Chapter 12

Fruits and Nuts

Learning Objectives

1. Understand the importance of ideal site selection in the production of fruit and nuts.
2. Understand the ideal site conditions for planting fruit trees, nut trees, vines and several small fruit plants.
3. Understand how to choose and plant healthy fruit and nut bearing plants.
4. Understand methods of proper pruning and training of fruit/nut trees and vines.
5. Understand what varieties to plant and when to harvest various fruits and nuts.
Growing fruits and nuts in the home garden can be very rewarding. However, the key to success is realizing fruit and nut production involves a series of important, timely tasks. Master Gardeners will encounter many questions as home orchards and edible landscaping become more popular. It is important that volunteers learn how each type of fruit and nut produces and how and when to prune, pollinate and fertilize so healthy plants and good harvests can be grown. Each of these practices should be considered as part of a puzzle. If all of the pieces of the puzzle are present and put in their proper place, positive results can be assured. However, neglecting any of these areas will jeopardize the effectiveness of the other practices, resulting in reduced yields and quality.

**Tree Fruits, Tree Nuts and Grapes**

**Site Selection**

For commercial fruit and nut growers, site selection is considered to be the most important of the thousands of management decisions to be made throughout the life of the planting. The fact that non-commercial fruit and nut growers generally do not have a lot of choices in site selection does not diminish the importance of this area in any way. Yields, crop quality and plant longevity will be greatly affected by site. Consider the following criteria in deciding where to plant:

- With few exceptions, during the growing season fruit and nut crops need to be planted where they can receive full sun throughout most of the day. As shade levels increase, tree and vine growth becomes spindlier and the number of fruit buds formed declines and finally ceases. Disease pressure also increases as shading increases. Also, large trees that shade plantings can provide competition for moisture and nutrients.

- Pawpaw is one of the few fruit crops that will tolerate shade. In fact, shading is very desirable for young trees. With time, the need for shade decreases; however, even mature pawpaw trees will benefit from light shading.

- Elevated sites are very desirable for fruit and nut production. Such sites are less prone to frost, dew and therefore, disease problems. Frost and dew cause disease problems because the longer plants remain wet, the greater the likelihood of certain diseases occurring.

- In site selection, elevation refers to height in comparison to other land in the immediate area - not feet above sea level. It is quite common to see a 5- to 10- degree F rise in minimum temperature on a spring night for every 100 feet increase in vertical height of the site. Therefore, on some nights, frost may settle on low areas but not on elevated areas.

- Hilltops offer the advantages previously outlined. However, wind on some of these sites may impair tree training and spray application. In addition, hilltops are frequently more eroded than hillsides, so rooting depth and water-supplying capacity of the soil may be compromised.

- The direction of slope for a fruit and nut planting is not as critical as elevation. Plants on a south to southwestern slope tend to experience more winter injury and spring frost problems than those on other slopes. On the positive side, these
plants will likely ripen earlier. Plants on a northeastern slope stay dormant a little longer in the spring. However, due to exposure to morning sun, these plants dry off earlier in the day and may experience less disease pressure than plantings on the other slopes. If other factors are similar, direction of slope can be considered as a way to make a final decision among several sites.

- Soils having poor internal or surface water drainage should be avoided or modified prior to planting. During the growing season, fruit and nut crops situated in waterlogged soils will be injured within a relatively short period of time.

- Under good soil conditions, fruit and nut crops tend to be relatively deep rooted. Planting in sites having less than 24 to 30 inches of rooting depth often causes problems. Under prolonged cold or wet conditions, plant injury is quite likely. Also, fruit and nut trees will be poorly anchored due to restricted root systems.

- The ideal soil pH for most fruit and nut crops is 6.0 to 6.5. When soils are too acidic, the pH can be modified through
the addition of lime, or by applying an acidifying agent. Pre-plant soil testing is highly suggested for all fruit and nut crops. Pre-plant soil testing should be done far enough in advance to allow necessary corrections to soil pH to be made.

- Highly fertile soils do NOT make good sites for fruit and nut production. This is due to the shading and crowding of plants that frequently occurs on these sites. The shading and crowding cause disease pressure to increase and fruit quality to decrease. Therefore, for fruit and nut production, a soil that is low to moderately fertile is more desirable, as plant growth and fruiting can be manipulated through the addition of necessary fertilizers. The diagram in Figure 3 outlines necessary production practices and the time period that each should be implemented.

### Plant Selection

Fruit trees, nut trees and grapevines may be purchased as bare-root or containerized plants. Most of the time, the plants that are available are bare-root. That is, they were field-grown, dug and shipped with a moist material wrapped around the roots to keep them from drying out. When properly managed, bare-root plants will perform as well as, or possibly better than, those grown in a container. They are usually less expensive, too.

Plants grown in containers can have problems. Prior to planting, unprotected root systems can be subject to cold injury. Cold injury can occur if the plant is exposed to subfreezing temperatures for extended periods of time. Also, if proper attention is not paid to watering plants in the nursery or garden center, the root system can quickly dry out to the point that injury or death will occur. Along with this problem comes the potential for excessively high temperature that can develop in the root zone of container plants that are displayed outside, particularly if they are set on asphalt lots. On hot, sunny days heating and drying of the root system can occur in a very short period of time.

Trees and vines that are left in containers for extended periods can become pot bound, necessitating heavy root pruning at planting time. In this situation, extensive top pruning may be needed to compensate for the reduction in the root system to avoid low survival and growth rates.

Many people feel that bigger is better when it comes to planting fruit and nut trees and grapevines. Actually, the reverse may be true. Healthy, small-to-medium-size trees or vines may have better survival rates, develop a more desirable shape and begin to bear significant crops before larger plants.

Big trees may be big simply because they have been growing in the nursery longer than the smaller trees. If this is the case, the big trees will probably be branched. Unfortunately, the branches may grow from the trunk at the wrong height; be poorly distributed around the trunk; have weak crotch angles; or be damaged during the digging, grading, packing and shipping operations necessitating their removal. For these trees, success in getting older trees to limb out at the desired locations will be difficult.

For apple and pear trees, consider selecting trees that are 4 to 6 feet high (3/8- to 5/8-inch caliper) and having no side branches. Stone fruit trees typically side branch in the nursery. Ideally, these branches should be removed at planting. Select trees in the 24-to-30-inch size range. If this size is unavailable, try to get trees from either the next larger size or the next smaller size. Nut trees larger than 6 to 8 feet in height are not recommended. With the exception of V. vinifera varieties, most grape vines are propagated as rooted cuttings. One-year-old field grown plants are suggested.

When purchasing new plants, always use a reputable nursery to assure getting healthy plants of the correct variety. As long as the variety and the rootstock are among those adapted to Tennessee growing conditions, it is not essential to purchase plants from local nurseries. In fact, it may be necessary to pur-

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**When to Plant Bare-Root Fruit Trees and Container Grown Trees and Vines**

Perhaps the best time to plant bare-root fruit trees, nut trees and grapevines in Tennessee is in late winter to early spring (mid-February through mid-March). In contrast, container-grown trees and vines may be planted throughout the year. However, supplemental watering for all container-grown plants and staking trees will aid both in survival and growth of these plants.
chase plants from distant nurseries to get the desired varieties and type of fruit or nut crop.

Even with good quality, dormant plants, fall planting poses the risk of plant injury due to severe winter cold, which may occur some years. Planting about one month or longer prior to the time that growth would start will allow the root system to become established and generally result in better plant growth the first year.

Planting later than late winter/early spring raises some problems. Unless trees and vines were purchased from a northern nursery, they may no longer be dormant, even if stored under proper conditions. Such plants may get off to a weak start or may not survive. If the spring weather turns hot and dry, late-planted material may not do well. In addition, when planting late, you lose the flush of growth that occurs in the spring and plant survival may be all that can be expected.

**Plant Storage**

Trees and vines may be held in the shipping package for several weeks if they are stored in a cool, damp area. Plants should not be stored where they will be exposed to temperatures below freezing. Even though the tops of dormant trees and vines can withstand sub-zero temperatures, their root systems may be injured or killed at temperatures just below freezing. While in storage, root systems must be checked and moistened, if necessary.

If plants are to be held for a long time prior to setting, they should be “heeled out.” This process involves digging a trench, taking the plants out of the bundle, lining them out in the trench and covering the root systems with soil. Care should be taken to work soil around the roots and eliminate air pockets. Watering will help to establish good root-soil contact. Digging the trench on the north side of a building or placing the plants in the trench with their tops leaning toward the southwest will lessen heating and help keep the plants dormant.

**Planting**

Holes should be dug just before planting. If holes are dug well in advance of planting, rain may seal the side and bottoms of the hole to the point that roots will not penetrate them. Additionally, if soils are wet when the holes are dug, the sides and the bottom of the hole could be glazed, this frequently occurs when an auger is used to bore holes. If this problem does occur, break the glaze prior to planting. This will allow roots to grow in the surrounding soil.

Immediately prior to planting, trees and vines need to be removed from the shipping packages or from the trench in which they were heeled. The root systems should never be allowed to dry out because exposure of the roots to air, even for a short time, can damage them. To protect the roots from drying out, immerse them in a bucket of water and then take them, in the bucket, to the planting site.

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**Inspect Before Buying**

When you get your trees or vines from the nursery, inspect them to see that they are in good condition. Be sure the roots are moist and in good shape. A healthy root should feel firm when you squeeze it - not spongy, but also not brittle. The interior tissue of a healthy root should be white to a very light tan color. Darker colored root tissue suggests problems. If the roots are dry or if the roots just do not look right, contact the nursery right away.

**Figure 4.**

Heeling Cut
Trees: Take them out of the package, line them out in a trench and cover roots with soil.

**Figure 5. Root Pruning**
Holes should be dug wide enough to accommodate the root system without crowding the roots or having to bend them around to fit in the hole. Roots that are curled around to fit the hole will not straighten out and will not grow into the surrounding soil. It is better to prune exceptionally long roots as opposed to crowding them into holes. Dead, broken, diseased or pest-infested roots should be removed prior to planting.

Depth of planting is also important. For non-grafted and non-budded plants, a good suggestion is to set the depth at the same depth the plant was in the nursery. Close inspection of the color and texture of the bark on the trunk should reveal the original soil line.

With grafted plants, the graft union should always remain aboveground, but no higher than 2 inches aboveground, see Figure 6. Trees set too deeply may not survive or, if they do, they may grow poorly for the first few years. With dwarf apple trees a unique situation exists. If the graft union is very far below the soil line, the scion—the variety grafted onto the rootstock—will root. When this occurs, the effect of the rootstock will be lost and the previously dwarf tree will revert to standard size.

Trees that are not set deeply enough exhibit numerous problems: anchorage of the tree will be reduced, trees will exhibit weaker growth and suckering of the rootstock will occur. With certain apple variety/rootstock combinations, the tendency to burr knot on the trunk and scaffold limbs will increase. Burr knots are aerial roots that resemble cankers at their point of origin. As their size and numbers increase, movement of water and nutrients up and down the trunk is impeded. The rough knots become a haven for certain pests such as dogwood borer, which can further weaken the tree and lead to its demise.

Once the tree or vine is placed in the hole and the roots are spread, the hole should be backfilled with soil. At this time, it is important not to mix amendments such as peat moss, sawdust, manure or fertilizer with the soil. Such a practice would amount to building a “flower pot,” which causes the roots to develop instead of growing out into the surrounding soil. This, in turn, causes the tree or vine to become root-bound within a short amount of time, which then causes growth to be stunted and plants to be weakened and maybe killed. Also, when filling the hole with soil, the soil should be worked among the roots to reduce the number and size of air pockets. Once the roots are covered with soil, it should be firmed by stepping on it or tamping it. If the soil is not very moist, water can be added to the hole. The last step is to fill the hole to the same depth as the surrounding ground. If a depression is left as a place to water the plant during the first summer, be it should be filled prior to winter. This is because the freezing and thawing of water in direct contact with the tree trunk can cause damage to the plant.
Weed Control
Weeds offer strong competition to young trees and vines for moisture and nutrients. Several trials have demonstrated that growth may be reduced by one third or more where this competition exists. In fact, survival may be in question during a hot, dry summer. Therefore, it is advisable to maintain weed and grass-free areas extending at least 2 to 3 feet from the trunks of trees and vines.

To remove weeds from an area, care must be taken. Lawn mowers and string trimmers will work, but they will seriously injure or kill trees and vines if they contact the plant. Shallow hoeing will also work, but care must be taken to not hit the trunks and to not dig too deeply, as the developing root system is fairly shallow.

One safe option to use for weed control is mulch. In addition to controlling weeds, mulches will reduce drying of the soil. However, care must also be taken with mulches because mulches placed up against the trunk of trees or vines offer sites for insects, diseases and voles to damage the plant. If mulch is to be used, it should be kept back from the trunk a foot or more. This will allow sunlight, air movement and spray penetration on all parts of the trunk, thus reducing potential problems.

Don’t Guess, Soil Test!
Proper fertilization and liming is essential for good growth and fruiting in fruit trees, nut trees and grapes. To obtain the best results, a soil test should be taken several months prior to planting to determine soil pH as well as phosphorus and potassium levels. Separate samples should be collected from different types of crops because specific needs may vary. It is not necessary to collect separate samples from different varieties of the same crop. Samples should be taken from the area that fertilizer is applied - under the canopy of trees and vines.

Often times, the pH, the phosphorus and the potassium levels of the subsoil differ significantly from the levels in the topsoil. In such cases, amendments should be added in accordance with the subsoil test results. This is because once trees or vines are planted, it is difficult, or impossible, to modify the subsoil pH or nutrient levels. Attempts to incorporate the needed materials could result in damage to plant root systems. For more detailed information on how to do a soil test, see Chapter 3, Soils and Plant Nutrition.

Lime Requirements
All fruit and nut trees and grapevines perform best at a soil pH of 6.5. If the soil pH gets significantly lower than this level, some necessary elements may be made unavailable to the plant, while others may become more available, resulting in potentially toxic effects.

Tennessee Soils
Most Tennessee soils are more acidic than is desirable for all fruit and nut crops, except for blueberries.
If lime is applied to the soil, it should be broadcast uniformly over the entire orchard or vineyard floor, not just around the plants.

Fertilization

Timing

Generally, fertilizer should be applied every year beginning with the year that the trees or vines are set. For established plants, the best time to fertilize is about 1 month prior to the time that growth begins in the spring. For newly set trees and vines, the best time to fertilize is about 3 weeks following planting.

Fertilizers should be applied to the soil surface in a 10- to 12-inch band beginning at the outer edge of where the hole was dug and extending outward, see Figure 9. Placing the fertilizer on the soil where the hole was dug is potentially dangerous. With settling of the soil, rain or watering can wash the fertilizer up against the base of the plant causing fertilizer burn to the trunk.

To get good growth of young, non-bearing trees and vines, a light application of fertilizer can be made every month to 6 weeks until midsummer. However, to prevent plants from growing too late in the fall and sustaining cold damage, applications should be discontinued in midsummer. Bearing trees and vines should only receive one fertilizer application per year. Fertilizing these plants during the growing season could result in delayed fruit ripening and excessive fruit softening.

One possible modification of these rules involves stone fruits, where late frosts or freezes can reduce or eliminate crops. For these trees, a split application of the fertilizer could be done. A split fertilizer application is done by applying one half of the desired amount before growth begins in spring. After the chances of spring frosts have passed, the status of the crop is assessed. If a good crop remains on the tree, the other half of the fertilizer can be applied. However, if frosts have thinned the crop or eliminated it, the second application can be reduced or eliminated altogether.

Application

Broadcast fertilizers should be applied uniformly on the ground under the canopy of established trees or vines. If holes are punched in the soil and fertilizer is put in them instead of broadcasting it, holes should be punched all the way around the plant under the canopy. The holes should be about 4 to 6 inches deep.

Fertilizer spikes for fruit trees are available at garden centers. While they work well, they are not superior to conventional fertilizers and they are more expensive. However, if this is the method used, the directions on the label should be followed exactly.

Rates

Suggested rates for fertilizer are based on several factors: type of plant, age, size, growth and fruiting the previous year. Phosphorus and potassium fertilization rates should be based on soil test results.

Nitrogen for tree fruits, except pears, is calculated at the rate of 1/10 pound of actual nitrogen per year of tree age, with rates leveling off at about the sixth or seventh year. For example, a 3-year-old peach tree should receive 3/10 of a pound of actual nitrogen. If a 10-10-10 fertilizer is being used, 3 pounds of it would be applied. Remember, a 10-10-10 fertilizer has 10 percent actual nitrogen. One pound of it contains 1/10 pound of actual nitrogen. Pears should be fertilized at one half of this rate, since pears tend to be very fire blight susceptible. Vigorously growing trees are more susceptible to fire blight than trees growing at moderate rates.

With grapevines, if phosphorus and potassium levels are adjusted based on pre-plant soil testing, nitrogen may be the only fertilizer needed throughout much of the vineyard’s life. Like fruit and nut trees, a moderate growth rate is desired for grapevines. A moderate growth rate increases yields and fruit quality.
while decreasing disease pressure, as compared to highly vigorous vines. To achieve moderate growth, low rates of nitrogen are suggested. One-tenth of a pound of actual nitrogen should be used per vine, regardless of age. Also, a straight nitrogen source such as ammonium nitrate may be more desirable than a balanced fertilizer.

If vine growth is highly vigorous, nitrogen should be withheld for a year or longer until the growth rate declines. On the other hand, weak vines should receive about one and one-half times the normal nitrogen rate. However, increasing nitrogen rates may not increase vine vigor if trunk or root damage is present.

Occasionally, magnesium deficiency will occur in grapevines. The most obvious symptom is interveinal chlorosis, yellowing of the leaf tissue between the veins, see Figure 10. If symptoms do not show up until close to harvest, there is no problem. However, if symptoms show up in the early or middle part of the growing season, corrective measures are needed. Epsom salts, magnesium sulfate, may either be applied to the ground beneath the vine or sprayed to the foliage.

Nut trees should be fertilized with a balanced fertilizer at the rate of 1/10 pound actual nitrogen per inch of trunk diameter. Trunk diameter should be measured about 2 feet aboveground. Tree growth the previous year should also be taken into account. Mature pecan trees should make at least 8 inches of terminal growth on the main limbs each year. Similar growth rates are desirable on other types of nut trees as well.

Some sources indicate that zinc should be applied to the soil around pecan trees to prevent deficiency of this element. Zinc deficiency shows up as a rosette, or witches broom, on the end of twigs. Research has shown that no yield loss due to low zinc levels occurs if there are no visible zinc deficiency symptoms. If zinc deficiency is evident, 1 pound of zinc sulfate should be broadcast under each affected tree.

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<th>Table 1. Desirable Growth Ranges For Fruit Trees</th>
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<tr>
<td><strong>Type of Tree</strong></td>
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<td>Peach &amp; Nectarine</td>
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<td>Non-bearing</td>
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<td>Bearing</td>
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<td>Apple</td>
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<td>Bearing, non-spur type</td>
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<td>Bearing, spur type</td>
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<tr>
<td>Plum &amp; Sweet Cherry</td>
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Pruning and Training
Pruning is an important cultural practice for all fruit crops. The success or failure of all other cultural practices is at least, in part, dependent upon a proper pruning job. Pruning and training are used together to develop the desired framework in young trees or vines. When properly done, the plant will have a framework capable of supporting a full crop of fruit. The canopy will be open to allow good sunlight as well as wind and spray penetration, which will maximize fruit quality while reducing disease pressure. Although as the tree or vine approaches maturity, the training program is complete, pruning needs to be done every year. Benefits of annual pruning include:

- **Keeping trees or vines within desired size limit:** As plants get too large, too thick or overgrow neighboring plants, the quantity and quality of the fruit decreases. Pest pressures increase and harvest becomes more difficult.

- **Renewing fruiting wood:** As wood becomes older, it will no longer be fruitful. Annual pruning involves removing a certain amount of the older wood each year, thereby encouraging development of new wood as sites for future crops.

- **Reducing the tendency to overbear:** Most healthy trees and vines have the potential to produce larger crops than they can handle. Unless corrective measures are taken, fruit size will be small, plants will be weakened and more subject to cold injury. Additionally, the following year’s crop will be small. With many types of trees, fruit buds are formed during the previous summer. Therefore, pruning is a fruit-thinning operation. Although sufficient fruit thinning cannot be accomplished through pruning alone, it can definitely help.

- **Removing diseased wood from trees and vines:** This practice will lessen disease potential and open up the canopy for the following growing season.

When to Prune Fruit Crops
Trees and vines should be pruned following planting and prior to the start of growth. Pruning at this time will increase survival and growth during the first year. It will also compensate for roots that may have been lost during the interval from digging in the nursery through planting.

The ideal time for pruning most fruit crops is late winter, prior to the time plants start to grow. All non-bearing young trees should be pruned at this time and all large cuts should be made when the plants are dormant.

Stone fruits such as peaches, nectarines and plums can be pruned after the trees have blossomed and the chance of a late frost has passed. The type and severity of pruning may be modified somewhat to compensate for partial crop loss due to late frosts or freezes.

Grapes may be pruned after new growth has started. Pruning at this time will delay bud break on the areas of the vine where the crop
is desired. Although grapevines will “bleed” when pruned in late winter or early spring, bleeding is not damaging to the plant.

Apple and pear trees should be pruned while dormant. At this time, fire blight cankers can be removed to decrease infection pressure during the growing season. Specific information on pruning practices of various fruit and nut plants will be presented in sections pertaining to that plant.

**Pruning Tips**

Proper pruning involves: knowing which cuts to make to get the proper response and how to make the cuts to help cuts heal properly. The following tips should be considered when pruning:

- The more upright a limb grows, the more vigorous it will be and the longer it will take to begin fruiting. When pruning, the strong and upright growth, except for the trunk of the tree, should be removed and the weaker, more spreading limbs should be retained, see Figure 12. This is especially important as you go higher in a tree because upper limbs should never be allowed to overgrow lower limbs.

- Upright growing limbs may be spread to a more horizontal position by using limb spreaders or by tying limbs down, see Figure 13. For a discussion on making and using limb spreaders and tying limbs down, please see the sections on Pruning and Training below.

- Vigorously growing, upright limbs have a weak connection to the tree trunk due to the presence of dead tissue, known as bark inclusion, between these two parts. Such limbs are very apt to break at the point of attachment and tear down the trunk, doing considerable damage. Limbs that grow more horizontally form wider angles where they meet the trunk. This is a much stronger junction and is not as apt to break. If a choice exists, the wide-angled limbs should be retained and the narrow-angled limbs should be eliminated. This is because the branches at narrow-angles tend to break easier, see Figure 14.
Pruning Tips (continued)

▪ To prevent damage to the tree when cutting out a large limb, three cuts should be made. The first should be about 8 to 12 inches from the base of the limb and about one-third of the way through on the underside of the limb. The second cut should be made about 8 inches farther out on the limb. At this point, the limb should be nearly cut off, starting on the top side. When this cut is almost through, the limb will drop down. Finally, tear back to the bottom cut and let the limb fall free. The third cut should cut off the stub, see Figure 15.

▪ When removing a limb, a stub should not be left. Stubs are places for rots or insects that may damage the rest of the tree. To remove side limbs, cut close to the base of the limbs. There will be a small collar or swelling at the intersection of side limbs with the trunk. Thus, the cut should be made where the collar tapers down to the limb. This will result in a smaller cut that will heal faster than one made flush against the trunk, see Figure 16.

▪ Vertical limbs are removed by cutting just above a side branch. The cut should be made at an angle so the water will drain off.

▪ Wound dressing is not necessary. In fact, the cut will heal quicker without it. This rule holds for large and small cuts.
Proper pruning involves making certain cuts to maintain plant size, fruit quality and consistency. Knowing which cuts to make and the order in which to make them will simplify the pruning operation and increase its effectiveness. The following sequence of cuts suggests a logical approach to pruning a fruit tree:

1. Root suckers arising around the base of the tree should be removed. These suckers are sites for insect and disease problems to arise.
2. Dead, broken and diseased limbs should be cut out. The removal of these limbs makes it easier to determine which other pruning cuts need to be made.
3. Low, drooping limbs – especially if they are shorter than the limbs above them – should be removed. These limbs generally produce few, poor quality fruits as well as interfere with taking care of the ground under the tree. Their removal will enable good air circulation under the trees, which will reduce disease potential.
4. Excessive upright limbs should be removed from the centers of trees. One central trunk should be maintained in apple and pear trees. Others need to be taken out.
5. The least desirable limb should be removed when a limb grows directly over a second limb or where two limbs cross over each other within 24 to 30 inches.
6. Tree height may be reduced by cutting the upright portion of a limb, just above a branch growing to the outside.
7. Upper limbs should be cut back further than lower limbs to allow for good light penetration to the lower limbs.
8. Once the larger cuts have been made, watersprouts and vigorous shoots growing off the tops of limbs should be removed.
9. Weak and shaded shoots growing off the undersides of branches, called hangers, should be removed.
10. Some of the smaller shoots at the ends of limbs should be thinned to allow for good light penetration into the fruiting zone of the tree. See Figure 14 for illustrations on several types of detailed cuts that can be made.

Pruning Neglected Trees and Vines

When trees or vines are not pruned for several years, many problems arise. As the canopy of the plant gets thicker, fruiting will become restricted to the outside and upper part of the canopy, as these are the only areas receiving adequate sunlight for fruit bud formation and fruit development. Disease problems get worse since interior leaves are less resistant to infection and the dense canopy restricts sun, wind and spray penetration, thus favoring disease development.

If the plant is not in too bad of shape, it may be possible to prune it and partially restore the potential to yield quality fruit. To do this, the larger cuts should be made first. Where severe pruning is needed, the entire process should be done over several years to lessen the shock to the tree or vine.

For trees, make large cuts should be made to open up the canopy to sun and wind penetration. Upper limbs should be cut back shorter than lower limbs; this will increase...
light penetration to the lower limbs. Also, some of the older shoots should be thinned to encourage the development of young, fruitful wood.

With neglected grapevines, new canes growing from the trunk, or as close to it as possible, should be selected. All the old canes should be removed by cutting at the trunk. The new canes can then be trained to trellis wires. If there are no new canes arising at the trunk, an old cane at each wire and on each side of the trunk can be retained. These canes can then be spur pruned by pruning new lateral shoots back to within two or three buds of the old cane. The other old canes should be removed at the trunk. This may stimulate new canes to grow directly from the trunk. If the grapevine has more than one trunk, one can be cut off at ground level to force a new shoot to sprout next to the soil surface. Then this new shoot can be trained to the trellis to form a new trunk. Within 1 or 2 years, the remaining trunks can be cut at ground level and the new cane can be used to establish a new canopy in the vine.

If plants have been neglected for too long, it may be more desirable to cut the old trees or vines down and plant new ones.

**Pruning and Training Apple Trees**

Semi-dwarf apple trees are trained to a central leader system, which resembles a Christmas tree in shape, see Figure 15. In this system, the trunk, known as the central leader, is straight with layers of side branches growing off of it. Each layer is shorter and about 30 to 36 inches higher than the layer below it. This assures good light penetration to all parts of the tree. This training process takes several years depending on the desired final tree size, since only one layer of side branches, known as scaffold limbs, can be developed each year.

Each layer of scaffold limbs should consist of no more than three or four side branches that arise from the trunk. The side branches should all be within a distance of about 12 inches from the bottom to the top limb, layered and well spaced around the trunk. Limbs making up the lower layer of scaffold should form about a 45 to 60 degree angle where they intersect with the trunk, see Figure 19. A limb that grows more vertically will have a weak
point of attachment with the trunk and be too vigorous, see Figure 20. Limbs in the upper scaffold layers should be weak and arise from the trunk at nearly 90-degree angles. It is imperative to select these weaker limbs in order to develop the desired tree shape.

At planting and for each year up until the final height of the tree has been reached, the trunk needs to be cut back. Topping will stiffen the trunk and force the development of lateral shoots, some of which may be selected for scaffold limbs.

The concepts outlined above can be utilized in pruning and training apple trees beginning at planting in the following manner: at planting, if the tree is an unbranched whip, the top can be cut off just above a bud, at about 6 to 8 inches higher than the height at which the bottom layer of limbs is desired, see Figures 21 and 22. During the following growing season, the shoot arising from the top bud will grow straight up and be the central leader. If left, shoots from buds just below the top one will grow almost vertically and form undesirable limbs. Therefore, these shoots need to be removed during the first growing season or no later than the first dormant pruning. Shoots growing lower on the tree will have wider angles and grow more horizontally. Some of these will be selected for scaffold limbs. If necessary, they can be spread to the proper angle as described below. During dormancy, the central leader should be cut off at about 36 to 40 inches above the highest scaffold, see Figure 23.

Limb spreading may be used to orient scaffold limbs to the desired point. Spreading may be done the first year a limb begins to develop. It may be done during any of the next several years to lessen limb vigor, increase fruiting and to increase light penetration into the tree canopy. Limb spreading may be done in any type of fruit or nut tree.

Spreading new shoots early in the season during which they start to grow is effective in transforming what would have developed into a narrow crotch angle into a desirable one. The first year a shoot grows is the only time during which the point of attachment of a limb onto the trunk can be strengthened.

New shoots can be spread to the desired position by using a spring-type clothespin or a toothpick. The spreader should be inserted when the new shoot is about 4 to 5 inches long.
The clothespin should be clipped on the trunk just above the shoot to be spread and gently positioned so the shoot will grow between the ends of the clothespin.

If a toothpick is to be used, one end should be gently pushed through the tender bark of the new shoot, about 2 inches from the base. The shoot should then be carefully spread down to the desired angle and the other end of the toothpick should be pushed through the bark of the trunk. Spreaders should be left in position for about 5 weeks. In subsequent years, limb spreading may be needed to encourage heavier fruiting and reduce growth rates of vigorous branches.

After the limb has been held in the desired position for about five or six weeks during the growing season, spreaders and straps can be removed. If the tree has enough desirable scaffold limbs, the rest of the side branches and the top the central leader can be removed at 36 to 40 inches above the highest scaffold branch. If desirable scaffold limbs do not exist, all of the side branches can be removed and the tree can be topped 6 to 8 inches above the height desired for the lower limbs.

Scaffold limbs should be shortened to about one-third of their length by cutting just past a bud on the underside of them. This procedure will stiffen the scaffold limb, force side shoots

Making Limb Spreaders

Several materials can be used to make good limb spreaders.

- Heavy, stiff pieces of wire of varying lengths may be sharpened on both ends and used. These come in especially handy as limbs get bigger. Pieces of wood of varying lengths having a cross sectional area of about 1 square inch can be made into good spreaders by driving a small nail into each end, cutting the head off the nail and sharpening the exposed end of the nail. These spreaders can hold limbs out in the desired position by pulling the limb away from the trunk and inserting the spreader to maintain this position, see Figure 24. Although these spreaders will create small wounds in trees at this point of insertion, they will not do as much damage as a forked stick will do where it contacts the tree trunk and scaffold limb.

- Limbs may be tied down to the desired position instead of using spreaders. A soft, wide strap should be used over the limb to prevent girdling. Also, the strap should not be tied tightly around limbs being spread. The strap should be tied to the base of the tree or to a stake driven into the ground, see Figure 25.
to grow and encourage the scaffold limb to grow out correctly and vigorously.

In successive years, the central leader and scaffold limbs can be developed as outlined above with the following exception. Only wide-angled, weak scaffold limbs should be kept. These scaffold limbs should not be cut back because they do not need to be invigorated.

Selecting weak, flat-growing shoots in the upper part of the trees being trained to the central leader form is a very important practice. Upright growing shoots tend to be very vigorous and do not bear fruit early in their life. However, weak, flat growing shoots stay small and bear fruit at an early age. Since the upper portion of a central leader tree must be smaller than lower parts, weak growth and early fruiting are essential.

Additionally, watersprouts should be removed from scaffolds and weak shoots should be removed from the undersides of scaffold limbs. Vigorous shoots growing at the ends of the scaffolds that compete with the main part of the scaffold limb should also be removed, see Figures 26 A, B, C and D.

Once the tree has reached its final desired size, the leader should be cut just above a weak side branch. If necessary, the scaffold limbs should be directed back to a weak side shoot. If the scaffold limbs on the lower layer need to get longer, the main shoots should not be cut back. Instead, they should be grown a little longer and bent down. This will slow down and eventually stop elongation, see Figure 27. During succeeding prunings, watersprouts should be removed at the top of the tree as well as throughout the tree. Weak shoots growing from the underside of branches should continue to be removed. Also, some of the side shoots and spurs should be thinned to encourage continuous development of fruit and to allow good light penetration throughout the canopy of the tree, see Figure 28.

**Pruning and Training Stone Fruits**

Peach, nectarine, plum and tart cherry trees should be trained to the open-center system. This form resembles the shape of a vase. Three or four side limbs, well spaced around the trunk, should be developed at about 18 to 24 inches aboveground. These limbs should grow off the trunk at wide angles and grow out at about 60 degrees from the ground. Each scaffold limb should be allowed to side branch. The main part of the scaffold limb should always be the dominant part. Any vigorous shoots that compete with it should be removed.
Pruning and training should be started when the tree is planted. Low limbs, limbs below the height desired for the scaffold limbs, should be cut off flush with the trunk. Upper shoots should be cut back to about 1/4 inch in length. Also, the top should be cut out of the tree at a height of about 6 to 8 inches higher than the desired height for scaffold limbs, see Figure 29.

During the first growing season, three or four side shoots should be developed into scaffold limbs. Vigorous, upright shoots in the top of the tree should be pinched back to stop their growth.

The first dormant pruning, which occurs one year after planting, involves completing the selection of scaffold limbs, removing lower limbs and cutting upper limbs back to stubs, about 2 or 3 inches long. Scaffold limbs should not be headed back. Instead, they should be grown out straight from the trunk. If any vigorous shoots should compete with the main part of the scaffold limb, these shoots should be removed. Also, any vigorous watersprouts growing off of the top of the scaffold limbs and weak shoots growing on the undersides of the scaffolds should be removed, see Figure 30.

During the second dormant pruning, stubs above the highest scaffold limb should be removed. Watersprouts or vigorous shoots growing on the undersides of scaffold limbs should also be cut off. In addition, shoots growing off the side of the central part of the scaffold limbs should be thinned out, leaving them about 6 to 8 inches apart, see Figure 31.

The weight of the crop and foliage should bend over the end of the scaffold limbs, stopping their upward growth, see Figure 32. If the ends of the scaffolds get too high to reach while standing on the ground, they should be headed back to an outward growing side shoot, see Figures 33, 34 and 35.

Proper pruning and training allows trees to fruit from the ends of scaffold limbs all the way back close to the trunk. New fruit wood is continuously developed as side shoots on scaffold limbs are thinned out and new shoots grow.
Several terms are unique to grapes. The following glossary defines the terms seen later in the text.

Pruning and training grapevines should begin prior to the start of growth in the first year of planting. Training will be carried out over the first 2 or 3 years and involves developing the proper vine shape for the trellis. Pruning should continue throughout the life of a vine. The three trellises described here are the two-wire vertical trellis, the single-wire trellis and the T-trellis. The two-wire vertical trellis has a lower wire, about 3 feet aboveground and an upper wire, about 6 feet aboveground. The single-wire trellis utilizes one wire at about 4 1/2 to 5 feet aboveground. The T-trellis uses three wires. A lower wire is secured to posts about 3 to 3 1/2 feet aboveground. At about 5 feet aboveground, a cross arm extending 2 feet on each side of the post will be attached. A wire will be directed down the row on each side of the cross arm, see Figure 36.

At planting, new vines should be cut back to one cane. That cane should then be cut back to two buds or nodes. Prior to the start of growth, a stake should be driven beside each plant. As a shoot or shoots grow, they should be loosely secured to the stake to develop a straight, healthy trunk, see Figure 37.

The trellis should be constructed prior to the first dormant pruning, one year after planting. If the two-wire vertical trellis using the four-cane kniffen system is used, cut 2 inches above the wire and tie the trunk to the wire, but only if it is higher than the top wire. If lateral canes exist, select two by the bottom wire and renewal spurs can be made by pruning back to two buds. The renewal spur will be a reliable source of canes for the next dormant pruning.

At the second dormant pruning, a cane on each side of the trunk at both the top and bottom wires should be selected. These canes should be loosely tied to the wire. Then, depending on vine vigor, 8 to 12 buds should be counted out from the base and the end of the cane should be cut off. Four renewal spurs—one on each side of the trunk at the top and bottom wires—should be developed, see Figure 37.

During succeeding years, canes that fruited the past growing season should be identified and cut off at the trunk. A new cane should be selected on each side of the trunk at the lower and upper wires and loosely secured to the appropriate trellis wires. Depending on vine vigor, canes should be headed at 8 to 12 buds in length and four renewal spurs should be selected and developed as previously outlined. All other canes should be removed.

With the T-trellis, two trunks beginning at, or close to, the soil line are developed. They are loosely secured to the lower wire. This wire is for trunk support only. As the trunks grow above the lower wire, they are directed towards

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**Figure 35. Illustrations of Terms Contained in the Glossary**

- **Compound Bud**:
  1. Primary bud
  2. Secondary bud
  3. Tertiary bud
  4. Lateral shoot scar
  5. Leaf scar

- **Shoot (before becoming woody) Cane (after becoming woody)**

- **Spur**

- **Cordon**

- **Trunk**
opposite wires on the horizontal cross arms. If a single trunk is used, it should be headed at the lower wire to encourage development of two shoots which will be directed to the upper wires, as described for vines having two trunks. After shoots have reached the upper wires, they should be headed to encourage lateral branching. The laterals will be used for fruiting canes and renewal spurs in the same manner as described for the vertical trellis.

The systems described above are cane renewal systems. That is, at each dormant pruning, all canes that grew prior to the previous summer are removed. Some new canes are retained for fruiting. Some others are developed into renewal spurs. Older canes can be identified by their grayish-black shaggy bark and the absence of buds. New canes have prominent buds and smooth bark that is often bronze colored.

Some types of grapes such as muscadines and certain wine varieties are spur pruned instead of cane renewal pruned. The main difference is that semi-permanent cordons replace the canes on the trellis wires. These cordons are allowed to develop side shoots all along them. At pruning time, some of the shoots are removed entirely, leaving the remaining shoots spaced 6 to 8 inches apart on the cordon. Remaining shoots are then cut back to spurs about two to five buds in length, depending on the type of grape. Fruit will develop close to the cordon and new canes will develop a curtain of growth below the cordon.

The bilateral cordon system uses a single-wire trellis. The trunk is headed a few inches below the wire. A shoot is developed on the wire for each side of the trunk. These shoots, referred to as cordons after one year, will be retained for several years and spur pruned. Bilateral cordon training is used for low to moderate vigor vines.

Due to the nature of growth with spur pruning, grapes should be trained to either a single wire about 5 feet above ground or to a T-trellis. The vertical trellis is not suggested with spur pruned vines, as the growth on the lower wire would be heavily shaded by growth on the top wire.

Pruning and Training Nut Trees

While pruning and training practices are not as extensive for nut trees as they are for fruit trees, they are still important for developing young trees. At planting, the top should be cut back to one-half of its original length. That is, a tree that is 6 feet tall following planting should be pruned to 3 feet high. Topping the new tree increases survival and growth rates as
well as lessens the demand on the root system once growth starts.

Nut trees should be trained to a central leader shape. Eliminating branches that arise from the trunk at narrow angles as high as one can reach will result in a stronger framework in the trees. Low limbs should be removed, as they will interfere with safely caring for the ground below the trees. Also, lower limbs that are shorter than those above them will be shaded, which will result in reduced yields. These lower limbs can usually be removed with no appreciable loss in yields. This will result in better air circulation around the tree and a subsequent reduction in disease pressure.

**Thinning Tree Fruits and Grapes**

Frequently, fruit trees and grapevines will set excessively large crops. Failure to reduce the crop load can result in several problems including: reduced fruit size and quality, limb breakage and reduced cropping the following year. Fruit thinning involves removing a portion of the crop to avoid these problems.

Since fruit buds for a crop are formed during the growing season the year before the fruit develops, pruning may be regarded as a fruit-thinning practice. During the pruning operation, some shoots and canes that have fruit buds are removed. However, with a properly pruned fruit tree or grapevine, a full crop of fruit can be set on a fraction of the remaining fruit buds. If frosts or freezes do not destroy a large number of the remaining fruit buds, additional thinning will be required. Shortly after bloom, the number of remaining fruits or clusters will be evident. Fruits should be thinned in accordance to fruit size. Please see Table 2.

<table>
<thead>
<tr>
<th>Table 2. Ideal Thinning Distance Between Fruits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
</tr>
<tr>
<td>Large fruits, including: apples, peaches and pears</td>
</tr>
<tr>
<td>Plums</td>
</tr>
<tr>
<td>Grapes</td>
</tr>
<tr>
<td>Cherry and nut trees</td>
</tr>
</tbody>
</table>

![Figure 37. Pruning and Training Grapevines, Four Cane Kniffen System](image1)

![Figure 38. Identifying “Old” Vs. “New” Growth on Grapevines](image2)
Pest Control
Pest control is an integral part of quality fruit production. Many insects and diseases will cause severe damage to fruits and foliage if left unchecked. Timely and thorough applications of the proper pest control practices will assure higher quality fruit, healthier trees and higher a yield of crops.

What to Plant
Decisions regarding what types and varieties of fruit and nut crops to plant and whether to select full size, semi-dwarf or full dwarf trees are crucial to the success of planting. Once that decision has been made, the next step is to determine how many trees or vines to plant. Factors involved in this decision include spacing requirement, yield potential, pollination characteristics and productive life span. See Tables 2 and 3 for help deciding how many plants will be needed, spacing and age for first production, age to full production and productive life span. Please be aware that figures in these tables are only approximations. Many factors can affect them.

Trunk Guards
Trunk guards are often used around trunks of young trees and vines to protect against damage from rabbits, surface-feeding voles and equipment damage. While proper use of guards can protect trees, their misuse can cause some of the same difficulties as mulches placed against the trunk. Solid guards block sunlight, wind and sprays from reaching the trunk. Guards that fit snugly around the trunk can also girdle it as the trunk expands in diameter. Therefore, a good rule for most guards is to put them on in the fall and to remove then in the spring.
Table 3. Fruit Tree Recommendations

<table>
<thead>
<tr>
<th>Crop</th>
<th>Rootstock</th>
<th>Training System</th>
<th>Spacing</th>
<th>Age to First Crop</th>
<th>Age to Full Production</th>
<th>Yield/Tree at Maturity</th>
<th>Productive Lifespan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>In Row</td>
<td>Between Row</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apples</td>
<td>Dwarf: Malling 9 Mark</td>
<td>Slender spindle</td>
<td>4 ft.</td>
<td>12 ft.</td>
<td>2 to 3 yrs.</td>
<td>3 to 4 yrs.</td>
<td>1 to 1½ bu.</td>
</tr>
<tr>
<td></td>
<td>Malling 26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Semi-Dwarf: Malling 7 (1)</td>
<td>Central leader</td>
<td>8 to 10 ft.</td>
<td>16 to 18 ft.</td>
<td>3 to 4 yrs.</td>
<td>4 to 6 yrs.</td>
<td>2 to 4 bu.</td>
</tr>
<tr>
<td></td>
<td>MM 106 MM 111</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard: Seedling</td>
<td>Modified central leader</td>
<td>20 ft.</td>
<td>30 ft.</td>
<td>4 to 6 yrs.</td>
<td>10 to 12 yrs.</td>
<td>8 to 12 bu.</td>
</tr>
<tr>
<td>Pears</td>
<td>Dwarf Central leader</td>
<td></td>
<td>10 ft.</td>
<td>18 ft.</td>
<td>3 to 4 yrs.</td>
<td>5 to 6 yrs.</td>
<td>1 bu.</td>
</tr>
<tr>
<td></td>
<td>Standard Central leader</td>
<td></td>
<td>20 ft.</td>
<td>30 ft.</td>
<td>5 to 6 yrs.</td>
<td>8 to 10 yrs.</td>
<td>3 to 4 bu.</td>
</tr>
<tr>
<td>Peach, nectarine</td>
<td>Standard: Lovell Open center</td>
<td>16 to 20 ft.</td>
<td>20 to 24 ft.</td>
<td>3 to 4 yrs.</td>
<td>5 to 6 yrs.</td>
<td>3 to 5 bu.</td>
<td>15 to 17 yrs.</td>
</tr>
<tr>
<td>Plum</td>
<td>Standard: Myrobalan Peach (Lovell, Haford)</td>
<td>Open center</td>
<td>16 to 20 ft.</td>
<td>20 to 24 ft.</td>
<td>4 to 5 yrs.</td>
<td>6 to 8 yrs.</td>
<td>2 to 3 bu.</td>
</tr>
<tr>
<td>Tart cherries</td>
<td>Standard: Mazzard, Mahaleb</td>
<td>Open center</td>
<td>16 to 20 ft.</td>
<td>20 to 24 ft.</td>
<td>3 to 4 yrs.</td>
<td>5 to 6 yrs.</td>
<td>50 to 60 lb.</td>
</tr>
<tr>
<td>Sweet cherries</td>
<td>Standard: Mazzard, Mahaleb</td>
<td>Open center</td>
<td>16 to 20 ft.</td>
<td>20 to 24 ft.</td>
<td>5 to 6 yrs.</td>
<td>8 to 10 yrs.</td>
<td>60 to 80 lb.</td>
</tr>
<tr>
<td>Quince</td>
<td>Standard - Agers Quince or rooted cuttings</td>
<td>Open center</td>
<td>15 ft.</td>
<td>15 ft.</td>
<td>3 to 4 yrs.</td>
<td>10 yrs.</td>
<td>1 bu.</td>
</tr>
<tr>
<td>Pawpaw</td>
<td>Seedling (rooted cutting) or start from seed</td>
<td>Natural</td>
<td>30 ft.</td>
<td>30 ft.</td>
<td>5 to 7 yrs.</td>
<td>10 to 12 yrs.</td>
<td>25 to 50 lb.</td>
</tr>
<tr>
<td>Mulberry</td>
<td>Rooted cuttings seed</td>
<td>Natural (varies from large shrub to a fairly large tree)</td>
<td>15 ft.</td>
<td>15 ft.</td>
<td>5 to 7 yrs.</td>
<td>10 yrs.</td>
<td>8 to 10 yrs.</td>
</tr>
</tbody>
</table>

Figures given are approximate values. They will vary depending on soils, cultural practices, climate conditions (rainfall, temperature extremes).
Harvesting Fruit and Nut Crops

Several factors are involved when determining the optimum harvest time. For most fruits, the intended use will dictate harvest date to a degree. As a rule, fruits that will be stored for a period of time should be harvested at an earlier stage of ripeness than those being selected for immediate consumption. This is because fully tree-ripened fruit will generally have the best eating quality, but it will not last long in storage. However, there are some special cases that need to be considered.

European pear varieties such as Bartlett, Bosc, Seckel, Moonglow, Ayers, and Keiffer will have fewer grit cells and attain better quality if they are picked at a mature green stage, held in a refrigerator for a couple weeks, and then allowed to ripen fully at room temperature. Asian pears, however, do not respond the same way. For the best quality, they should be harvested when the tree is ripened.

Grapes also differ in their ripening characteristics. Unlike most other fruits, grapes will not ripen beyond the stage at which they are harvested. Therefore, grapes need to be harvested when they reach the best condition for their intended use. For jelly, grapes should be picked at a full green stage if they are to be harvested for an earlier stage of ripeness than those being harvested at an earlier stage. As a rule, fruits that are picked at a mature green stage and then allowed to ripen fully at room temperature will generally have the best eating quality. However, there are some special cases that need to be considered.

Table 3. Fruit Tree Recommendations

<table>
<thead>
<tr>
<th>Crop</th>
<th>Rootstock</th>
<th>Training System</th>
<th>Spacing</th>
<th>Age to First Crop</th>
<th>Age to Full Production</th>
<th>Yield/Tree at Maturity</th>
<th>Productive Lifespan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persimmon</td>
<td>Own root (American) / Grafted onto American rootstock (Oriental)</td>
<td>Natural</td>
<td>In Row: 10 ft. / 10 ft.</td>
<td>Between Row: 10 ft. / 10 ft.</td>
<td>4 to 5 yrs. / 4 to 5 yrs.</td>
<td>10 yrs. / 10 yrs.</td>
<td>200 to 250 lb. / 50 to 100 lb.</td>
</tr>
</tbody>
</table>

Figures given are approximate values. They will vary depending on soils, cultural practices, climate conditions (rainfall, temperature extremes).

Grafting

Grafting is a type of vegetative propagation used to achieve one or more of several beneficial effects including size control, earliness of bearing, pest resistance of the root system, and adaptability to various soil types and conditions. Budding is a type of grafting. Grafting should be used for:

- All fruit trees
- Nut trees that are set with the nut crop being an important objective, however if timber production is the primary objective seedling trees should be planted

Vitis vinifera grape varieties grafted to a phylloxera resistant rootstock. Most other types of grapes are not grafted.
...harvested somewhat early to get a light, clear jelly that is free of crystals. Grapes for fresh consumption should be are harvested when the taste is right. Grapes harvested for juice should generally be allowed to ripen fully, as this will allow for maximum sugar levels. Grapes used in wine production should be harvested when the pH, total acidity and sugar level of the juice is at the correct levels for the wine being made.

Once the use of the fruit is determined, it is time to determine if the fruit is at the desired ripeness. Contrary to popular thought, surface color does not always determine ripeness. In fact, color may be deceptive, as the red color of several fruits may develop well in advance of ripening. Therefore, the under color, or ground color, is more reliable. For example, when ripe, the ground color will turn from green to yellow in yellow flesh peaches. In white-flesh peaches, the ground color will turn from green to a greenish white or white. On many apply varieties, the ground color will turn to a pale green and then to a greenish yellow.

Another method of determining fruit ripeness is fruit drop. When sound fruit begins to drop from the tree, the fruit should be ripe. If fruits pulled from the tree do not separate easily and cleanly at the stem, then the fruit is not fully ripe. Keep in mind, however, that fruits suffering disease, insect or mechanical damage may ripen before good fruit.

Measurements of sugar and starch levels, flesh firmness and ethylene gas generation are also used to determine harvest time. Finally, one of the best indicators of fruit ripeness is taste. However, because personal preferences vary, this parameter may not be valid if someone else will be getting the fruit.

In contrast to fruits, when nut crops are mature, the shucks will open and the nut will drop. For the best quality, nuts should not be allowed to remain on the ground for more than a couple of days, as quality will deteriorate.

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### Seed Color as a Ripeness Test

Seed color in apples is only a rough indicator of maturity. Seeds will change from white to tan to almost black as the fruit matures.
### Table 5. Fruit Tree Varieties for Tennessee

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Almost all apple varieties can be grown in Tennessee. These varieties are fire blight resistant. All apples need cross-pollination.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas Black</td>
<td>Semi-dwarf; cross pollinate with Liberty and Freedom; good storage apple; deep red with yellow flesh</td>
</tr>
<tr>
<td>Enterprise</td>
<td>Cross pollinate with Goldrush; resistant to apple scab and moderate resistance to mildew; red skin; stores well</td>
</tr>
<tr>
<td>Freedom</td>
<td>Semi-dwarf; cross with Arkansas Black and Liberty; cedar apple rust resistant</td>
</tr>
<tr>
<td>Goldrush</td>
<td>Semi-dwarf; cross pollinated with Enterprise; resistance to apple scab, mildew and other common problems; golden yellow skin with red blush; crisp flavor</td>
</tr>
<tr>
<td>Liberty</td>
<td>Semi-dwarf; cross with Arkansas Black and Freedom; resistant to cedar apple rust and other common problems; yellow skin with deep red stripes; crisp, tender and juicy; good for eating or cooking</td>
</tr>
<tr>
<td>Asian:</td>
<td>Asian and European varieties will not cross pollinate each other; all need cross pollinators for better fruiting</td>
</tr>
<tr>
<td>Asian:</td>
<td>Asian pears bloom later than European pears, avoiding late frost. Asian pears should be allowed to ripen on the tree. All varieties listed are fire blight resistant</td>
</tr>
<tr>
<td>Shineiki</td>
<td>Cross pollinate with Chojuro; medium-large, yellow pear; sweet mild and juicy flesh; ripens in July</td>
</tr>
<tr>
<td>Hosui</td>
<td>Cross pollinate with Chojuro or Shineiki; medium-large golden yellow; crisp like an apple, very juicy; ripens in August</td>
</tr>
<tr>
<td>Chojuro</td>
<td>Cross pollinate with Shineiki or Hosui; most popular Asian pear; crisp, sweet flavor; stores well; ripens in September</td>
</tr>
<tr>
<td>European:</td>
<td>European pears can ripen in storage after harvest. All varieties listed are fire blight resistant. Can pollinate each other.</td>
</tr>
<tr>
<td>Ayers</td>
<td>Yellow fruit with red blush; flesh is smooth and sweet; American variety</td>
</tr>
<tr>
<td>Moonglow</td>
<td>Extra large pear that is yellow with a slight red blush; very smooth flesh, juicy and excellent mild flavor for eating, cooking or canning</td>
</tr>
<tr>
<td>Orient</td>
<td>Large, nearly round, firm pear; flesh is juicy and only moderately gritty</td>
</tr>
<tr>
<td>Seckel</td>
<td>Fruit is small with a rich yellow-brown skin when ripe; sugary sweet flavor</td>
</tr>
<tr>
<td>Warren</td>
<td>A medium size dew-drop shaped pear with smooth but slightly russetted skin; flesh is white, smooth and juicy; excellent flavor</td>
</tr>
</tbody>
</table>

### Plum

<table>
<thead>
<tr>
<th>Varieties</th>
<th>All varieties could benefit from more than one tree for better pollination, but some require more than one tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruce</td>
<td>Needs more than one tree for good pollination; frost hardy tree semi-dwarf tree with weeping habit; sunset orange fruit with a sweet, mellow flavor; ripens in May–June</td>
</tr>
<tr>
<td>Methley</td>
<td>Self fertile</td>
</tr>
<tr>
<td>Ozark Premier</td>
<td>Self fertile</td>
</tr>
<tr>
<td>Stanley</td>
<td>Prune type</td>
</tr>
</tbody>
</table>

### Peach

<table>
<thead>
<tr>
<th>Varieties</th>
<th>No need for cross-pollination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contender</td>
<td>White</td>
</tr>
<tr>
<td>Nectar</td>
<td>White</td>
</tr>
<tr>
<td>Carolina Gold</td>
<td>Yellow</td>
</tr>
<tr>
<td>China Pearl</td>
<td>White</td>
</tr>
<tr>
<td>Intrepid</td>
<td>Yellow</td>
</tr>
</tbody>
</table>
As previously stated, fully ripe fruits do not store for long periods. Therefore, most types of fruit should be harvested before they are fully ripe. Also, fruits having defects should not be stored, as they will deteriorate quickly.

Ideally, fruit and nut crops should be stored at temperatures very close to, or just below, freezing - about 31 to 32 degrees F. Relative humidity of the storage location should be between 85 to 90 percent, this will lessen moisture loss and shriveling. The storage location should also have sufficient air circulation. This lessens the build-up of ethylene gas, which hastens ripening. Sometimes fruits, especially apples and pears, are individually wrapped to prevent direct contact with another fruit that may be going bad. Most refrigerators run about 40 degrees F. Automatic defrosting models have fairly dry air. Thus, to prevent excess moisture loss and shriveling, it is probably advisable to keep fruits in plastic bags. Nut

### Table 6. Grapes Varieties for Tennessee

<table>
<thead>
<tr>
<th>Grape Type</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>American Bunch</strong></td>
<td></td>
</tr>
<tr>
<td>Seeded</td>
<td></td>
</tr>
<tr>
<td>Concord</td>
<td>purple</td>
</tr>
<tr>
<td>Sunbelt</td>
<td>purple</td>
</tr>
<tr>
<td>Catawba</td>
<td>red</td>
</tr>
<tr>
<td>Steuben</td>
<td>purple</td>
</tr>
<tr>
<td>Niagara</td>
<td>white/light green</td>
</tr>
<tr>
<td>Golden Muscat</td>
<td>white</td>
</tr>
<tr>
<td>Valvin Muscat</td>
<td>white</td>
</tr>
<tr>
<td><strong>Seedless</strong></td>
<td></td>
</tr>
<tr>
<td>Marquis</td>
<td>white</td>
</tr>
<tr>
<td>Reliance</td>
<td>pink to red</td>
</tr>
<tr>
<td>Mars</td>
<td>black</td>
</tr>
<tr>
<td>Saturn</td>
<td>red</td>
</tr>
<tr>
<td>Jupiter</td>
<td>red</td>
</tr>
<tr>
<td><strong>Hybrids</strong></td>
<td></td>
</tr>
<tr>
<td>French-American</td>
<td></td>
</tr>
<tr>
<td>Chambourcin</td>
<td>red</td>
</tr>
<tr>
<td>Noiret</td>
<td>red</td>
</tr>
<tr>
<td>Corot Noir</td>
<td>red</td>
</tr>
<tr>
<td>Chardonel</td>
<td>white</td>
</tr>
<tr>
<td>Seyval</td>
<td>white</td>
</tr>
<tr>
<td>Traminette</td>
<td>white</td>
</tr>
<tr>
<td>Vidal</td>
<td>white</td>
</tr>
<tr>
<td><strong>American</strong></td>
<td></td>
</tr>
<tr>
<td>Cynthiana or Norton</td>
<td>red</td>
</tr>
<tr>
<td>Cayuga White</td>
<td>white</td>
</tr>
<tr>
<td>Vignoles</td>
<td>white</td>
</tr>
<tr>
<td><strong>Vitis vinifera</strong></td>
<td></td>
</tr>
<tr>
<td>Red Wines</td>
<td></td>
</tr>
</tbody>
</table>

### Table 6. Grapes Varieties for Tennessee

<table>
<thead>
<tr>
<th>Grape Type</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hybrids</strong></td>
<td></td>
</tr>
<tr>
<td><strong>American</strong></td>
<td></td>
</tr>
<tr>
<td>Cynthiana or Norton</td>
<td>red</td>
</tr>
<tr>
<td>Cayuga White</td>
<td>white</td>
</tr>
<tr>
<td>Vignoles</td>
<td>white</td>
</tr>
</tbody>
</table>

**Storage**

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kernels can be frozen and stored for more than a year with no detectable loss in quality.

**Landscaping with Fruits and Nuts**

Fruit and nut crops can make a productive and attractive landscape. However, the care necessary is greater than the care necessary for strictly ornamental plants. Pruning, training, fertilization and pest control practices are required to promote good yields and fruit quality. These practices may differ considerably from those used for ornamentals. A poorly cared for fruit or nut planting detracts from, rather than adds to, the landscape.

**Small Fruit Production**

Small fruits grown in Tennessee are wonderful additions to gardens due to their use in foods such as: jams, jellies, preserves, pies, muffins, pancakes, yogurt and ice cream. Blueberries are a popular small-fruited plant in Tennessee. After they are established, the plants are not difficult to maintain. Establishment, however, can be difficult. Plants can be easily grown in existing home landscapes and provide fruit while adding beauty to the landscape. Birds are usually the most troublesome pest after plants begin to fruit. After planting, the first good fruit yield will generally occur after three to five years. However, the length of time to fruiting will vary with the age of the transplants, the rate of growth and the health of the plant.

Blackberries and raspberries, also known collectively as brambles, are also often found in Tennessee home gardens. They have vigorous growth, are not easily harmed by spring frost and consistently produce high-quality fruit. Because of their excessive growth, brambles should be planted in an area where they can be contained. They are effective screens along property lines in landscapes. By choosing different types of brambles, fresh fruit can be harvested 5 to 6 months each year.

**Fertilizing Small Fruit**

Recommendations for fertilizing small fruits are determined from soil samples sent to the laboratory. When applying lime and sulfur, the recommendations from the soil test should be followed exactly. Lime is normally available from local garden supply centers. It may be purchased as either agricultural or hydrated lime. Either is effective in changing the pH and should be applied at least 6 weeks ahead of the intended planting date. The pH should be checked every 2 to 4 years.

Fertilizer can be applied in either the inorganic or organic form. Organic fertilizers are products of living things and include manure, fish and bone meal. Rabbit and poultry manure should be applied with care because they are high in nitrogen. If applied to strawberries in the spring, these materials stimulate excessive vegetative growth and soft fruit formation. Soft fruits are more subject to decay. Use of manure may make weed control difficult. Organic fertilizers normally do not furnish a complete fertilizer unless materials supplying the different nutrients are applied.

Inorganic fertilizers usually supply nitrogen, phosphorus and potash. Examples of mixed fertilizers are 6-12-12, 12-24-24, 10-10-10 and 15-15-15. Guide to fertilizing small fruits with inorganic and organic materials are summarized in Tables 8 and 9.

**Blueberries**

Blueberries are becoming more popular with gardeners in Tennessee. One reason for the surge in popularity of blueberries is that once established, they can remain productive for many years with relatively minimal labor input and few disease or insect problems. Additionally, blueberries store well under refrigeration, have many food uses and have a long harvest season.

There are two types of blueberries grown in Tennessee: rabbiteye (Vaccinium ashei) and highbush (Vaccinium corymbosum L.). Rabbiteye blueberries are native to the gulf coast region of the United States. Compared to the highbush blueberries, rabbiteye blueberries bloom earlier, are more tolerant to heat and drought and have more vigorous growth—if left unpruned, they can reach up to 20 feet. The earlier bloom of rabbiteye is due to its fewer required chilling hours.

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Storing Fruits and Vegetables

Apples stored with potatoes, onions, cabbage and peppers for extended periods can “pick-up” the taste of these vegetables. Therefore, they should be kept separate.
Highbush blueberries are native to the East Coast and Great Lakes regions of the United States. In the South, they have performed better when grown at higher elevations and with irrigation. The later flowering and earlier fruiting dates make them better adapted to avoid spring frost flower injury and hot summer temperatures during harvest. Compared to rabbiteye blueberries, highbush blueberries have better winter hardiness.

A third type of blueberry, called South highbush, was developed from crosses between Northern highbush cultivars and blueberry species from Florida. These have not been widely planted, but are being evaluated in Tennessee for their adaptability to our climates.

**Growth and Development**

Blueberry plants have a fine, thread-like root system located near the soil surface. When deep and organic mulches are used, the majority of the root system is located at the interface of soil and mulch. Blueberry roots lack root hairs, which reduces their efficiency in water absorption. The roots are sensitive to low soil oxygen levels, a situation known as waterlogging. For these reasons, blueberries grow best on soils having good internal and surface...
Blueberries often produce multiple flushes of vegetative growth during the growing season. In this growth pattern, the shoot tip dies, forming a black tip. The black tip falls off within a few weeks and the vegetative bud immediately below it begins growing. This sequence may be repeated several times on the same branch, forming a zigzag growth pattern. Most shoots are twiggy and are not excessive in growth. However, occasionally a shoot will emerge with excessive vigor and soon outgrow even older shoots in length. Usually, these shoots are devoid of fruit buds and must be pruned to develop good fruiting wood.

Leaves of blueberries arise from slender vegetative buds that can be distinguished from fruiting buds because they are larger and near spherical in shape. Vegetative bud break usually occurs 1 or 2 weeks prior to bloom. Leaves from a waxy upper surface at maturity, which decreases the effectiveness of foliar sprays applied after mid-summer.

Flower buds form during late summer to early fall and become distinguishable by their spherical shape by mid to late fall. Each flower bud contains several individual flowers. Flowers begin to emerge following the fulfill-

### Table 8. Inorganic Fertilizer Guide for Small Fruits

<table>
<thead>
<tr>
<th>Crop</th>
<th>Time of Application</th>
<th>Pounds of Inorganic Fertilizer to Apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blueberries</td>
<td>At planting</td>
<td>Apply 1 ounce of 12-4-8, or equivalent fertilizer, per application in a 3-foot circle around each plant. Increase amount of fertilizer by ounce per application for each year of age of the plant, up to six years old. If the pH begins to rise, it may be necessary to use ammonium sulfate.</td>
</tr>
<tr>
<td>Blueberries</td>
<td>March, mid-May and late June (maintenance)</td>
<td></td>
</tr>
<tr>
<td>Brambles</td>
<td>At planting</td>
<td>Apply 2.5-3.0 lbs. of ammonium nitrate fertilizer per 100 square feet of row.</td>
</tr>
<tr>
<td>Brambles</td>
<td>March and annually (maintenance)</td>
<td>Apply 2.5-3.0 lbs. of ammonium nitrate fertilizer per 100 square feet of row except on fertile soils. Omit fertilizer on fertile soils.</td>
</tr>
<tr>
<td>Brambles</td>
<td>After harvest</td>
<td>Apply 2.5-3.0 lbs. of ammonium nitrate fertilizer per 100 square feet of row when the foliage is dry. Brush foliage to remove fertilizer.</td>
</tr>
<tr>
<td>Strawberries (matted row)</td>
<td>At planting</td>
<td>Follow soil test</td>
</tr>
<tr>
<td>Renovation (annual maintenance)</td>
<td></td>
<td>Apply 6 lbs. of 6-12-12, or equivalent fertilizer, per 100 square feet of row before cultivation.</td>
</tr>
<tr>
<td>Late August (annual maintenance)</td>
<td></td>
<td>Apply 2.5-3.0 lbs. of ammonium nitrate per 100 square feet of row when the foliage is dry. Brush foliage to remove fertilizer.</td>
</tr>
</tbody>
</table>
ment of their chilling requirement and the accumulation of heat units. Flower petals are fused, forming a tube. This favors pollination by bumblebees and reduces the effectiveness of honeybees. Flower buds will be found on the terminal 2 to 3 inches of the shoots.

Berry size has a positive correlation with seed number and with shoot vigor. Berries continue to increase in size until their final blue color appears. However, because acids continue to decline and sugars continue to increase for several days after the blue color change, color is not an indication of ripeness. Therefore, fruit should be allowed to fully ripen on the bush before harvest. This will allow the fruit to and become sweeter. If harvested prematurely, blueberries will never reach the quality they would have reached on the bush. In general, blueberry fruits are mature about 90 days after petal fall.

Site Selection
Where possible, blueberry plants should be established on a site elevated above surrounding areas in the garden or yard. This allows for good air drainage to minimize frost injury in the spring. Plantings on north-facing areas are desirable because they warm up more slowly in the spring and bloom later.

Blueberry plants grow well in well drained, coarse to medium textured soils. Fine textured, clayey soils should be avoided. Soils with poor internal and/or surface drainage must be modified before successful growth will occur. This is because blueberries will tolerate standing water for only a short period of time. In areas with questionable drainage or with a water table less than 30 inches below the soil surface, plantings should be on raised beds that are 12 to 18 inches high.

Blueberries require a more acid soil than most fruit crops and grow best in soils with pH levels between 4.8 and 5.5. Blueberries should not be planted in high pH soils that

|Table 9. Organic Fertilizer* Recommendations for Small Fruits|
|---|---|---|
|Material| Main Nutrient Applied| Pounds Applied per 1,000 Sq. Feet|
|Dried blood| Nitrogen| 10|
|Fish meal| Nitrogen| 15|
|Cottonseed or soybean meal| Nitrogen| 20|
|Steamed bone meal| Phosphate| 25|
|Rock phosphate**| Phosphate| 300|
|Wood ashes| Potash| 100|
|Fresh cattle manure| Nitrogen, Potash| 500 (10 bu.)|
|Compost| Nitrogen, Potash| 750 (15 bu.)|
|Fresh horse manure| Nitrogen, Potash| 500 (10 bu.)|
|Fresh chicken manure| Nitrogen| 280 (5 bu.)|

*These amounts are recommended for working into the soil at planting.
**Nutrients in rock phosphate are not readily available the first year, but become more available in subsequent years. This is the reason for the high initial rates.

Cross-Pollinating Highbush Blueberries
Most highbush blueberries are self-fertile, but may benefit from cross-pollination. Two or more cultivars of rabbiteye blueberries should always be planted to ensure cross-pollination.

Figure 42.
Location of Fruit and Leaf Buds on Dormant Blueberry Plants
(1) Fruit Buds: Plump and Located on the Terminal 2-3 Inches of Shoots
(2) Leaf Buds: Small, Pointed and Located on the Basal Part of the Shoots
have been limed in the last 3 years. This is because the lime will constantly offset the acidifying effects of the sulfur. Also, newly cleared land where large amounts of wood or logs have been burned should be avoided. This is because the alkaline minerals in the ash will raise the soil pH above the range for optimum plant growth. Blueberries should not be planted lower on slopes than crops where the soil pH is maintained at higher levels. This is because runoff water from these points can wash into the blueberry planting.

**Soil Preparation**

For blueberries, soil preparation should begin at least 1 year before planting. The planting areas should be tilled and a soil test should be taken so the soil pH can be modified as needed. Soil pH levels above 5.6 must be adjusted with sulfur. Sulfur should be applied and incorporated into the soil at least 6 months before planting. If possible, blueberries should not be planted in areas just treated with sulfur, as root injury could occur. If plants are already in the ground and the pH is too high, sulfur may be added to the soil surface. Soil pH should be monitored yearly the first 3 years after planting and every third year following. All soil samples should be taken under the dripline of the plants.

Brambles, poison ivy, bermudagrass, johnsongrass, honeysuckle and other perennial weeds need to be eradicated before planting blueberries. Cultivation and/or systemic herbicides can be used for the control of these weeds. Additionally, if blueberries are going to be planted in areas where grass has been established, the grass should be eliminated with an herbicide before tilling the area.

Finally, at least 6 months prior to planting, additional nitrogen and at least a 6-inch-deep compost consisting of composted pine bark or decomposed softwood sawdust should be incorporated into the area where the plants are to be set.

**Plant Selection and Establishment**

Healthy, true-to-name plants should be purchased from a reputable nursery. Most blueberry plants set are 2-years-old and either bare-rooted or container-grown.

When bare-rooted plants arrive from the nursery, the shipping containers should be immediately opened and the roots should be felt to see if they are still moist. Blueberry roots are naturally brown on the outside and white on the inside. Before planting, the shoots should be cut to a height of 6 to 12 inches, or approximately one-third of the top can be removed, including all flower buds. Newly set plants should not be allowed to flower and fruit the first or second year after planting.

Blueberries should be planted in the late winter or early spring. Soil preparation and planting should be avoided when the soil is excessively wet. Plants should be set at the same depth they grew in at the nursery. If container-grown plants are used, it is very important that the root ball be unwound or broken apart. This is because pot-bound blueberry plants grow poorly and frequently die during droughts. Extra care should be taken to prevent drying of the fine fibrous root systems during the transplanting operation.

Rabbiteye blueberry plants are generally set about 6 feet apart in a row. Highbush varieties are set 4 to 5 feet apart in rows, as they are less vigorous than rabbiteye plants. For best results, one-fourth to one-half bushel of wet peat moss should be mixed with the soil at each plant site. It is very important that the peat moss be thoroughly wet and mixed with the soil.

Since young blueberry plants are poor competitors with weeds, the area within 2 to 3 feet of the base of each plant should be kept weed free. A mulch of 4 to 6 inches of well-rotted sawdust, finely ground pine bark or pine straw around the base of the blueberry plant will discourage weed growth and conserve soil moisture.

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**Compost Materials**

Leaf mold, composted leaves or other composted materials are beneficial soil amendments and require less nitrogen than pine bark or decomposed softwood sawdust for their decomposition. However, they break down in the soil more rapidly than bark and sawdust. Keep in mind that organic matter decreases drainage.
Blueberries need irrigation to achieve their yield and aesthetic potential. Their reaction to drought is first noted by a reddening of the foliage. Extended drought causes thin and weak shoot growth, decreased fruit set and early defoliation. Irrigation is important for new plantings, established plants and during flowering and fruit development. Irrigation during the berry enlargement period, when the weather is dry, will increase berry size and yields. Also, irrigating during dry periods, which generally occur during August and September and sometimes as early as May, will increase growth and bud formation for next season. Plants require between 1 and 1 3/4 inches of water per week. If rainfall is deficient, it must be supplemented with irrigation. Soaker hoses or drop lines work well with blueberries in home gardens. Overhead sprinklers may be used, but crusting of the mulch may prevent water from ever reaching the blueberry roots.

**Mulching**

Blueberries benefit greatly from organic mulches. Studies with both highbush and rabbiteye blueberries have shown that organic mulches increase productivity by 30 to 50 percent. Mulches reduce evaporation of soil moisture, increase water uptake by the soil, improve water-holding capacity of the soil, reduce soil temperature and reduce weed competition. However, roots forming under mulches are much shallower than those forming in bare soil. For this reason, once mulching is started, it needs to be continued. Mulch also needs to be used on clay or dry soils if there is no irrigation besides rain. As the mulch decomposes, it should be replenished with more mulch material around the plants. Additionally, supplemental nitrogen will need to be applied with the mulch.
Pruning

Blueberries need little pruning in comparison to other fruit crops, especially if it is done on a regular basis. Pruning controls bush height, rejuvenates fruiting wood and maintains productive shoots. When planting bare-rooted plants, one-third to one-half of the top of the plants and all flower buds should be removed. When planting container-grown plants, only flower buds should be removed at planting and in the second year.

In the third to fifth years, little pruning is required. Extremely vigorous 1-year-old shoots should be cut 1 foot below the top of the bush. This should be done in the summer as these vigorous canes grow. This will encourage the formation of productive laterals. Any weak, low-growing shoots should also be removed.

After the fifth year, a systematic program of renewal pruning is recommended for mature plants. The renewal should begin by removing weak or diseased shoots and low growing shoots, especially if they are shorter than shoots above them. Then, starting with the older canes, approximately two per year should be cut back either to a strong lateral or to within 1 foot of the ground. New strong lateral branches will usually develop below the cut. Canes on highbush blueberries should be cut off at the ground level to encourage growth of new canes from the suckers. By using this systematic approach, a new bush framework is developed over a 4- or 5-year period.

Pollination

The size of a blueberry fruit is dependent on three factors: seed number, source of pollen and moisture availability. When seed numbers are high, fruits tend to be larger and ripen more quickly. High seed numbers result from good bee activity and a pollen source from another cultivar. Self-pollinated flowers usually produce smaller berries.

Highbush types are self-fertile, but all the other types of blueberries benefit from cross-pollination, resulting in larger and earlier maturing fruit. Most rabbiteye cultivars are completely self-sterile; therefore, interplanting two or more cultivars is essential. Regardless of the number of cultivars planted, each cultivar should always be adjacent to a different cultivar. This will ensure maximum pollination.

Unlike strawberries, blackberries, and apples, the honeybee does not pollinate blueberries efficiently. The best pollinators for blueberries are the solitary southeastern blueberry bee and bumblebees. Blueberry flowers are pollinated when flowers are sonicated. Sonication occurs when bumblebees and blueberry bees “buzz” on the flower by vibrating their wing muscles. Honeybees are unable to do this and are therefore, not as efficient. Honeybees also may feed on nectar through a hold in the base of the flower made by carpenter bees, thereby passing up the chance of pollination.

Harvesting Fruit

Generally, the berries are not fully ripe until 3 to 6 days after turning blue. Too early harvesting can result in reduced berry size and poorer quality fruit with less sugar. When berries start to be ready for harvest, they should be harvested at weekly intervals, depending on
the rate of ripening. The harvest period of rabbiteye varieties is usually 6 to 8 weeks. Mature rabbiteye plants normally produce 20 pints or more per bush. Fruit should not be harvested until after the dew has evaporated to reduce post-harvest fruit rots.

**Disease and Insect Pests**

Blueberries grown in home plantings in Tennessee seldom have disease or insect problems. Rabbiteye blueberries are more resistant to insect and disease damage than are highbush blueberries. For more details on disease and insect pests of blueberry plants, see Chapters 17, Plant Pathology and Chapter 18, Entomology.

**Animal Control**

Rodents, such as voles, may become troublesome, especially when organic mulches are used. They may damage roots as well as irrigation lines. Close mowing of grass near the planting, baits, clean yards and clean gardens aid in the control of rodents.

Birds are also attracted to blueberry plantings. Netting placed over blueberry plants is the most effective way of discouraging birds. Some devices such as plastic owls and snakes or other artificial “scare” devices have temporary effects on birds.

**Brambles**

A bramble is defined as any plant belonging to the Rubus genus. Rubus typically have perennial roots with shoots that are biennial. This means that the shoots, called canes, grow vegetatively in the first growing season (primocanes), go through a dormant season, then leaf out, flower, fruit and die during the second growing season. Canes are referred to as floricanes during the second year. The one exception is the primocanes from the ground in the spring. The primocanes grow, flower and fruit in the same season.

**Types of Brambles**

Raspberries and blackberries are the most common bramble crops. Regarding raspberries, the red, black and purple types are the most commonly grown. The word “type” is used intentionally, because the difference among them lies not only in the color of the fruit, but in the growth habit, the cultural practices, the disease problems and the other characteristics.

There are two types of red raspberries: summer-bearing and primocane-bearing. Summer-bearing red raspberries bear fruit in the early summer. They have the typical biennial lifecycle of a bramble, so canes die after fruiting. Primocane-bearing types such as Heritage, form fruit during the first year in the fall. Primocane-bearing raspberries, also called “everbearing” raspberries, fruit again in the spring on buds closer to the base of the plant.

Because both of these red raspberries produce new canes, called suckers, primarily from the root system, they are usually grown in a hedgerow. They are the most winter hardy of the raspberries because they can withstand temperatures as low as -20 degrees F when properly acclimated. It should be noted that all winter hardiness temperatures are estimates of the temperature a plant can tolerate without substantial injury when fully dormant. Once a plant begins to lose its dormancy, it can be injured at much higher temperatures. This frequently occurs in Tennessee.

As opposed to red raspberries, black raspberries initiate new canes from the crown of the plant, rather than from root suckers. They are usually grown in a “hill” system. Each plant is grown independently, with pruning and maintenance done on a per-plant basis.

![Figure 46. Biennial Life Cycle of a Bramble Cane, Excluding Everbearing Types](image-url)
Unlike red raspberries, black raspberries require summer tipping because individual canes will grow to unmanageable lengths. Black raspberries bear their fruit the earliest in the season. They are also the most winter tender of the raspberries.

Purple raspberries are hybrids of red and black raspberries. They initiate new canes predominantly from the crown, but may sucker between plants as well. They are essentially grown as black raspberries are and are intermediate in cold hardiness.

Gold raspberries are also available, although not widely grown. Efforts are underway to develop a better, more viable, gold raspberry. The formerly predominant cultivar, Fallgold, is susceptible to a virus disease and should not be planted.

In contrast to raspberries, blackberries can be either thorny or thornless. Most thornless types are more cold tender—they are damaged at about 0 degrees F—and they require trellising. Thorny types have excellent fruit quality, but are grown less often because the thorns are brutal and present an obstacle in harvesting. Generally, thorny types will tolerate temperatures to about -10 degrees F. More recently, thornless upright blackberries have been developed at the University of Arkansas. These blackberries grow well in Tennessee conditions, but are more sensitive to freezing temperatures than thorny types.

Raspberries appear to be less subject to winterkill than blackberries, but more susceptible to anthracnose or viruses. This could be a major factor in determining whether to plant blackberries or raspberries. Red raspberries are likely to require support to improve cane erectness and keep fruit from making soil contact.

### Table 12. Different Types of Blackberries

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Growth Habit</th>
<th>Ripening order</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choctaw</td>
<td>Thorned</td>
<td>1</td>
<td>Small berries, high yields</td>
</tr>
<tr>
<td>Chickasaw</td>
<td>Thorned</td>
<td>2</td>
<td>Large berries</td>
</tr>
<tr>
<td>Kiowa</td>
<td>Thorned</td>
<td>3</td>
<td>Very large berries</td>
</tr>
<tr>
<td>Shawnee</td>
<td>Thorned</td>
<td>4</td>
<td>High yields, most susceptible to double blossom</td>
</tr>
<tr>
<td>Arapaho</td>
<td>Thornless/erect</td>
<td>1</td>
<td>Low yields</td>
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<tr>
<td>Ouchita</td>
<td>Thornless/erect</td>
<td>2</td>
<td>High sugar levels</td>
</tr>
<tr>
<td>Navaho</td>
<td>Thornless/erect</td>
<td>3</td>
<td>Firm berries</td>
</tr>
<tr>
<td>Apache</td>
<td>Thornless/erect</td>
<td>4</td>
<td>Large berries</td>
</tr>
<tr>
<td>Chester</td>
<td>Thornless/semi-erect</td>
<td>5</td>
<td>Very high yields, later ripening</td>
</tr>
<tr>
<td>Triple Crown</td>
<td>Thornless/semi-erect</td>
<td>6</td>
<td>Very high yields, later ripening</td>
</tr>
</tbody>
</table>

Other Types of Brambles

While the brambles described above are the ones most commonly grown near the home in the United States, many “novelty” brambles have been developed. These include tayberries, tummelberries, loganberries and boysenberries, all of which are hybrids between red raspberries and blackberries. All are produced on a very small scale nationally. Of these, the tayberry is the most cold tolerant.

Site Selection and Preparation

Brambles require full sun and well-drained soils. The year prior to planting, the soil should be tested to determine the pH and the need for fertilizer. Brambles grow best in soils that have a pH of 6.0 to 6.8. If the soil test shows that the soil is too acidic, the soil can be amended with lime. Lime should be applied the fall before planting.

Brambles also do well in soils that are high in organic matter. Therefore, before planting, the organic matter of the soil should be increased. Also, perennial weeds should be controlled prior to planting and brambles should not be planted on sites where strawberries, potatoes, tomatoes, peppers or eggplants have been recently grown. This is because plants can transmit fusarium wilt to the brambles.
Slope and exposure of the site are also very important. Plantings made on a slope are in less danger of bloom kill by late frosts than plantings made in surface depressions. North and east slopes are less susceptible to winter injury caused by fluctuating winter temperatures.

Brambles benefit greatly from irrigation, especially during fruit swell, which occurs the week before the fruit ripens. Trickle irrigation is preferred for brambles, because wetting the fruit with overhead irrigation may increase the incidence of disease. Irrigation will also greatly enhance the emergence and growth of primocanes during dry periods. However, brambles do not tolerate wet soils, so the amount of irrigation needs to be monitored.

**Planting and Establishment**

To be safe from disease, virus-tested, tissue-cultured raspberry plants should be planted in the early spring. Following are some suggested in-row spacings: red raspberries, 24 inches; black raspberries, 30 inches; purple raspberries, 36 inches; and blackberries, 36 inches.

Between-row spacing should be at least 6 feet, although row spacing depends on the garden or landscape plan. Also, flower blossoms should be removed the first year to encourage plant establishment. Finally, it should be kept in mind that June-bearing red raspberries will grow naturally in a hedgerow. Suckers, originating from the root system, will fill in the entire length of the row.

**Pruning Untrellised Raspberries**

Floricanes of all brambles die after fruiting is complete. Thus, floricanes should be removed immediately after fruiting to facilitate air circulation throughout the canopy. This is all of the summer pruning that is necessary for brambles. The only exception is suckers growing outside the 12-inch hedgerow. These may be removed at any time. Spring pruning of brambles is best done in late February or early March. This is the best time to prune because any cane dieback or bud injury from cold will be apparent.

Black and purple raspberries require summer topping throughout the summer and florican removal. Black and purple raspberries should be topped at 36 to 48 inches when only 3 to 4 inches of new growth needs to be removed to reach the desired height. Topping encourages the development of lateral, or fruiting, branches and increases the strength of the cane. However, topping plants later than this can result in an increased incidence of cane blight because the wound that results from removing larger-diameter wood takes longer to heal. Note: Black raspberries tend to have a very prostrate growth habit in the first year. If canes are pruned as described above, they will attain a more erect habit in subsequent years.

Raspberries can be dormant pruned anytime canes are fully dormant. For dormant pruning of raspberries, all dead, damaged and weak canes should be removed and remaining canes should be thinned to no more than six canes per plant. Remaining canes should be topped at 48 to 60 inches in height, removing about one-fourth of the cane. Canes that have

<table>
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<th>Table 13. Types of Red Raspberries</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>Latham</td>
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<td>Mandarin</td>
</tr>
<tr>
<td>Titan</td>
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<tr>
<td>Caroline</td>
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<td>Heritage</td>
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<table>
<thead>
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<th>Table 14. Other Raspberry Varieties</th>
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<tbody>
<tr>
<td>Color</td>
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<tr>
<td>-------</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>Purple (cross between black and red)</td>
</tr>
<tr>
<td>Purple</td>
</tr>
<tr>
<td>Yellow (mutations of red primocane bearing)</td>
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<tr>
<td>Yellow</td>
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<td>Yellow</td>
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the largest diameters should be kept. Lateral branches should also be headed back to 8 to 12 inches. These are general rules for raspberries, however more vigorous plants can support longer lateral branches. In addition, if a trellis system is used, even a nominal one such as the “T” trellis shown in Figure 50, canes can be topped higher (up to 60 inches), as long as they are supported by the trellis.

Everbearing red raspberries may be mowed to a height of 1 to 2 inches late in the dormant season. Home gardeners or small producers may opt to fruit the canes again in spring. Fruit will be borne on the overwintered canes at the leaf axil below the point where fruiting occurred the previous fall. While this is a viable option, only about 10 percent of the total “Heritage” yield is borne during the summer when fruited in this manner.

Pruning Blackberries
Erect blackberries, either erect thorny or erect thornless, do not require trellising. They have, as the name suggests, very strong upright canes. Erect blackberries should be pruned similarly to black and purple raspberries, specifically, they should be headed back to 48 to 60 inches in the summer, with laterals cut back to 12 to 18 inches and canes thinned to 10 inches apart in the hedgerow during the dormant pruning. Removal of laterals on the lower 12 to 18 inches of canes will facilitate better air circulation throughout the planting resulting in reduced disease pressure.

Trailing blackberries should be summer tipped at about 6 inches above the highest trellis wire and tied to it during the summer months. For dormant pruning, five to eight of the strongest canes should be selected and all laterals originating on the lower 3 feet of the canes should be removed. The remaining laterals should be tipped back to 12 to 18 inches.

Trellis Systems
Trellis systems generally do not have any bearing on the type of pruning a plant receives. Rather, they allow the plant to support more surface area for fruit production. Several trellises have been used and have provided successful results.

Harvesting Brambles
Brambles, like all small fruit crops, should be harvested in the morning after the dew has dried. This allows a minimum of field heat to build up in the fruit, and results in a longer shelf life. Ripe berries detach easily. They should be rolled off the plant, rather than squeezed or pulled, and put in shallow containers, as deep containers result in the crushing of berries in the lower layers.
Postharvest Care of Bramble Fruits

Raspberries are notorious for their poor shelf life. This is due, in part, to the form and structure of the fruit, which is composed of many loosely attached drupelets. Poor shelf life is also a result of the fruit’s very high postharvest rate of respiration—it is the highest of any temperate zone fruit—as well as its susceptibility to the Botrytis fungus.

Picked berries need to be kept out of direct sunlight and moved into cold storage immediately, removing any internal heat by using convective cooling (fans) and maintaining temperatures no higher than 32 degrees F. Berries can be kept for up to a week under these conditions.

Blackberries should be handled similarly, although blackberry shelf life is several days longer than raspberries.

Strawberries

The strawberry plant is in many ways unique. It is an herbaceous perennial, composed of leaves, a crown and a root system. The root system is composed of two kinds of roots: semipermanent, which last for more than a season, and transient, which last for only days or weeks. The root system is distributed through the soil differently depending on the soil type. In sandy soils, the roots may extend as deeply as 12 inches, with up to 50 percent located in the lower 6 inches. In heavier soils, such as clay loams, 90 percent of the roots may be located in the top 6 inches of soil. This shallow root system is partially responsible for the strawberry plant’s sensitivity to water deficiency and excess.

Runners, or stolons, arising from the buds at the base of the leaves are the strawberry plant’s device for asexual propagation. The matted-row system of strawberry culture, which is the major cultural system in home gardens in Tennessee, takes advantage of the strawberry plant’s runnering capacity as a means of establishing many plants from a few.

Types of Strawberries

The strawberry most commonly grown in Tennessee is the June-bearing strawberry. It is so named because it bears fruit during that month in some places. It bears fruit somewhat earlier than this in Tennessee. This type is
a short-day plant. This means that it initiates flower buds under short-day conditions, which are generally less than 12 hours/day of sunlight. The plant’s response to day length has to do with when the flower buds form. This process occurs in the short days of late September through early November, and may continue through the warm days in March. It is essential at this time for the plant to have a full, well-established leaf canopy. This is because the leaves provide energy for flower bud initiation. Temperatures below 60 degrees F will also induce flower bud formation.

In recent years, day-neutral strawberries have been selected to fill a niche in the summer-fall strawberry market. Day-neutral strawberry plants initiate flower buds regardless of day length. They will flower and produce fruit and runners simultaneously. Day-neutral rather bear three crops throughout the season - early summer, midsummer and fall, prior to first frost.

**Site Selection and Preparation**

The site should be selected the year before planting. Early site selection allows the grower to properly prepare the soil, an essential first step toward a successful strawberry planting. Strawberries should not be planted in locations that have had potatoes, tomatoes, eggplant, peppers or raspberries planted in them for the past 3 years. These crops harbor the Verticillium organism, which is a serious pathogen of the strawberry. While many cultivars are resistant to this pathogen, none are immune. Additionally, strawberry planting should not follow sod. This is because grubs that infest sod roots consume strawberry roots as well. In addition, grass can become a serious weed problem in the strawberry patch. Sites that are heavily infested with sedge, nutgrass, quackgrass, Johnsongrass and/or thistles should be avoided or treated with a systemic herbicide prior to planting.

Strawberries require full sun and adequate air drainage. Air drainage lessens the danger of spring frost damage to flower buds as well as disease problems. A gentle slope will allow for adequate air drainage.

**Soil**

Strawberries grow and produce satisfactorily in a wide range of soil types from sands to heavy loams. They are not notably sensitive to soil pH, but they grow and produce best in soils with a pH of 6.3 to 6.8. Best yields are obtained when plants are grown in deep fertile soils, with high organic matter and good internal drainage. Soils with poor drainage induce smaller strawberry root systems and crowns because of reduced oxygen for root respiration. Wet soils also encourage the proliferation of many fungal diseases that may infect strawberry plants.
Soil Testing
Soil should be tested for lime and mineral requirements the summer or fall before planting. Testing the previous year allows the grower to incorporate lime into the top 6 inches of soil the fall prior to planting. After the initial soil fertility adjustment, only nitrogen is applied annually, unless subsequent soil tests recommend further fertilizer needs.

Mulching
Strawberries and other small fruits benefit from being mulched with organic materials. A 2- to 4-inch pine needle or wheat straw mulch is ideal for matted-row strawberries. Mulches should be applied in early winter, after the plants have been exposed to several freezes and are fully dormant. Mulching at this time will protect plants from winter injury and delay flowering in the spring, thereby providing frost protection to the blossoms. When growth begins in early spring, most of the mulch should be removed to allow sunlight to reach the plants. Leaves do not make good mulch, as they can smother plants.

Renovating Strawberries
Renovation is the renewal of established strawberry beds. It is usually done shortly after harvest and it is essential to maintain production over a long period of time. Renovation is a relatively simple procedure composed of fertilizer application, weed removal, thinning the remaining plant stand, irrigation and narrowing of the rows.

In renovation, fertilizer is applied before cultivation. This enables better movement of fertilizer down into the root zone. It also stimulates new runner development, which is necessary to maintain long-term production. Thinning is important because it prevents excessive foliage growth, increases fruit size and removes less productive plants. When thinning, older plants should be removed more frequently then runner plants because the highest production occurs on the runner plants. The ideal plant spacing for strawberries within a matted-row system is 6 x 6 inches. Also, rows should be narrowed. This is beneficial to the plants because the increased light penetration to fruit will result in increased yields and quality and decreased disease pressure. After completion of the above practices, if dry, the soil should be irrigated. Irrigation dissolves fertilizers and stimulates new runners and fruit bud development. These practices are extremely important in maintaining productive strawberries.

Fertilizing Strawberries
The ideal time to apply fertilizer to established strawberry plantings is after harvest in mid-to-late June, and in late August or early September. Nitrogen should not be applied to established plantings just before or during fruit harvest. This will cause fruit to be soft and more susceptible to disease. Nitrogen applied in mid-to-late June is usually applied in a complete fertilizer such as 6-12-12 or 10-10-10.

Adequate levels of nitrogen, phosphorus and potassium must be available in the soil at the time of planting. Nitrogen is necessary to stimulate good foliage and root growth. Phosphorus is necessary in order to develop a good root system and potassium has been shown to improve both color and soluble solids in strawberry fruit. As other plants, a soil test should be taken prior to planting to determine exactly how much fertilizer is needed in the soil for a new strawberry planting.

Irrigation
Irrigation is required for a good crop of strawberries. Not only is the root system of the strawberry plant shallow, but also rainfall in Tennessee is most often uneven. Trickle irrigation has been used successfully to provide adequate soil moisture for strawberries. As water becomes more expensive, trickle systems may become a more cost effective means of irrigating the garden or orchard.
**Planting**

Virus-free, 1-year-old plants should be set out early in the spring, about 3 or 4 weeks before the average date of frost. Specific spacing of the plants will depend upon the training systems used. However, plants should never be crowded and they should be placed no less than 12 inches apart in rows 3 to 3 ½ feet apart. Each plant should be set so that the base of the bud is at the soil level. The roots should be spread out and the soil should be firmed carefully around them to prevent air pockets that allow them to dry out.

**Harvesting**

In the home garden, strawberries should be allowed to get an overall red color and become fully ripe before harvesting. It is at this stage that the sugar content is highest and the flavor is best. To prevent bruising, the berries should be picked carefully by the stems. Because the berries will not keep until the next harvest, it is important to harvest ripe berries every day during the peak of the season. Ripe strawberries may be held for a day or two in a refrigerator.

**Blossom Removal**

During the first season, all flower stems on the plants should be removed as soon as they appear. This strengthens the plants and allows early and vigorous runner production. The early-formed runners are removed as they appear.

**Pest Control**

Birds are one of the biggest pests in home garden strawberry production. Sometimes, it will be necessary to cover the plants with a plastic netting to keep the crop from being eaten before the berries are ripe enough to harvest.

**Summary**

Home fruit and nut production is an increasingly popular area of hobby gardening. As a Master Gardener, you will encounter questions about how to grow and care for fruiting plants. It is important that you become familiar with the references at the end of this chapter so that you can recommend publications to Extension clientele. New varieties and cultivars are continually being tested in Tennessee for fruit quality, yield production and winter hardiness. As these results are published, this information will be available on the websites and publications listed below.

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<td>Bilateral cordon system</td>
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<td>Fruiting spur</td>
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<td>Ground color (under color)</td>
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<td>Hangers</td>
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Test Your Knowledge

1. For commercial fruit and nut growers, what is considered to be the most important of the thousands of management decisions to be made?

2. Is it usually better to buy fruit trees, nut trees, and grapevines as bare-root or containerized plants?

3. Why is it important to prune fruit/nut trees and vines?

4. What is lime used for in fruit/nut production?

5. What factors effect blueberry fruit size?

Resources

The University of Tennessee Extension publications
utextension.tennessee.edu

eXtension Publications from other Land Grant Institutions
eXtension.org