yellowish-white caterpillar with dark spots when young; old larvae are greenish or coppery; up to 3/4 inch long. Overwinters in south Florida and spreads northward each year.

Damage: Burrow into buds, blossoms, vines and fruits. The larvae push out small masses of green, sawdust-like excrement from holes in the fruit, causing rotting and loss of fruit.

What to do: Plant as early as the weather will allow. Apply a recommended insecticide during the fruiting period.

Nonchemical Control of Insects

Chemical dusts and sprays offer the most consistent, most effective and easiest method of controlling insects. However, they do have disadvantages: they kill both the bad and good insects; Chemicals used previously may no longer be effective (the insects are said to be resistant to this chemical or group of chemicals. They are toxic and must be handled and stored carefully. They may leave excessive pesticide residues on the food unless label instructions are carefully followed; and they are often expensive.

There are many excellent cultural, mechanical and biological control methods that can be used for insect control. Most gardeners will find that a combination of non chemical and chemical methods work best.

Garden Site Selection

Where possible, avoid planting your vegetable garden in ground that was in sod within two to three years. Soil insects are more likely to be numerous in this situation. Digging or plowing the garden as described below will help.

Soil Preparation

Several species of soil insects (wireworms and white grubs) feed on the roots and seeds of garden vegetables. Many of these pests are harbored on weeds or grasses in the garden before vegetables are planted. The garden should be dug or plowed in the fall and again in the spring, at least three weeks before planting. This practice not only eliminates weeds supporting these pests, but also exposes many pests to drying, cold weather and predators. Rotating crops to new locations in the garden also aids in reducing insects.

Vigorous Plants

Healthy plants are better able to tolerate pest damage than weak sickly ones. Use only the plant varieties best suited for your part of Tennessee and use the correct amounts of fertilizer, lime and water. You can obtain a basic soil test through the county Extension office for $6 per sample.

Plant Early

The number of insects successfully overwintering is actually quite low, but because of their reproductive capacity, large populations develop by late summer. If corn, cucurbits, tomatoes, peppers, eggplant and cole crops are planted as early as weather permits, many of these vegetables will be mature and harvested before heavy insect pressure occurs.

Diversified Planting

Many insects attack plants belonging to a certain species or family and reject unrelated ones. For example, striped cucumber beetles enjoy cucumber, squash and melons (cucurbit family) and are not a pest of corn or beans. Thus, do not plant all those cucurbits or others of the same group in one place in the garden if you can avoid it. If you have many tomato plants, do not put them all in the same location. Insects that begin to attack a particular vegetable often will spread to similar neighboring plants. You may be able to reduce your losses if you do not put all of one group in the same location. Groups of related vegetables are as follows:

Cole crops - cabbage, cauliflower, collards, brussels sprouts, broccoli

Greens - lettuce, endive, mustard, turnips (tops)

Root/bulb crops - sweet potatoes, onion, garlic radishes, turnips, beets, carrots

Cucurbit crops - cucumbers, gourds, melons, pumpkin, squash

Legumes - beans, peas

Do Not Plant Seed Too Deep

Seed planted deeper than accompanying directions may often rot before they germinate and crack through the soil.

Use Physical Barriers

Transplants such as tomato, pepper and eggplant can be wrapped with a 4 X 4 inch strip of aluminum foil to prevent cutworm damage and contact with the soil-borne southern blight organisms. Wrap the stem area between the roots and leaves with foil and plant so 2 inches of stem are below the soil and 2 inches are above the soil. Do not allow the soil to touch the uncovered stem above the foil.

Companion Planting

There is little data to prove or disprove the value of companion planting, although this arrangement has been used by many gardeners who claim success. Presumably some herbs and other plants repel specific insect pests and planting these in association with a particular vegetable gives some protection. A few common plantings are as follows:

- Interplant beans with rosemary to control Mexican bean beetles.
- Interplant tomatoes with basil to repel the tomato hornworm.
- Interplant eggplant with catnip to repel flea beetles.
- Interplant cucumbers with radish or nasturtiums to control cucumber beetles.
- Interplant cabbage with thyme to control imported cabbageworms.

There are many other combinations found in the literature, but remember there is little definite information available on their effectiveness. The latter four listed have been tested in south Georgia with disappointing results.

Water the Garden

Furrow irrigation is ideal. If overhead sprinklers are used, water after the dew dries in the morning or early in the afternoon so the foliage will dry before night. Do not allow foliage to be wet for more than 8-10 hours.

Harvest Vegetables

The longer a vegetable is in the garden, the longer it is exposed to insect attack. In addition, overripe vegetables are more attractive to certain insect pests and invite an unwanted invasion.

Weeds in or around the Garden Area

Some insects are first attracted to weeds and will then move into your vegetable garden. In addition, heavy weed stands increase humidity and subsequent insect severity. Constant weed control is essential, because destruction of a heavy weed stand can cause migration of an insect population to the crop. Mulching is a good way to keep the weeds down in the garden, and it has many other benefits as well.

Use Bacillus thuringiensis

This biological insecticide contains a toxin of a bacterium that is deadly to cabbageworms (and other caterpillar species), but harmless to humans, pets and beneficial insects. It is available under the trade names of Dipel®, Thuricide® and others.

Handpicking Some Insects

Destroying insects that are large enough to pick and slow enough to capture, and destroying egg masses are often quick methods of insect control. Tomato hornworms are often easily controlled by handpicking. Removing Colorado potato beetles by hand is also successful.

Cut out the Squash Vine Borer

When the squash vine borer is found tunneling in the base and runners of squash, you can split the stem to find the larva, kill or remove it, and place about a shovel full of damp soil over the wound to encourage new roots.

Solarization

Solar heating of moist soil by means of polyethylene mulching, particularly during the summer months, is effective in reduction of soil-inhabiting pests. Soil should be tilled, fairly moist and covered with clear plastic for optimum control of these pests.

Repelling Insect Vectors in Tomatoes and Cucurbits

Thrips and aphids spread several diseases and the only protection against the disease is controlling the insect vector(s). Highly reflective surfaces tend to repel most thrips and aphids. Aluminum foil or plastic painted with a chrome-colored paint may aid in repelling these insects.

Crop Rotation

Crops should be rotated to avoid the buildup of pests associated with that crop.

Resistant Varieties

Resistant varieties are either tolerant of pests, not prefered by pests or negatively affect pests. Resistant varieties should be used whenever possible.

Proper Plant Spacing

Proper plant spacing allows the plant canopy to shade the ground, thereby preventing weeds from growing and decreasing the rate at which the soil dries. Plants spaced too far apart will allow weeds to grow and those spaced too closely could be stressed due to competition for light, nutrients and water.

Clean up All Plants

Many insects will mature or overwinter in plants they fed on. Removing debris or end-of-season plowing will reduce pest populations.

Heat

Where allowed, burning off old crop residue may reduce soil-inhabiting pests.

Insect Predators, Parasitoids and Disease-Causing Organisms

Outbreaks of insect pests in home gardens often result because the pests have no natural enemies or their natural enemies are lacking. The natural enemies of garden insect pests that play the greatest role in keeping pests in check are predators, parasitoids and disease-causing organisms. These natural enemies are found on a wide variety of crops–they go where the pest is. It is important that you be able to recognize these beneficial organisms, and not mistake them for destructive pests needing control.

Predators

The most common predators in gardens are various beneficial insects and spiders. Predators actively seek, kill and consume a large part of the pest insect. Common predators are lady beetles, ground beetles, lacewings, praying mantids, damsel bugs and spiders.

Several mail order businesses advertise predators for sale, particularly lady beetles and praying mantids. Release of these beneficials in a garden rarely leads to pest suppression, because the beneficials quickly disperse in search of additional prey. In addition, there are generally a number of these beneficials already in the garden. Therefore, it is more important that you learn to distinguish the beneficial insects from the destructive ones already in your garden than to buy or import insects.

Lady Beetle

Lady beetle adults are oval-shaped insects that vary in color but usually have black or orange-red spots on their wing covers. Lady beetle larvae are spindle or carrot-shaped with conspicuous warty or spiny backs. They usually are black, blue and orange with thick, stubby legs. Both the lady beetle adults and larvae feed on small, soft-bodied insects and insect eggs. Lady beetle eggs are yellow to orange and laid in a cluster of five to 20 eggs. They are found standing on end in con-

tact with one another. All stages of lady beetle development are usually found on the foliage of plants.

Ground Beetle

Ground beetle adults are flat, black or brown, long-legged and swift-running insects. Sometimes the colors are brilliant metallic greens, blues or purples, occasionally spotted with iridescent dots or pits of gold. The adults range in length from 1/2 to 1 1/2 inches. Ground beetle larvae are dark-colored, slender, a little flat and slightly tapering to the tail, which terminates in two bristly, hair-like or spine-like structures. Both the adults and larvae feed on small, soft-bodied insects, eggs and worms. Ground beetle adults and larvae are generally found on the soil, acting as ground level predators.

Lacewing

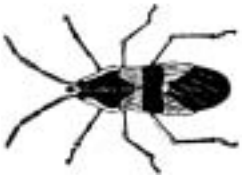
Lacewing adults are insects that have many veins in their wings, giving them a net-like appearance. The wings are held roof-like over the back. The adults are green or brown, and some have characteristic golden-colored eyes. Lacewing larvae are about 1/2 inch long, spindle-shaped insects with long, sharply pointed mandibles that protrude out from the front of the head. These larvae are tan and white with a warty or spiny appearance. Larvae eat small, soft-bodied insects, eggs and worms. The eggs of the lacewings are small, green to whitish and are always laid at the end of a slender, thread-like stalk.

Praying Mantid

Praying mantids are green or brown with long bodies and papery wings (if they are present). These medium to large insects are readily recognized by the enlarged front legs that are used for grasping its prey.

Eggs are laid in a mass, arranged in a definite pattern of rows and glued together. The egg mass is rather commonly observed glued to branches of trees, fence posts or other objects. The winter is spent in the egg stage. Only one annual generation of this insect has been observed. The praying mantid has often been given too much credit as a predator, perhaps because of its size and menacing looks. Praying mantids are basically lazy and generally wait for the prey to come to them. In addition, they will feed on other beneficial insects.

Damsel Bug



Damsel bug adults are long, slender, cigar-shaped insects. They are tan to brown and about 1/2 inch long. The wings are light smoky-colored. The front legs are thick and made for grasping and holding their prey. Damsel bug nymphs resemble the adults except they have no wings and appear very fragile. Both the adults and nymphs feed on small, soft-bodied insects, worms and eggs.

Spider

Spiders are not insects, but this group of arthropods is very important as predators of insects in the garden. Many types of spiders are found in the garden and vary greatly in size and color. They will prey on almost any insect that comes within their range.

Parasitoids

Some insects will feed inside the bodies of other insects, eventually killing them. These insects are called parasitoids.

One of the most common parasitoids found in home gardens is a braconid wasp, which lays its eggs in the body of tomato hornworms. The eggs of this parasitoid hatch into larvae that riddle the internal organs of the hornworm during development. As pupation occurs, the parasitoids can be observed in white cocoons on the back of the hornworm. These are often mistaken for hornworm eggs by the gardener and subsequently destroyed. However, effort should be made to preserve these pupae, since the adult parasitoids will emerge from them to continue their beneficial activities.

Diseases

Microorganisms pathogenic to insects occur commonly among protozoa, bacteria, fungi and viruses. The most common natural diseases in garden insect pests are caused by the latter two groups of microorganisms. However, they are usually effective in reducing pest numbers only after pests reach high population levels. Such pest levels are too destructive to vegetables to await the spread of the disease.

Because of the increased interest and research in diseases for controlling pest insects, it is expected that more of these biological control agents will be made available in the future.

Sources of Biological Control Agents:

These may be found in "Commercial Sources of Predators and Parasites.

Chemical Control
Insecticide Precautions

Insecticides used incorrectly can be injurious to you and your garden vegetables. The best insurance against hazards is the careful observance of the insecticide label directions and precautions. Before purchasing an insecticide, and again before using it, you should read the label and make sure you are able to follow all directions and precautions.

Store all insecticides behind locked doors (or at least out of reach of children) in original containers with the labels intact. The storage area should keep the insecticides from freezing temperatures, but do not sacrifice safety by storing near food, clothing or medicines.

Apply insecticides selectively and carefully. Do not apply an insecticide when there is danger of drift to other areas. Generally, the wind is most calm in early morning or late evening hours. Avoid prolonged inhalation of an insecticidal spray or dust. When applying an insecticide, you should wear at least a long sleeved shirt, long pants, shoes and socks.

After handling an insecticide, do not eat, drink or smoke until you have washed with soap and water. If an insecticide is swallowed or gets in the eyes, follow the first aid treatment given on the label and get prompt medical attention. If an insecticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

The insecticides recommended for home garden use are among the safest available, but should be treated as potentially dangerous poisons. The best way to dispose of an insecticide is to use it in accordance with label directions. When a container is empty, it should be rinsed three times with water, and the rinse water should be added to the spray tank. Empty containers of most homeowner insecticides can be disposed of with household garbage. Wrap in several layers of paper and tie. Follow the directions on the label.

Insecticides vary in their toxicity to humans and domestic animals. The toxicity is measured in milligrams of the insecticide per kilogram of body weight of the test animal that produces a 50 percent mortality rate in tests. Since a milligram is 1/1000 of a gram and a kilogram is 1000 grams or 2.2 pounds, the toxicity is actually expressed in parts per million. As the toxicity rating is based on the amount of the

active ingredient of an insecticide in a mixture, it follows that the diluted spray mixture is a much smaller toxic hazard than a concentrate.

The Insecticide Label

Always read the label carefully on the insecticide container. It will tell you the active ingredient as well as the maximum amount or concentration that can be used safely. Pay particular attention to warning statements and precautions. Always observe recommended intervals between the last application and harvest to avoid harmful residues on the produce. Apply an insecticide product only to those crops that are listed on the label.

- Highly toxic insecticide labels have:
  "DANGER POISON" signal words
  SKULL & CROSSBONES
- Moderately toxic insecticides have:
  Warning signal word
- Slightly toxic insecticides have:
  Caution signal word

Common Insecticides

Sevin© is the trade name of carbaryl, a carbamate insecticide. It is relatively safe, controls many kinds of insects and is the most common garden insecticide used. However, mites may build up where it is used. Sevin is also very toxic to honey bees. Use it as little as possible when the plants are in bloom and apply it late in the day when bee activity is reduced.

Malathion is an organophosphate insecticide frequently used in the home garden because it is relatively safe to apply, and its residues disappear quickly. It effectively controls many pests, including aphids, spider mites and bean beetles. Malathion is available as a 4 or 5 percent dust, a 25 percent wettable powder and as a five-pound-per-gallon emulsifiable concentrate.

Pyrethrum is a contact botanical insecticide, not a stomach poison, and provides rapid knock-down of many garden insect pests.

Cyfluthrin is a pyrethroid which is similar to pyrethrum, but is synthetic, more photostable and has a longer residual. Cyfluthrin is used against a wide variety of insects, including caterpillars, flea beetles and others.

Spinosad is a mixture of spinosyn A and spinosyn D fermentation products derived from the bacterium, *Saccharopolyspora spinosa*. This product is active against caterpillars, leafminers, thrips, Colorado potato beetle and some borers. Spinosad does not impact predatory beneficial insects, beneficial mites and spiders.

Bacillus thuringiensis val. kurstaki is a bacterial insecticide that is sold in most home garden stores under the trade names Dipel, Thuricide and others. This product is extremely effective against various caterpillars (particularly cabbageworms). However, good coverage of plants is necessary since the toxins of this bacterium must be eaten by the caterpillars before they become diseased.

Chemical Control of Insects

The severity and type of pest problems on garden vegetables usually vary considerably from year to year. During most growing seasons, consistent production of high quality vegetables is assured only with the use of pesticides for control of insects and diseases. This is not to suggest that vegetables cannot be grown without pesticides by using nonchemical methods, but it will usually take more effort on the part of the gardener and some damage (sometimes severe) must be accepted.

The pattern of pesticide use (preventive and curative) depends largely on the type of pest. Generally, fungicides are used to prevent the establishment of diseases, and insecticides are used after insect infestations are found. However, if you do have an insect pest that usually causes serious damage, an insecticide should be applied when the infestation first develops. Fungicides should be applied before there is evidence of plant damage. Repeat treatments of both fungicides and insecticides should be made every week or 10 days if disease development or insect infestations continue, or as directed by label. More frequent applications may be needed during moist weather. Whether you use a dust or a spray, only those parts of the plant that are actually coated with the fungicide or insecticide are protected.

Pesticides may be used as a dust or a spray. Dusts are ready to use when purchased; they require no mixing. They can be applied with less expensive equipment than that needed for sprays. Sprays must usually be mixed by the home gardener, but they are frequently more effective. Some sprays are in ready-to-use form, but they are generally more expensive.

Dusts

Home gardeners usually prefer dusts because they are easier to handle and apply. Dusts should be applied while the air is calm, usually in the early morning or late afternoon. Plunger, bellows and rotary types of hand dusters are satisfactory for home garden use. An applicator that delivers a continuous cloud of dust is generally more effective than one that delivers dust in puffs. Apply an even light coating of dust at the label recommended rate. Force it through the foliage so both sides of the leaves are covered.

Sprays

It is usually necessary to prepare sprays by mixing wettable powders or emulsifiable concentrates with water. Compressed-air, knapsack and bucket pump sprayers are best for applying sprays. The compressed-air sprayer is usually the handiest. Both plastic and metal (stainless steel and galvanized) sprayers are available. Stainless steel sprayers are more expensive but will last much longer. Plastic sprayers are quite good but must be kept from high temperatures and extended periods in direct sunlight.

If a wettable powder is used, stir it vigorously in a small amount of water to make a smooth suspension. Add the slurry to the full amount of water, and stir until completely mixed. When applying a wettable powder spray, shake the applicator frequently to keep the powder from settling to the bottom.

If you use an emulsifiable concentrate, shake the pesticide container well before measuring out the spray mixture.

Advantages or Disadvantages of Dusts versus Spray Applications

Dusts:

Advantages

- Ready-to-use formulations
- No mixing required
- Duster less expensive than sprayer
- Dust formulations less expensive than spray formulations

Disadvantages

- Do not adhere to plant surfaces as well as sprays
- Blow in the wind
- Drift to plant blossoms, injure bees
- Less effective control
- Less plant protection

Sprays:

Advantages

- Better coverage of plant surfaces with mist spray
- Adhere to plant surface
- Less toxic to bees
- Less problem with drifting
- Higher level of control
- Better plant protection

Disadvantages

- Mixing required
- Agitation of wettable powder spray mixture in sprayer required
- Formulations more expensive than dusts

The Compressed Air Sprayer

The nozzle is the most important part of the sprayer for it determines the spray pattern of insecticide delivered to a plant surface. Different nozzle spray patterns include a solid stream, a flat fan spray, hollow cone or solid cone pattern. The nozzle determines the amount of spray output at a given pressure during a specified time. Many garden sprayers have an adjustable nozzle that will deliver two or more spray patterns. To determine the delivery rate of your sprayer in gallons per minute, follow these steps:

1. Fill the sprayer tank with clean water.
2. Pump the air pump until the desired pressure of 20 to 40 psi is reached in the tank.
3. Adjust the nozzle to deliver the desired pattern.
4. Place the spray nozzle in a bucket, can or jar to collect the liquid to be sprayed.
5. Open the valve and discharge the spray liquid into the bucket, can or jar for a specified time period of 20 or 30 seconds.
6. Measure the ounces of water collected.
7. Multiply the ounces collected in 20 seconds by 3 or in 30 seconds by 2 to determine the fraction of a gallon sprayed per minute.

Applying an Insecticide to Plants

Spraying

It is important that the sprayed plants be thoroughly covered. To get thorough coverage, spray the plant from two or three directions and from underneath as well as from above. If the label instructions say "wet thoroughly or to the drip point," apply a mist spray until the plant begins to drip.

A fine mist of spray will deposit many fine particles on the foliage, resulting in better coverage and a higher level of control.

Using Insecticides Properly to Prevent Pollution

The proper use of insecticides will reduce the pollution of our environment to a minimum. Insecticides are carried into water on soil particles which erode. Take measures necessary to prevent erosion.

DO NOT pour excess spray mixtures or insecticides into sewage systems. Every little bit disposed of in this way adds to the stream pollution problem. Wash the residues from your empty container and mix them into your garden spray. Apply the last drop of the pesticide to your plants.

Cleaned cans or bottles can be delivered to a sanitary landfill. Observe wind conditions and avoid spraying during periods of windy weather to prevent drift.

Mixing a Garden Spray

- Read the label carefully.
- Measure the amount carefully using level teaspoon or tablespoon quantities.
- Mix the insecticide thoroughly in a small volume of water, then bring the liquid up to the desired level.
- Wash all insecticides off the skin immediately.

Applying a Garden Spray

- Adjust sprayer to deliver a fine mist spray.
- Direct spray to infested areas of plant.
- Thoroughly wet plant parts to the point of runoff.
- Apply sprays during periods of favorable weather:
  - 70-85F - temperature
  - Wind less than 5 miles per hour
  - No rain forecast within 24 hours
- Repeat application if rainfall exceeds 1/2 inch within 24 hours after applying.
- Keep sprayer in good condition:
  1) Wash thoroughly after each use.
  2) Hang tank upside down with pump assembly removed for complete drying.
  3) Do not use your insecticide or fungicide sprayer for spraying weed killers or vice versa.
  4) Buy two sprayers and label them.

Application Rate of Insecticides for Home Gardens

Estimate the amount of spray or dust you will need to cover your garden vegetables for effective control. These rules of thumb for estimating amounts are based on the lineal feet of a row or the number of square feet See the label for actual rates (ounces/square or linear feet).

- One-half gallon will spray 100 feet of row.
- One-half gallon will spray 250 square feet.
- Four ounces (1/4 lb.) of dust will treat 120 feet of row.
- Four ounces (1/4 lb.) of dust will treat 250 square feet.

Row Applications

- Rows 12 inches apart - 43,560 feet of row per acre
- Rows 24 inches apart - 21,780 feet of row per acre
- Rows 36 inches apart - 14,520 feet of row per acre
- Rows 48 inches apart - 10,890 feet of row per acre

Example:

How much spray should you put on 100 feet of row if the nozzles on the spray boom are 24 inches apart and the recommended application rate is 150 gallons per acre?

Calculation:

150 gallons for 21,780 feet = X gallons on 100 feet.

$$X = \frac{150 \times 100}{21{,}780} = 0.688 \text{ gallons per nozzle per 100 ft.}$$

(slightly less than 2 1/2 qts.)

Safe Handling of Insecticides

Home gardeners can control insect pests with reasonable safety by observing these safety rules:

- Keep insecticides in the original, labeled container.
- Keep insecticides in a locked storage cabinet.
- Read the label each time you use the insecticide.
- Measure the amount to be mixed carefully.
- Do not exceed the recommended rate of application.
- Handle the insecticide carefully when mixing to avoid splashing of liquid concentrates and billowing of dusts and powders.
- Wear protective clothing and other personal protection equipment, as directed by the label.
- To protect yourself when mixing insecticides, it is suggested that protective clothing and equipment such as chemical-resistant gloves, a long-sleeve shirt, long pants and protective eyewear be worn.
- Wash all insecticides off the skin immediately, using plenty of soap and water.
- Avoid breathing the spray mist or vapor.
- Always mix insecticides out of doors near a source of water.
- Clean up any spilled materials to prevent children from entering a heavily contaminated area.
- Apply insecticides only to those plants listed on the label.
- Observe the time intervals between the last application and harvest.

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
ASPARAGUS asparagus beetle Japanese beetle	carbaryl (Sevin)	4 - 8 tsp	1	Treat fern and brush growth as beetles appear. Do not treat more than once every 3 days.
	permethrin 2.5%EC 0.25%D	3 Tbsp Apply according to label	3 1	Do not apply more than 4 times per season.
BEANS aphids	malathion 50%EC 25WP	2 tsp 3 Tbsp	1 1	Do not exceed 5 lbs/acre.
	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 1 - 1 ½ oz/ 50 ft. row 2 2/3 Tbsp	 3 3	Do not apply more than 3 times per season.
	Safer Insecticidal Soap 49EC	5 Tbsp	0	When available, insecticide treated seeds should be used to avoid problems with seed corn maggots and other soil insect pests.
bean beetles (Mexican bean beetle, bean leaf beetle)	carbaryl (Sevin) 50WP 5D	 2 Tbsp 1/4 - 1/2 lb dust/1000 sq ft	 0 0	
	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 1 - 1 ½ oz/ 50 ft. row 2 2/3 Tbsp	 3 3	Do not apply more than 3 times per season.
	esfenvalerate 0.425%	2 Tbsp	3	
corn earworm	carbaryl (Sevin) 50WP	2 1/2 Tbsp	0	Repeat treatments at 7-day intervals (or as directed by label)– may be needed on late beans.
	esfenvalerate 0.425%	2 Tbsp	3	
	permethrin 2.5%EC	4 Tbsp	3	Do not apply more than 8 times per season.
	spinosad 0.5%	4 Tbsp	3	Maximum of 6 applications per season; wait 5 days before reapplying.
cowpea curculio	See peas.			
spider mites	Safer Insecticidal Soap 49EC	5 Tbsp	0	Do not apply during heat of day or when leaf temperature exceeds 90 F. Repeat treatments at 3- to 5-day intervals particularly during hot weather. Begin at first signs of mites and off-color.
	malathion 50EC	1 Tbsp	1	

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
BEANS, CONT'D thrips, lima bean borer	spinosad 0.5%	4 Tbsp	3	Maximum of 6 applications per season; wait 5 days before reapplying.
stink bugs, thrips, lima bean borer	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 1 - 1 ½ oz/ 50 ft. row 2 2/3 Tbsp	 3 3	Do not use more than 3 times in one season.
whitefly	Soap (insecticidal, M-Pede) 49EC Beauvaria bassiana (Mycotrol) ES, WP	2 Tbsp see label	0 0	
BEETS flea beetles	carbaryl (Sevin) 50WP	2 - 4 Tbsp	14;3	14 days if tops used; 3 days if tops not used.
BROCCOLI aphid	malathion 50EC 25WP	2 tsp 3 Tbsp	3 3	On foliage as aphids appear.
	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	1 1/4 - 1 ½ oz/ 50 ft.row 2 2/3 Tbsp	7 7	No more than 4 applications per year.
	Safer Insecticidal Soap 49EC	5 Tbsp	0	
cabbageworms	Bacillus thuringiensis subsp. kurstaki (Dipel, Thuricide and other formulations)	As recommended on the label.	0	Treat as soon as damage is found and repeat weekly (or as directed by label).
	esfenvalerate 0.425%	2 Tbsp	3	
	permethrin 2.5%EC 0.25%D	2 Tbsp Apply according to label.	1	Do not apply more than 8 times per season.
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.
stink bugs	carbaryl (Sevin) 50WP	4 - 8 Tbsp/2 1/4 gal	3	
	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 1 1/4 - 1 ½ oz/ 50 ft.row 2 2/3 Tbsp	 7 7	No more than 4 applications per year.
BRUSSELS SPROUTS aphid	endosulfan 9.9EC (Thiodan 0.75) malathion 50EC	 2 2/3 Tbsp 2 tsp	 14 7	No more than 4 applications per year.
cabbageworms	Bacillus thuringiensis subsp. kurstaki (Dipel, Thuricide and other formulations)	As recommended on the label.	0	Begin treatment when first noted and repeat weekly (or as directed by label) until harvest.
	permethrin 2.5%EC 0.25%D	2 Tbsp Apply according to label.	1	Do not apply more than 8 times per season.
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
CABBAGE aphid	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 1 1/4 - 1 ½ oz/ 50 ft.row 2 2/3 Tbsp	 7 7	No more than 4 applications per year.
	malathion 25WP	4 - 5 tsp	7	
	Safer Insecticidal Soap 49EC	5 Tbsp	0	
cutworm	permethrin 0.25%D	Apply according to label.	1	Do not apply more than 5 times per season.
cabbageworms	Bacillus thuringiensis subsp. kurstaki (Dipel, Thuricide and other formulations)	As recommended on the label.	0	Good coverage is essential. Upper and lower leaves. Treat as soon as damage is found and repeat weekly (or as directed by label) until harvest.
	permethrin 2.5%EC 0.25%D	2 Tbsp Apply according to label.	1	Do not apply EC formulation more than 10 times per season. Do not apply D formulation more than 5 times per season
	esfenvalerate 0.425%	2 Tbsp	3	
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.
flea beetles	carbaryl (Sevin) 50 WP	 2 - 4 Tbsp/2 1/4 gal	 3	On foliage, as needed.
	malathion 25 WP	4 - 5 tsp	7	
	permethrin 0.25%D	Apply according to label.	1	Do not apply more than 5 times per season.
harlequin bug	malathion 25 WP	4 - 5 tsp	7	
	9.9EC (Thiodan 0.75)	2 2/3 Tbsp	7	
CANTALOUPE aphid	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 1 1/4 - 1 ½ oz/ 50 ft.row 2 2/3 Tbsp	 0 2	
	Safer Insecticidal Soap 49 EC	5 Tbsp	0	
cucumber beetles	carbaryl (Sevin) 50 WP	 2 Tbsp	 0	On foliage as needed.
	endosulfan 3D (Thiodan) 9.9 EC (Thiodan 0.75)	1 1/4 - 1 ½ oz/ 50 ft.row 2 2/3 Tbsp	0 2	No more than 6 applications per year.
	esfenvalerate 0.425%	2 Tbsp	3	For use on adult beetles.
	permethrin 2.5%EC 0.25%D	As recommended on the label	0	Do not apply D formulation more than 8 times per season. For use on adult beetles.
leafminer	spinosad 0.5%	4 Tbsp	5	Maximum of 6 applications per season; wait 5 days before reapplying.

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
CANTALOUPE CONT'D pickleworm	carbaryl (Sevin) 50 WP	2 Tbsp/2 1/4 gal	0	Late-planted cantaloupes are heavily attacked. Begin treatments at first bloom; repeat weekly.
	endosulfan 9.9EC (Thiodan 0.75)	2 2/3 Tbsp	2	No more than 6 applications per year.
	esfenvalerate 0.425%	2 Tbsp	3	
	permethrin 2.5%EC 0.25%D	As recommended on the label	0	Do not apply D formulation more than 8 times per season.
	spinosad 0.5%	4 Tbsp	5	Maximum of 6 applications per season; wait 5 days before reapplying.
spider mite	Safer Insecticidal Soap 49EC	5 Tbsp	0	
COLLARDS aphid	endosulfan 9.9EC (Thiodan 0.75)	2 Tbsp	21	Do not exceed 1 application per season.
	malathion 25WP	3 Tbsp	7	
	Safer Insecticidal Soap 49EC	5 Tbsp	0	
cabbageworms	Bacillus thuringiensis subsp. kurstaki (Dipel, Thuricide and other formulations)	As recommended on the label	0 0	Begin treatments as soon as damage is found and repeat weekly until harvest.
	esfenvalerate 0.425%	2 Tbsp	7	
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.
flea beetles	carbaryl (Sevin) 50 WP	2 - 4 Tbsp/2 1/4 gal 1 1/4 - 2 1/2 Tbsp	14 3	On foliage as needed.
	endosulfan 9.9EC (Thiodan 0.75)	2 Tbsp	21	Do not exceed 1 application per season.
harlequin bug	malathion 25WP	3 Tbsp	7	On foliage as needed.
	9.9EC (Thiodan 0.75)	2 Tbsp	21	Do not apply more than 1 application per season.
	carbaryl (Sevin) 50 WP	2 - 4 Tbsp/ 2 1/4 gal	14	
CORN, SWEET corn earworm, fall armyworm, European corn borer	carbaryl (Sevin) 50 WP	4 - 8 Tbsp/2 1/4 gal	7	Begin treating when silks appear. Repeat at 2-day intervals (or as directed by label) with sprays directed at ears.
	cyfluthrin 0.003% cyfluthrin 0.75%EC	Ready to use formula 1 Tbsp	0 0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 5 times per season.
	esfenvalerate 0.425%	2 Tbsp	1	

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
CORN, SWEET (CONT'D)	permethrin 2.5%EC 0.25%D	3 Tbsp Apply according to label	1	Do not apply more than 6 times per season.
corn earworm, fall armyworm, European corn borer	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 3 days before reapplying.
flea beetle	carbaryl (Sevin) 50 WP	4 - 8 Tbsp/2 1/4 gal	7	Early application on seedling corn is usually necessary. Application during pollen shed will seriously reduce bee populations.
	cyfluthrin 0.003% cyfluthrin 0.75%EC	Ready to use formula 1 Tbsp	0 0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 5 times per season.
CUCUMBER aphid	Safer Insecticidal Soap 49EC	5 Tbsp	0	
	9.9EC (Thiodan 0.75)	2 2/3Tbsp	2	Do not apply more than 6 applications per season.
cucumber beetle, squash bug	carbaryl (Sevin) 50WP 5D	4 Tbsp/2 1/4 gal	1 0	Apply Sevin late in the day to minimize killing pollinating insects.
	endosulfan 9.9EC (Thiodan 0.75)	2 2/3 Tbsp	2	Do not apply more than 6 applications per season.
	esfenvalerate 0.425%	2 Tbsp	3	For use on cucumber beetle adults.
	malathion 25WP	5 Tbsp	0	
	permethrin 2.5%EC 0.25%D	As recommended on the label	0	For use on cucumber beetle adults. Do not apply D formulation more than 8 times per season.
	carbaryl (Sevin) 50WP	2 Tbsp/2 1/4 gal	1	Late-planted cucumbers are heavily attacked. Begin treatments at first bloom and repeat weekly (or as directed by label). Apply Sevin late in the day to minimize killing pollinating insects.
	endosulfan 9.9EC (Thiodan 0.75)	2 2/3 Tbsp	2	
	esfenvalerate 0.425%	2 Tbsp	3	
	permethrin 2.5%EC 0.25%D	As recommended on the label	0	Do not apply D formulation more than 8 times per season.
spider mites	Safer Insecticidal Soap 49EC	5 Tbsp	0	
EGGPLANT aphids	endosulfan 9.9EC (Thiodan 0.75)	1 1/3 Tbsp	1	Do not make more than 2 applications per year.
	malathion 50EC 25WP	2 tsp 0.3 oz	3 3	Apply treatment when aphids and repeat when needed.

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
EGGPLANT (CONT'D)	Safer Insecticidal Soap 49EC	5 Tbsp	0	
Colorado potato beetle	carbaryl (Sevin) 50WP 5D	2 Tbsp 1/2 lb dust/1000 sq ft	0 0	On foliage as needed.
	endosulfan 9.9EC (Thiodan 0.75)	1 1/3 Tbsp	1	Do not make more than 2 applications per year.
	esfenvalerate 0.425%	2 Tbsp	7	
	permethrin 2.5%EC 0.25%D	6 Tbsp Apply according to label	3	Do not apply EC formulation more than 16 times per season. Do not apply D formulation more than 10 times per season.
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; Wait 4 days before reapplying.
flea beetle	carbaryl (Sevin) 50WP	2 Tbsp	0	On foliage as needed.
	malathion 50EC 25WP	1 Tbsp 4 - 5 tsp	3 3	
lacebug	malathion 50EC 25WP	2 tsp 4 - 5 tsp	3 3	
spider mite	malathion 50EC 25WP	1 Tbsp 4 - 5 tsp	1 1	Repeat treatments are often necessary. Do not use Kelthane!
	Safer Insecticidal Soap 49EC	5 Tbsp	0	
	endosulfan 9.9EC (Thiodan 0.75)	1 1/3 Tbsp	1	
whitefly	pyrethrin (aerosol)		1	
	endosulfan 9.9EC (Thiodan 0.75)	1 1/3 Tbsp	1	
LETTUCE aphid	malathion 50EC 25WP	1 Tbsp 3.2 - 4 Tbsp	7 14	
cabbageworms	Bacillus thuringiensis subsp. kurstaki (Dipel, Thuricide and other formulations)	As recommended on the label	0 0	Begin treatments as soon as damage is found and repeat weekly (or as directed by label) until harvest.
	permethrin 2.5%EC 0.25%D	4 Tbsp Apply according to label	1	Do not apply EC formulation more than 10 times per season. Do not apply D formulation more than 5 times per season.
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
MUSTARD GREENS aphid	malathion 50EC 25WP	2 tsp 4 - 5 tsp	7 7	
	endosulfan 9.9EC (Thiodan 0.75)	2 Tbsp	21	Do not exceed 1 application per season.
caterpillars	Bacillus thuringiensis subsp. kurstaki (Dipel, Thuricide and other formulations)	As recommended on the label	0 0	Begin treatments as soon as damage is found and repeat weekly or as necessary (or as directed by label) until harvest.
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.
flea beetles	carbaryl (Sevin) 50WP	2 - 4 Tbsp/2 1/4 gal	14	
OKRA aphids	malathion 50EC	2 tsp	1	On foliage as needed.
corn earworm	carbaryl (Sevin) 50WP	2 - 4 lb/acre	0	On foliage as needed.
	permethrin 2.5%EC	As recommended on the label	1	Every 5 to 10 days as needed.
stink bug	carbaryl (Sevin) 50WP	2 - 4 lb/acre	0	
ONIONS thrips	malathion 50EC	1 Tbsp	3	
PEAS aphid	diazinon 25EC	2 tsp	7	On foliage as needed. Do not use on dried bean or pea varieties such as pinto beans, dried limas, split peas or blackeyed peas.
	malathion 50EC	2 tsp	3	
	Safer Insecticidal Soap 49EC	5 Tbsp	0	
cowpea curculio	esfenvalerate 0.425%	2 Tbsp	3	
European corn borer	carbaryl (Sevin) 50 WP	2 Tbsp	1	This insect is a more serious pest on late peas. Treat 1-2 weeks prior to bloom.
	esfenvalerate 0.425%	2 Tbsp	3	
	spinosad 0.5%	4 Tbsp	3	Maximum of 6 applications per season; wait 5 days before reapplying.
lesser cornstalk borer	spinosad 0.5%	4 Tbsp	3	A problem on late peas. Maximum of 6 applications per season; wait 4 days before reapplying.

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
PEPPER aphid	endosulfan 4D (Thiodan) 9.9EC (Thiodan 0.75)	 1 ½ - 2 oz/ 50 ft.row 1 1/3 - 2 2/3 Tbsp	 1 1,4	 One day pre-harvest interval if maximum of 1 1/3 Tbsp used. Do not make more than 2 applications per year.
	malathion 50EC 25WP	2 tsp 3.2 - 4 Tbsp	3 3	
	Safer Insecticidal Soap 49EC	5 Tbsp	0	
armyworms, cabbage loopers, corn earworms, leafminers	cyfluthrin 0.003% cyfluthrin 0.75%EC	Ready to use formula 1 Tbsp	7 7	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 6 times per season.
	permethrin 0.25%D	Apply according to label	3	Do not apply more than 8 times per season.
	spinosad 0.5%	4 Tbsp	1	A problem on late peas. Maximum of 6 applications per season; wait 4 days before reapplying.
flea beetle	Sevin 50WP	2 Tbsp	1	
European corn borer	carbaryl (Sevin) 50 WP	4 - 8 Tbsp/2 1/4 gal	1	Spray plants thoroughly, especially pepper caps, every 3 days after blossoms appear and fruit forms.
	cyfluthrin 0.003% cyfluthrin 0.75%EC	Ready to use formula 1 Tbsp	7	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 6 times per season.
	esfenvalerate 0.425%	2 Tbsp	7	
	permethrin 2.5%EC 0.25%D	4 Tbsp Apply according to label	3	Do not apply more than 8 times per season.
	spinosad 0.5%	4 Tbsp	1	A problem on late peas. Maximum of 6 applications per season; wait 4 days before reapplying.
POTATOES, IRISH aphid	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 1 ½ / 50 ft. row 2 2/3 Tbsp	 0 1	 Do not plant root crops other than carrots, potatoes, sugar beets and sweet potatoes as follow-up crops. No more than 6 applications per season.
	malathion 50EC	2 tsp	0	

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
POTATOES, IRISH (CONT'D)	esfenvalerate 0.425%	2 Tbsp	7	
Colorado potato beetle	permethrin 2.5%EC 0.25%D	3 Tbsp Apply according to label	7 14	Do not apply EC formulation more than 12 times per season. Do not apply D formulation more than 8 times per season.
	spinosad 0.5%	4 Tbsp	7	A problem on late peas. Maximum of 6 applications per season; wait 7 days before reapplying.
flea beetle, leafhoppers	carbaryl (Sevin) 50WP 5D	 2 Tbsp 1/2 lb dust/1000 sq ft	 0 0	
	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 1 ½ / 50 ft. row 2 2/3 Tbsp	 0 1	Do not plant root crops other than carrots, potatoes, sugar beets, and sweet potatoes as follow-up crops. Do not make more than 6 applications per year.
potato tuberworm	carbaryl (Sevin) 50WP	 2 Tbsp	 0	Treat when foliage or tuber damage is noticed. Store promptly after digging to avoid tuberworm infestation in storage. Do not plant root crops other than carrots, potatoes, sugar beets and sweet potatoes as follow-up crops.
	endosulfan 9.9EC (Thiodan 0.75)	2 2/3 Tbsp	1	
	esfenvalerate 0.425%	2 Tbsp	7	
	permethrin 2.5%EC 0.25%D	3 Tbsp Apply according to label	7 14	Do not apply EC formulation more than 12 times per season. Do not apply D formulation more than 8 times per season.
	spinosad 0.5%	4 Tbsp	7	A problem on late peas. Maximum of 6 applications per season; wait 7 days before reapplying.
RADISHES aphid	malathion 50EC 25WP	2 tsp 4 - 5 tsp	7 7	
cutworms	cyfluthrin 0.003% cyfluthrin 0.75%EC	Ready to use formula 1 Tbsp	0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 5 times per season.
	esfenvalerate 0.425%	2 Tbsp	7	
flea beetles	carbaryl (Sevin) 50 WP	 2 - 4 Tbsp	 3	

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
SQUASH & PUMPKIN aphid	endosulfan 9.9EC (Thiodan 0.75)	2 2/3 Tbsp	2	Do not make more than 6 applications per year.
	malathion 50EC	2 tsp	3 pumpkin- 1 squash	Do not apply unless leaves are dry.
	Safer Insecticidal Soap 49EC	5 Tbsp	0	
cucumber beetles, flea beetles	carbaryl 50WP 5D	2 Tbsp Apply according to label	0 0	Apply Sevin late in the day to minimize killing pollinating insects. Leaf injury may occur if tender foliage is wet or humidity is high.
	endosulfan 3 D (Thiodan) 9.9EC (Thiodan 0.75)	1 1/4 - 1 ½ /50 ft. row 2 2/3 Tbsp	0 2	Do not make more than 6 applications per year.
	esfenvalerate 0.425%	2 Tbsp	3	
	permethrin 2.5%EC 0.25%D	4 Tbsp Apply according to label	3 0	Do not apply more than 8 times per season.
leafminer	spinosad 0.5%	4 Tbsp	3	A problem on late peas. Maximum of 6 applications per season; wait 5 days before reapplying.
pickleworm, squash vine borer	carbaryl (Sevin) 50WP	2 Tbsp	0	Treat when damage to blossoms or other plant parts is noticed. More of a problem on late squash than early. Direct sprays at base of plants for vine borer control.
	endosulfan 9.9EC (Thiodan 0.75)	2 2/3 Tbsp	2	Apply Thiodan 0.75 weekly or as directed by label. Same precaution for Sevin as with cucumber beetles.
	esfenvalerate 0.425%	2 Tbsp	3	
	permethrin 0.25%D	Apply according to label	0	Do not apply more than 8 times per season.
	spinosad 0.5%	4 Tbsp	3	A problem on late peas. Maximum of 6 applications per season; wait 5 days before reapplying.
squash bug	endosulfan 9.9EC (Thiodan 0.75)	2 2/3 Tbsp	2	
	esfenvalerate 0.425%	2 Tbsp	3	
	permethrin 2.5%EC 0.25%D	As recommended on the label	0	Do not apply D formulation more than 8 times per season.

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
TOMATO aphid	endosulfan 9.9EC (Thiodan 0.75)	1 1/3 Tbsp	2	On foliage as needed. Do not apply more than 6 applications per year.
	malathion 50EC 25WP	2 tsp 4 - 5 tsp	1 1	
	Safer Insecticidal Soap 49EC	5 Tbsp	0	
cutworms	carbaryl (Sevin) 50WP	2 Tbsp	0	Mix WPs in enough water to get sufficient coverage of plants and soil around plants.
	cyfluthrin 0.003% cyfluthrin 0.75%EC	Ready to use formula 1 Tbsp	0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 5 times per season.
	esfenvalerate 0.425%	2 Tbsp	1	
	permethrin 2.5%EC 0.25%D	As recommended on the label	0	Do not apply D formulation more than 6 times per season.
flea beetles, blister beetles	carbaryl (Sevin) 50WP 5D	 2 Tbsp 1/2 lb dust/1000 sq ft	 0 0	Flea beetles are more destructive on new set plants. Blister beetles are more common later in the season.
	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 3/4 oz/50 ft. row 1 1/3 Tbsp	 1 2	 Do not make more than 6 applications per year.
	esfenvalerate 0.425%	2 Tbsp	1	
	malathion 25WP	3 Tbsp	3	
	permethrin 0.25%D	Apply according to label	0	Do not apply more than 6 times per season.
Colorado potato beetle	carbaryl (Sevin) 50WP 5D	 2 Tbsp 1/2 lb dust/1000 sq ft	 0 0	Flea beetles are more destructive on newly set plants. Blister beetles are more common later in the season.
	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 3/4 oz/ 50 ft. row 1 1/3 Tbsp	 1 2	 Do not make more than 6 applications per year.
	esfenvalerate 0.425%	2 Tbsp	1	
	permethrin 2.5%EC 0.25%D	As recommended on the label	0	Do not apply D formulation more than 6 times per season.
	spinosad 0.5%	4 Tbsp	1	A problem on late peas. Maximum of 6 applications per season; wait 4 days before reapplying.

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
TOMATO (CONT'D) leafminer	endosulfan 3D (Thiodan) 9.9EC (Thiodan 0.75)	 3/4 oz/50 ft. row 1 1/3 Tbsp	 1 2	 Do not make than 6 applications per year.
	spinosad 0.5%	4 Tbsp	1	A problem on late peas. Maximum of 6 applications per season; wait 4 days before reapplying.
spider mite	Safer Insecticidal Soap 49EC	2 ½ oz.	0	No more than 3 applications in 2 weeks. Do not apply in heat of day when leaf temp above 90F.
stink bug and leaf-footed bug	carbaryl (Sevin) 50WP	4 - 8 Tbsp/2 1/4 gal	0	
	cyfluthrin 0.003%	Ready to use formula	0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 5 times per season.
	endosulfan 3 D (Thiodan) 9.9EC (Thiodan 0.75)	 1 - 1 ½ oz/50 ft. row 2 2/3 Tbsp	 1 2	 Weekly treatments may be needed for late season control. Do not make more than 6 applications per year.
	esfenvalerate 0.425%	2 Tbsp	1	
	permethrin 0.25%D	Apply according to label	0	Do not apply more than 6 time per season.
tomato fruitworm and hornworm	Bacillus thuringiensis subsp. kurstaki (Dipel, Thuricide and other formulations)	As recommended on the label	0 0	Begin treatments when damage is first noted and repeat weekly until harvest. Handpicking of hornworms is often sufficient if few plants are involved.
	carbaryl (Sevin) 50WP	4 - 8 Tbsp/2 1/4 gal	0	
	cyfluthrin 0.003%	Ready to use formula	0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 5 times per season.
	endosulfan 9.9EC (Thiodan 0.75)	 2 2/3 Tbsp	 2	 No more than 6 applications per season.
	esfenvalerate 0.425%	2 Tbsp	1	
	permethrin 2.5%EC 0.25%D	As recommended on the label	0	Do not apply D formulation more than 6 times per season.
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.

VEGETABLE/INSECT	INSECTICIDE (Active Ingredient) & FORMULATION (Trade Name)	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
TOMATO (CONT'D) whitefly	Pyrethrin (aerosol)	According to label	0	Inspect undersides of leaves when purchasing transplants. Do not buy if whiteflies are observed. Spray underside of leaves; repeat weekly or as directed by label.
	Safer Insecticidal Soap 49EC	5 Tbsp	0	
	Beauvaria bassiana (Mycotrol) ES, WP	see label		
tomato pinworm	endosulfan 9.9EC (Thiodan 0.75)	2 2/3 Tbsp	2	Do not make more than 6 applications per year.
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.
TURNIPS aphid	malathion 50EC 25WP	2 tsp 4 - 5 tsp	7 3	On foliage as needed.
caterpillars	Bacillus thuringiensis subsp. kurstaki (Dipel, Thuricide and other formulations)	As recommended on the label	0 0	Begin treatment when damage is first found and repeat weekly until harvest.
flea beetles, harlequin bug	carbaryl (Sevin) 50WP	2 - 4 Tbsp/2 1/4 gal	14 tops	
WATERMELON aphid	endosulfan 9.9EC (Thiodan 0.75)	2 2/3 Tbsp	2	No more than 6 applications per year.
	Safer Insecticidal Soap 49EC	5 tsp	0	
cucumber beetles	carbaryl (Sevin) 50WP 80WP 5D	 4 Tbsp/2 1/4 gal 1 1/2 Tbsp Apply according to label	 0 0 0	Apply Sevin late in the day to minimize killing pollinating insects.
	esfenvalerate 0.425%	2 Tbsp	3	
	permethrin 2.5%EC 0.25%D	As recommended on the label	0	Do not apply D formulation more than 6 times per season. For use on adult beetles.
rindworms	See pickleworms on cantaloupes, but check label to ensure watermelon is listed.			
spider mite	Safer Insecticidal Soap 49EC	2 ½ oz.	0	No more than 3 applications in 2 weeks. Do not apply in heat of day when leaf temp above 90F.
thrips	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.

*** Rates vary according to manufacturer; read the label to determine the correct rate for the product chosen.**

Listed below are some of the products used to give rate recommendations in the previous tables.

Active Ingredient	Trade Name
cyfluthrin 0.003%RTU	Bayer Advanced Garden™ Lawn & Garden Multi-Insect Killer, Concentrate
cyfluthrin 0.75%EC	Bayer Advanced Garden™ Lawn & Garden Multi-Insect Killer, Ready to use
esfenvalerate 0.425%	Ortho Concentrate Bug-B-Gon® Multi-Purpose Insect Killer
permethrin 2.5%EC	Bonide® Eight Insect Control
permethrin 0.25%D	Ortho Bug-B-Gon® Multi-Purpose Garden Dust$_1$
thiodan 9.9%EC	Dragon Thiodan Insect Spray
thiodan 3D	Dragon Thiodan Vegetable and Ornamental Dust
spinosad 0.5% spray	Ferti-lome Borer, Bagworm, Leaf miner and Tent Caterpillar Spray

NOTE: Slugs and snails can be controlled in home gardens using metaldehyde baits. Consult the label for specific vegetables it can be used on. Grasshoppers and crickets can be controlled in the home garden using a 5 percent Sevin bait.

Insecticides in these tables are listed as active ingredient of the insecticide on one line and the formulation(s) (Trade Name) in lines below. These are suggested formulations, other formulations do exist. If you are unable to find the formulation listed, but can find the active ingredient and formulation, always check the label on the pesticide container to ensure the formulation chosen can be used on the pest or site needed. As always, follow the label directions when applying pesticides.

Fire Ants

Ants occasionally feed on vegetable plants in home gardens. They tunnel into potatoes underground and feed on okra buds and developing pods. The worst damage usually occurs during hot, dry weather. Ants may also be a nuisance to gardeners during weeding and harvesting.

Treatment options

- Ant mounds can be shoveled out of the garden or treated with very hot water, taking care not to disturb or treat the garden plants. Caution should be taken to prevent hot water and/or steam from injuring the applicator.
- A bait, Extinguish (methoprene), is labeled for cropland.
- Since most other baits are not registered for use inside gardens, those baits can be applied around the garden perimeter. Foraging ants from colonies both inside and outside the garden will collect the bait and take it to their colonies.
- To prevent ants from entering a garden, apply insecticidal spray or granules around the perimeter of the garden as a barrier, and treat individual mounds near the garden as needed.

Ways to Minimize Pesticide Use in Gardens

Prevent Pest Problems

Choose the proper site and plants

- Avoid planting your vegetable garden in ground that was in sod within two to threes years. Soil insects are more likely to be numerous in this situation.
- Dig or plow the garden in the fall and again in the spring, at least three weeks before planting, to eliminate weeds supporting soil pests and to expose many pests to drying, cold weather and predators.
- Select resistant varieties when possible.
- Diversify plantings so plants are less visible to pests and natural enemies are better retained.
- Rotate crops to new locations in the garden to aid in reducing insects.

Encourage healthy growth of plants because stressed plants are often more susceptible to pests

- Water plants in the morning to allow foliage to dry (furrow or drip irrigation is preferable).
- Space plants properly because overcrowding of plants can cause water, nutrient, and light stress and "under crowding" can lead to weed problems.
- Control weeds constantly because destruction of a heavy weed stand can cause insect pests to migrate to the crop.
- Mulching is a good way to keep the weeds down in the garden, and it has many other benefits as well.
- Fertilize and adjust pH according to soil test results.
- Planting seeds too deep can cause them to rot before germinating or cracking through the soil.

Inspect regularly

- Inspect plants regularly for pests, pest damage, natural enemies, and conditions that lead to pest problems.
- Friend or foe? You should know! It is important to be able to distinguish pests from their natural enemies (other organisms that kill pests such as syrphid flies, lacewing larvae, parasitic wasps, lady bird beetles, insect-killing nematodes, pathogenic fungi, predatory mites, etc.).
- Early detection of pests can:

  1) reduce the spread of the pest,
  2) reduce the amount of pesticide used and therefore the cost of control, and
  3) allow for use of natural enemies or slow-acting, less toxic pesticides when there is not an imminent threat of damage.

Use alternative control methods

- Handpick pests when the pests are readily seen (Colorado potato beetles).
- Use water to force aphids and others small sucking insects from plants.
- Use physical barriers. Transplants such as tomato, pepper and eggplant can be wrapped with a 4 x 4 inch strip of aluminum foil to prevent cutworm damage and contact with the soilborne southern blight organism. Use 6-inch copper sheeting place 2 inches into ground to block slug invasions.
- Repel insect vectors in tomatoes and cucurbits. Aluminum foil or plastic painted with a chrome-colored paint may repel thrips and aphids.
- Pick vegetables before they are overripe and are more attractive to certain insect pests.
- Encourage the conservation of natural enemies by reducing the amount of pesticide applied.
- Plant flowering plants, such as clovers and Queen Anne's lace, to provide a food source (nectar and pollen) for natural enemies and enhance their control of pests.
- Use pesticides such as microbials (*Bacillus thuringiensis*), botanical insecticides (such as pyrethrum and rotenone), and insecticidal soaps because they have less nontarget effects.

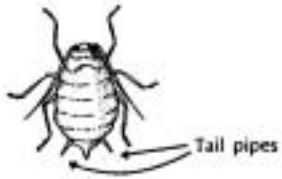
Pictorial Key of Common Adult Insects on Vegetables

Smaller than a period; adults have 8 legs

Spider mites

Larger than a period; adults have 6 legs

Small, soft bodied; 2 tail pipes



Aphids

No tail pipes

Base of front wing is leathery; rear is transparent

Front wings—entirely membranous, finely netted, usually green

Lacewing

Like tiny white moths; wings covered with whitish dust

Whitefly

Front wings entirely hardshelled (beetles)

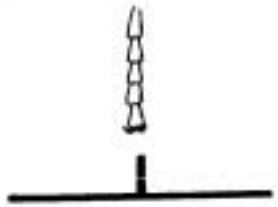
Scutellum almost ½ length of wing

Stink bug

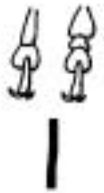
Scutellum much less than ½ length of wing

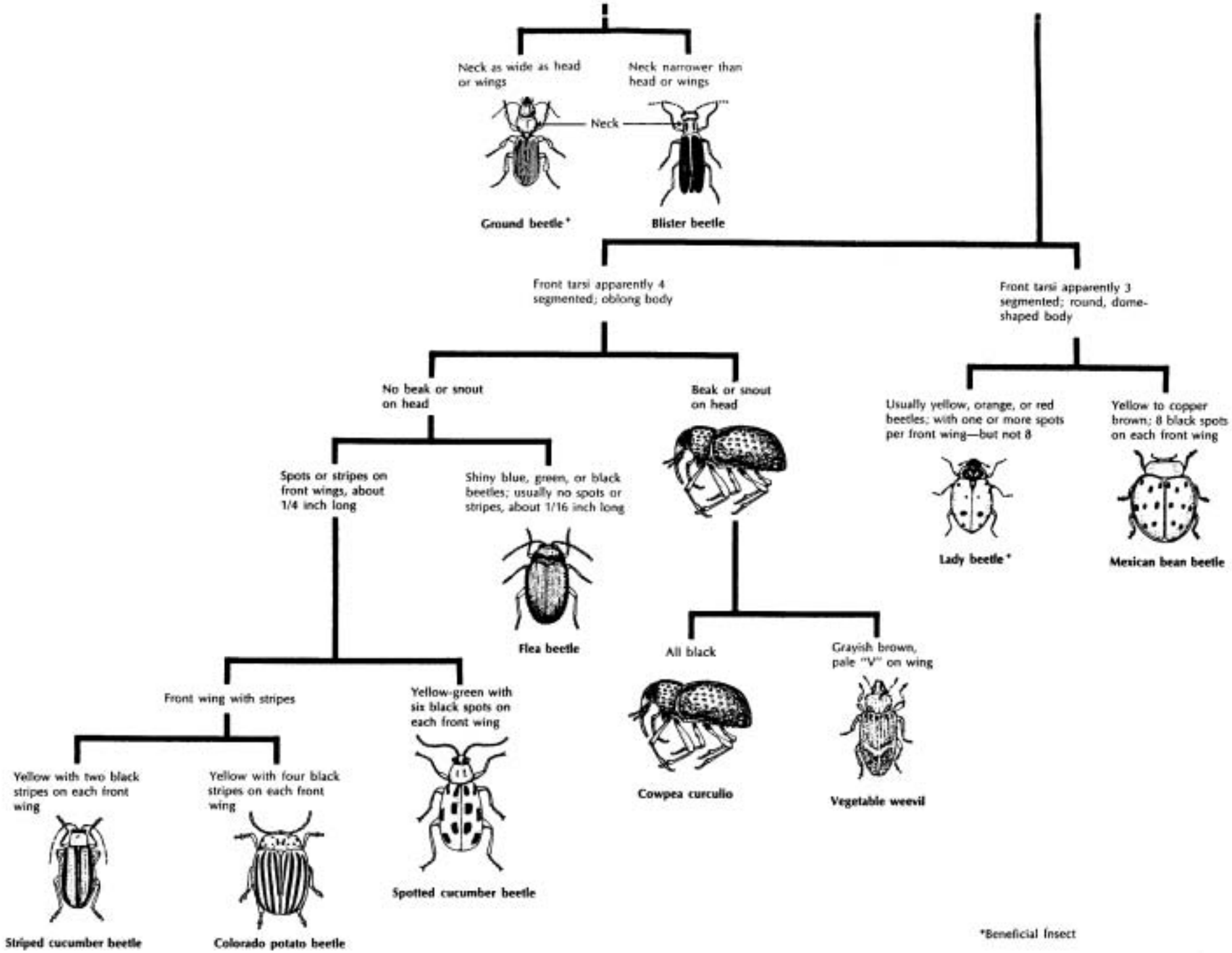
Squash bug

Tarsi (front foot)—5 segmented; beetle usually much longer than diameter of a pencil



Tarsi (front foot) — 3 or 4 segmented; beetle is about as long as or less than diameter of pencil





*Beneficial Insect

Pictorial Key to Common Immature Insect Pests on Vegetables

Not Worm-Shaped (Nymphs)

No tail pipes extending from rear of body

Shield-shaped; brown or green bugs often with orange or black markings; disagreeable odor

Stink bug

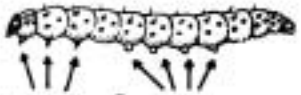
Oblong body; greenish brown often with 2 black spots on abdomen

Squash bug

Tail pipes extending from rear of body

Aphids (Plant Lice)

Worm-Shaped Larvae

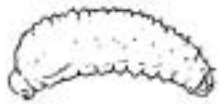


Prolegs present; 6 true legs; caterpillars

No prolegs; 6 true legs; beetle larvae.

No true legs; no prolegs; found in soil

Not transparent; body twice as long as wide; head end distinguished by brown mouthparts



White fringed Beetle Larvae

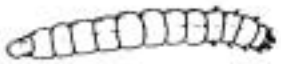
Almost transparent; body four times long as wide; mouthparts not visible

Root Maggots

Found in soil

Found on leaves

Slender, white or brown, hardshelled worms



Wireworms

Fat, soft, C-Shaped, white grubworms

White Grubs

Reddish brown, hump-backed, smooth-skinned grubs without spines

Colorado Potato Beetle

Yellow, spiny larvae causing lacy appearance in leaves of beans

Mexican Bean Beetle

Green, brown, or black larvae without horn at rear of body

Red or black horn at rear of body

Hornworm

Light green to nearly black larvae up to 1¾ inches long with coarse black hairs and alternating light and dark stripes running lengthwise on body; 4 pairs of prolegs

Corn Earworm (tomato fruitworm)

Light green larvae up to 1½ inches long; body makes a looping motion while moving; 2 pairs of prolegs

Cabbage Looper

Light green, cigar-shaped larvae less than ¼ inch long; 3 pairs of prolegs

Diamondback Moth

Leaf green, velvety-skinned larvae; 4 pairs of prolegs

Imported Cabbage Worm

Precautionary Statement

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label. Persons who do not obey the law will be subject to penalties.

Disclaimer Statement

Pesticides recommended in this publication were registered for the prescribed uses when printed. Pesticides registrations are continuously reviewed. Should registration of a recommended pesticide be canceled, it would no longer be recommended by the author. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product.

Vegetables

Care of the Vegetable Garden

A productive garden requires considerable attention and care. Insects, diseases and weeds must be controlled; water and nutrients must be supplied; plants must be supported; and harvests must be made at the proper time for best flavor, yield and nutritional quality. This factsheet discusses these practices.

Weed Control

Lack of proper weed control probably limits production in home gardens more than any other production practice. Weeds compete with vegetable plants for water, nutrients and sunlight and must be controlled if garden vegetables are to grow and produce well. Weeds also serve as a refuge for insects, as well as alternate hosts for diseases. Weeds may be controlled by cultural practices, mechanically, chemically or by a combination of these three practices.

Begin cultural controls by preventing weeds from developing mature seed. Maintain clean cultivation while vegetables are growing. Whenever vegetables are not present in the garden area, mow or turn under weeds before they develop seed.

Weeds are easiest to remove when they are small. Hoe or till frequently, but shallowly so as not to cut vegetable roots or allow valuable moisture to escape. Pull weeds directly in the row by hand. Weeds pull easier with less damage to surrounding plants when the soil is moist.

Use mulches to control weeds and to retain moisture. Both black plastic and various organic mulches may be used.

Black plastic mulch absorbs sunlight and speeds warming of garden soils. Lay strips of black plastic over previously fertilized and worked garden soils a week before planting. Weight the edges of the strips with soil. Cut slits or x's in the strips at the desired locations and seed or transplant through them. A sharpened bulb setter may also be used to cut holes in plastic mulch.

Commonly used organic mulches include leaves, straw, compost, rotted sawdust and grass clippings. Be careful when collecting grass clipping and leaves not to collect weed seed. These light-colored mulches reflect sunlight and are best used around cool-season plants or on warm-season plants when the soil temperature has become sufficiently warm. Apply them 2 or 3 inches thick and turn them under at the end of the growing season. The few weeds that grow through organic mulch can be easily pulled.

Commercial vegetable growers use a wide range of chemicals (herbicides) to kill weeds or to prevent weed seed from germinating. Herbicides are very difficult to use in the home garden. None are effective on all weeds, last all season or are labeled for use on all vegetable crops. They are also difficult to apply uniformly to small plots, often must be purchased in large containers and can be quite expensive. A good understanding of herbicides is essential for proper use.

Disease and Insect Control

Garden vegetables are susceptible to a wide variety of insect and disease problems. Unless these problems are controlled, they will reduce yield and quality and may cause crop failure.

Begin control of insects and diseases with sanitation and common sense. Turn insect- or disease-infested plant residues under soon after harvest or remove them from the garden plot. Do not save seed from diseased plants. Support tall-growing, non-supporting vegetables such as tomatoes and cucumbers as needed. Space rows and plants within rows far enough apart so air can circulate freely. Time plantings to avoid the worst pest problems whenever possible. Avoid sprinkler irrigation late in the afternoon, as wet plants are more susceptible to certain diseases. If overhead irrigation is used, apply water just before sunrise. If applied then, the plants are already wet and will dry during the morning hours like normal.

Rotation of plant families between different sections of the garden in successive years will reduce some insect and disease problems. Peas and beans, for example, are in the same plant family and are susceptible to many of the same insects and diseases. Other common vegetable families include cucurbits (squash, pumpkins, muskmelon, watermelon and cucumbers); crucifers (cabbage, cauliflower, broccoli, kale, collards, kohlrabi, turnips, mustard and radish); and solanaceous vegetables (Irish potatoes, peppers, eggplants and tomatoes).

Grow disease-resistant varieties whenever they are available. Many of the varieties recommended in the other factsheets of this series are resistant to one or more disease problems. These varieties are not immune to disease problems, but frequently will bear a respectable crop despite the presence of one or more diseases.

Use non-chemical means of insect control when they are available and adequate. These include sanitation, barriers, repellents, traps and baits. Encourage beneficial insects and birds. When only a few large insects are present, they may sometimes be successfully removed by hand.

Frequent observation (scouting) of the garden is yet another key to the control of insect and disease problems. Walk through the garden at least every two or three days and look for problems. Identify the insect or disease and its recommended treatment before the problem becomes severe. Your county Extension office and the UT references listed at the end of this factsheet can provide the most current recommendations.

Use the least toxic recommended control measure before a problem gets out of control. Consider, for example, insecticidal soaps, summer oils, microbial agents such as *Bacillus thuringiensis* (*Bt*), botanically derived chemicals like rotenone and traditional agricultural chemicals. Whatever you decide to use, **be sure to follow the label instructions exactly**. Chemical labels list a wealth of information such as pests controlled, vegetables on which the chemical may be used, how long after application before the vegetable may be harvested, etc. **It is illegal and can be harmful both to yourself and to the environment to use agricultural chemicals for any purpose or in any manner not permitted by the label**.

Since you will get better coverage of the entire plant with a spray, you will generally be more successful controlling insects and diseases with a spray than with a dust. Use a tank-type sprayer where water and the control agent are mixed together and considerable pressure can be obtained. Be sure to treat the lower side of the leaves and stems, as insect and disease problems frequently originate there.

Fertilization

A soil test should be taken and an analysis performed. Lime should be applied in the fall or first thing in the spring, while a complete fertilizer containing nitrogen, phosphate and potash should be applied prior to final soil preparation.

In addition, vegetables grown primarily for their leaves and those with an extremely long growing or production season usually benefit from nitrogen sidedressings. Sidedress nitrogen by sprinkling ammonium nitrate or another high-nitrogen fertilizer beside the row or around individual plants. Keep the fertilizer at least 6 inches away from the base of the plants if possible, and brush off any that remains on the leaves. Excessive ammonium nitrate or ammonium nitrate applied too near plants will damage them.

Side dress cucumbers, cantaloupe, pumpkins, watermelon and winter squash with 1 to 1½ pounds of ammonium nitrate per 100 feet of row or 1 tablespoon per plant when the vines are 1 foot long. Use the same amount on tomatoes, peppers and eggplants when the first fruit is about 1 inch in diameter and once a month thereafter. Sidedressing earlier or at higher rates can cause the flowers and small fruit of these vegetables to abort.

Use 1 to 1½ pounds per 100 feet of row or 1 tablespoon per plant on broccoli, cabbage and cauliflower three or four weeks after planting. Use the same 1 to 1½ pounds per 100 feet of row on corn when it is 8 to 12 inches tall and on okra after the first harvest. Use 2 to 3 pounds on greens six weeks after seeding.

Other fertilizers may be used to sidedress vegetables, but the amount must be adjusted so the actual nitrogen

applied is the same as that contained in the above-suggested amounts of ammonium nitrate. An example of another fertilizer is field-grade calcium nitrate. Calcium nitrate is an excellent nitrogen source for vegetable crops, but must be used at twice the rate of ammonium nitrate.

Irrigation

To maximize production, vegetables require from 1 to 2½ inches of water per week, depending on the stage of development, as well as environmental conditions. Vegetables require less water early in the growing season when they are small and more when they are large and during certain critical growth stages. Most years have dry periods when irrigation will greatly benefit plant growth, yield and ultimately quality.

Gardeners commonly irrigate with a lawn sprinkler. Apply water slowly to reduce erosion and runoff. Place cylindrical containers in the irrigated area to measure the total water applied and its distribution. Apply 1 to 1½ inches of water, then do not irrigate again for several days. Frequent shallow watering promotes shallow root growth. Shallow roots will require more frequent watering than roots that are distributed deeper in the soil. Shallow plant roots are also easily damaged by cultivation.

To reduce the incidence and/or spread of disease, irrigate early in the day so plants dry before evening. Since the plants are already wet with dew, the ideal time to irrigate is just prior to sunrise. The dew and added water should dry by mid-morning, minimizing the time plant tissue is wet.

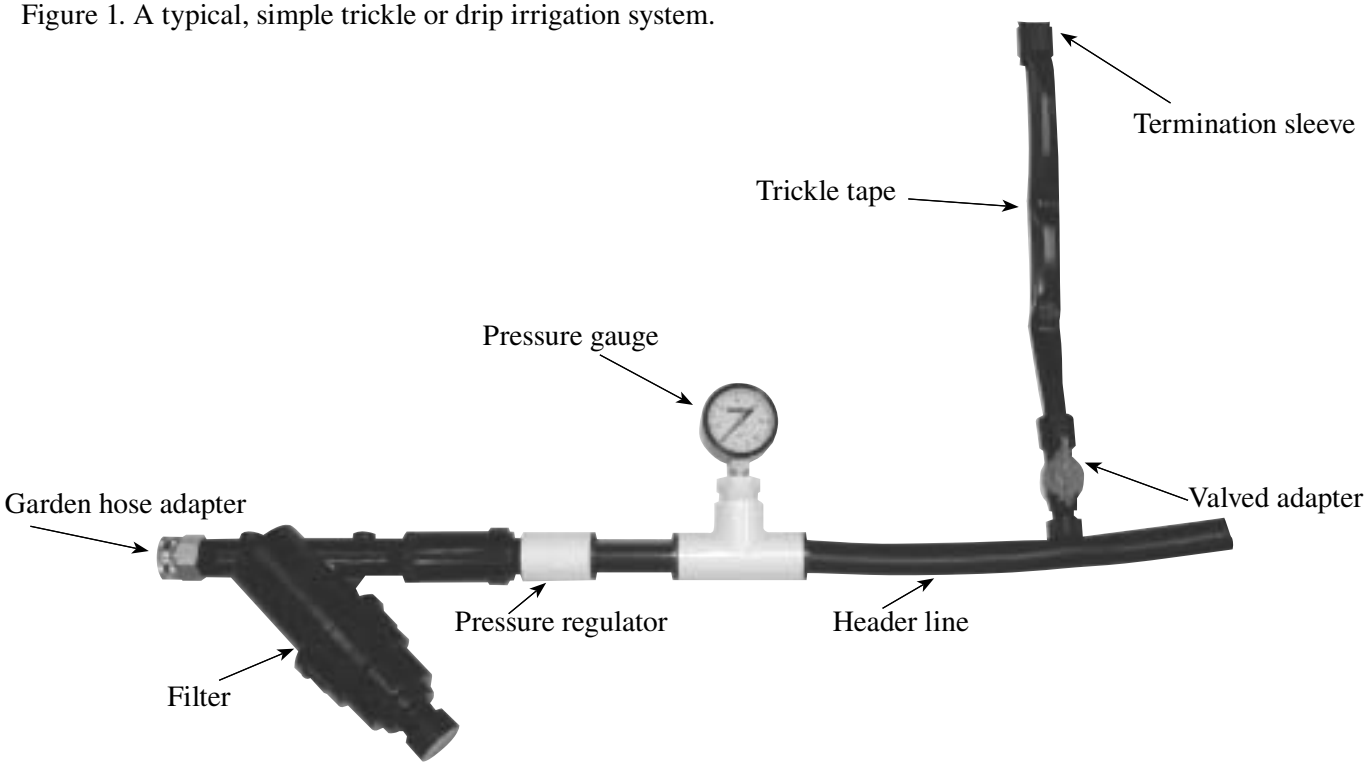
Cultivation prior to overhead irrigation will increase water infiltration and reduce runoff, as well as subsequent erosion. The crust that forms after irrigation will reduce evaporation.

Several forms of trickle irrigation are also available for use in home gardens. Trickle irrigation has the advantages of reducing total water usage by up to 50 percent, not wetting plant foliage and maintaining relatively dry aisles between rows. This enables watering and walking in the garden nearly simultaneously while reducing weed growth, disease problems and soil compaction. However, a trickle irrigation system may be somewhat expensive to purchase.

Trickle or drip systems generally consist of several parts. An example of a simple drip irrigation system is illustrated in Figure 1 below.

Depending on the system, an adapter from garden hose threads to national pipe threads (NPT) may be required. Next, a back- flow preventer should be connected to the water source to prevent reverse water flow into the source. A screen or disk filter should be placed in the line after the back-flow preventer. Even well and municipal water can contain sand or other minute particles that could plug drip tape. Therefore, a filter is essential for all systems. Next, a 10- to 12-psi pressure regulator should be connected. Most trickle tape is designed to operate at 8 to 10 psi. If the pressure is allowed to drop below 6 psi, the water "free-flows,"

Figure 1. A typical, simple trickle or drip irrigation system.



running to low points or flowing out at the beginning of the tape.

A header hose that extends across the end of the garden attaches to the end of the pressure regulator. Soaker hoses or trickle tape (thin-walled polyethylene pipe with emitters spaced about a foot apart) are placed beside each row and connected to the header hose at the end of each row. The last, but not least, component of the drip irrigation system is a pressure gauge. If you do not know the pressure on the system, you do not know if it is operating correctly. If using only one gauge, place it at the highest point in the field. If two or more gauges are used, place one at the end of the longest row, and one at the highest elevation in the field.

A soaker hose is a non-engineered product made of ground tires. It is generally inexpensive, but since it is not "engineered," it is not uniform in water application. Another disadvantage is that wildlife and rodents like to chew on the extruded rubber product. This makes large holes that magnify the lack of water uniformity.

If taken care of properly, the adapter, back-flow preventer, filter, regulator, header line and gauges should last several seasons. If damage from wildlife and/or rodents is prevented, soaker hoses may be used for multiple seasons. Occasionally trickle tape can be reused. However, trickle tape is relatively inexpensive, and it may be easier to discard the old and use new tape next year.

Plant Supports

Yields of certain vegetables are higher, quality is increased and losses from fruit rot are reduced when plants are grown on supports.

Support the taller English peas varieties, pole beans and half runner beans vertically on stakes, trellises or wires. Support tomatoes on individual 6-foot stakes or with cages made of 6-foot lengths of concrete reinforcing wire. Tomatoes grown in cages do not need to be pruned, but do need to have their growing ends pushed back into the cage every other day or so. Fasten the cages to stakes or provide support to prevent cages from blowing over.

Vigorous varieties of peppers may also benefit from trellising. Tying the plants to a stake will reduce lodging.

Ten-foot lengths of concrete reinforcing wire made into a circular cage may be used to support cucumbers. Plant the seed around the outer edge of the cage and assist the plants in beginning to climb by pushing them into the cage.

Frequent Harvests

Many vegetables quit setting fruit unless they are harvested frequently. These include cucumbers, summer squash, okra and green beans. Never allow fruit that is over-mature to remain on these plants if you want the plants to continue producing. If you want to save seed, save seed from some of the last fruit set rather than from the first.

Over-mature fruit are also more susceptible to diseases, as well as attractive to insects.