23

Establishment and Management of an Orchard

Purpose and Expected Outcomes

The purpose of this section is to discuss the general principles and cultural practices employed in the establishment of a small-scale fruit orchard.

After studying this chapter, the student should be able to

1. Discuss the establishment of an orchard.
2. Discuss the management of an orchard.

Overview

The science and art of producing and marketing fruits and nuts is called *pomology*. The classification of fruits was presented in Chapter 2. Vegetable fruits are discussed in Chapter 20. These fruits are usually annual plants or cultivated as such (e.g., tomato and pepper). Further, the term *fruits* technically includes nuts, which are dry fruits. However, the terminology *fruits and nuts* is conventionally used to make the distinction between the two kinds of fruits. The discussion in this section is limited to fruits borne on trees (**fruit trees** or tree fruits).

Fruit Trees
Trees that bear fleshy fruits.

23.1 Importance of Fruit and Nut Trees

Fruit and **nut trees** are utilized for food and are also found in the landscape. They are used as shade trees and as ornamental plants. As sources of food, fruits are rich in vitamins (A, C, B_6, and folacin) and minerals (potassium, magnesium, copper, and iron). Fruits are important sources of fiber in the diet, and the pectins they contain are known to be effective in controlling blood cholesterol levels. Important temperate fruits include apple, pear, peach, plum, cherry, and apricot. Nuts are dry fruits. Generally, they are also rich in vitamins (riboflavin, thiamin, and niacin) and minerals (calcium, phosphorus, iron, and potassium).

Nut Trees
Trees that bear dry, indehiscent, single-seeded fruits with a hard pericarp or shell.

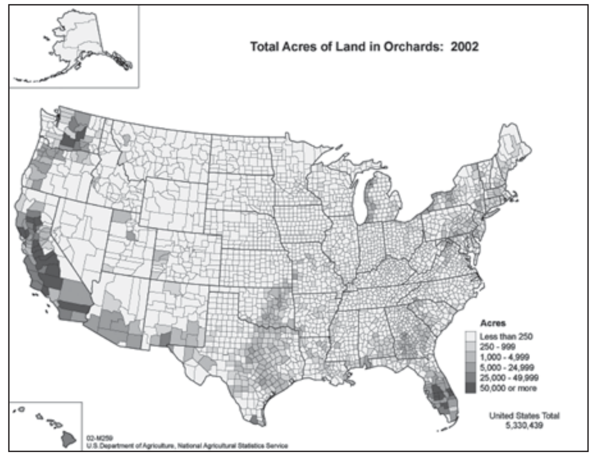

FIGURE 23–1 Geographic distribution of orchards in the US. *(Source: USDA)*

23.2 Production Regions

Deciduous tree fruit (e.g., apple, pear, sweet cherry, plum, nectarines) production is currently concentrated in the Pacific Northwest states of Washington, Oregon, and Northern California (Figure 23–1). These regions benefit from the temperate, dry conditions and the water from snowmelt from the mountain ranges that feed the streams and rivers for irrigation use. The region is influenced by the Pacific Ocean that tempers the climate during the winter. The mild winter temperatures (0–10°C) are ideal for developing dormancy as well as for the chilling treatment needed by trees. Citrus production is concentrated in Florida.

23.3 Locating a Fruit Orchard

Orchard
A parcel of land devoted to the cultivation of fruit trees.

The success of an **orchard** depends on the soil, site, and management of the enterprise. Areas in the United States where commercial orchards occur in large numbers include the Great Lakes region, the Central Valley of California, the Washington Valley, and the Fort Valley Plateau of Georgia.

These areas are characterized by climatic and soil conditions that are ideal for fruit tree production. However, the home grower living outside of these ideal regions can successfully grow adapted fruit trees by observing certain basic factors described in the following sections.

23.3.1 TEMPERATURE

Temperature-related injury to fruit trees can occur in any of the four seasons—winter, spring, summer, or fall. The U.S. Department of Agriculture (USDA) hardiness zone map should first be consulted in deciding the kind of fruit plants to grow. The effect of temperature is moderated by the presence of features such as hills and large bodies of water. Low winter temperatures can damage not only flower buds but also the whole plant. To prevent frost injuries, low-lying areas should be avoided. The upper parts of hills are preferred for fruit culture.

All fruit crops are prone to damage as a result of a late spring freeze, when blooming occurs. Because the blooms are sensitive to low temperature, they are easily damaged permanently when temperatures drop to about −22.2°C (28°F) or lower. The freeze may occur by one of two mechanisms, which are wind dependent. On a windless, calm night, freezing can occur in spring when cold, heavy air settles in low-lying areas. This type of freeze is called *radiation freeze*. By locating the orchard on higher grounds, damage from this type of freeze is minimized. On the other hand, crops can be exposed to cold temperatures under windy conditions, called *advective freeze*. This wind-aided freeze is problematic because it is difficult to protect crops from it.

When late-maturing cultivars are planted, they are prone to freezing in early fall. Certain fruit trees such as apple are intolerant of the high heat prevalent in summer. The orchard should thus be located on the northern or eastern slopes in regions in the Northern Hemisphere.

23.3.2 LIGHT

Light is critical to fruit tree productivity, which is highest in full sunlight. It is important for light to penetrate the plant canopy to reach the inner fruiting branches for fruiting to occur; fruit trees must thus be pruned to open up the canopy to increase reproductive growth. Certain fruit trees exhibit a photoperiodic response by slowing growth in one season or producing flowers only under certain light conditions.

23.3.3 WATER

Fruit trees need adequate soil moisture for proper growth and good yield of high-quality fruits. Fresh fruits may consist of about 90 percent or more water. However, they are intolerant of waterlogged conditions. In fact, a significant amount of fruit production occurs in areas where rainfall is inadequate to sustain production. These dry areas depend on irrigation for successful production. Fruit trees, especially in dry regions, are irrigated by *microirrigation methods* (drip). It is critical that the trees have adequate moisture during the last 30 days of fruit development. An erratic or insufficient moisture supply leads to reduced productivity, and the fruits grown under such conditions are prone to physiological disorders.

23.3.4 SOIL

The soil should have a good texture that poses minimal resistance to root penetration and is easy to till. Sandy loams are ideal for fruit tree production. Fruits such as peach, nectarine, and apricot prefer well-drained, coarse-textured soils in the region of sand or silt loams. Cherry prefers silt loams, while apple grows well on silt loams to clay loams. Pear and quince, on the other hand, prefer finer-textured soils in the region of silt loam to clay. In considering soil, one should pay most attention to the texture of the subsoil. It might be necessary to use a subsoiler (a plow capable of being operated to depths in excess of 15 inches [38.1 centimeters] to break any pans that may occur at the site) as part of the land preparation activity.

The soil used for fruit tree production should be deep (4 to 6 feet deep or 1.21 to 1.82 meters). Peach and nectarine are deeply rooted and require deep soils, while pear and quince are not as deeply rooted. Tree roots prefer freely draining soil. Excessive moisture in the soil in spring (during bud and shoot development) is undesirable; the water table should not be high. Further, accumulated irrigation water or rain water should drain within a few days. Certain fruits such as peach and nectarine perform best under very well-drained soil conditions.

23.3.5 SLOPE

The slope of the land should encourage both air and water drainage. Land that is very flat is not desirable unless it occurs at a higher elevation than the surrounding land. Thus, valley floors and river bottoms are not good fruit tree lands, because they are prone to flooding and frost damage. Land with excessive slope is difficult to cultivate and manage and soil erosion is likely. Generally, a 1 to 10 percent slope is acceptable. Further, west slopes should not be selected in cold regions or areas of high elevations since they may not have sufficient heat units to properly mature the crop. North slopes minimize the potential for plants to be damaged by frost or sunburn. However, these sites provide conditions that delay the blooming of plants and thus also harvesting.

Most fruit trees perform well on slightly acidic soils (pH 5.5 to 6.5). Some plants, including plum, prefer a soil pH of 6 to 7. In terms of choosing a site for fruit tree production, one should pay more attention to the soil's physical characteristics, since soil fertility can be readily amended.

23.3.6 LABOR

For a small garden, labor is usually not a problem. However, for a large operation, labor is needed for fruit harvest and also for various pruning operations. A commercial orchard should be located where seasonal labor is readily available and affordable.

23.3.7 MARKET

Home gardens are designed primarily for home consumption. However, contingency plans should be made to handle surplus produce. The surplus can be preserved by processing it in a variety of ways. If a large operation wishes to serve the general public, markets and marketing strategies should be carefully considered. Dry fruits can be stored for long periods. However, fresh produce is highly perishable and thus markets must be known before production. Strategies for marketing were further discussed in Chapter 27.

23.4 PROPAGATION

Fruit tree production depends on the selection of the right cultivar. The right cultivar is adapted to the production area, resistant to major diseases in the area, high yielding, of desirable quality, and ripens to coincide with market demands. Planting materials are of two basic types—asexual and seed.

23.4.1 ASEXUAL PROPAGATION OF FRUIT TREES

Asexually propagated planting materials are widely used in establishing orchards. These seedlings are produced by either grafting or budding. In selecting cultivars, one should pay attention not only to the fruit cultivars (the scion or bud cultivar) but also to the rootstock. Rootstocks are used for several purposes, as already described in Chapter 10. They are resistant to soilborne diseases and insect pests and tolerant of the local soil conditions (to which the fruiting cultivar is not). Such conditions include pH, salinity, and soil moisture. Sometimes dwarfing rootstocks or mauling rootstocks are used to dwarf the plant and control its size. Suitable dwarfing rootstocks are available only for certain fruits. Asexual propagation ensures that the fruits produced are true to variety (true to type). Certain fruit species are asexually propagated but without grafting or budding. The planting materials are raised from cuttings, suckers, layers, and other methods. Species amenable to such procedures include olive, fig, quince, and pomegranate.

23.4.2 PROPAGATION OF FRUIT TREES BY SEED

Propagation of fruit trees by seed results in fruits that are not true to type, due to the consequence of meiosis. The degree of deviation from type depends on the species in question. Seeds are needed sometimes to produce the rootstock (or understock) used in asexual propagation. Most fruit seeds need special treatment to germinate. The causes of delay in germination for fruit seed are several, the most common being dormancy of the embryo. When embryo dormancy occurs, the seed must undergo a period of postharvest physiological modification (after ripening) at the appropriate temperature and in the presence of air and moisture. In practice, after ripening of seed is accomplished by stratification. It entails mixing seed with a moisture-holding material such as peat, sawdust, or even sand. These materials are also porous enough for aeration. The mixture is then held at a cool temperature in storage for the appropriate duration according to the plant species. Plum and apple seeds require stratification at 1 to 5°C (34 to 40°F) for about 60 to 90 days, while peach is stratified for 75 to 100 days at 0 to 7°C (32 to 45°F). Black walnut and hickory may be stratified at 1 to 10°C (33 to 50°F) for about 60 to 90 days.

Certain seeds experience a delay in germination caused by a hard seed coat. In this instance, the seed may be soaked in hot water (or dropped in boiling water momentarily), mechanically scratched (scarification), or soaked in sulfuric acid.

23.5 The Annual Cycle of a Fruit Tree

A temperate fruit tree undergoes a certain developmental cycle during which a number of physiological and developmental changes occur. These changes are influenced by the environment. In winter, fruit trees enter a dormant period that affects seeds and buds. This type of dormancy, *endodormancy*, is caused by certain internal, physiological mechanisms. Upon exposure to cold temperature, the dormancy is effectively broken. This *winter chilling requirement* is essential for the plant to be prepared for proper development when spring arrives. For most fruit trees, the winter chilling requirement temperature is 7°C (45°F) or lower. The duration of chilling varies both within and among species.

Springtime brings the warm temperatures and heat units needed for the dormant buds that have been successfully winter chilled to develop into either flowers or shoots. At some point during the growth cycle of the tree, the flowers become pollinated, fertilized, and then produce fruits. Many trees have an inherent capacity to self-regulate the load of fruits borne during the season by the process of self-thinning. Excessive blossoms as well as fruit drop occur at certain times. However, species such as apple and peach are ineffective in self-thinning. Generally, fruits require seed development for fruits to set properly. As previously indicated, fruits differ in growth pattern. Apple development follows the classic sigmoid curve, while peach development follows the double sigmoid curve.

Flower buds for the next year's crop are formed in mid- and late summer. Deciduous fruits generally follow this pattern. The environmental conditions must be appropriate for the desired number of fruiting branches to be formed. An unfavorable condition may cause most buds to develop into vegetative buds. Fruit tree flowers are generally perfect. However, fruits such as walnut and pecan are monoecious. Endodormancy starts in the late fall, and plants remain in this state until winter chilling occurs to break the dormancy.

23.6 Spacing Fruit Trees

The proper spacing among trees in an orchard is determined by the following:

1. *The adult size of the plant.* Trees grow slowly but eventually occupy a significant amount of space. It is important to know what size the plant will ultimately attain before deciding on plant spacing for the orchard.
2. *Rootstock.* Certain rootstocks, as previously discussed, have the capacity to affect the size of the fruiting cultivar. While some rootstocks have a dwarfing effect (e.g., M9 in apple), others, such as MM1110, enhance the growth of the flowering cultivar.

3. *Growing environment.* The growing environment determines how much of the plant's potential will be achieved in cultivation. Under conditions of proper temperature, high soil fertility, and adequate moisture, plants generally grow large.
4. *Predetermined planting density.* In terms of tree density, three strategies of planting are adopted in orchards. Stone fruits and nuts are highly productive under a *low-density* planting strategy (with a plant population of about 250 trees per hectare [100 trees per acre]). Using dwarfing rootstocks enables the grower to increase plant density because of the size-reducing effect of the rootstock. This practice allows a *high-density* strategy to be adopted whereby a plant population of 500 to 1,235 plants per hectare (200 to 500 plants per acre) can be achieved. This close spacing is employed under intensive plant culture; effective management and high fertility are required for success. Operations using close spacing make use of various plant training systems, coupled with regular pruning to control growth and plant size. Fruit trees may also be spaced moderately in the orchard. This *medium-density* spacing is possible if plants are small in adult size. It allows a density of about 250 to 500 plants per hectare (100 to 200 plants per acre).

23.7 Fruit Tree Planting Styles

Trees in an orchard may be arranged in one of several ways, the most common being the *square system*. In this system, all plants are equally spaced between adjacent plants. The *quincunx* arrangement is a variation of the square system whereby the permanent crop is interplanted with a temporary crop that is grown, harvested, and completely removed from the field after several years. Consequently, the open space between trees is utilized until the trees have attained adult size. Other plant arrangements are also in use.

23.8 Growth Regulators

Growers of certain tree fruits like apples and pears use growth regulators to modify tree growth and structure, remove excess fruit (fruit thinning), modify fruit maturity, and for preharvest drop control. Training plants successfully requires that seedlings have a certain minimum number of branches (3–5) arranged in a certain way. Growers may use growth regulators to stimulate additional branching for the specific training system to be used. Those consisting of cytokinins and gibberellic acid (e.g., Promalin, Typy) help stimulate additional branch growth. Excessive shoot growth may be suppressed by applying growth regulators like Apogee®. Another important application of chemicals in tree fruit production is the use of growth thinners (containing, e.g., NAA, 6-BA) to control actual fruit size and to sustained high productivity of the tree. Growth regulators are also used to manage fruit harvest. Application of a chemical like ReTain on apples can help expand the harvest window while fruit retain their firmness without dropping. Delayed ripening can promote proper and more complete fruit red color development provided warm days and cool nights persist. Other fruit disorders associated with ripening (e.g., water core, stem end cracking) can also be reduced with such treatment.

23.9 Pest Control

Nematodes are an economic pest in fruit crop production. They parasitize on tree roots, reducing vigor and crop yields. Also, they predispose tree fruits to diseases and reduce winter hardiness of the plants. The tomato ringspot virus (ToRSV) is transmitted by the dagger nematode (*Xiphinema* spp.) and causes peach stem pitting and apple union necrosis. Perhaps the most widely known nematode pest of fruit trees is the root-lesion nematode (*Pratylenchus penetrans*) that destroys the tissue of the cortex, promoting infection by root-rotting microbes. Nematode control in orchards is challenging. Growers may use nematicides or cultural practices in their orchards. Treating the soil prior to planting trees will not only help control parasitic nematodes, but also reduce the incidence of soilborne viral infections (e.g., stem pitting in stone fruits and union necrosis in apple). Fumigation with broad-spectrum fumigants is also effective.

Tree fruits are also attacked by numerous insect pests and other pathogens. Common diseases include scabs, mildews, blotches, cankers, and rots. Insect pests include aphids, leaf miners, borers, scales, moths, and various hoppers and flies. Mites also plague fruit trees.

Pest control in orchards is accomplished by two basic kinds of spraying—tree spraying for disease and insect pests and ground spraying for weed control. Aerial spraying of trees is commonly achieved by using air-blast sprayers, while hydraulic sprayers are used for herbicide application. The use of herbicides in orchards has the advantage of eliminating tree bark damage from mechanical weeders and leaving the soil undisturbed, thereby reducing soil erosion.

23.10 Ground Covers

It is important to prepare the soil prior to fruit crop establishment such that perennial weeds are excluded from the field. It is best to establish a ground cover of grass at least a year prior to planting the crop. An application of 2,4-D helps to eliminate perennial weeds. Immediately before planting, the rows where the trees will be planted should be treated with glyphosate or paraquat to kill the grass to facilitate planting.

23.11 Harvesting

Producers should establish the proper harvest maturity for the crop for optimal produce quality. A schedule of harvesting should be planned ahead to enable labor to be scheduled for the operation. The optimal harvest maturing depends on the cultivar, the intended use, and postharvest storage and shelf life desired. Proper timing is of the essence since prematurely harvested fruits are less flavorful, have poor color and taste, small fruit size, and poor storage. On the other hand, delaying the harvest operation can predispose the fruit to developing watercore, excessive softness, and reduced storage and shelf life.

Maturity indices have been developed for various fruits. Elements in these indices include starch, sugar, acid content, fruit firmness, flesh color, and seed color, as well as presence of watercore and internal ethylene concentration (requires the use of a gas chromatograph). These elements are not equally important. Background color, starch content, and firmness (e.g., by using the Effigi fruit tester) are key indicators since they correlated well with sugar content, flavor, aroma, texture, acidity, and shelf life. Fruits with poorly developed background color will fetch low prices on the fresh market. Other key factors to consider include the immediate use of the crop. Will the fruit be sold on the fresh market or for processing? Is the fruit climacteric or nonclimacteric? If the fruit color will not change in storage, it is critical to harvest it at peak color in the field.

23.12 PRUNING AND TRAINING

Training and pruning are critical operations in orchard management for high and sustained productivity of tree fruits. Pruning of tree fruits is discussed in detail in Chapter 19.

OUTCOMES ASSESSMENT

1. Discuss the geographic distribution of orchards in the United States.
2. Discuss the key factors to consider in locating an orchard.
3. Discuss the importance of pruning and training in orchard management.
4. Discuss the propagation of tree fruits by vegetative methods.
5. Discuss the use of growth regulators in orchard management.