Tree Fruits

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Producing Tree Fruit for Home Use

AG-28

Growing tree fruit in the home garden or yard can be a rewarding pastime. However, careful planning, preparation, and care of the trees are essential for success. This publication tells you what to consider before planting, how to plant your trees, and how to take care of them to ensure many seasons of enjoyment.

Part 1: Planning Before Planting

Fruit Selection

Selecting the type of fruit to grow is the first step in tree fruit production. To begin, you need to know which tree fruit can be grown in North Carolina.

Your region's climate determines the type of fruit you can grow successfully. The climate must be compatible with the growing requirements of the selected fruit crop. To take an extreme example, a tropical fruit such as the banana simply cannot survive in North Carolina. Bananas require a warmer climate and a longer growing season. Other tree fruit that may look promising in the glossy pages of mail order catalogs are also destined to fail if grown in incompatible climates. Climatic conditions vary greatly from one region to another in North Carolina, so make sure that the fruit you choose can grow successfully in your area.

Table 1. Potential Tree Fruit Crops for North Carolina

Fruit	Location	Varietal Considerations	Management
Apples	Throughout North Carolina	Most varieties will grow in North Carolina.	Moderate
Asian Pears	Throughout North Carolina	Plant fire blight-resistant varieties only.	Moderate

Chestnuts	Throughout North Carolina	Chinese and Chinese-American hybrids.	Low
Figs	Eastern North Carolina and southern piedmont	Select varieties that set fruit without pollination.	Low
Nectarines	Throughout North Carolina except at higher elevations	Select varieties that require at least 750 hours of chilling.	Very high
Peaches	Throughout North Carolina except at higher elevations	Select varieties that require at least 750 hours of chilling.	High
Pears	Throughout North Carolina	Plant fire blight-resistant varieties only.	Moderate
Pecans	Eastern North Carolina and southern piedmont	Select varieties suitable for North Carolina conditions.	Low
Persimmons	Eastern North Carolina and southern piedmont	American and Oriental are suitable.	Low
Plums	Eastern North Carolina	Use late-blooming varieties.	Moderate

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Fruit crops that can be grown in North Carolina are listed above in Table 1, along with additional information that will help to ensure success. Tree fruits that are not included in the list may grow in North Carolina, but few consistently produce quality fruit. For example, apricot and cherry trees can grow in certain areas where the climate is favorable, but they must be carefully managed and usually do not bear fruit consistently.

Note also that different crops require different levels of management. Low-management crops such as pecans, figs, and persimmons require little attention to training, fertility, or insect and disease control. On the other hand, peaches and plums require intensive management.

Site Selection

Selecting a good site for your fruit trees is crucial to their success. A number of factors should be considered (Figure 1a and 1b).

Selecting a site.

Figure 1a: Poor site selection. Fruit trees should not be planted in areas shaded by houses, buildings, or other trees. They also should not be planted near fences or hedges, as these keep cold air trapped around young trees.

Figure 1b: Well-selected site. All fruit trees are planted away from barriers and in areas that receive sufficient light.

Soil Type and Drainage

Plant fruit trees in well-drained and fairly fertile soil. Avoid poorly drained soils. A tree's root system grows throughout the year. Water that remains standing in the root zone (18 to 24 inches deep) at any time during the year can drown the tree. During the growing season, standing water can drown some types of fruit trees in just three days. Poorly drained soils also promote the growth of root rot organisms.

When poorly drained soils cannot be avoided, problems may be alleviated by planting the trees in raised beds. (See Figure 3.) The beds are formed by shaping well-drained topsoil into beds 18 to 24 inches high and 4 to 5 feet wide. Raised beds have been used successfully in both backyard and commercial orchards. Trees grown in raised beds must be irrigated more frequently during the growing season because the beds present a larger exposed surface area from which water can evaporate.

Soil Fertility

It is also important to consider soil fertility and acidity. Ideally, the soil pH should be around 6.5, but North Carolina soils are more typically acidic. Acidic soils reduce the amount of nutrients available to the trees. When this happens, fertilization does not benefit the trees but results in runoff or leaching. To alleviate the problem, it will be necessary to add lime to the soil to reduce the soil pH.

Before planting, collect soil samples for analysis. Soil samples should be taken from two depths; the first from the top 8 inches of soil and the second from the 9- to 16-inch depth.

Soil fertility analyses are free in North Carolina. Contact your county Cooperative Extension agent for instructions on collecting and submitting soil samples and for the necessary forms and sample boxes. Test results will be returned to you with recommendations for fertilization and liming. Once the test results have been received, the soil should be amended with the recommended materials, which should be worked into the soil before trees are planted.

Air Drainage

Adequate air drainage is as important as proper water drainage. In North Carolina, spring frosts and freezes are common, and a small difference in elevation can mean the difference between a full crop and no crop at all. Remember that cold air is heavier than warm air and settles in low areas, so choose a site that allows cold air to flow downhill away from the trees. Select higher sites with an unobstructed, gradual slope. Avoid low sites, which are commonly known as frost pockets.

Sunlight

Plant fruit trees in areas that receive full sunlight. Avoid areas shaded by taller trees, houses, or buildings (Figure 1).

Most fruit tree buds require 30 percent sunlight to produce high-quality fruit. Although the exterior of a tree may receive full sun, sunlight can be reduced by one-half just 12 inches inside the canopy of the tree. Eighteen inches into the tree canopy, light may be reduced nearly 75 percent, which is below the level needed for successful fruit production. Partially shaded trees can also have increased disease problems.

Nematodes

Nematodes are microscopic worms that live in the soil. Several types of fruit trees, including peach, plum, and figs, can be damaged or destroyed by nematodes.

An inexpensive soil test can be conducted to check for nematodes. For information, contact your county Cooperative Extension agent. The test results will be returned with recommendations for your crop. Avoid soils with high nematode populations. Soils with unacceptable nematode populations can be treated with a soil fumigant. However, most fumigants must be applied by a licensed pesticide applicator and can be costly. Contact your county Cooperative Extension agent for specific recommendations.

Variety Selection

After selecting the fruit and the planting site, you must choose the variety of fruit to plant. Novice growers often try to plant the same varieties that they see at their local grocery stores. Many times, however, these fruit are produced in areas with different climatic conditions from those in North Carolina. The result, at best, is fruit that looks much different than expected. At worst, the variety will fail to produce a crop. Plant varieties that are known to grow well in your region. Check temperature requirements and chilling factors before purchasing your trees. Table 2 lists some of the fruit varieties recommended for North Carolina.

Table 2. Variety Recommendations for North Carolina

Fruit	Recommended Varieties	Pollination Notes	Disease Notes	Other Considerations
Apples	Gala, Ginger Gold, Jonagold, Empire, Red Delicious, Golden Delicious, Crispin (Mutsu), Stayman, Rome, Fuji	Requirements vary. Some varieties are self-fruitful. Others require	Summer rots are the most serious disease problems and can destroy an entire crop. No varieties are resistant. Some	In warmer regions, red varieties may not color well.

		pollination (see note 1).	varietiesare resistant to apple scab, powdery mildew, cedar apple rust, or fireblight. These include Redfree, Prima, Priscilla, Jonafree, and Liberty.	
Asian Pears	Twentieth Century (Nijisseiki), Nititaka (*pollen source*), Shinseiki (New Century), Chojuro.	At least two varieties are needed to ensure adequate pollination.	Fire blight is the biggest concern.	Asian pears are very crisp and juicy.
Chestnuts	**Chinese:** Nanking, Meiling, Kuling, Abundance, Crane **Chinese-American Hybrid:** Revival, Carolina, Willamette	All require pollination from another variety. Plant at least two varieties of the same type to assure optimal nut size and production.	Most Chinese and hybrid chestnuts are highly resistant to the chestnut blight fungus.	Many people prefer the hybrid chestnut varieties, citing superior quality over the Chinese varieties.
Figs	Celeste, Brown Turkey, Brunswick/Magnolia (*for preserves*), Greenish, Marseille.	Only varieties that do not require pollination can be grown in North Carolina.	No serious disease problems except nematodes.	Fruit may drop prematurely as a result of drought or excessive shade, moisture, or fertilization.
Nectarines	Summer Beaut, Sunglo, Redgold, Flavortop, Fantasia, Carolina Red (*see note 2*).	Self-fruitful. Do not require pollination by other varieties.	Nectarines should be planted only on Lovell or Halford rootstocks to avoid premature death. The lack of hair on nectarines makes the fruit more susceptible to diseases than peaches, and a multipurpose fungicide and insecticide spray program will be required.	Many varieties were developed in California and may not do well in North Carolina.
Peaches	Redhaven, Norman, Carolina Belle (*white-fleshed*), Winblo, Contender, Summer Pearl (*white-fleshed*), Cresthaven, Encore,	Self-fruitful. Do not require pollination by other varieties.	A multipurpose fungicide and insecticide spray program will be needed during the growing season.	Only varieties that require 750 hours of chilling are recommended.

	Legend. (*Many varieties are the result of a peach breeding program at NCSU and have been developed for North Carolina* (*see note 2*)).			
Pears	Moonglow, Magness (*not a pollen source*], Kieffer, Harrow Delight, Harrow Sweet, Harvest Queen, Seckel.	At least two varieties are recommended to ensure adequate pollination.	Plant only fire blight-resistant varieties.	Pears bloom earlier than apples and should be planted on higher sites.
Pecans	**Type I:** Cape Fear and Pawnee. **Type II:** Stuart, Forkert, Sumner, Kiowa, Gloria Grande	Pollination by another variety is essential. One variety from each of the two groups must be used for pollination.	Scab is the most serious disease in North Carolina. However, a fungicide spray program is usually not practical.	Careful variety selection is essential to avoid frost or freeze problems and to allow a long enough season for maturation.
Persimmons	Fuyu, Jiro, Hanagosho (*very good pollen source*). (*Only large-fruited Oriental persimmons are recommended for North Carolina*.)	Pollination is not required for fruit set but is recommended.	No serious disease problems.	If nonastringent varieties are planted, fruit may not be suitable for eating until they are fully mature and their flesh is soft.
Plums	**Japanese:** Methley (*self-fruitful*), Byrongold, Burbank, Ozark Premier (*may bloom early*). **European:** Bluefre, Stanley, Shrophire (Damson) (*see note 2*)	Some varieties are self-fruitful, but planting two varieties is recommended.	A multipurpose fungicide-insecticide spray program will be needed during the growing season.	Later blooming varieties should be selected to avoid damaging spring temperatures.

Note 1. Pollination requirements for apples vary with variety. For varieties requiring cross-pollination, it is recommended that at least two varieties with overlapping bloom periods be planted together. For self-fruitful varieties, pollination by another variety will increase yield and quality.

Note 2. To break bud and grow properly in the spring, peaches, nectarines, and plums must be exposed to temperatures in the 40°F range for a required number of hours during the dormant season. This period is referred to as the chilling requirement. In North Carolina, varieties with chilling requirements of at least 750 hours are recommended to prevent trees from blossoming too early in the spring, which increases the risk of freeze damage and resultant crop loss.

Rootstock Selection and Tree Spacing

Almost all commercially available fruit trees have been budded or grafted; that is, the top portion, or *scion*, of the desired fruit variety is attached to the root system, or *rootstock*, of a different variety. Trees are grown this way because some popular varieties grow and crop better on rootstocks other than their own. In some cases, the rootstock is more resistant to certain troublesome diseases. In the case of apple trees, the rootstock can be chosen to limit growth, producing trees that crop well and are easier to manage than full-sized trees. The choice of rootstock is very important for some fruits, such as apples, but not of much consequence for others.

Apple trees are grown on a wide variety of rootstocks. These are called *size-controlling* rootstocks because they control the size of the tree; however fruit size is not reduced (Figure 2). In general, the smaller the tree, the sooner it will bear fruit after planting. Table 3 lists the rootstocks commonly used for apple trees and indicates their effect on tree size, using the "seedling" or standard rootstock as the basis of comparison. Thus, for example, the M.9 rootstock will produce a nonspur-type tree that is only 35 percent as large as it would be if grown on a seedling rootstock. The table also lists the time required for the trees to reach bearing age and the degree of rootstock resistance to two important diseases.

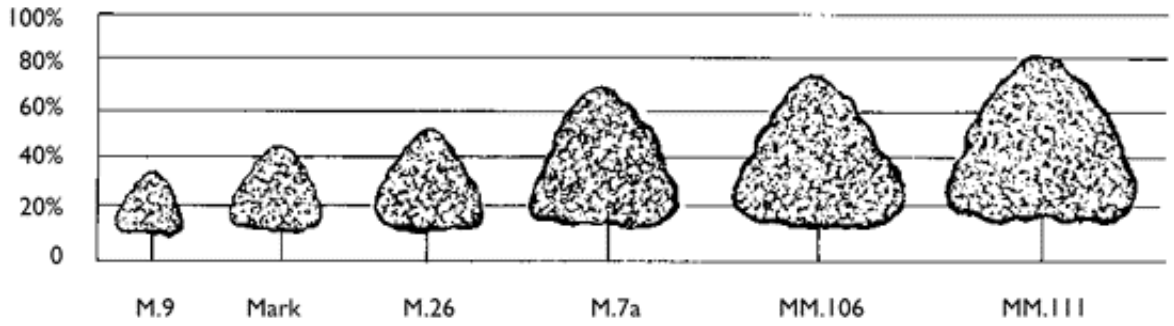

Figure 2. Tree size shown as a percentage of the size the tree would reach if grown on a seedling, or standard, rootstock.

Table 3. Commercially Available Apple Rootstocks and Their Characteristics

Rootstock	Tree Size as Percentage of Seedling (Nonspur)[a]	Tree Size as Percentage of Seedling (Spur)[a]	Fruit Bearing Age (Years)	Resistance to Crown Rot	Resistance to Fire Blight
Seedling	100	80	6 - 10	Medium	High
MM.111	85	70	4 - 6	Medium	Low
MM.106	80	70	3 - 4	Very Low	Low
M.7a	70	60	3 - 4	Medium	High
M.26	50	40	2 - 4	Medium	Very Low
Mark	45	35	2 - 3	Medium	Low

M.9	35	20	2 - 3	Medium	Low

[a]See Figure 2.

Two categories of growth habit are included in the table: spur and nonspur. Trees with a spur-type growth habit bear the majority of their fruit on very short branches called spurs. Nonspur varieties produce fruit on longer branches. Since spur-type varieties have fewer long branches, the trees are more compact.

Because the choice of rootstock affects the size of the trees, it also affects the optimum spacing between the trees. Table 4 gives the recommended distance between trees for both spur and nonspur varieties. Note that very vigorous varieties should be spaced farther apart.

Table 4. Recommended Planting Distances for Apple Trees Grown on Size-Controlling Rootstocks

	Distance Between Trees (feet)		
Rootstock	**Nonspur Varieties**	**Spur Varieties[a]**	**Very Vigorous Varieties[b]**
Seedling	18 - 25	12 - 16	25 - 35
MM.111	14 - 18	9 - 12	20 - 25
MM.106	12 - 16	8 - 11	17 - 22
M.7a	10 - 14	7 - 9	14 - 20
M.26	8 - 12	5 - 8	11 - 17
Mark	6 - 8	4 - 5	8 - 11
M.9	4 - 8	3 - 5	6 - 11

[a]For spur-type varieties such as Redchief Red Delicious, Starkrimson Red Delicious, Lawspur Rome, and Oregon Spur.

[b]For very vigorous varieties such as Rome Beauty, Granny Smith, and Jonagold.

Apple trees on rootstocks of a size class smaller than M.7a bear fruit while they are still very young. They should be supported by stakes to promote optimum growth and to help support the fruit load in the early years. Use 10-foot stakes and drive them 2 feet into the ground. Stakes are commonly made from 1-inch-diameter aluminum electrical conduit or 3-inch-diameter wooden posts. Tie the tree loosely to the above-ground portion of the stake. Strips of plastic or heavy-duty canvas or cloth can be used as ties. Do not use materials that will restrict tree growth or girdle the tree.

Peaches, nectarines, and plums are also affected by choice of rootstock. In the Southeast, trees are susceptible to peach tree short life (PTSL), a condition that causes sudden death of the tree after only four or five years of growth. With proper rootstock selection, nematode suppression, and cultural practices, the threat of this condition can be minimized. At present, only trees grown on Lovell or Halford rootstock are recommended for use in North Carolina. Trees grown on these rootstocks should be spaced 20 feet apart. Spacing recommendations for other fruit trees are given in Table 5.

Table 5. Spacing Requirements for Other Tree Fruits

Fruit Crop	Minimum Spacing Between Trees (feet)
Asian Pears	20
Chestnuts	40
Figs	10
Pears	20
Pecans	70[a]
Persimmons	15

[a]At maturity, approximately 20 years.

Part 2: Cultural Practices

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Training & Pruning Fruit Trees

AG-29

Growers often neglect the annual training and pruning of fruit trees. Without training and pruning, however, fruit trees will not develop proper shape and form. Properly trained and pruned trees will yield high quality fruit much earlier in their lives and live significantly longer.

A primary objective of training and pruning is to develop a strong tree framework that will support fruit production. Improperly trained fruit trees generally have very upright branch angles, which result in serious limb breakage under a heavy fruit load. This significantly reduces the productivity of the tree and may greatly reduce tree life. Another goal of annual training and pruning is to remove dead, diseased, or broken limbs.

Proper tree training also opens up the tree canopy to maximize light penetration. For most deciduous tree fruit, flower buds for the current season's crop are formed the previous summer. Light penetration is essential for flower bud development and optimal fruit set, flavor, and quality. Although a mature tree may be growing in full sun, a very dense canopy may not allow enough light to reach 12 to 18 inches inside the canopy. Opening the tree canopy also permits adequate air movement through the tree, which promotes rapid drying to minimize disease infection and allows thorough pesticide penetration. Additionally, a wellshaped fruit tree is aesthetically pleasing, whether in a landscaped yard, garden, or commercial orchard.

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Pruning vs. Training

Historically, fruit tree form and structure have been maintained by pruning. Tree training, however, is a much more efficient and desirable way to develop form and structure.

Pruning is the removal of a portion of a tree to correct or maintain tree structure. Training is a relatively new

practice in which tree growth is directed into a desired shape and form. Training young fruit trees is essential for proper tree development. It is better to direct tree growth with training than to correct it with pruning.

Pruning is most often done during the winter, commonly referred to as dormant pruning. Training includes summer training and summer pruning as well as dormant pruning. The goal of tree training is to direct tree growth and minimize cutting.

Dormant Pruning vs. Summer Pruning

Trees respond very differently to dormant and summer pruning. Dormant pruning is an invigorating process. During the fall, energy is stored primarily in the trunk and root system to support the top portion of the tree. If a large portion of the tree is removed during the winter, while the tree is dormant, the tree's energy reserve is unchanged. In the spring, the tree responds by producing many new vigorous, upright shoots, called water sprouts, which shade the tree and inhibit proper development. Heavy dormant pruning also promotes excessive vegetative vigor, which uses much of the tree's energy, leaving little for fruit growth and development.

Historically, much of the vigorous, upright vegetative growth has been removed during the dormant season; heavy dormant pruning results in a yearly cycle with excessive vegetative growth and little or no fruit production.

Timing of dormant pruning is critical. Pruning should begin as late in the winter as possible to avoid winter injury. Apple and pecan trees should be pruned first, followed by cherry, peach, and plum trees. A good rule to follow is to prune the latest blooming trees first and the earliest blooming last. Another factor to consider is tree age. Within a particular fruit type, the oldest trees should be pruned first. Younger trees are more prone to winter injury from early pruning.

Summer pruning eliminates an energy or foodproducing portion of the tree and results in reduced tree growth. Pruning can begin as soon as the buds start to grow, but it is generally started after vegetative growth is several inches long. For most purposes, summer pruning should be limited to removing the upright and vigorous current season's growth; only thinning cuts should be used. To minimize the potential for winter injury, summer pruning should not be done after the end of July.

Types of Pruning Cuts

Thinning Cut - removes an entire shoot back to a side shoot. Thinning cuts do not invigorate the tree in comparison to some of the other pruning cuts.

Heading Cut - removes only the terminal portion of a shoot. This type of cut promotes the growth of lower buds as well as several terminal buds below the cut. When lateral branches are headed into oneyearold wood, the area near the cut is invigorated. The headed branch is much stronger and rigid, resulting in lateral secondary branching. Older trees can be held in their allotted space by mold and hold cuts, which are devigorating heading cuts made into twoyearold wood. Young trees and branches where heading cuts are made will be referred to as headed.

Bench Cut - removes vigorous, upright shoots back to side branches that are relatively flat and outward growing. Bench cuts are used to open up the center of the tree and spread the branches outward. *This is a major cut and should only be used when necessary.*

When making pruning cuts, it is important to use techniques that will allow the cut surface to heal quickly. Rapid healing minimizes the incidence of disease and insect infection. Pruning cuts should be flush with the adjacent branch without leaving stubs. Also, when large horizontal cuts are made, they should be slightly angled so that water does not set on the cut surface, allowing the growth of rot and disease organisms.

Many compounds are available as wound dressing or pruning paints. But the best treatment is to make proper pruning cuts and allow the tree to heal naturally. If preferred, tree paints and wound dressing may be used for aesthetic reasons, but they will not promote healing.

Training Systems

One of the most frequently asked questions is, "To what shape should I train my fruit tree?"

It is difficult to give one answer. You can choose from many different training shapes and forms with multiple variations on each form. This bulletin focuses primarily on the central leader and open center training systems for mediumdensity orchards. A list of fruit trees conventionally trained to each system is also included. A fruit tree may be trained to any system. Depending on the form and function of the desired shape, you may want to train a tree to a nontraditional system.

Whatever system is chosen, keep in mind that the objectives of training and pruning are to achieve maximum tree life and productivity.

Central Leader Training - Apple, Cherry, Pear, Pecan, Plum

A central leader tree is characterized by one main, upright trunk, referred to as the leader. Branching generally begins on the leader 24 to 36 inches above the soil surface to allow movement under the tree. The first year, 3 to 4 branches, collectively called a *scaffold whorl*, are selected. The selected scaffolds should be uniformly spaced around the trunk, not directly across from or above one another. Above the first scaffold whorl, leave an area of approximately 18 to 24 inches without any branches to allow light into the center of the tree. This light slot is followed with another whorl of scaffolds. Alternating scaffold whorls and light slots are maintained up the leader to the desired maximum tree height. See Figure 1.

The shape of a properly trained central leader tree is like that of a Christmas tree. The lowest scaffold whorl branches will be the longest and the higher scaffold whorl branches will be progressively shorter to allow maximum light penetration into the entire tree.

Developing a Central Leader Trained Tree At Planting

Fruit trees are frequently purchased as whips, which are unbranched trees ranging from 1/2 to 3/4 inch diameter. The tree should be planted in early winter with the graft union 2 inches above the soil surface. Just before the buds start to grow in the spring, the tree should be headed, or cut off, at 30 to 34 inches above the soil surface. The height at which the tree is headed depends upon where you want the first whorl of branches. Once the tree is headed, permanent branches will be selected from buds growing within 4 to 12 inches below the heading cut. See Figures 1 and 2.

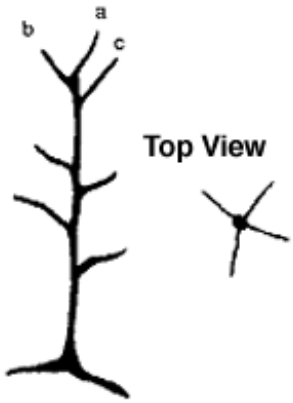
Figure 1. Pruning a central leader tree

At Planting
As the buds begin to swell, head the tree at 30 to 34 inches above the soil surface.

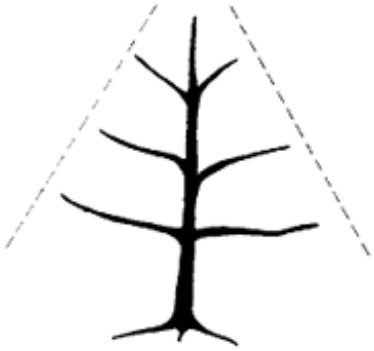
Dormant Pruning
Head the tree at 24 to 30 inches above the highest branch of the first scaffold whorl.

Top View

First-Year Summer Pruning
Summer prune when new growth is 3 to 4 inches long. Leave **a** as the new leader, and remove **b** and **c**. Select four uniformly spaced laterals for the first scaffold whorl, and remove the remaining lateral branches.



After pruning the third year
Three scaffold whorls have been developed with three to four branches uniformly spaced around the tree in each whorl. A light slot of 18 to 24 inches is left between each scaffold whorl. Note the Christmas-tree shape that allows light penetration to the lower branches and interior of the tree.



Steps in Pruning:

- Leave only one trunk for the central leader.
- Remove branches with crotch angles less than 60 degrees.
- Remove all branches directly across from one another on the leader.
- Space lateral branches uniformly around the leader to prevent crowding as the limbs grow in diameter.

Figure 2. Newly planted apple tree headed back

Summer Pruning

After the new vegetative growth has reached 3 to 4 inches in length, summer pruning should begin. The first step is to select one upright shoot near the top of the tree to be the leader. After selecting the leader shoot, remove all other competing shoots for approximately 4 inches below it; rehead the tree above this leader. See Figures 3 and 4.

Figure 3.
Left: Heading an apple tree at planting results in several competing shoots below the cut.
Right: For central leader tree, a single leader needs to be selected by removing the undesired shoots.

Figure 4. Central leader plum trees must also have competing shoots removed.

At this time, side shoots (laterals) should be spread out to form an angle of 60 to 70 degrees between the leader and the side shoot. This angle is referred to as the branch or crotch angle. Branches that do not have a wide branch angle are overly vigorous and have a weak point of attachment to the leader. These branches frequently break under a heavy fruit load. Spreading the lateral branches will also slow the growth of the branches to a manageable level and promote the development of secondary or side shoots on the scaffolds. When growth is only 3 to 4 inches, toothpicks or spring clothespins can be used to spread branches. See Figure 5. After a proper branch angle is attained, clothespins can be moved to the ends of longer limbs to weigh down the branches as they start to grow upward.

Figure 5. Central leader apple trees. Toothpicks are used to spread the lateral branches outward during the first growing season.

During the first year, minimize further summer pruning. Limit it to the removal of shoots growing upright or downward. Summer is the optimal time to select the leader and scaffold branches and remove undesirable growth. Branches lower than the desired height should also be removed. A young orchard or tree should be summer trained and pruned once a month through July to remove unwanted growth and to properly orient young branches. Summer pruning will greatly reduce the amount of dormant pruning needed.

Failure to summer prune the first year will result in an improperly trained tree, and drastic dormant pruning will be required to correct tree structure.

Succeeding Years

Managing the central leader is one of the most important aspects of dormant pruning. The leader should be headed at approximately 24 to 30 inches above the highest whorl of scaffolds to promote continued branching and scaffold whorl development. Dormant pruning should also eliminate dead, diseased, and damaged wood.

Unwanted growth, such as upright growing shoots and laterals with sharp branch angles not removed during summer pruning, should also be removed at this time. Unbranched lateral branches should be headed back by approximately 1/4 of their length to encourage side branches and to stiffen lateral branches.

Summer pruning in succeeding years should eliminate competing shoots where dormant heading cuts were made (on the central leader and laterals) as in the first year. Summer is also the optimal time to remove unwanted side shoots and excessive growth. All laterals should have a wide branch angle, and spreading of lateral branches is essential for many varieties. Lateral branches will need to be spread for about the first five years, using a larger spreader each year.

Spreaders can be made with 1inchsquare wood pieces with a finishing nail driven in the end and cut off at an angle. Spreaders are frequently made in lengths of 6, 12, and 18 inches. See Figure 6.

Figure 6. Wooden limb spreaders can be made from wood and finishing nails in various lengths.

Spreading branches in later years reduces vigor and promotes fruit development on the lateral branches. The reduced growth rate and the weight of the crop load will also help pull the branches down to a proper angle. However, it is important that the young tree is not allowed to crop too early where the weight of the fruit pulls the branches below horizontal. Once the branches are below horizontal, they are weak and nonproductive and need to be removed and replaced. See Figure 7.

Figure 7. Well-trained apple trees. Note the branch angles and the development of scaffold whorls.

Another objective of dormant pruning is to control the length of the lateral branches. In order to maintain the

Christmastree shape (Figure 1), lateral branches need to be cut back. Once the tree has reached its desired height and lateral spread, it will be necessary to mold and hold the lateral branches and the central leader with heading cuts. This can be done by cutting the laterals and leader back into twoyearold wood to a sidegrowing shoot. It is a good rule to cut back to a side shoot that is close to the same diameter as the lateral or leader being cut.

Mature Trees

Mature trees that have been properly trained and summer pruned will require minimal pruning. The first step would be to remove dead, diseased, and damaged wood and then upright shoots and shoots below horizontal. To prevent shading, it is important to maintain the Christmastree shape by heading lateral branches with mold and hold cuts. See Figure 8. For quality fruit production, it is also essential that the light slots between the scaffold whorls be maintained.

Figure 8. Mature, well-trained apple trees, left, and pecan trees, right. Note that the distance between branches needs to be increased for larger trees.

Mature fruit trees that have not been properly trained frequently do not have a true central leader shape. For those trees, the objectives of training and pruning as discussed earlier must be considered. In many cases, too many lateral branches and upright limbs (some may be 6 or more inches in diameter) have been left and need to be removed to allow proper light penetration. This pruning needs to be done during the dormant season.

Neglected trees often have overgrown tops that act as an umbrella, shading the rest of the tree. The tops of these trees need to be cut back or removed. Remember, if the principles of pruning are followed, there are no perfect cuts and no incorrect cuts. However, do not remove more than 30 percent of the tree top to avoid shifting the tree into an excessively vegetative state with little fruit development.

Pecan Tree Consideration

Pecan trees should be trained to a central leader. The lateral branches, however, should be spiraled up the leader. Approximately 12 to 15 inches should be left between branches for adequate light penetration initially. As the tree matures it will be necessary to remove branches to prevent crowding and allow light penetration. See Figure 8, above.

Modifications of the Central Leader

Multileader Tree

A multileader tree is the goal of another training system and an ideal option for pear varieties that are

susceptible to fireblight. With a multileader tree, if one leader is infected with fireblight, it may be removed without loss of the major portion of the tree. See Figure 9.

Figure 9. An apple tree trained to a multileader system. This would be an ideal training system for pear trees in North Carolina where fireblight is a threat.

The multileader tree uses the same concept as the central leader tree except there are several leaders in the center of the tree. Each leader is maintained the same as an individual central leader tree. The only difference in training a multileader from the central leader is that in the first and second year instead of removing the competing leaders, several should be left and maintained. On the tree in Figure 1, it would be necessary to leave shoots a, b, and c for a multileader tree. However, it would be necessary to put spreaders between the selected leaders to get the shape of the tree in Figure 9.

HigherDensity Central LeaderTraining Systems

In the commercial apple industry, there is much interest in higherdensity orchards with 1,000 or more trees per acre. The first requirement for higherdensity systems is smaller trees, which is accomplished with sizecontrolling rootstocks. Two of the betterknown higherdensity training systems are the slender spindle and vertical axe. Both are modified central leader trees with branches continually along the central leader to the top of the tree. Light penetration is not a problem as the maximum height of the tree is limited to approximately 6 to 12 feet, with a canopy spread of 3 to 4 feet outward from the leader.

There are many other types of higherdensity training systems, some with elaborate trellis systems. The slender spindletype tree is the most popular highdensity training system. Highdensity training systems, however, will not be discussed in this bulletin because of the differences in management practices.

OpenCenter or Vase Training - Peach, Nectarine, Plum

With the opencenter system, the leader is removed, leaving an open center. Instead of having a central leader, the opencenter tree has 3 to 5 major limbs, called scaffolds, coming out from the trunk. This training system allows for adequate light penetration into the tree, which minimizes the shading problem prevalent in highervigor trees such as peach.

At Planting

At planting, peach trees should be set so that the graft union will be 2 inches above the soil surface. As the buds begin to swell, the unbranched trees (whips) are generally headed approximately 30 to 34 inches above the soil surface. As discussed with the central leader system, new branches will come from the buds that are 6 to 9 inches below the heading cut.

Trees that are branched at planting are handled differently than the whips. The work that needs to be done under the tree determines the appropriate height for branching, which is usually 24 to 32 inches. Remove branches that are too low. If there are 3 to 4 uniformly spaced branches around the tree that can be selected as scaffolds, the tree is headed just above the highest selected scaffold. Any remaining branches not selected as scaffolds should be removed. However, if there are less than 3 scaffolds the tree should be cut back to a whip and the side branches removed. See Figures 10a and 10b.

Summer Pruning

After the new vegetative growth is approximately 3 to 4 inches long, it is time to select the shoots that will become the major scaffolds. The lowest scaffold should be 24 to 32 inches above the soil surface to avoid interfering with cultural work under the tree, such as harvesting and weed control. It is best to select 3 to 4 scaffolds that are uniformly spaced around the tree, with wide branch angles, and not directly across from another scaffold. See Figure 10a.

Figure 10a. Training and pruning young peach trees.
Left: Well-branched peach tree to be trained to an open-center system
Right: 3 to 5 well-spaced scaffolds re selected and the tree is headed above the highest scaffold.

During the summer, these shoots should be spread out to a 45 to 60 degree angle and held in place with a

During the summer, these shoots should be spread out to a 45 to 60 degree angle and held in place with a toothpick or clothespin. All other upright growth should be removed. It is best to come back through every month during the summer to remove upright growth that is shading the primary scaffolds and to make sure that the scaffolds have been spread to a proper angle. Many times the crotch angle is proper initially, but as the scaffolds grow, they turn upright. A spring clothespin placed on or near the end of a shoot will pull the scaffold down to a proper angle. Extreme care must be taken when using the clothespins as weights. Periodic checking is essential to assure that the scaffolds are not too flat.

Figure 10b. Training and pruning young peach trees.
Left: Tree after heading, branches lower than 24 inches are also removed.
Right: Top view of uniformly spaced scaffolds.

Succeeding Years

After the first year of growth, the primary scaffolds should be selected and properly trained outward. Scaffolds should be headed during the dormant season of the first three years to promote continued lateral branching on the scaffolds and to stiffen and strengthen the scaffold. Scaffolds should be headed to outwardgrowing shoots similar in angle to those being removed. Bench cuts should be avoided. See Figure 11a.

Figure 11a. Dormant pruning a mature open-center peach tree.
Left: Tree before pruning.
Right: Heading a scaffold to an outward growing shoot.

If summer pruning is being practiced, undesirable shoot growth can be removed as soon as growth is 4 to 6 inches long. Summer pruning can also be used to direct scaffold growth outward to the desired growing points instead of waiting until the dormant season.

For bearing trees, the goal of dormant pruning is to remove vigorous upright growth on the scaffolds and trunk that was not removed during the summer. See Figure 11b.

Figure 11b. Dormant pruning a mature open-center peach tree.
Left: Removal of vigorous upright shoots in the center of the tree.
Right: Tree after pruning.

The upright growth left in the tree during the growing season may shade out lateral growth near the trunk. This shading causes lateral fruiting wood only on the ends of the scaffolds, which results in broken scaffolds under a heavy fruit load. It is best to keep the fruiting wood on the scaffolds as close to the tree trunk as possible to reduce tree breakage and to produce the highestquality fruit.

Also, during the dormant season, damaged, dead, and diseased wood, such as cankers, should be removed from the tree. Shoots with shriveled and dried fruit from the previous season, called mummies, should also be removed from the orchard to reduce disease pressure for the coming season.

[Commercial Horticulture] [Educational Resources]

Prepared by
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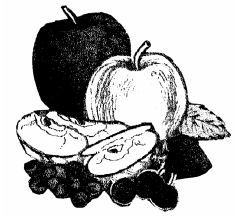

GROWING APPLE TREES IN THE HOME GARDEN

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Growing apple trees in the home garden can be fun and rewarding. Several factors are important to consider before planting for successful apple production. Apple variety and rootstock, site selection, proper planting, training and pruning, adequate fertility, and pest control all contribute to healthy and productive trees. A brief discussion of these considerations follows.

Rootstocks and Tree Spacing - All apple trees sold commercially consist of two parts that are grafted together to form the tree. The "scion" is the top portion that branches and bears fruit and is grafted onto a "rootstock". The type of fruit is determined by the scion variety. The rootstock can be a "seedling", which produces a full size or standard tree, or the rootstock can be "size-controlled" or "dwarfing", which produces a tree that is smaller than full size. The rootstock determines the relative size of the tree but does not affect the type or quality of fruit that the tree bears. Different rootstocks are desirable because they can control the size of the apple tree, reduce the time until the tree reaches fruit-bearing age, and may offer some pest resistance.

Table 1 lists some important characteristics of the rootstocks that are commercially available. Tree size is relative and is shown as a percent of the size that the tree would be on a full size seedling root-stock. Rootstock, soil fertility, and pruning can influence tree size, and therefore influence tree spacing. Table 1 suggests a range of planting distances with the wider distances for trees planted in good, fertile soils and optimum growing conditions. Trees on the more dwarfing root-stocks must be staked for the life of the tree to obtain optimum growth and to prevent leaning and potential tree breakage. Commonly used stakes consist of a 3-inch diameter wood pole or a 1-inch diameter metal conduit. The stake should be 10 feet high with 2 feet driven into the ground approximately 6 inches from the base of the tree.

Table 1: Rootstock Characteristics.

Rootstock	Tree Size as Percent of Seedling	Tree Spacing in Row (ft)	Anchorage	Years to Fruit Production
Seedling*	100	15-18	Excellent	6-10
MM.111	85	14-18	Excellent	4-6
MM.106	80	12-16	Excellent	3-4
M.7a	70	10-14	Fair	3-4
M.26**	50	8-12	Poor	2-4
Mark**	35-40	6-8	Good	2-3
M.9**	35	4-8	Poor	2-3

* Mature tree is 12-20 feet tall, depending on variety.
** Trees should be staked and tied to the stake at planting.

Table 2: Variety characteristics in order of maturity.

Variety	Fruit Color	Fruit Use	Relative Bloom Time	Potential Cross-Pollinizers
Gala	Yellow-orange to red	Fresh	Early to Midseason	Golden Delicious
Empire	Dark red over green background	Fresh, cooking	Early	Golden or Red Delicious, Gala
Jonagold*	Yellow with light red stripes	Fresh, cooking	Midseason	Gala, Empire
Golden Delicious	Yellow green to light yellow	Fresh, cooking	Midseason to Late	RedDelicious Gala, Empire
Red Delicious	Red	Fresh	Early	Golden Delicious, Gala
Stayman*	Blush to red	Fresh, cooking	Midseason	Gala, Golden or Red Delicious
Rome	Blush to red	Fresh, cooking	Late	Fuji, Braeburn
Braeburn	Green with light red blush	Fresh	Midseason	Rome, Fuji
Fuji	Green with red stripes	Fresh	Midseason	Rome, Braeburn

* Pollen produced by these varieties is sterile.

Varieties - The variety of apple selected should be based on fruit characteristics, bloom time and pollen compatibility. Table 2 (above) shows several popular varieties in North Carolina, listed in order of fruit maturity. Nurseries can also provide varietal information and pollen compatibility suggestions. Crabapple trees can also be used as pollinizers if they bloom at the same time as the desired variety.

Pollination - All apple varieties should be considered self-incompatible, meaning that they cannot pollinate themselves or any flowers of the same apple variety. The highest quality fruit is harvested when cross-pollination occurs with a suitable pollinizer variety. You will need to plant at least two varieties of apple trees together in order to maximize fruit production and quality. Make sure that the varieties you choose have overlapping bloom dates, so that both varieties bloom at the same time. Some varieties, such as Winesap, Mutsu, Jonagold, and Stayman, produce sterile pollen and should never be used as pollinizers. However, pollen from other varieties can be used to pollinate these pollen-sterile varieties. Remember, two trees of the same apple variety cannot be used for cross-pollination. Since the pollen from apple blossoms is transferred primarily by bees, be careful not to spray insecticides during bloom when honey bees are present.

Site Selection

Soils - Take a soil test prior to planting your apple trees. Your local County Extension Center can instruct you in collecting the soil sample, help you interpret the results, and provide valuable information about the soil in your county. Results from the soil test will determine the soil amendments necessary to correct nutrient deficiencies and adjust soil pH. The amendments should be worked into the soil to a depth of 12 to 18 inches where the tree will root, not just the planting hole. Apple trees will tolerate a wide range of soils as long as water and nutrients are not limiting and soil pH is adequate. Avoid heavy, poorly-drained soils and low spots, since apple trees cannot survive if water remains standing in the root zone.

Air Drainage - It is important to select a site where the tree will not be in a "frost pocket", where cold air settles in low-lying areas. In a frost pocket, low spring temperatures commonly kill the blossoms or developing fruit because cold air settles around the tree. Good air drainage, especially during early spring frosts, is critical. Choose a higher site with a slope if possible so cold air will flow down away from the trees and will not accumulate around the trees. Do not plant the trees close to a fence row, wooded area, or at the bottom of a hill, as cold air drainage will be impeded.

Other Considerations - Apple trees require full sun and should be planted where the trees will not be shaded from large trees or buildings. Follow tree spacing guidelines that pertain to the rootstock you have chosen from Table 1. Do not plant trees near wooded areas or streams to avoid animal damage. Prior to planting, remove weeds either manually or with an approved herbicide that will not harm the young tree. If you are planting the tree in a lawn, remove the grass from the planting area in a 4-foot diameter circle. Grass competes with young trees for available water and nutrients and can significantly reduce tree growth and productivity.

Planting the Tree

Tree Purchase and Preparation - Purchase a healthy 1-year-old nursery tree, 4 to 6 feet tall, with a good root system. A small tree with a good root system will transplant better than a large tree. When you get the tree, protect it from injury, drying out, mouse or vole damage, freezing, and overheating. If the roots have dried somewhat, soak them in water for about 24 hours before planting. If you are unable to plant the tree immediately, there are two options:

1) Wrap the roots in plastic along with moist sawdust or newspaper, and place the tree in a refrigerator or cooler at 40°F. Never store the tree with fruit or vegetables, as ethylene gas from ripening foods can kill young trees.

2) "Heel-in" the tree. To heel-in a tree, dig a trench and place the tree roots evenly in it, cover the roots with soil, sawdust or peat, and water the tree thoroughly. The tree can be kept for several weeks using this method before permanently planting.

Planting the Tree - In North Carolina, trees can be set from late fall to early spring. To plant the apple tree, first dig a hole approximately twice the diameter of the root system and 2 feet deep. Place some of the loose soil back into the hole and loosen the soil on the walls of the planting hole so the roots can easily penetrate the soil. Spread the tree roots on the loose soil, making sure they are not twisted or crowded in the hole. Continue to replace soil around the roots. As you begin to cover the roots, firm the soil to be sure it surrounds the roots and to remove air pockets. Do not add fertilizer at planting time as the roots can be "burned". Fill the remainder of the hole with the loose soil, and pressthe soildown well. **Important:** The graft union must be at least 2 inches above the soil line so that roots do not emerge from the scion. When you have finished planting the tree, water well to eliminate air pockets and provide good contact between the roots and the soil.

Training and Pruning
Central Leader Trees

Proper training and pruning of fruit trees is essential to the development of a strong tree framework that will support fruit production. Properly shaped trees will yield high-quality fruit much sooner and will live significantly longer. Regular pruning and training will also maximize light penetration to the developing flower buds and fruit. Additionally, a well-shaped tree canopy permits adequate air movement through the tree, which promotes rapid drying to minimize pest problems.

Central Leader Trees - A central leader tree has one main, upright trunk, called the "leader". Branching should begin on the leader 24 to 36 inches above the soil surface to allow work under the tree. The first year, 3 to 4 branches, collectively called a "scaffold whorl", are selected. The selected branches should be spaced uniformly around the trunk, not directly across from or above one another. The major lateral branches are commonly referred to as scaffold branches on which the central leader tree is "built". Above the first scaffold whorl should be an area of 18 to 24 inches, called a "light slot", without any branches to allow light to reach all lower leaves and fruit. This light slot is followed by another whorl of scaffolds. Maintain alternating scaffold whorls and light slots up the leader to the desired maximum tree height. The shape of a properly trained central leader

tree is like that of a Christmas tree (except with slots for light). See Figure 1.

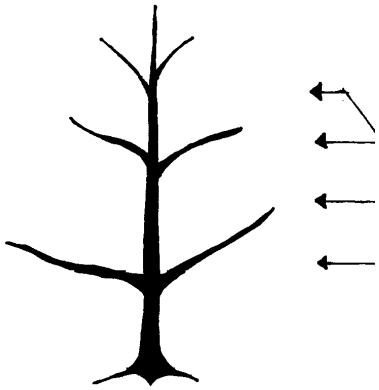


Figure 1. Side view of a central leader tree.

Newly Planted Trees - After early winter planting, wait until just before the buds start to grow in the spring to "head", or cut, the unbranched central leader to 36 inches above the soil surface to encourage new lateral branching. When new growth is 3 to 4 inches long, identify the most upright shoot that will continue to be the central leader. Leave it and remove all new shoots growing 3 to 4 inches immediately below this new terminal to prevent competition. This will also encourage lateral growth in the area 6 to 14 inches below the cut tip of the young tree. Branches that form 6 to 14 inches below the cut tip of the tree are less vigorous, less upright, and easier to train as productive scaffold limbs. When the lateral branches, or scaffold branches, are 3 to 6 inches long, they should be spread to a wider crotch angle that will provide a stronger framework for fruit production. Toothpicks or clothespins can be used to prop the young branches out to a 50 to 60 degree angle. This angle will slow vegetative growth, promote lateral branches, and allow the tree to initiate flowers and produce fruit sooner.

Scaffold Training - Improperly trained fruit trees have very upright branch angles, which result in excessive vigor and serious limb breakage under a heavy fruit load. Larger branches can be spread out using short wooden boards with a notch cut in each end for the branch to fit into. Hanging weights on the branch or tying it down with string wrapped loosely around the limb are other methods for spreading the branches. All upright growth from scaffold branches should be either pulled down to a horizontal position or removed when it is 3 to 4 inches long.

Dormant Pruning vs. Summer Pruning - Pruning the tree during the winter, while it is dormant, will invigorate the tree and cause it to grow and branch more the following season. To promote scaffold branch development, cut the central leader 20 to 28 inches above the highest usable scaffold whorl during the dormant season. It is best to do dormant pruning in late winter or early spring, after the risk of severe freeze is over. Be sure to remove any dead or diseased wood and dried apples at this time as well. After the tree resumes growth in the spring, continue to train the scaffold branches of the tree as you did the previous growing season. Select a new upright shoot to continue the central leader, and remove all new shoots 4 inches below it. Also select the branches to form another whorl of 4 to 5 scaffold branches. Prop all lateral branches out to a 50 to 60 degree angle.

Summer pruning will devigorate the tree and cause it to grow less in that growing season. Remove all undesirable branches directly across from one another on the central leader when they are 3 to 4 inches long. Also, select lateral branches that are spaced uniformly around the leader to prevent crowding as the limbs grow in diameter. Once the tree has filled its allotted space, lateral branches will need to be cut back to their desired length during the summer to devigorate the tree and prevent further growth, <u>not</u> during the dormant season. Ask your County Extension Center for information on the best way to prune your apple tree.

Fruit Thinning - Apple trees often set a heavier crop of fruit than the limbs can withstand. To ensure good fruit size, return bloom for the following year, and to prevent tree breakage, it is necessary to thin the fruit. Every apple blossom results in a bloom cluster of 5 to 6 blossoms. Apples should be thinned when they are about the size of a dime. Cut off enough fruit so that the remaining apples are spaced 4 to 6 inches apart, and leave only one fruit per cluster. It may seem like very few fruit remain, but you will harvest higher-quality fruit, potentially reduce insect and disease problems, and increase the chances for a full crop the next season.

Fertility - Adequate tree nutrition is essential for quality apple production. Determine the nutrient status of your soil by taking a soil sample prior to planting and each year thereafter at the same time of

year. Follow the fertilization guidelines provided by the soil test. This will prevent over-fertilization, will be cost-efficient, and will maintain healthy and productive trees. A leaf sample taken in July or August will determine the nutrient status of the tree and can be helpful in conjunction with the soil test. In addition to soil analysis and foliar analysis, regular observation of vegetative growth is a useful indicator of tree fertility. Optimum fertility exists if lateral, outward growth is between 12 and 18 inches per year.

If you are unable to take a soil test, a useful rule is to apply 1 pound of 10-10-10 fertilizer to each tree the first year, 2 pounds the second year, and 3 pounds the third year up to a maximum of 5 to 6 pounds for a mature tree. Always adjust rates of fertilizer application according to annual shoot growth. Apply fertilizer in late winter or early spring before growth begins. Fertilizer should be broadcast on the soil surface around the drip line of the tree. The "drip line" is the circular line at the outer ends of the branches. Avoid getting fertilizer within 6 inches of the trunk as it could burn the tree.

Weed Control - Controlling weeds and gras-ses around young apple trees minimizes competition for soil nutrients and moisture, encourages vigorous tree growth, and increases fruit size. It will also help to minimize damage from pine and meadow voles, and other rodents. Keep all vegetation controlled out to the drip line of the tree where the outer branches end. Do not use weed whips; these will girdle the tree without any visible signs of injury. Avoid mechanical weed cultivation, such as tilling, as it damages shallow tree roots. Herbicides are effective, but follow the label directions carefully and keep them off the tree. Mulch will also control weeds and conserve soil moisture, however rodents may burrow under the mulch and gnaw tree trunks and roots. When using mulch, place rodent guards around the base of the tree, and pull mulch back in the fall, leaving a 1-foot circle of bare soil surrounding the trunk.

Disease and Insect Control - Diseases and insects can cause serious damage to apple trees and fruit. Good sanitation practices are necessary to control pest problems. Cut out all dead or diseased wood, remove dried apples, and clear leaves and fallen debris away from trees. Disinfect pruning tools with a 10% solution of a household disinfectant (Lysol) or bleach, before and after use and between trees. Household disinfectants, such as Lysol, will not corrode tools or ruin clothing. A regular spray program is essential for high fruit quality and healthy trees. Use a multipurpose fungicide and insecticide labeled for apples. These can be obtained from a garden center and will include application instructions. A spray to control fungus problems should be applied when the first sign of green tissue appears. A horticultural oil should also be sprayed on apple trees at the first sign of green growth in the spring to suffocate scale insects and reduce overwintering mite and aphid eggs. For homeowners with only a few trees, premixed orchard sprays are available from many garden centers. Begin applications after full bloom is over and spray every 10 to 14 days throughout the summer.

If you think you have an insect or disease problem, contact your County Extension Center immediately. It is important to identify the pest accurately so an effective treatment can be selected.

Harvesting and Fruit Storage

Apples reach maturity at different times, depending on variety and climate. There is not a specific date at which you can expect to harvest your apples. Instead, you can observe your apples as they grow and inspect the fruit for certain changes which indicate maturity. The "ground" or base skin color of the apples changes from green to yellow as the fruit matures. Flesh color also loses its greenish tint and turns yellow or white. When you are convinced that the apples look mature, take a bite! A mature fruit will be crisp and juicy. A pleasing taste is the final indicator of fruit maturity.

Proper storage conditions help prolong the shelf-life of your apples. Store apples at 32°F and maintain high humidity. The crisper drawers of many refrigerators work well, but keep the fruit away from vegetables since ripening fruit gives off gas that may spoil vegetables. Apples can also be stored in plastic bags in the refrigerator to prevent fruit dehydration.

Always remember, "An apple a day...!"

North Carolina
Cooperative Extension Service
NORTH CAROLINA STATE UNIVERSITY
College of Agriculture and Life Sciences

Growing Peaches in North Carolina

The peach, *Prunus persica (L.) Batsch*, is native to China. From China, peaches were introduced to Persia, Greece, and temperate European countries including Italy, Spain, and France. Peaches were introduced to the southeastern United States more than 300 years ago when the Spanish visited the Florida region in the 1500s. It is believed that in the northeastern United States the early English and French settlers brought peach seeds with them.

Until the early 1900s, most peach varieties developed from chance seedlings. One cultivar, Chinese Cling, is the ancestor of Elberta; from Elberta, many of our first commercial varieties were developed. Some of the peach cultivars selected between 1850 and 1900 are still grown commercially. These include J. H. Hale and Belle of Georgia. Today there are more than 200 peach varieties available for home and commercial production.

Commercial peach production in the Southeast expanded rapidly in the early 1900s. Improvements in transportation, such as the introduction of refrigerated boxcars, tractor trailers, and air freight greatly increased the marketing potential of many commercial crops. Today South Carolina and Georgia rank second and third, respectively, among the nation's peach-producing states. California is the nation's top producer of both fresh and processed peaches. North Carolina ranks approximately ninth in peach production, growing an average of 35 million pounds of fruit annually for the fresh market.

Commercial peach production in the Southeast, as well as the Northeast, has been plagued by various problems in recent years. Spring frosts and freezes have adversely affected commercial production in the Southeast during the last decade. Another difficulty is peach tree short life (PTSL), a disease complex most severe on replant sites with sandy soils. PTSL is the greatest threat to Southeastern peach producers. A 10-point PTSL management program has been devised to minimize the probability of PTSL. Adherence to the 10-point program is a good strategy for both home and commercial peach growers, especially in lighter and sandy soils.

Getting Started

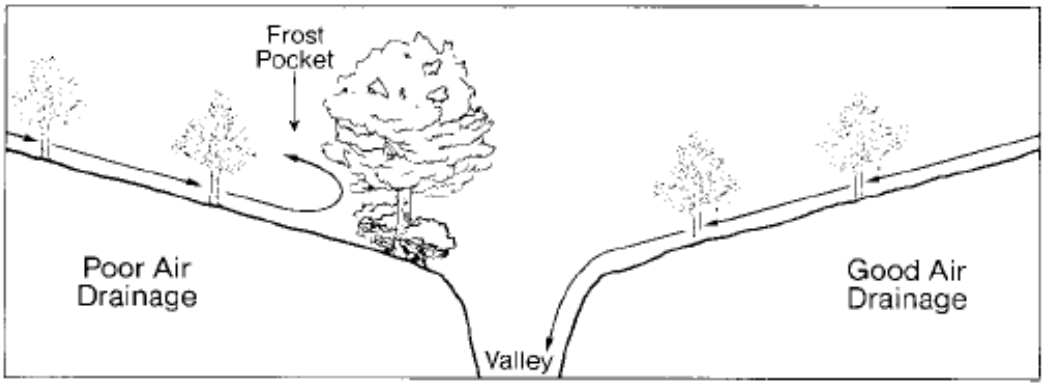
Economic Considerations

Before planting a peach orchard, a grower must identify market outlets for the fruit. Many growers who have not identified markets before planting have been disappointed by initial sales. In addition, consistent annual full cropping has not occurred in the state during the last decade. If you are concerned about the economic efficiency of your peach orchard, consult your local Extension agent, who has a copy of a computer software package called *Budget Planner*. You will need to supply production records and equipment lists to run the program to get an accurate estimate of your production costs.

It is important to realize that North Carolina peach growers have been caught in a difficult situation because of low prices and the lack of consistent cropping for large-scale shipping. At present, most of the peaches produced in North Carolina are sold at roadside retail outlets which provide greater returns to the grower. However, to survive economically, North Carolina peach growers must compete in the marketplace with a quality product. Growers must continue to ensure that producing a quality product remains their ultimate goal.

The bottom line is: *Do your homework before you plant an orchard!*

Selecting the Site



Cold air drainage is an extremely important consideration in site selection. Avoid planting trees at the bottom of a hill near woods or other obstructions that create frost pockets.

Successful peach growing depends primarily on the site selected for the orchard. The site must have good air drainage to minimize the risk of late winter and early spring frost and freeze injury (Figure 1). The windiness of the site also should be considered. Level land is suitable if the area has good air drainage or if there is little chance of spring frost. Planting next to wooded areas, windbreaks, or high hedgerows is not advised because these obstructions will impede air drainage, allow frost pockets, and increase shading that will reduce crop yield and increase the chance of disease and insect problems. To minimize these problems, plant at least 80 feet from wooded areas for optimal conditions.

Peach trees can withstand fairly cold temperatures (about -12°F); however, hardiness is affected by the

preconditioning the trees receive before being exposed to winter temperatures. If the tree is late in going into dormancy, or *hardening off*, it will be more susceptible to cold winter temperatures. For example, excessive levels of nitrogen fertilizers in late summer can delay the onset of dormancy and increase the tree's

susceptibility to winter cold injury. If a tree is cropped too heavily, its reserves are depleted and the tree may be susceptible to winter injury.

The cold sensitivity of peach flower buds is highly correlated with variety. Some varieties are known to be hardy, such as Reliance or Surecrop. The time of bloom for a given variety is determined by the length of the chilling requirement and the weather conditions in the spring. Chilling is fulfilled between 33°F and 45°F and is necessary for the tree to bloom and grow properly. Varieties that require 850 to 1,000 hours of chilling tend to bloom later than those with a shorter chilling requirement. In North Carolina, varieties with less than a 750-hour chilling requirement are not recommended because they may bloom too early and the flowers could be killed by frosts or freezes. Table 1 lists the chilling requirements as well as many of the fruit characteristics of selected peach varieties. (Refer to the "Sources of Additional Information" section for other pertinent publications.)

Table 1. Characteristics of Selected Peach and Nectarine Varieties in North Carolina

Variety	Freestone or Clingstone (Cs)	Browning Tendency	Maturity Season	Chilling Requirement (hours)	Bacterial Spot Resistance	Comments
Derby	Cs	Low	Early	750	+++++	N.C. variety; medium to large fruit.
Candor	Cs	Very low	Early	950	++++	N.C. variety; medium-size fruit.
Dixired	Cs	Low	Early to mid	950	++++	Late-blooming variety.
Surecrop	Semi-Cs	Moderate	Mid	1,000	++++	Late-blooming variety.
Pekin	Semi-Cs	Low	Mid	950	+++++	N.C. variety; medium-size fruit.
Reliance	Semi-Cs	Low	Mid	1,000	++++	Late-blooming variety; poor quality, soft flesh.
Redhaven	Semi-Cs	Low	Mid	950	+++	Industry standard; recommended for freezing.
Clayton	Semi-Cs	Very low	Mid	950	+++++	N.C. variety; small-size fruit, excellent flavor.
Norman	Fs	Very low	Mid	850	++++	N.C. variety; medium to large fruit; good for canning and freezing.
Carolina Belle	Fs	Very high	Mid	750	++	N.C. white-fleshed variety, large fruit.
Raritan Rose	Fs	---	Mid	1,000	++	White variety; softens rapidly.
Topaz	Fs	Low	Mid	750	+++	Recommended for canning and freezing; flower buds are cold sensitive.
Sunglo^{N}	Fs	Very High	Mid	550	+	Nectarine; susceptible to bacterial spot.
Nectar	Fs	---	Mid	1,050	++	White peach variety; late blooming.
Winblo	Fs	Very low	Mid	800	+++	N.C. variety; medium to large fruit; good for canning and freezing.
Redgold^{N}	Fs	Low	Mid	800	+	Nectarine; susceptible to bacterial spot.

						bacterial spot.
Ellerbe	Fs	Low	Mid	850	+++	N.C. variety; medium to large fruit; good for canning and freezing.
Contender	Fs	Low	Mid	1,050	+++	N.C. variety; large fruit size; very cold tolerant.
Summer Pearl	Fs	---	Mid to late	900	+	White variety; very susceptible to bacterial spot; high quality.
Biscoe	Fs	High	Mid to late	900	++++	N.C. variety; large, high-quality fruit; recommended for canning.
Belle of Georgia	Fs	---	Mid to late	850	++	White variety; freezes well; popular for local markets.
Elberta	Fs	Very high	Mid to late	850	+++	Favorite yellow variety, especially for local market.
Encore	Fs	---	Late	900	+++	Hardy, late-blooming variety.
Monroe	Fs	High	Late	750	+	Susceptible to bacterial spot.
Emery	Fs	Very high	Late	900	++++	N.C. variety; medium to large fruit.
Legend	Fs	Low	Late	950	+++	N.C. variety; large fruit size.
Parade	Fs	Low	Late	850	++	Very-late-maturing California variety.

+++++ = very high resistance + = low resistance ^{N} = Nectarine

Soil types. Peach trees, like many fruit trees, prefer deep, well-drained, fertile soils with a pH of 6.0 to 6.5. They do not grow well in heavy, slow-draining soils. Peach trees, however, can be grown on a wide range of soil types --- even when soil conditions are less than ideal --- if pH, drainage, and fertility are modified. If the pH is less than 5.5, preplant liming with deep incorporation (12 to 18 inches) is recommended. Poor drainage can be modified by planting the trees on raised beds or berms. A raised bed 1 to 2 feet high and 4 to 6 feet wide is sufficient to improve drainage. However, irrigation is recommended with raised beds because of increased soil moisture evaporation from a larger exposed surface area. Soil drainage also can be improved by adding drain tiles and ditches. Soil fertility must be adjusted before planting. Adjustments should be based on soil test results.

Selecting Peach Varieties

When choosing a peach variety, the main features to consider are the chilling requirement, the time of ripening, and the intended market for the crop. The characteristics of various peach and nectarine varieties are listed in Table 1. As mentioned previously, varieties with less than a 750-hour chilling requirement should not be planted in North Carolina because of the risk of crop loss due to spring frosts or freezes. Time of ripening is especially critical for commercial growers who sell to local markets, roadside retail, or have pick-your-own operations. It is recommended that growers select multiple varieties that will ripen over a six- to eight-week period. Thus, the harvest season can be extended, and repeat business is possible. For roadside retail sales, it is essential to have varieties with overlapping maturity dates for a continual supply of fruit. Variety selection should be tailored to consumer demands in a given locale.

Rootstocks for Peaches

Two rootstocks are recommended for North Carolina peach orchards: Lovell and Halford. These rootstocks

Two rootstocks are recommended for North Carolina peach orchards: Lovell and Halford. These rootstocks have performed well in a variety of soil types and weather conditions, and are the only rootstocks suitable for North Carolina. Other rootstocks, such as Nemaguard and Siberian C, have not proven to be winter hardy in North Carolina and are not recommended. Lovell and Halford are not nematode resistant; preplant fumigation is necessary on sandy soils with a history of root-knot or ring nematode problems. A promising new rootstock that performs well on PTSL sites in South Carolina and Georgia may be available in North Carolina within the next three years.

Planting

Before planting the trees, take a soil sample and have it analyzed for pH nutrient requirements and nematode populations. Instructions for soil sampling can be obtained from your county Extension Center. Results from the soil test will determine the amendments necessary to correct nutrient deficiencies and improper pH.

Trees can be planted from late fall (after Thanksgiving) until early spring. Late-fall-planted trees may be more prone to winter injury, and late spring plantings (after mid-April) are not recommended. Early winter (late December to early January) is the optimal time for planting in North Carolina. The trees' roots should never be exposed to freezing temperatures or drying conditions before or during planting.

When the trees arrive from the nursery, open the package. If the roots are dry, moisten them immediately. If the trees are to be planted within 24 hours, soak the roots in water until planting. Trees that are to be held for more than 24 hours before being planted should be heeled in. This is done by digging a trench, placing the roots in the trench, and covering them with soil. If refrigerated storage is available, soak the roots and place the trees (with their roots wrapped in plastic and moist sawdust or paper) in a storage room at 35°F to 40°F until planting time. Do not place the trees in the same storage room with apples because apples give off ethylene gas, which can harm the peach trees. For the same reason, ventilate an empty apple storage area completely before using it to store trees. Make sure that the soil used for heeling in is not infested with nematodes, especially in areas with sandy soils.

Peach trees planted in a residential setting should be approximately 18 to 20 feet apart. Avoid planting in shade from neighboring trees and buildings.

Recommended planting distances and number of trees per acre for large or commercial plantings are listed in Table 2.

Table 2. Planting Guide for Commercial Growers

Planting Distance (feet)	Number of Trees (per acre)
12 by 20	181
15 by 20	145
18 by 20	121
20 by 20	108

Before planting the tree, dig a hole large enough to accommodate the root system without curling or cramping the roots. Use of an auger is not advised for heavy clay soils because the hole will act like a clay pot and restrict root growth. Prune off the ends of any large roots that are twisted, too long for the hole, or damaged. It is much better to cut roots back than to curl them up to fit into the hole. Dig the hole deep enough so that the graft union will be 1 to 2 inches above the soil line when finished planting.

Place some of the native topsoil into the bottom of the hole and then the tree. Cover the roots with soil, making sure that the graft union is 1 to 2 inches above the soil line after planting. Water the tree to firm the

soil and get rid of air pockets.

CAUTION: Do not put fertilizer into the planting hole as it may "burn" the roots. Allow the soil to settle before applying fertilizers around the tree.

Fertilizers

Fertility requirements should be determined by visual analysis, soil analysis, and foliar analysis. Trees putting on 12 to 18 inches of terminal growth per year usually require less fertilizer in heavier soils. Foliar samples for analysis should be collected from mid-July through mid-August. Instructions on sampling can be obtained from your county Extension Center. A small fee is charged for each sample submitted for analysis. Table 3 lists the recommended foliar concentrations of key elements for peaches.

Table 3. Suggested Peach Foliar Analysis Levels Based on Foliar Analysis Report

Nutrient	Desired Range
Nitrogen	2.0 to 3.0 percent
Phosphorus	0.1 to 0.3 percent
Potassium	1.5 to 3.0 percent
Calcium	1.0 to 1.8 percent
Magnesium	0.2 to 0.4 percent
Iron	50 to 100 ppm
Manganese	50 to 100 ppm
Zinc	20 to 40 ppm
Copper	5 to 10 ppm
Boron	20 to 40 ppm

Source: G. Cummings, North Carolina State University

General rule-of-thumb fertilization rates for peach trees are shown in Table 4. The principal nutrients needed are nitrogen and potassium, but it may be necessary to supply other nutrients as well.

Table 4. Fertilizer Guide for Peach Trees

Age (years)	Annual Amount of 10-10-10 Fertilizer (pounds per tree)*
Newly planted	0.25 to 0.5
1 to 2	0.5 to 1.0
3 to 5	1.5 to 3.0
5 to 10	3.0 to 5.0
over 10	5.0 to 7.0

NOTE: Adjust the rate for your trees' overall vigor.
* Other formulations are appropriate; adjust the amount applied for the nitrogen-phorphus-potassium content.

Nitrogen. This nutrient must be applied regularly to both nonbearing and bearing peach trees. Bearing trees

need enough nitrogen to ensure good terminal growth (12 to 18 inches per year), fruit production, and fruit size. If a peach tree does not receive sufficient nitrogen during its nonbearing years, its growth will be weak. The amount of nitrogen needed is determined by the tree's age, overall vigor, crop load, and weed competition. Too much nitrogen can stimulate excessive vegetative growth (such as watersprouts), increase susceptibility to winter injury, and decrease fruit color and flower bud formation.

Nitrogen can be applied in early winter (mid December) on heavy soils or in the early spring before bud swell. On sandy soils in North Carolina, it is best to apply nitrogen in the spring just before or during bud break. Summer nitrogen applications are not recommended. For orchards on piedmont soils that have a high native fertility, the lower rates of nitrogen in Table 4 should be adequate for good tree growth and fruit production. On sandy soils, the higher rate should be used.

A split application of nitrogen fertilizer is highly recommended in North Carolina because of the high probability of a spring frost or freeze in many locations. Half of the fertilizer is applied in late February or early March; if a crop is set, the other half is applied in late April or early May. For trees on sandy soils, a third nitrogen application may be necessary. Nitrogen should not be applied after June 15 to avoid winter injury and decreased fruit quality.

If terminal shoot growth is too vigorous (more than 12 to 18 inches), reduce the amount of nitrogen applied. If terminal growth is weak (less than 6 to 8 inches), increase the amount of nitrogen.

Potassium. If soil and leaf analyses indicate a deficiency, potassium can be added in the late fall or spring. Although the most common potassium source is muriate of potash, other potassium sources will work equally well. Cost may be the deciding factor. Excessive potassium can interfere with calcium and magnesium uptake and is therefore undesirable.

Other Nutrients. Many North Carolina sites may need additional phosphorus, calcium, and magnesium. Soil and leaf analyses are the best means to determine what is needed to correct deficiencies.

Weed Control

Weed control can help reduce competition for water and nutrients between weeds and young trees. Also, certain weeds are hosts for disease-causing organisms, including fungi, viruses, and nematodes, as well as catfacing insects. For this reason, only grasses are recommended in peach orchards with a vegetation-free strip down the tree row.

Mulching. Mulching under trees --- alone or combined with chemical weed control --- is an excellent home orchard management tool. Using a mulch:

- Controls weeds and erosion
- Conserves water
- Improves soil structure
- Adds nutrients and organic matter.

Pine straw and hay are among the many materials that can make good mulches. The mulch should be applied under trees to a depth of 4 to 5 inches.

However, this practice holds risks for commercial peach growers. Disadvantages may include the cost of labor to apply the mulch, scarcity of mulching materials, and the increased possibility of fire and rodent damage. Therefore, mulching is not advised for commercial peach orchards because it increases the potential for vole damage and collar-rot injury to trees.

Chemical Weed Control

If chemical weed control methods are used, you may need to reduce the amount of nitrogen fertilizer to avoid excessive tree growth. The appropriate herbicides labeled for use on peaches should be selected for specific weed problems. Certain herbicides are labeled only for *nonbearing* trees; it is illegal to use these herbicides on bearing trees. Consult your county Extension agent; AG-146S, *Peach and Nectarine Disease and Pest Management Guide*; or the current *North Carolina Agricultural Chemicals Manual* for herbicide recommendations.

Flowering and Pollination Biology

Most peach varieties, with the exception of some varieties like J. H. Hale and Marsun, are self-fertile. Peaches can thus be planted in solid blocks of one variety if desired.

Bees and other wild insects are the main agents involved in transferring pollen among trees in an orchard. Care should be taken during bloom to spray only those chemicals that will not harm bees and other beneficial insects. Many insecticides are toxic to bees and should be avoided during bloom. Also, remove blooming vegetation from the orchard to minimize competition for bees and to avoid bee kills from pesticide applications.

Fruit Thinning

Fruit thinning is a practice required for increasing fruit size and balancing crop load.

Peaches have a tendency to overbear, and the trees commonly split if the crop load is too heavy. Trees should not be allowed to bear fruit for the first two years after planting as this can decrease the tree's growth and bend the framework branches or scaffolds. Once the trees begin to bear, fruit thinning is necessary for producing high-quality, marketable peaches --- there are no shortcuts.

Thinning is a labor-intensive process. The early-maturing clingstone peach varieties may require several thinning treatments, and the cost of labor may become a major concern. Early varieties should be thinned first, before mid- or late-season varieties.

Timing is critical for thinning to be beneficial. With all varieties, it is recommended that thinning be done before pit hardening, which is within 40 days of bloom. Thinning early varieties after the pit hardens does not increase fruit size substantially. With mid- and late-season varieties, thinning can be delayed until after the first drop through June drop (the second period of fruit drop) but no later than pit hardening. Under North Carolina conditions, it is best to thin peaches as early as possible.

The amount to thin from a tree depends on the tree's size and bearing capacity. Obviously, trees in poor vigor should not be allowed to bear as much fruit as moderately vigorous trees. If a tree has set a uniform crop of fruit, a general rule of thumb is to thin fruit 6 to 8 inches apart on the shoot. After a spring freeze, however, the crop is sometimes borne on the basal portion of the shoots. In this case, only light thinning is recommended. Clusters of fruit should be broken so that orchard sprays can cover the fruit well.

Thinning relies heavily on hand labor. Beating the trees with a rubber hose or plastic baseball bat to knock the fruit off is the most popular thinning method. High-pressure water sprays, tree shakers, and rope drags have been relatively unsuccessful.

Research has been conducted on blossom and fruit thinning with growth regulators and other chemicals. Currently no chemicals are labelled for peach bloom or fruit thinning.

Training and Pruning Peach Trees

Peach trees are easy to train and prune in contrast to apple or pear trees. The first three years of growth should be devoted to training the peach tree to a shape that will allow it to bear a full crop. If trees are left unattended, fruit production will initially be good, but as light becomes limited in the interior portion of the tree, the crop will be borne only on the tree's periphery. Pruning keeps the tree open to light, which helps maintain fruit production close to the trunk. Pruning also:

- Helps keep the tree at a desirable height
- Decreases the incidence of certain diseases by allowing the foliage and fruit to dry more quickly
- Allows spray to more readily penetrate the tree's canopy and cover the leaves and fruit
- Removes dead, damaged, and diseased wood.

Peach trees are trained to the open center system in the Southeast. The open center system is designed to give the tree an open, vaselike shape (Figure2).

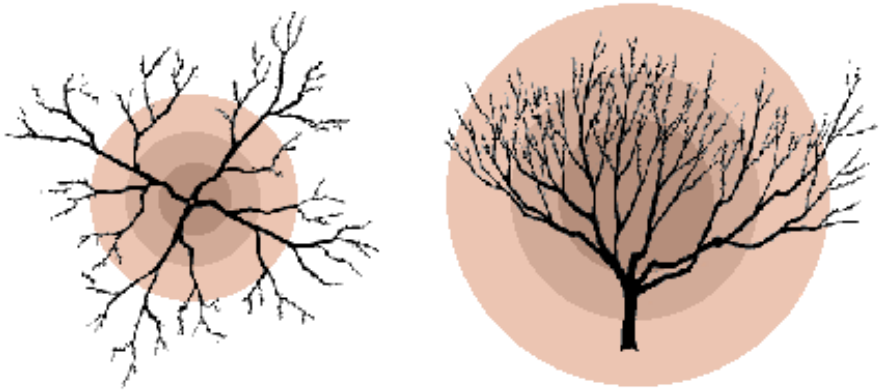


Figure 2. Peach trees are trained to an open center to optimize light distribution within the tree. Trees with this vaselike form should be strong enough to bear an optimal crop load. ***LEFT*** *An overhead view of an open center tree. Concentric circles approximate the yearly development of the tree. Note the scaffold branch orientation.* ***RIGHT*** *A side view of an open center tree with concentric circles approximating the yearly development.*

Summer Pruning and Training

Summer pruning is strongly encouraged, especially for removing watersprouts, rootsuckers, and diseased wood. Summer pruning also can be very beneficial during the first three years of tree growth to produce the desired tree shape and promote earlier production. Undesired growth should be removed in early summer when the growth is 3 to 6 inches long or after harvest between late July and mid-August. The goal of summer pruning is to thin out growth rather than head back (Figure 2). Heading back cuts may stimulate new growth in the area of the cut; this growth will be susceptible to winter injury.

Peaches bear most of their crop on last year's wood, so it is important when pruning not to remove an excessive amount of one-year-old wood. During the dormant season, one-year-old wood is distinguished by its reddish tinge.

Dormant Pruning

Dormant pruning should be done in late winter or early spring (late February to early March) as close to bloom as possible and as soon as the risk of a hard freeze is over.

At planting, the newly set tree should be headed, or cut back, to a height of 24 to 30 inches from the soil surface. This forces the tree to form new side branches approximately 18 to 24 inches above the ground. During the following winter (when the tree is entering its second growing season), select three to five scaffold branches with wide angles (45 to 60 degrees). These branches, or primary scaffolds, also should be headed back to a length of 24 to 36 inches. These primary scaffolds should not arise from one point along the trunk. Ideally, they should be spaced 6 to 12 inches apart, with the lowest scaffold 18 to 22 inches above the ground. Scaffolds should not be directly opposite or above each other as limbs in these positions will be more likely to break once they begin to bear a normal crop load. When viewed from above, the scaffolds should form angles of approximately 90 to 120 degrees, giving the tree balance (Figure 2, left).

During the dormant season of the second year, the scaffolds should be cut back to an outward and upward growing lateral branch approximately the same diameter as the scaffold being pruned. Lateral branches from the scaffolds also should be selected approximately 18 to 20 inches from the trunk. These lateral branches may be pruned back to promote secondary branching. All upright growth not removed during summer pruning should be removed, as well as growth below horizontal.

During the dormant season of the third year the primary scaffolds can be pruned so that there are two secondary scaffolds arising from each approximately 3 feet from trunk (Figure 2, inner circles). These secondary scaffolds should be pruned to outward and upward growing laterals if needed to maintain the open center system of the tree.

On each secondary scaffold, approximately 3 feet from the first split, another split may be required to form tertiary scaffolds (Figure 2, outer circle). Lateral branching from all of the scaffolds is to be encouraged for fruit production. One of the problems with peach trees is that lateral branching from the scaffolds closer to the trunk is discouraged because of excessive shading. (This problem can be eliminated with summer pruning.) At this time all vigorous upright shoots not removed during summer pruning also should be removed along with the shoots growing downward.

By the fourth year, the basic framework of the tree should be completed. Prune moderately to thin out undesirable branches; peach trees will suffer from reduced yields if pruned too severely. Also, remember that moderately pruned trees bear sooner than heavily pruned trees. However, allowing trees to bear excessive crop loads before establishing the tree's framework can stunt the tree as well as destroy its shape.

Pruning the Bearing Peach Tree

The bearing peach tree is pruned to maintain a good balance between vegetative growth and fruit production. The first two years should be spent on training only. Beginning in the third and fourth years, the trees can be moderately cropped.

Pruning bearing trees is critical if you want to maintain healthy, fruiting wood. Remove weak, shaded-out wood, diseased or dead wood, watersprouts, and rootsuckers. Tree height can be controlled by cutting back the top portion of the tree to weak, outward growing branches or to a side branch. It is important to maintain a consistent tree height or the entire crop may be too far above ground for convenient picking and pest control.

All branches of the tree should be exposed to adequate sunlight to ensure good flower bud production. This can be a challenge in the lower portion of the tree. On the secondary scaffolds, it may be better to tip the terminal shoots of these branches during the spring rather than cut them back to laterals. If fruit quality and

yield diminish in older trees, heavy, careful pruning may be necessary to restore tree shape and allow more sunlight to penetrate the tree's interior.

Remember that peach trees need to be pruned for many reasons. Pruning produces and maintains a desirable tree shape and size, and allows for good flower bud development and fruit quality. Pruning also aids in disease and insect control because the leaves and branches can receive a more efficient spray distribution.

Diseases and Insect Pests of Peaches

Diseases and insect pests of peach trees and fruit must be controlled if you wish to produce an attractive product. Many pests and diseases also threaten the survival of the peach tree, so proper control is highly recommended. Consult the 10-point PTSL management program if you are locating your orchard in a replant site or a site with known nematode infestations. Your county Extension Center should be contacted for current pest control recommendations. Also, the publications listed in the "Additional Sources of Information" section will be useful.

Proper orchard spray equipment is essential for disease and insect control. For orchard operations, an airblast sprayer is most effective. For any operation of more than 5 acres, an airblast sprayer is highly recommended. Backpack sprayers are simply not adequate for large orchards because their coverage is limited. Consult your county Extension agent for equipment recommendations for your operation.

Bacterial Diseases

Bacterial Spot

Bacterial spot affects fruits, leaves, and twigs of susceptible varieties; it is a serious disease in the sandhills and coastal plain. It is less of a concern in the piedmont. When planting an orchard, avoid highly susceptible varieties. Some of the most susceptible varieties are Sunhigh, Jerseyland, Elberta, Southland, and Blake. Relatively resistant varieties include Candor, Dixired, Norman, Pekin, Winblo, Biscoe, Emery, Redhaven, Redskin, Contender, and Legend.

Fungal Diseases

Peach Leaf Curl

Peach leaf curl will not kill a tree but can cause foliar damage in the spring. Control consists of one fungicide application in the fall or early spring before bud swell.

Rhizopus Rot

Rhizopus rot is primarily a postharvest disease, although some orchard infections may occur. Maintain fungicide applications up until harvest and cool fruit immediately after harvest. Do not allow the fruit to become overripe before picking. If you use a hydrocooler, make sure the water is clean. Chlorination of hydrocooler water may be necesary.

Brown Rot

Brown rot effects blossoms, young shoots, and fruits. It can be controlled with properly timed fungicide applications. Orchard sanitation is very important for adequate control. Clean up and destroy mummified fruit (mummies) and infected plant material. Also, avoid bruising the fruit at harvest. Hydrocooler water should be kept clean; dirty dumptank water can actually increase brown rot as well as rhizopus rot infections. Prune and maintain adequate vigor in the trees; excessive vigor can increase the incidence of brown rot infections.

Peach Scab

Peach scab is a fungus and infects fruit just after shuck split. However, the symptoms do not appear on the fruit until mid- to late-May as small, shallow, greenish black spots. With severe infections, the fruit may crack. Control measures depend on properly timed fungicide applications. Fungicide treatments are especially important during the four to six weeks after shuck split.

Viral Infections

Stem-Pitting Virus

On heavy piedmont soils, stem-pitting virus has been a problem in the past. This virus is transmitted by nematodes, which feed on alternate hosts such as dandelions. Control measures include obtaining clean plant material from a reputable nursery, eliminating wild hosts (including wild cherries and plums), controlling broadleaf weeds, and maintaining good cultural practices.

Nematodes

Nematodes are microscopic wormlike organisms rather than insects, and can transmit viruses affecting peaches. The ring nematode is associated with the PTSL disease complex. Ring and root-knot nematodes are especially troublesome in sandy soils. A nematode analysis is strongly recommended before planting to determine if preplant fumigation is necessary. There is a small fee for an analysis. Consult your county Extension Center for sampling instructions. See the section on the 10-point PTSL management program for a discussion on nematodes.

Insect Pests

Scale Insects

White peach scale attacks peach trees; in severe infestations, young trees can be killed. This scale insect primarily damages shoots and larger branches. White peach scale eggs and overwintering adults can be controlled with one dormant oil spray in the early spring before budbreak. If the infestation is severe, two dormant oil sprays applied two weeks apart, as close to bloom as possible, are recommended for control.

San Jose scale also can attack peach trees. Control measures are the same as for white peach scale.

Mites

Several species of mites can attack peach foliage. They feed on the leaves, which then become bronzed or blackened. In severe mite infestations, defoliation may occur and fruit development may be abnormal.

Orchard mite populations usually increase during warm, dry weather. As many as eight or nine generations may develop in one growing season. Mites can be controlled with an approved miticide.

Sucking Insects

Stink bugs and lygus bugs are sucking insects that attack the peach fruit. They can cause premature fruit drop and misshapen fruits (catfacing). These insects overwinter in winter annual broadleaf weeds including vetch and chickweed. Broadleaf weed control in the orchard can assist greatly in minimizing damage from this type of insect.

Peach Tree Borer

Borers can attack young or old trees; this insect is generally attracted to diseased or stressed trees. Severe infestations can kill young trees. An accumulation in the spring of brown gum and brown frass around the trunk of the tree at the soil line is evidence of the presence of peach tree borers. Prevention is the best way to avoid infestations. Application to the tree trunk of an approved insecticide in late summer, combined with sound cultural practices in the orchard, will diminish the chances of peach tree borer infestations.

Oriental Fruit Moth

The oriental fruit moth attacks most of the stone fruit species as well as apple and pear trees. The most characteristic symptom of this insect's presence is shoot death at the terminal end. Fruit injury also may occur in some instances. A regular insecticide program will control the adult moth.

Plum Curculio

The plum curculio feeds on and lays eggs in almost all pome and stone fruits as well as blueberry, grape, and wild persimmon. Adults may attack the fruit at any time but prefer young peaches or mature peaches that are about two weeks away from harvest. Very few peaches are attacked during the pit hardening stage. Control consists primarily of insecticides, but orchard sanitation helps considerably. Remove volunteer peach trees along roadsides as well as abandoned orchards. Destroy thickets of wild hosts if they are located near the orchard.

The 10-Point PTSL Management Program

This section presents recommended practices for sound orchard management and should be considered by all peach growers.

1. Preplant Phosphorus and Lime Application. The soil pH should be adjusted to at least 6.0 --- preferably 6.5 --- before planting the trees. Lime and phosphorus move slowly through soil, so deep incorporation of these materials is recommended before planting. Always base application rates of lime and phosphorus on soil test results.

2. Preplant Subsoiling and Backhoeing. Subsoiling helps improve soil drainage and promotes better root growth. It also helps soil amendments to move through the soil profile better. Backhoeing is recommended to break up severely compacted soil and to remove residual tree roots. Backhoeing must be done carefully in sites with heavy clay soils; if done improperly, the soil structure may be damaged. After either subsoiling or backhoeing, let the soil settle naturally before planting a new orchard.

3. Preplant Fumigation. Preplant fumigation is highly recommended for replant sites. Research has shown that tree survival is greatly enhanced, as are tree vigor and yields. Fumigation is good for controlling most nematode species, but most nematicides do not control root rots and crown gall. If necessary, a broad spectrum fumigant may be used. Preplant nematicides and fumigants are extremely toxic and must be applied carefully. Also, adequate time should be allowed for soil ventilation before planting new trees; the trees may die if the soil has not been properly aerated.

4. Nursery Stock. Purchase trees from a reputable nursery. Nursery stock should be certified virus free and true to type. Purchasing trees from an unreliable source can also lead to problems with nematodes and peach tree borers. The bottom line is: *Quality pays!*

5. Rootstock selection. As discussed in a previous section, the only recommended rootstocks for North Carolina are Lovell and Halford. Nemaguard is resistant only to root-knot nematode, and trees on Nemaguard survive poorly in North Carolina. If planting in a replant site, preplant fumigation is necessary as neither Lovell nor Halford are nematode resistant.

6. Nutrition. Nutrient deficiencies have been associated with tree stress, which may make the trees more susceptible to winter injury or any of the other factors associated with PTSL. Maintaining adequate soil pH and good soil drainage can prevent nutrient stress. Preplant liming and incorporation is essential to increase subsoil pH as lime moves through the soil very slowly (about 1 inch per year).

A split application of nitrogen, which aids in controlling tree vigor during a crop loss, is recommended.

7. Time of Pruning. Pruning at the wrong time of the year results in excessive tree mortality in North Carolina. Do not dormant prune trees from October through mid-January. Trees are more susceptible to winter injury and PTSL during this time.

Summer pruning should consist of thinning cuts --- never heading back --- for tree training purposes. Avoid heavy summer and dormant pruning. Pruning is not a substitute for fruit thinning and should not be used for this purpose.

8. Orchard Floor Management. Herbicides are preferred to disking or cultivating for weed management. Peach roots are close to the soil surface and may be injured by disking. Weed control also is recommended for two other reasons: weeds compete directly with trees for water and nutrients, and many weeds are hosts for virus-transmitting nematodes and catfacing insects. Research has shown that many broadleaf weeds, such as dandelions, are hosts for nematodes that carry the stem-pitting virus. Ring and root-knot nematodes have a wide host range, so absolute avoidance may be impossible. Weed control will ultimately keep the trees vigorous and help improve survival.

9. Postplant Nematicides. Routine nematode analysis should be conducted either in early spring or late summer or, if possible, both times each year. If test results indicate that postplant treatment is necessary, make sure that an appropriate postplant nematicide is used.

10. Orchard Sanitation. Dead or diseased wood and prunings should be removed from the orchard during every winter season. Also, dead or diseased trees should be removed from the orchard. Infested plant material harbors diseases and insects that can attack healthy trees still in the orchard.

Harvesting and Storage

About 80 percent of the peach crop in North Carolina is marketed via roadside markets and pick-your-own

About 80 percent of the peach crop in North Carolina is marketed via roadside markets and pick-your-own operations, so shipping quality and maturity standards are not as important as they are to commercial growers in larger peach-producing areas. However, roadside markets are able to supply a tree-ripened peach to the consumer. The biggest challenge we face in North Carolina is maintenance of good postharvest quality. Few people have access to hydrocoolers, so they depend on refrigerators to keep fruit cool.

Control of diseases, especially brown rot and rhizopus rot, is essential for preventing postharvest disease problems. Too often, preharvest sprays are neglected and these diseases become serious problems. Sanitation in the packshed is necessary to prevent disease problems. Picking containers and storage boxes should be cleaned after every harvest season. Infected fruit should be culled so that repeat infestations can be avoided. Also, a fungicide dip can prevent infections if the fruit was not previously infested in the orchard. The best practice is to continue cover sprays until harvest and cool the fruit as rapidly as possible. Harvesting peaches in the early morning or later in the evening when the fruit temperature is lower also is recommended to prolong the storage potential of peaches.

Deciding when to harvest peaches is a matter of personal preference if sales are limited to the roadside market. Consumers prefer tree-ripened fruit, but fruit at this stage has an extremely short shelf life. As a compromise, it may be better to pick the fruit two to four days before it is fully ripe. The fruit will continue to ripen normally, and the taste will be unaffected.

Peaches that are almost fully ripe can be stored at 40°F for several days with no adverse effects on fruit quality or ripening. However, if they are stored for longer than two weeks at 40°F, they may not ripen properly and can develop internal breakdown. Almost ripe peaches can be stored at 32°F for two to three weeks, but internal breakdown may be a problem if they are stored longer than three weeks.

Peaches are highly perishable and care should be taken to maintain the highest quality possible whether you have a pick-your-own operation or a local roadside stand. Repeat sales can occur only if the consumer is pleased with your product.

Sources of Additional Information

Books

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Computer Software

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*For price and ordering information contact your county Extension agent or Agricultural Publications, North Carolina State University, Campus Box 7603, Raleigh, NC 27695-7603.

**Available from the Department of Plant Pathology, North Carolina State University, Campus Box 7616, Raleigh, NC 27695-7616.

[Horticulture] [Crops]

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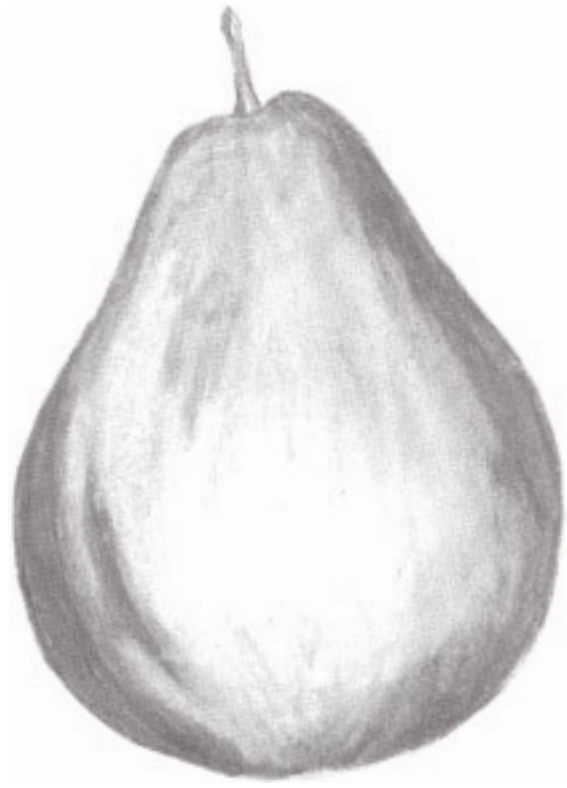
AG-30

*Web Version by **Leslie Ragus***

Growing Pears in North Carolina



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Contents

Introduction

Pears are one of the best known and well-liked fruits in the world. Although they do not rank first in the United States, pears are still a delectable and desirable fruit even in this country. Their many desirable features make them popular for fresh fruit, processed fruit, and eating out of hand. As an adjunct to salads, pears have few equals.

In North Carolina, pears are not a big crop, primarily because of the many problems which beset the growers. While pear culture is somewhat similar to apple culture, several factors inhibit pear production. Nevertheless, there are quite a few roadside market growers of pears primarily in the apple-producing areas of the state.

Two problems have discouraged pear production. The first is early bloom, with resulting crop loss due to late spring frosts. The second is the ravages of fire blight. This bacterial disease kills many of the more desirable pear varieties, often before the trees have become full size.

The Kieffer variety is an old variety that produces a fairly reliable product. Many homes in central and eastern North Carolina have one or more Kieffer trees. This variety will generally produce some fruit every year. Although the fruit is rough and of limited dessert quality compared to Bartlett, it is still used for jams, jellies, preserves, canning, and fresh eating.

Newer varieties, such as Moonglow and Magness, are somewhat more blight tolerant. Growers have reduced fire blight markedly by planting blight-tolerant varieties, applying low nitrogen fertilizer, prompt and early pruning of any blighted branches, and using antibiotic sprays.

Commercial pear production is concentrated largely in California, Oregon, and Washington. North Carolina may never equal these states in total volume but pear production for home use could well be expanded.

Growers have been reasonably successful in aerial spraying of water to reduce frost damage on apples when blossoms and buds are most tender. Its use on pears appears a possibility.

Site and Soil

Pears, like other tree fruits, require deep, well-drained, fertile soil with a pH of 6.0 to 6.5. Pears may grow on heavier soils and are a little more tolerant of poorer soil drainage than apples, but they still will not perform well on heavy, wet soils. A frost-free location is of prime importance.

Pears bloom earlier in the spring than apples, so frost damage can be a real hazard. Not only will a site lying higher than the surrounding area provide reasonable frost protection, but it will also permit the foliage to dry quickly following dews and rains. This will reduce the severity of leaf diseases which thrive when humidity or rainfall or both occur over prolonged periods.

Since the use of water for frost control has worked reasonably well on apples, a site with water available for irrigation should increase the chances of an annual crop of pears.

Varieties

Pear production in North Carolina is limited to a few varieties, mainly because of fire blight and frost problems.

The **Bartlett variety** has for years been the ultimate for pear quality. The fruit is large, juicy, and highly flavored. The trees produce well under ideal conditions. Bartletts in the Raleigh area would be ready to harvest in early August. This variety is very susceptible to fire blight. If Bartlett is planted, a great deal of attention to summer pruning and chemical spraying is needed to keep the tree alive.

The **Kieffer** is popular in eastern North Carolina. Its quality is considered somewhat inferior to Bartlett, but it produces heavily. The fruit is an attractive yellow when allowed to fully ripen, and the "grit" cells (a grainly texture) become somewhat less evident. This variety is adapted widely to North Carolina soil and climatic conditions and is more blight resistant than most other varieties grown in the state. The fruit is large and ripens in early August in the Raleigh area. As trees of the Kieffer variety age, they grow somewhat unsightly, but may remain in production for 50 years.

The **Moonglow variety** (Fig. 1) was introduced by the U.S. Department of Agriculture. It has good eating quality (nearly as good as the Bartlett), is a good producer, and is tolerant to fire blight. This large, attractive pear ripens in mid-August (about 2 weeks after the Bartlett) in the Raleigh area. The ripened fruit is rather soft, juicy, and relatively free of "grit" cells. Trees of this variety start production in the third year.

The **Magness variety** was introduced by the U.S. Department of Agriculture at the same time as the Moonglow. It is similar to Moonglow in fruit quality and tolerance to fire blight. It is pollen-sterile and therefore needs a variety such as Moonglow for a pollen source.

The **Seckel variety** (commonly called "Sugar Pear"), has a very small, yellowish brown, russetted fruit of excellent flavor. The trees are very productive and somewhat blight resistant. The fruit ripens in late August in the Raleigh area.

Preplanting and Planting

Set pear trees in early winter (usually after Thanksgiving) or in early spring.

When the trees arrive from the nursery, open the package. If the roots are somewhat dry, wet them down by sprinkling immediately. If the trees are to be planted within 24 hours, put the roots in water until planting time. If the trees are to be held for over 24 hours, heel them in by making a trench and covering the roots. If a refrigerated storage is available after the roots are soaked, place the trees (with roots wrapped) in a 35° to 40°F storage room until planting time. Do not store trees with apples because the fruit gives off ethylene gas. For this reason, air an empty storage before storing trees.

Space trees in the yard 25 feet apart in all directions. Space trees in a larger planting 12 to 15 feet apart in the row, with the rows 25 feet apart. The closer setting will accommodate 145 trees per acre, while the more distant setting will require 117 trees per acre.

Dig the planting hole large enough to accommodate the entire root system without cramping. Dig the hole deep enough so tree will be 2 inches lower than it grew in the nursery. Pear trees are usually grafted. Therefore, see that the graft union is at least 2 inches above the soil line to avoid growth from the rootstock which usually voids the grafted variety.

Place topsoil in the bottom of the hole and around the entire root area. Apply at least 1 gallon of water to firm the soil. *Do not* put any fertilizer in the planting hole since fertilizer will burn the roots.

Training and Pruning

Pruning is necessary to: (1) develop a desirable tree shape, (2) maintain the tree at a desirable size, (3) make spraying for insect and disease control easier, (4) improve fruit quality by allowing better light penetration, (5) improve tree strength, and (6) encourage branching.

Generally, pear trees are not pruned as much after the third year as are apple trees. Prune the newly set tree (a whip 3-5 feet tall and ½ to ⅝ inches in diameter) by removing the top one-third just as the buds start to swell in the early spring (Fig. 2).

Summer Pruning

Pruning the first growing season includes the removal of all except the terminal growth and one branch, which forms a 70-90° angle with the trunk (Fig. 3). Dormant pruning after the first full year of growth includes removal of all branches which form a narrow angle with the trunk (Fig. 4).

Pruning through the third year should remove all developing branches with less than 70-90° trunk angles, crossing branches, and branches that are closer than 8-12 inches apart in a whorl up the trunk starting at 12 inches from the soil line (Fig. 5).

Pruning after the third year should be reduced to as few cuts as possible. Reduce nitrogen application to just enough to produce 2-3 inches of new growth per year. If the terminal growth exceeds that figure, omit the nitrogen entirely.

Summer pruning should include prompt removal of all fire-blighted wood. Prune wood several inches below the blighted area. Removal of bloom buds prior to bloom on young trees helps to reduce fire blight. Dormant pruning should include removal of all diseased and broken branches. Cuts to reduce limb rubbing and shading are necessary. However, the cuts should be small to keep new growth to a minimum, thereby reducing the possibility of fire blight.

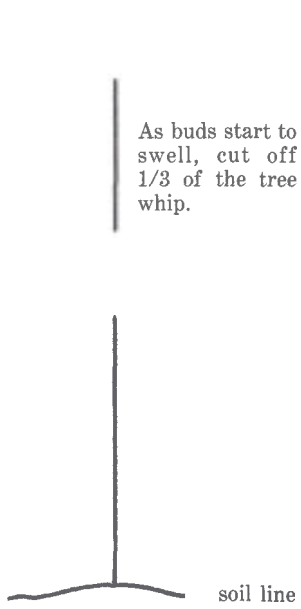

Fig. 2 — Pruning the newly set tree.

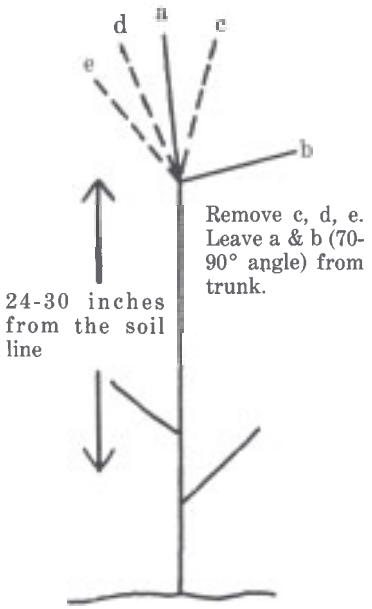

Fig. 3 — Summer pruning the first season.

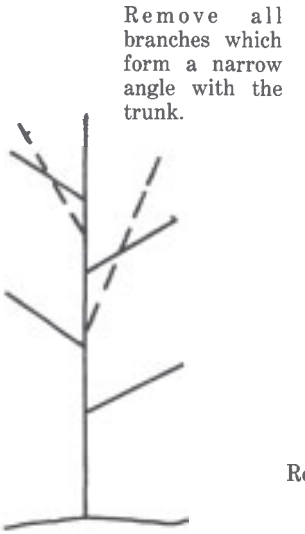

Fig. 4 — Second season pruning.

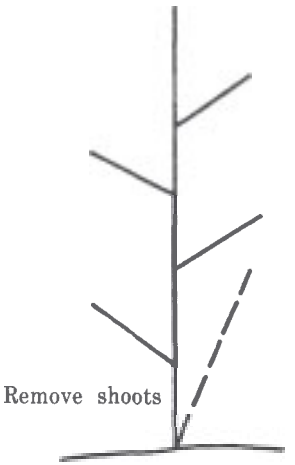

Fig. 5 — Third season pruning.

Soil Management

All soil management and fertilizer applications are centered on the control of fire blight. During the first season, apply 1 pound of 10-10-10 fertilizer per tree in a band 1 foot from the tree trunk just as buds start to swell in the spring. Apply 2 pounds of 10-10-10 the second year and 3 pounds the third year. After the third year, apply only enough nitrogen fertilizer to produce 2-3 inches of growth yearly. Apply 1 pound of a 16% nitrogen fertilizer for each six trees as buds swell, if the terminal growth is less than 2-3 inches.

If growth is over 2-3 inches, reduce the amount of nitrogen. If growth is only 2-3 inches, increase the amount slightly. As the tree grows larger, increase the amount of fertilizer so as to produce the 2-3 inches of growth.

Disease and Insect Control

The major disease of pears is fire blight. Control is possible through variety selection, reduction of nitrogen fertilizer, summer pruning (when needed), and spraying with streptomycin during bloom. Varieties considered most susceptible to fire blight are Bartlett and Clapp's Favorite. Slightly less susceptible varieties are Comice and Waite, while fairly resistant varieties are Kieffer, Moonglow, Magness, and Seckel.

Summer prune all pear trees to remove all fire blight-infected spurs and shoots a week or two after petal fall and any time thereafter when infected spurs and shoots are present. Prune tree branches 6 inches beyond visible infected portion to assure removal of diseased area. Remove prunings from the orchard and destroy them.

If bloom bud clusters are cut from young trees before blooms appear, the chances of fire blight affecting the many scaffold branches are reduced. Streptomycin sprays at suggested times and rate reduce fire blight infection.

Fruit spot or leaf blight, fruit rots (bitter, black, and white), sooty blotch, and flyspeck can be controlled by following the suggested pear spray schedule.

Scale, Codling Moth, Curculio, and plant bug are the major insects affecting pears.

To control both diseases and insects affecting pear production, follow the current pear spray schedule available from your county extension office.

Harvesting and Storage

Pears for home use could stay on the tree until they are yellow and ready to pick. This usually involves picking the fruit slightly ahead of the time for immediate consumption. A mushy ripe pear is highly undesirable.

You can determine maturity of pears for local sale in the following manner:

A pear increases in size as it matures. The sugar content increases and the fruit color changes from a green to a yellowish-green. The seeds of the mature fruit have turned from white to dark brown. The fruit stem separates easily from the spur.

Pears ripen readily after harvest, so if you do not plan to use them immediately, keep them in refrigerated storage at 30°-31°F. Ripen pears at 60°-70°F before using or selling.

If you follow careful storage practices, the pear-eating season can be extended for weeks for the higher quality pears and even months for a variety such as Kieffer. Trial and error will soon indicate the better storage practices to follow.

North Carolina
Cooperative Extension Service
NORTH CAROLINA STATE UNIVERSITY
College of Agriculture and Life Sciences

Growing Pecans in North Carolina

AG-81

For many generations, pecans have been grown on family homesteads in North Carolina as part of a means for survival. Today, pecans are still grown in North Carolina, for income and enjoyment, predominately in the southeastern part of the state. Growing pecans requires patience and a long-term commitment. However, pecan trees can grow and produce quality nuts for decades with minimal effort and expense. Some commercial pecan plantings in North Carolina are well over 75 years old and still very productive. In years when a full crop is obtained, North Carolina produces 5 to 6 million pounds of pecans annually. The level of production ranges from several trees in the backyard to commercial orchards with 20 acres or more. Holdings of 20 to 30 trees are common. Whether you own a few trees or a commercial orchard, growing pecans can be enjoyable as well as profitable. However, as with any venture, planning is essential. This document will explain how to produce pecans successfully.

Contents:

Getting Started

Selecting a Site

North Carolina is on the northern fringe of the commercial pecan-producing region of the United States. The limiting factor is the length of the growing season.The probability of spring frost damage to early and mid-season varieties and the limited selection of late-maturing varieties for North Carolina are both limitations of pecan production. North Carolinas' northern-fringe location makes proper site and varietal selection crucial for consistent, profitable production.

Pecans do not grow well in all areas of the state. The best area is the coastal plain, extending to the eastern edge of the piedmont. Although pecan trees can be grown further west, nut production is limited because of inconsistent cropping.

The selected site should have well-drained, deep soils (4 to 6 feet) with moderate soil-moisture-holding capacity. Pecan trees are native to river valley soils and have a relatively high water requirement. They do best on sandy loam soils but also can be grown on heavier soils such as clay loams if the soils are well drained. In areas where the soil is lighter and relatively dry, irrigation is required.

To reduce the potential for frost or freeze damage, select a site at a higher elevation or one on a gradual slope. Do not plant in low areas where cold air tends to settle; these areas are frequently referred to as frost pockets. As cold air settles, the moist air is frequently seen as fog or dew. Orchards planted on a slope also dry more quickly after wet periods, decreasing the wetting period of the orchard and minimizing conditions that favor diseases. Climatological maps can be used to determine potential sites for growing pecans. Information on the length of the season for a particular area, indicated by the number of frost-free growing days and the probability of frost in the spring, is readily available. For help, contact your county Cooperative Extension Center.

Knowing the history of the site is also a very good indicator of how well pecans will grow. Does the site frequently have frost in late spring or in early fall? Does it have standing water during wet periods, and is water readily available during very dry periods if irrigation is needed? What has been planted on this site in the last several years? Have herbicides or pesticides been used that may still be present in the soil? If so, will they reduce pecan tree growth when planted? Are pesticides or growth regulators applied to nearby fields that may harm pecan trees? Are homes or public areas nearby that might restrict spraying? All of these questions should be answered before you plant pecan trees.

Selecting Pecan Varieties

When selecting a pecan variety, consider pollination requirements, length of growing season, cold tolerance, and scab resistance. Table 1 lists the varieties that have the greatest potential for commercial success in North Carolina. All of the varieties listed have an appropriate growing season and adequate cold hardiness, and they are at least moderately resistant to scab, the primary pecan disease in the state.

Table 1. Pecan Varieties for North Carolina

Variety	Size (Nuts/lb)	Percent Kernel	Scab Resistance (years)	Fruit Bearing Age	Comments
T Y P E I					
Cape Fear	55	55	Moderate	5 to 7	A native North Carolina variety.
Pawnee	54	55	Moderate to Low	6 to 7	New USDA release, may be greatly affected by aphids.

T Y P E I I

Stuart	48	48	Moderate	8 to 10	Major variety grown in North Carolina, high, consistent yields on mature trees.
Sumner	55	52	High to Moderate	5 to 6	Late maturing, consistent cropper.
Forkert	53	62	Moderate to Low	5 to 6	Thin-shell variety.
Chickasaw	64	55	Moderate	5 to 6	Kernels may be dark, severe alternate bearer.*
Elliott	71	53	High	7 to 9	May be aphid-susceptible, older trees may alternate bear.
Kiowa	46	56	Moderate	5 to 6	May alternate bear.
Gloria Grande	48	48	High	7 to 9	Very cold tolerant.

Pecan Varieties Not Recommended for North Carolina

The following common varieties are not recommended for North Carolina because of their inability to tolerate the cold, the short growing season, or pests:

Desirable; cold sensitive, weak tree structure, and moderate to poor scab susceptibility

Mahan ; nuts fill poorly, highly scab susceptible, and severe alternate bearer

Schley ; low yielding, highly scab susceptible, and soft shells result in many vertebrate control problems

Success ; variable nut quality but frequently poor, highly susceptible to scab, and severe alternate bearer

*Alternate bearing trees are prone to producing heavy crops every 2 to 3 years.

Pollination requirements for pecan trees differ from all other tree fruit crops. Pecan trees are monoecious, which means that they have separate male structures, called catkins, and female flowers on the same tree. However, the time at which the male catkins release pollen is not the time at which the female flowers can be pollinated. Pecan trees are separated into two pollination groups referred to as Type I and Type II. Catkins on Type I trees release their pollen before the female flowers are receptive and catkins on Type II trees release their pollen after the female flowers are receptive. Because of this difference, both Type I and Type II pecan trees are required for pollination. To ensure maximum pollination and therefore, production, at least three varieties should be planted together.

Planning and Establishing an Orchard

When pecan trees are fully mature, approximately 20 years after planting, tree spacing should be approximately 70 to 80 feet between rows and also between trees within rows, or six to nine trees per acre. However, alternative management systems that may be more economical and increase cash flow on pecan plantings during the initial years will be discussed in this publication. Pecan trees have commonly been planted in fields that are grazed by animals during the growing season. However, this practice is not recommended with newer plantings. Several problems occur with this system: ground covers planted up to the trunk of the pecan tree reduce tree growth and promote insect problems, soil around the trees may be compacted by the animals, and large animals frequently damage young pecan trees. With grazing animals present, proper pesticides usually are not applied, resulting in greater insect and disease losses. Also, research has shown that nuts may be contaminated by bacteria found in the animals' manure, causing those who eat the nuts to become ill.

Another system is to plant six to nine pecan trees per acre and then intercrop between the pecan trees with peaches, corn, or grain. The advantage to this system is that it provides cash flow during the formative years of the pecan orchard. However, a disadvantage is that pecan trees may be neglected or damaged by the equipment being used for the intercrop. It is also easy to ignore the pecan trees as a long-term source of income when looking at the cash flow from the intercrop on a short-term perspective.

Pecan trees can also be planted initially on 30- to 35-foot centers, 36 to 49 trees per acre, with some of the trees being temporary and some permanent. When the trees start to crowd or shade each other, 12 to 15 years after planting, some of the temporary trees are removed, either by cutting them down or transplanting them with a very large tree spade. Again, at 17 to 20 years after planting, the remaining temporary trees are removed. For this system to be profitable, careful attention to detail is essential, and the orchard must be established with a well-designed management system. The permanent trees must be identified before planting, making sure that the correct varieties for pollination remain after the trees have been thinned. Also, the temporary trees selected must be precocious varieties(those that bear fruit early) such as Cape Fear, Kiowa, Sumner, Chickasaw, or Forkert.

It is very important to remove the temporary trees as soon as they begin to shade the permanent trees. It is often tempting to leave the temporary trees in for that "one more crop," thereby reducing the ultimate productivity of the permanent trees because of excessive shading. Two rules of thumb for tree thinning are to remove trees when branches of adjacent trees touch or when more than 60 percent of the orchard floor is shaded during the summer at noon.

Planting

Purchase and plant only healthy trees that have been produced by grafting a commercial variety onto a seedling rootstock. Using grafted trees will help ensure early production and high nut quality. Purchase the trees from a reputable nursery, usually as bare-root trees. A good size is 4 to 6 feet tall. Plant the trees in late fall or early winter for optimum results. Because pecan trees have a tap root, the planting hole should be deep and wide enough for the root system without curling the roots. Plant the tree so that the graft union is 2 inches above the soil surface after planting. The planting hole should be filled in with the native soil. Do not add any fertilizer to the tree hole. Do not apply fertilizers to the soil surface until the soil has settled around the newly planted tree. Water the trees well after planting. Maintaining adequate moisture throughout the first year is essential for tree growth and survival. Observe the trees periodically for damage from insects, borers, rodents, deer, rabbits, and diseases. Take corrective action at the first visible signs of damage.

Training and Pruning

After planting, cut back the top vegetative portion of the tree approximately one-third to maintain balance with the root system. During shipping and planting much of the tree's root system is damaged or removed.

Pecan trees should be trained to a central leader system. Central leader trees have a main trunk growing straight up with lateral branches, or scaffolds, from the main trunk spiraled every 8 to 16 inches (Figure 1a). Pecans are different from most fruit trees in that they have at least three buds at each node. The orientation of the branches from these nodes is very different and is used for tree training. Just before the buds begin to grow in the spring, buds can be selected to train the tree to a central leader form. The primary bud is the top bud and produces a very upright branch, which should be the central leader (Figure 1b). All other primary buds should be removed by rubbing them off just before bud break. Secondary and tertiary buds can be used for training the lateral branches, as shown in Figure 1b.

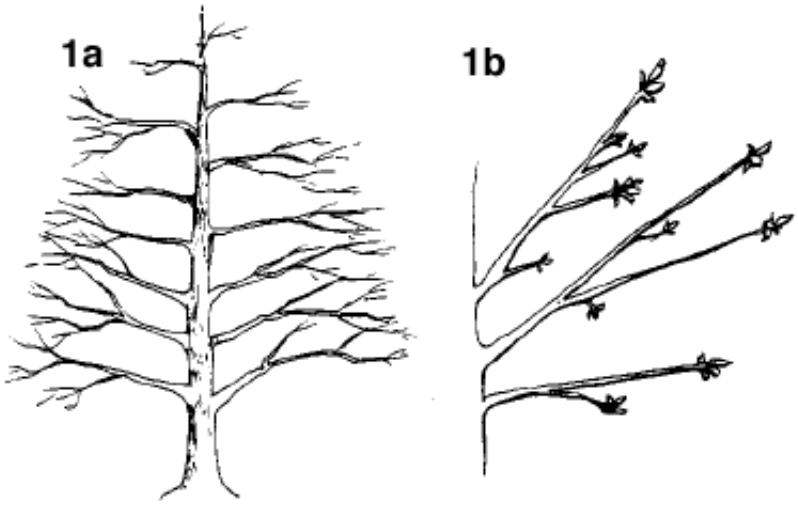

Figure 1a: Optimally trained central leader tree.
Figure 1b: Pecan trees have at least three buds at each node. The buds at the top result in branches more upright than lower buds and are used to train trees.

Because pecan wood is brittle, only branches with a wide crotch angle (greater than 60 degrees) should be selected. The lower scaffolds should be selected from secondary buds that have a little more of an upright angle. The scaffolds in the top portion of the tree, beginning in approximately the third year, should be selected from tertiary buds having a flat angle (80 to 85 degrees) to allow more light to penetrate the lower portion of the tree. It is essential to limit the height of pecan trees to approximately 40 feet for ease of management. The trees should be topped at the desired height by cutting to an outward growing lateral branch similar in diameter to the central leader being removed. It also is important to maintain a single central leader for optimal productivity and growth.

Old Tree Renovation

Many pecan plantings in North Carolina have been neglected for years. Renovating 75-foot-tall trees is costly and usually not economically feasible. Drastic pruning on older trees reduces their productivity for at least three years. This loss can never be recovered. The best way to manage these orchards is to thin out the trees as needed to attain proper light penetration. After removing the necessary trees, remove any dead, diseased, or damaged branches on the remaining trees. Any branches that are crowding and that cross within the trees also should be removed during the dormant season. If major pruning is planned, it should be done over a period of at least three years. Each year make several large cuts in each tree to minimize the production decrease and the resulting surge in growth from the pruning cuts.

Fertilization

Nutrition in pecan orchards should be managed using visual observation, soil analysis, and foliar analysis. Pecan trees should grow at least 8 to 10 inches on terminal branches each year for optimal production. If more or less growth occurs, the fertility program may need to be modified.

Soil samples should be collected and submitted for analysis at the same time each year. Samples should be taken from the soil surface to an 8-inch depth and from the 8- to 16-inch depth. Each sample should be a composite of at least 20 subsamples from across a field with the same soil type. Fields under different management systems or different soil types should be sampled separately. The samples can be submitted through your local Cooperative Extension Center. (For information on collecting samples, see Cooperative

Extension Service Publication AG-439-30, *Careful Soil Sampling*.) You will receive a report in the mail with recommendations for correcting the soil pH and any nutrient deficiencies. A soil analysis should be obtained before planting new trees, and the soil should be amended as necessary to a depth of at least 16 inches. Soil pH for pecan trees should be in the range of 6.0 to 6.5.

Foliar analysis can be determined with leaflet samples collected in mid-to-late July. The sample should consist of at least 100 leaflets from the middle of the compound leaves on the current season's growth. Collect leaflets that are not damaged and those that are growing in full sun. To ensure accuracy, do not collect samples after recent pesticide or nutrient spray applications. Place the leaflets in an open paper bag or in perforated sample bags to allow them to dry. Then submit the sample through your county Cooperative Extension Center along with a nominal fee for analysis. You will receive a foliar analysis report through the mail with recommendations for avoiding or correcting deficiency symptoms.

A rule of thumb for fertilizing nonbearing trees is to apply 1 pound of 10-10-10 fertilizer (10 percent Nitrogen, 10 percent Phosphorus, and 10 percent Potassium) per year of tree age, in late February or early March, not to exceed 25 pounds per tree. For bearing trees, apply 4 pounds of 10-10-10 fertilizer per inch of trunk diameter measured just below the scaffold branches. Broadcast the fertilizer in a broad band around the drip line of the tree. Pecan trees also require adequate zinc as determined by a soil analysis. If zinc deficiency symptoms are seen, foliar applications of 1.6 ounces of zinc sulfate in 5 gallons of water applied after 1 inch of new growth in the spring and repeated every 3 to 4 weeks will help correct the deficiency.

Managing the Orchard

Pecan orchards should have grassed row middles and vegetation-free strips down the tree rows. The bare strips are usually maintained with herbicides. Broadleaf weeds within the grass middles can be controlled with selective herbicides to eliminate alternate hosts for pecan pests. Cultivation is not recommended because even very shallow cultivation will destroy the trees' surface roots.

Irrigation is also strongly encouraged to maximize pecan production. Low-volume irrigation systems, such as drip or micro-sprinkler systems have been very effective at maintaining tree growth and productivity.

Managing Pests and Diseases

Insect Pests

Pecans are subject to attack by more than 20 insects and mites. However, only four insects, the pecan weevil, twig girdler, stink bug, and aphids, are usually of economic importance in North Carolina. It is important to be able to recognize damage caused by these insects and to understand their life history to know when to monitor for their presence and control them using Integrated Pest Management (IPM) strategies.

Pecan Weevil

The pecan weevil is the most serious late-season pest because it attacks the nut. Pecan weevils cause two types of damage (Figure 2). In the first type, weevils puncture the nuts in early August, causing the nuts to fall after two or three days. The second type is caused by larval feeding within the nut. At larval maturity, the larva chews a circular hole through the shell, and, as nuts fall to the ground, it exits the nut, and burrows into the soil.

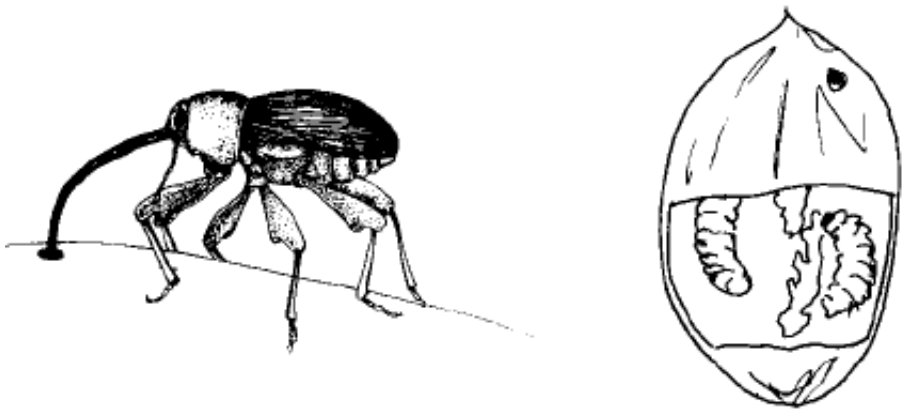

Figure 2: Pecan weevil and damage.

Adult pecan weevils are beetles with long slender snouts and thin legs. Beetles are reddish brown to gray and 0.3 to 0.5 inch long. The snout is longer than the body on the females and slightly shorter on the males. Eggs are white and are laid inside the developing pecan nuts. Larvae are creamy white, legless grubs with reddish brown heads (Figure 2). They have four stages and are 0.35 inch long when fully grown. Pupae develop underground and are seldom seen. Adult weevils emerge from the soil from August through September. Often a rainfall of 1 inch precedes their emergence. Adults crawl or fly, mate, and live for many days. Females chew holes into nuts where they lay eggs. At maturity the larvae exit the nut and burrow into the soil where they remain for one to two years. They pupate and emerge as adults in about three weeks and remain in the soil until the following August. Alternative hosts for pecan weevils are hickory trees.

Stink Bugs

Both southern green stink bugs and leaf-footed bugs attack pecan nuts. They puncture nuts both before and after shell hardening (Figure 3). If they feed before shell hardening, the nuts fall prematurely. If the feeding occurs after shell hardening, then black spots develop on the nut kernel. These black spots are bitter and referred to as kernel spot or bitter pit (Figure 3).

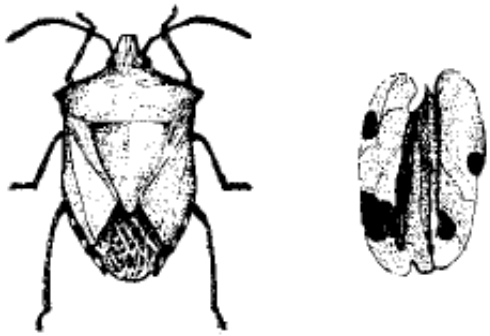

Figure 3: Stink bug and damage.

The southern green stink bug is large, green, shield-shaped, and about 0.5 inch long. Adults have wings, but nymphs are wingless. The leaf-footed bug has a narrow body and long, leaf-shaped hind legs.

Both species overwinter as adults in debris in the orchard. They emerge in the spring and lay eggs in grasses or soybeans and then move to pecans as adults. Both species produce four of five generations per year.

Twig Girdlers

The pecan twig girdler is a large beetle with long antennae (Figure 4). It girdles twigs and small branches in September. Females lay clear, glassy eggs in slits in the girdled branches. These branches fall to the ground when the force of the wind breaks the remainder of the partially severed twig. Larvae feed in the branch and exit to pupate in the soil. Only one generation is produced each year.

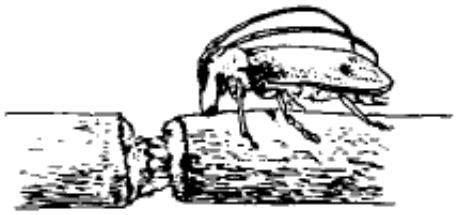

Figure 4: Twig girdler and damage.

Aphids

Two species of aphids affect pecans. Yellow and black aphids feed on the leaves of pecan trees and deposit honeydew, a sweet excrement, on the leaves. A black sooty mold fungus develops on the honeydew and turns the surface of the leaves black. Severely damaged leaves may appear speckled or may have patches that turn brown and die. Heavily infected trees exhibit premature leaf fall.

Adult aphids are either yellow or black and have soft bodies with delicate wings and a pair of tubes projecting from the abdomen. Immatures are wingless and usually appear in colonies. Both species overwinter as eggs in bark crevices. Nymphs are active in the spring. Ten or more generations may be produced a year.

Some other minor insects of concern include casebearers, leafminers, mites, fall webworms, spittlebugs, hickory shuckworm, and phylloxeras. For further help in insect identification and management, contact your county Cooperative Extension Center.

Insect Monitoring

Monitoring in a systematic way provides valuable information on the populations of pests and beneficial insects in an orchard. The results can be used to time pesticide applications properly. Two monitoring techniques used in pecan orchards are field surveying and insect trapping. In sampling for foliar insects, randomly select five compound leaves and five nut clusters from five trees in a 10-acre block. Record observations on a weekly basis and refer to these records regularly to make comparisons and identify trends. Marking trees with numbers is helpful in establishing permanent reference points.

Insect traps are used to catch pests, monitor their development, and indicate when additional sampling is

required. A black-light insect trap can be used for moths, beetles, and stink bugs. Pheromone traps containing a sex attractant also are available for many insects. These pheromone traps are very species specific. There are two ways to monitor for pecan weevils using traps. The first is to place cone cage traps under the tree's drip line and record the number of adult weevils collected. A second way is to use trunk band traps. Burlap bags can be wrapped in overlapping flaps around the trunks of several trees in an orchard. Daily collections of male and female weevils indicate when to spray, and destroying the weevils collected provides some physical control (Figure 5).

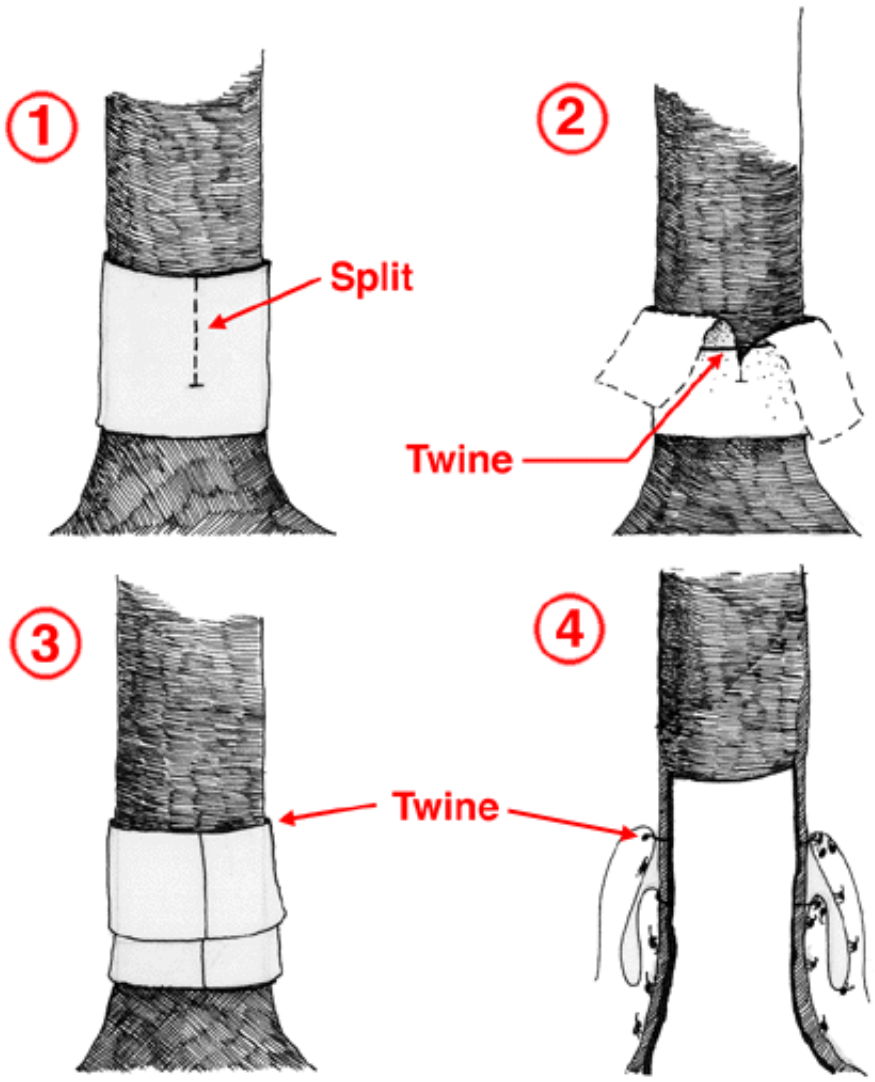

Figure 5: Pecan weevil monitoring: Burlap can be wrapped around pecan trees 3 to 4 feet above the soil and tied in place at the bottom. The remaining burlap is over lapped and then tied at the top, causing the weevils to walk over each flap and allowing time for grower observation.

Another method of monitoring pests is to place a sheet of plastic or cloth on the ground under the trees. Shake the trees and count the insects on the sheet. Trees also can be sprayed with a commercial pesticide and then checked later for the number and species of insects found on the sheet. In the case of twig girdlers, fallen twigs can be examined for the smooth, cut surface caused by adult beetles. The best management strategy for these insects is sanitation by removing and burying or burning these twigs as soon as they fall from the tree.

Insect and Disease Management

Recommendations for controlling insects can be found in the *North Carolina Agricultural Chemicals Manual* and in Sources of Additional Information. You also can contact your county Cooperative Extension Center for help in identifying pests and for recommended control measures. The pecan weevil, the most serious pest in North Carolina, can be controlled with foliar insecticide sprays during August. Weevil emergence as determined by trap catches will identify critical periods for pesticide application.

Some other pest management strategies include:

- establishing new plantings at least 200 feet from wooded areas to discourage insects, squirrels, birds, and other potential pests;
- not growing soybeans or vegetables close to pecan orchards as these plants support stink bug populations;
- using herbicides to control broadleaf weeds in late winter on the entire orchard floor; also control all vegetation in a strip down the tree row to destroy weed hosts and competition for nutrients and moisture;
- top-working neglected older trees or thinning out trees to ensure adequate spray coverage and light penetration;
- monitoring for aphids and their natural enemies; use an aphicide should populations increase;
- gathering and destroying fallen twigs during September to reduce twig girdler populations;
- gathering and destroying weevil-infested nuts as they fall;
- keeping areas around the orchard free of debris that may harbor overwintering insects.

Pecan Scab

In North Carolina the major disease of concern is pecan scab. It is caused by a fungus that attacks both the leaves and the shuck. This disease, which infects only immature leaves, primarily occurs early in the season and is identified by small circular spots that range in color from olive to black. These spots enlarge, causing the leaf to be smaller and deformed, which reduces the photosynthetic potential of the tree. Lesions on the nut shucks appear as small sunken black spots and in severe cases may turn the entire shuck black. Severely affected shucks will fall prematurely, and later infections may cause the shucks not to release properly from the nut.

Pecan scab is managed primarily by selecting resistant varieties and by applying a fungicide early in the season. Refer to your county Cooperative Extension Center for fungicide recommendations.

Sooty Mold

As mentioned in the insect section, sooty mold is a fungus that feeds on the sweet excrement of aphids. This secondary fungus covers the leaf surface as a black chalk and can limit the productivity of the leaves if it is heavy enough to limit their photosynthetic potential. This fungus can be managed by controlling the aphid populations in the tree.

Managing Other Pests

Other pests also may be encountered in a pecan orchard. They include sapsuckers, squirrels, blue jays, crows, and deer. One of the best ways to manage these pests is to locate the orchard at least 200 feet away from wooded areas and eliminate brushy and heavily wooded fencerows. Other specific control strategies are as follows.

Sapsuckers

Sapsuckers are birds, similar to woodpeckers, that peck holes in a ring pattern and frequently in concentric circles on the trunk and large branches of trees. They peck holes into the tree so that insects will be attracted to the sap oozing from the holes. The sapsuckers then return at a later time to feed on these insects. Although unsightly, minor damage of this type is tolerable. Extensive sapsucker feeding can weaken the brittle pecan wood, resulting in greater wind and ice damage. There are no effective ways to control this pest. For smaller orchards the use of aluminum flashing loosely placed around the tree trunks where the sapsuckers are starting to drill can provide some protection.

Squirrels, Crows, and Blue Jays

Squirrels, crows, and blue jays will enter the orchard and "steal" nuts. Aside from locating the orchard away from wooded areas, the best control method is the commercial noise makers, most of which sound like a gun firing. Many different systems are available; however, the animals will get used to the noise with time. Other scare materials, such as mylar balloons and plastic owls and hawks, may provide some wildlife control. Additional control strategies include removing the animals by means of traps or hunting -- both of which require pest removal permits. Squirrels may be controlled by placing 2-foot-wide strips of sheet metal all the way around the pecan tree, being careful not to girdle the tree. Springs may be used to hold the sheet metal to the tree while allowing flexibility for the tree to expand.

Deer

Deer can cause serious tree damage both by feeding on the new growth and by rubbing their antlers on younger trees during the fall. Several commercial products can be sprayed on the trees to repel deer, but the materials must be applied on a 10- to 12-day schedule. Hanging small bars of perfumed soap (with their wrappers still on), bags of human hair, or bone meal from individual trees also has proven effective in some situations. Again, removing animals by hunting when the law allows or with a pest removal permit are other options.

Harvesting, Storage, and Marketing

Pecans are harvested when the shuck opens, allowing the nuts to drop. Mechanical aids can be used to help speed nut fall. These devices range from a long pole used to shake small limbs to large commercial branch or trunk shakers that cause nuts to fall in a very short time. For a small-scale operation, sheets can be spread under the tree to catch the falling nuts. Nuts also can be picked up with small, push-propelled harvesters ranging from 12 to 48 inches wide for small-scale plantings or large, commercial mechanical nut harvesters. Nuts harvested by hand should be picked up every other day to prevent the nuts from molding or being destroyed or removed by pests.

Once harvested, the nuts must to be dried to 8 to 10 percent moisture, or to 3.5 to 4.5 percent for optimal long-term storage. For small-scale production, the nuts can be dried by placing them in porous burlap bags in a location with moderate ventilation and heat. Commercial dryers use forced air heated to approximately 100°F for optimal drying.

Pecans, like any nut, have a relatively high oil content and will spoil. For optimal storage, they can be held at 32°F for approximately one year. For longer storage periods, the nuts should be kept in a freezer.

If pecans are sold in the shell, the price is determined by the variety, nut size, shell damage, and whether any

of the shuck is still adhering to the shell. If the pecans are sold shelled, the price is usually determined by the percentage shell out, kernel color, development, insect damage, percentage of mold, and size. One problem that commonly reduces the price of nuts is the presence of a fuzzy material on the kernel. This material is a result of the nut being stressed during the growing season, often by inadequate moisture. The only way to avoid this problem is by allowing tree growth to proceed season long without any stress disorders.

Sources of Additional Information

Pecan Production in the Southeast; A Guide for Growers. $33.00, Head, Information Services, Alabama Cooperative Extension Service, Auburn University, AL 36849-5623

North Carolina Agricultural Chemicals Manual. Revised annually. $12.00, Publications Office, North Carolina State University, Campus Box 7603, Raleigh, NC 27695-7603

Epperson, D. L. et al. *Weather and Climate in North Carolina*. AG-375, North Carolina State University, 48 pp. *

Johnson, G. L. and K. M. Williams. *Risk of Frost and Freeze Damage for North Carolina Fruit Crops*. AG-403, North Carolina State University, 15 pp. *

Johnson, G. L. and K. M. Williams. *Low-Temperature Probability Data for North Carolina* . AG-403S, North Carolina State University, 91 pp. *

Sorensen, K. *Pecan Insects and their Management in North Carolina*. 1994. Entomology Insect Note, P-2, 5 pages. *

Sorensen, K. *Insects and Related Pests of Pecan*. 1987. Entomology Insect Note, P-1, 4 pages. *

**Contact your county Cooperative Extension Center for copies of these publications.*

[Horticulture] [Crops]

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AG-81

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College of Agriculture and Life Sciences

Department of Plant Pathology
Department of Entomology

Disease and Insect Management in the Home Orchard

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Homeowners who grow fruit in backyards or small orchards find that disease and insect pests often ruin the crop and in some instances damage the tree itself. In some years it may be possible to grow acceptable fruit without the use of pesticides, but in most years a few well-timed insecticide and fungicide sprays are needed. The effects of many pest problems can be reduced if several things are considered prior to buying and planting fruit trees.

One of the most important factors for producing fruit is selection of an area suitable for growing fruit trees. Fruit trees perform best in full sunlight and moist but well-drained soil having a pH of 6.0-6.5. If environmental conditions are not suitable for growing fruits, pest and disease problems are more difficult to manage and in some instances cannot be controlled. Additionally, fruit quality likely will be poor.

Second only to having a good location, is the selection of fruits and fruit cultivars that are adapted to your area of North Carolina. Your county extension agent can usually tell you what fruits and which cultivars of these fruits are best suited for your area. It is important to buy only quality trees that are disease and insect free. Also check the roots to be sure they have not been allowed to become dry. Large is not always better; a tree 3-4 feet in height is much easier to establish than a taller tree. Furthermore, most fruit trees should be cut-back to a 2-3 foot height when planted, and the new growth trained. Planting a smaller tree reduces stress on the root system allowing the tree to become better established during the first year after planting.

Once trees are planted, they require regular maintenance. Fruit trees need to be properly trained and annually pruned so that sunlight can penetrate through the tree (http://cals.ncsu.edu/hort_sci/extension/documents/ag-69.pdf). Pruning should also be done to remove damaged and diseased wood and to stimulate new growth. Pruning out dead wood and removal of mummied fruit is the most important cultural practice that can be done to reduce disease losses.

Fertilization and lime application to maintain proper tree growth and soil pH are usually necessary yearly. The goal of fertilization is to produce adequate tree growth to support a quality fruit crop, not to produce excessive tree growth. Trees that have been established for several years and growing in heavy-textured soil may require little or no yearly fertilization. Apply the fertilizer in a circle around the tree at the drip line (outer edges of the branch canopy). A grass and weed-free area around the tree should be maintained particularly during the first few years of tree establishment. Heavy mulching may lead to problems such as retaining excess water resulting in root rots and an environment conducive for destructive insects and other pests such as small rodents that can damage the tree trunk and root system.

Although the extent of pest injury can vary from year to year depending on environmental conditions, certain fruit are more likely to have problems than are others. Stone fruits (*Prunus* spp., eg., peach) generally require more care than pome fruits (eg. apples and pears). Tree fruits requiring the most care to those requiring the least are nectarine, peach, cherry, plum, pear and apple.

Conditions favoring disease development or insect occurrence vary depending on the particular disease or insect. Generally, warm, rainy or damp conditions are very conducive for the development of tree fruit diseases. For best control of diseases, fungicides and bactericides should be applied before rainfall but allowing 2-3 hours for spray material to dry. There are specific times of the year when certain pests can most easily be controlled. Also during the growing season, at certain stages of tree growth, fruit are more susceptible to particular diseases and insects and damage is likely to be greater than during other times of the growing season. Knowledge of these conditions can greatly reduce the number of sprays and fruit losses.

All fruit should be picked before becoming over-ripe. No fruit should be allowed to remain on the trees after ripening. All fruit should be picked and if not consumed, removed from the fruit-growing area. This helps reduce many disease and insect problems for later-ripening fruit. Rake and remove all dropped fruit and leaves after leaf fall which will reduce the likelihood of many diseases and insects the following year. Use of rigorous cultural and sanitation practices can usually reduce the number of sprays needed.

The pesticides selected for use in this information note were chosen because they are relatively safe to the user and the environment near the home, effective against a wide range of fruit diseases and insects and are usually available at many garden centers. For individuals with only a few trees, the combination fruit sprays available at garden centers may be most convenient. Some fungicides for use on fruit trees contain copper which is an effective fungicide but the foliage and some fruit of most fruit trees is quite sensitive to copper which can cause leaf and fruit spots and defoliation. Remember, **pesticides are designed to kill pests and as such they should be used, stored, and disposed of only as instructed on the container label**. **Always read and follow the directions on the container label before using the pesticide.**

Apples

DISEASES: During the early part of the growing season (initiation of new leaf and flowers through fruit set), apple scab, powdery mildew and fire blight are the primary disease problems. Apple scab affects both the foliage and fruit and infections can result in defoliation and malformed fruit. Powdery mildew primarily affects the foliage and is characterized by white fungal growth on the surface of affected leaves. Fire blight, a bacterial disease, can be particularly destructive during the bloom period, causing blossom blight and shoot and branch dieback as the bacteria grow from the blossoms into the shoots. In the Piedmont and Coastal Plain, cedar apple rust can be destructive on susceptible cultivars when they are grown in close proximity to the Eastern red cedar (the alternate host of the fungus on which cedar galls develop). Infections are characterized by yellow spots on the leaves and fruit. During the summer, bitter rot, black rot and white rot, can be destructive as fruit ripen, particularly in poorly pruned trees with dead wood within the tree. One of the most common disease complexes during the summer period is sooty blotch and flyspeck. The fungi that cause these diseases grow on the cuticle of the fruit, but do not cause any damage to the fruit themselves. For more information on apple diseases see "**A Growers Guide to Apple Insects and Diseases in the Southeast" (http://ipm.ncsu.edu/apple/contents.html).**

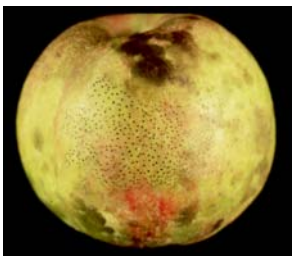
Apple scab

Fire blight

Cedar apple rust – gall on cedar, leasions on apple leaf

Bitter rot

Black rot



Fly speck and sooty blotch

For control of fungal diseases, apply captan + sulfur when the first green tissue is visible and repeat at 7-day intervals until blossoms begin to open. Captan is more effective than sulfur against most apple diseases but acceptable apples can be produced with sulfur, although sprays will need to be applied more frequently than the combination of captan + sulfur. DO NOT spray an insecticide during bloom because the insecticides can kill bees and other pollinating insects. However, spraying with streptomycin (several brand names available) just before any rainfall during bloom at the rate of 1 teaspoon per gallon of water (0.8 oz per 10 gallons) will aid in the control of fire blight.

When flower petals begin to drop, make a fungicide and insecticide application and repeat at 2 to 3 week intervals until 3 weeks before harvest. Use a 2-week spray interval if weather conditions are wet or there have been disease or insect problems in past years. You do not need to include sulfur in sprays with captan, beginning about 1 month after petal fall. Where cedar apple rust is a problem, include myclobutanil (sold under various trade names) in the sprays beginning at tight cluster and continuing for one month after bloom. If myclobutanil is used, you do not need to include sulfur in the spray program.

San Jose Scale

INSECTS: San Jose scale is a common home orchard pest that can kill trees within a few years if not controlled. The use of a horticultural oil (applied at 3% solution), just before or when buds begin to shown green in the spring is highly effective against scales. The plum curculio and oriental fruit moth are also common insect pests that often require control at petal fall. Both insects lay eggs directly in small fruitlets, with plum curculio damage causing a scarring of the fruit and oriental fruit moth larvae boring into the apple. Other insect pests that can directly injure fruit during the season include the codling moth, which is present in May and June, and the apple maggot that can be present from mid-July through mid-August. Indirect pests (i.e., those that feed on the leaves) that may occur include a number of different aphid species, which are common during the first 6 wks after bloom but are a concern on small, newly planted trees. The European red mite can cause bronzing of leaves and is most common during June and July.

Insecticide active ingredients (sold under various brand names) available for the home orchard are shown in the table at the end of this document. When choosing an insecticide to apply, be sure to match the correct product with the target pest to be controlled.

Pears

DISEASES: Pears are affected with many of the same diseases as apples with the exception of cedar apple rust, which does not occur on pears. Pear scab has not been reported in North Carolina. Fire blight tends to be more severe on pears than apples and can kill large limbs and even entire trees of susceptible cultivars; Bartlett is highly susceptible. Pear leaf spot (also called fabraea leaf spot) can be important on some cultivars.

Captan is not registered for use on pears. Use thiophanate methyl (Thiomyl Systemic Fungicide, other brands) at 2 teaspoons per gallon of water (6 2/3 tablespoons per 10 gallons). Use the same fungicide spray schedule for pears as described above for apples, excluding captan.

Fabraea leaf spot

INSECTS: Pears have a few additional insect pests beyond those mentioned for apple, most notably the pear psylla. The most opportune time to control psylla on pear is before bloom with an oil application, both as a dormant and delayed dormant (when green buds begin to appear) application. Pear leaves are highly susceptible to damage by mites, including twospotted spider mite, and the pear blister and pear rust mites. The use of horticultural oils after bloom at 1% solution can help to suppress mite populations. The codling moth and oriental fruit moth can both be serious pests of pears.

Peaches and Nectarines

DISEASES: The most common diseases encountered on peaches and nectarines are leaf curl, peach scab, and brown rot of fruit (the same fungus also causes blossom blight). Bacterial spot can cause significant fruit loss on some varieties in some locations. For a detailed description of and information about peach diseases (same diseases also occur on nectarines) see "Southeastern Peach Growers' Handbook" (http://www.ent.uga.edu/peach/peachhbk/toc.htm).

A bacterial disease, bacterial spot, affects both leaves and fruit. First symptoms on fruit may be confused with peach scab or chemical spray injury. Bacterial spot is best managed by planting tolerant varieties. It is more of a problem in the eastern third of North Carolina where peaches and nectarines are planted in light, sandy soils. A copper material applied in late autumn (late October – mid-November) and in early spring at budswell and again just before blossoms open may reduce bacterial spot as well as control leaf curl.

Bacterial spot:
--Leaf disease
Fruit disease --

Peach scab

Leaf curl can be controlled with a single application of Bordeaux mixture, fixed coppers or lime-sulfur (use rates recommended on product label). The spray for leaf curl must be applied during the dormant season before buds swell in late winter (usually February-March). This spray may be applied in the autumn once most of the leaves have dropped. Some cultivars of peaches and nectarines are less susceptible to leaf curl than are other cultivars. Peach and nectarine foliage is very sensitive to copper and can be injured and defoliation may occur, thus copper should not be sprayed in late spring and summer when leaves are present.

Leaf curl

Blossom blight

Brown rot

To control peach scab, captan or sulfur sprays should be started at late petal fall and repeated every 7-10 days for approximately 4 weeks. Chlorothalanil also is very effective against peach scab. Once scab lesions are observed, sprays will not be effective because the infections occurred during the 4-week period after petal fall. Chlorothalanil is best used in the place of captan + sulfur in the first 1 or 2 sprays of the season as injury to leaves may occur when used later and should not be used after fruit set. Peaches and nectarines that ripen mid-July or later should continue to be sprayed every 3-4 weeks. These fungicides can be applied in combination with the post-bloom insecticides.

If weather conditions are wet and brown rot has been a problem previously, 2 to 3 applications of captan or sulfur should be used starting 3 weeks prior to anticipated harvest. Use a formulation labeled for bearing fruit trees that does **NOT** contain insecticide. If sulfur is used for brown rot control, spray every 5 to 7 days starting 3 weeks before anticipated harvest when weather conditions are wet. Captan is a more effective fungicide than sulfur. Also, it does not need to be applied as frequently as sulfur. Not allowing fruit to become overripe on the tree and removing any rotten fruit from the tree area can aid in reducing fruit rots.

INSECTS: Scales can be serious pests of peaches and nectarines and a dormant oil application is important to manage them. The most serious insect pests of nectarines and peaches occur immediately after bloom, when a complex of stink bugs and plant bugs feed on small developing fruits and cause what is known as "catfacing" damage. The plum curculio and oriental fruit moth are also major pests that occur at this time. A 3-week period beginning at petal fall is a critical time for insect control, and two applications at 10-14 day intervals with a pyrethroid insecticide is often required to control the pest complex. As the crop approaches harvest, Japanese beetles and June bugs can feed on ripened fruit.

Peachtree borer is a clear-wing moth that lays eggs on tree trunks and the larvae bore into the base of the tree near the soil-line. This usually results in a dark yellow gum that contains saw dust-like wood particles called frass. A pyrethroid insecticide applied to the trunk of the tree (from the first scaffold limb to the ground) during the first week of September, will help to control this insect borer.

Peach Tree Borers

Stink bugs and stink bug injury

Catfacing damage

Cherries and Plums


Black knot

The fungal disease, black knot, can occur on branches of cherries and especially plums. This is most common when these fruit trees are grown near wooded areas that contain wild cherry. Black knot can be reduced by pruning out the knots as soon as observed and spraying a fungicide such as chlorothalonil just as new growth starts in the spring, with two additional sprays 7 to 10 days apart. The fruit disease most commonly encountered on cherries and plums is brown rot, the same disease that affects peaches and nectarines. Apply the first fungicide spray for brown rot 3 weeks before anticipated harvest. If frequent periods of precipitation occur, apply 1 to 2 additional sprays at 5-7 day intervals as recommended for peaches.

Cherries and plums are susceptible to attack by many of the same insect pests previously mentioned for peaches, including scales, plum curculio and peachtree borer, and precautions should be take to control these insects. The cherry fruit fly and black cherry fruit fly can also be common pests, and are similar in appearance and damage to the apple maggot. Cherries and plums are susceptible to damage by these fruit flies from late May through July. Most insecticides recommended for tree fruits are effective against cherry fruit fly, including carbaryl, malathion and the pyrethroids.

Pesticide use in the home orchard

Pesticides are designed to kill pests such as insects and disease-causing organisms like fungi and bacteria. **By law, they must be used, stored, and disposed of only as instructed on the container label. Always read and follow the directions on the container label before using a pesticide**. Before purchasing a pesticide, be sure that it is approved for use on the fruit crop to which you plan to apply it. The approved crops are stated on the pesticide label. Also, when preparing to spray fruit during the 3-week period before anticipated harvest, check the label to be sure that the pesticide can be applied within that time frame. Store all pesticides and containers (example sprayers, measuring instruments) used for application away from children and pets and do not use these containers for any other purpose.

For management of the most common diseases that affect fruit trees grown in the home orchard, the fungicides found in various brands of tree fruit sprays contain captan, sulfur, chlorothalonil, or copper. These materials generally are safe for use on most fruit trees, however, some plants are sensitive to copper and injury to fruit and leaves may occur when copper-containing materials are applied after the bloom period. Some products may also contain the fungicides myclobutanil (very effective for powdery mildew and rust diseases of apples and brown rot of peaches) or tebuconazole (effective for brown rot of stone fruits). Only copper and Agri-mycin (streptomycin) have activity against bacterial diseases such as fire bight. Agri-mycin does not control fungal diseases. Captan and sulfur often can be purchased individually and prepared as indicated in the table. Where one or just a few trees are involved, ready-to-use mixtures may be the best to purchase. Read and follow the directions on the container label. Pesticides for homeowner use and available at many garden centers are sold under the brand names such as Bonide^{tm}(http://www.bonideproducts.com/), Spectracide^{tm} (http://www.spectracide.com/), and Bayer Advanced™ (http://www.bayeradvanced.com/). A list of products, product labels and material safety data sheets (MSDS) can be found at their websites.

Additional Tips

-- Use personal protective equipment such as clothing, gloves, and a respirator as recommended on the product label.
-- Mix fresh spray for each application. Do not save spray mixture for the next application. This is not only unsafe, but the pesticide loses its activity and also can damage the sprayer. Carefully calculate the amount of spray needed so that excess does not result and create a disposal problem.
-- Most fungicides and insecticides can be mixed together in the same tank unless the pesticide label prohibits mixing them. DO NOT spray an insecticide during bloom because it is likely to kill pollinating insects such as honeybees.
-- Spray carefully and thoroughly to cover all parts of flowers, leaves, and fruit until a noticeable amount of water begins to drip from the foliage. Shake the sprayer often while spraying so that the chemicals do not settle out.
-- In most cases for disease control, apply the pesticide prior to rainfall; however, sprays should not be applied closer than 2-3 hours before rainfall to allow for sufficient drying.
-- Pesticides should be stored in a safe location that is cool and dry. Liquids should not be stored where the temperature will drop below 32° F.
-- ALWAYS Read and observe the instructions on the container label for the time interval between the last pesticide application and reentry into orchard or for harvest. This interval may vary depending on the pesticide.

Fungicides for disease control in the home orchard.

Pesticide	Rate (per 1 or 10 gallons of water)		Comments
Fungicide	1 gal	10 gal	A mix of captan and sulfur will control most tree fruit diseases. However, there are certain times that a substitute or an additional fungicide is recommended for control of a particular disease. These have been mentioned for the specific fruit crop. DO NOT mix captan and or sulfur with oil.
Captan 50% WP PLUS	1 tablespoon;	5 oz	
Sulfur 80-90% WP*	3 tablespoons	10 oz	

*Sulfur applied when temperatures are high (>85 F) may cause phytotoxicity.

There are several organic-approved fungicides available for disease control in the home orchard. These include sulfur, various formulations of copper, neem oil, phosphorus acid fungicides and biologicals. Biologicals are generally more effective in suppressing some diseases when disease pressure is light and use should be initiated before disease symptoms are observed or disease pressure (eg, wet weather) becomes high. Disease control results with biologicals can be variable depending on the disease, weather conditions, and how they are used. Organic disease control products can often be found at garden centers or can be purchased online from various sources.

Insecticides for use in the home orchard.

Only common names of active ingredients are listed, because insecticides are available under many different names and formulations. Consult the label for rates and preharvest intervals.

Insecticide	Class	Uses
Oils	Mostly petroleum based	Often referred to as horticulture oils or dormant oils. Oils have been used for >100 years to control scales and other pests of fruit trees. Applied as a dormant application it should be used at a 3% solution. Some highly refined or light weight formulations can be used after bloom, but should only be used at a 1% solution. Do not use in combination with or at least 10 days before or after a fungicide that contains sulfur or captan is applied, or severe leaf burn will occur.
Carbaryl	Carbamate	An old insecticide that controls a broad spectrum of pests, but is not effective against aphids or scales, and can flare mite populations. Also acts as a fruit thinning agent when applied to apples within about 2 weeks after bloom
Malathion	Organophospate	Another old insecticide that also has broad spectrum activity. Effective against insects with sucking mouthparts such as aphids.
Spinosad	Spinosins	A fermentation product of a soil-dwelling organism. It is effective against thrips and leafminers, and leaffrollers. Certain formulations are approved for organic use.
Azadirachtin (Neem)	Botanical	Extracted from the seed of the neem tree, formulations of this are approved for organic use. It is most effective against insects with sucking mouthparts such as aphids and leafhoppers, but also has some activity against plum curculio.
Insecticidal soap	Potassium salts of fatty acids	Insecticidal soap can help control soft bodied insects such as aphids and mites, but it has no residual activity.
Acetamiprid	Neonicotinoids	This relatively new insecticide has broad spectrum activity and provides good control of many major pests, including aphids, beetles, and oriental fruit moth. It can also flare mite populations.
Pyrethrin	Botanical	This botanical insecticide has rapid knockdown activity against many pests, but insects often recover. Piperonyl butoxide (PBO) is often mixed with pyrethrin to act as a synergist. It has very short residual activity, which limits its effectiveness.
Permethrin Cyhalothrin Bifenthrin	Pyrethroids	These three different pyrethroid insecticides are synthetic analogs of pyrethrins, but they have enhanced activity and much longer residual activity. They provide excellent control of many key pests, but they can also flare mite populations.

Recommendations of specific chemicals are based upon information on the manufacturer's label and performance in a limited number of trials because environmental conditions and methods of application may vary widely, performance of the chemical may not always conform to the safety and pest control standards indicated by experimental data. All recommendations for pesticide use were legal at the time of publication, but the status of registration and use patterns are subject to change by actions of state and federal regulatory agencies.

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