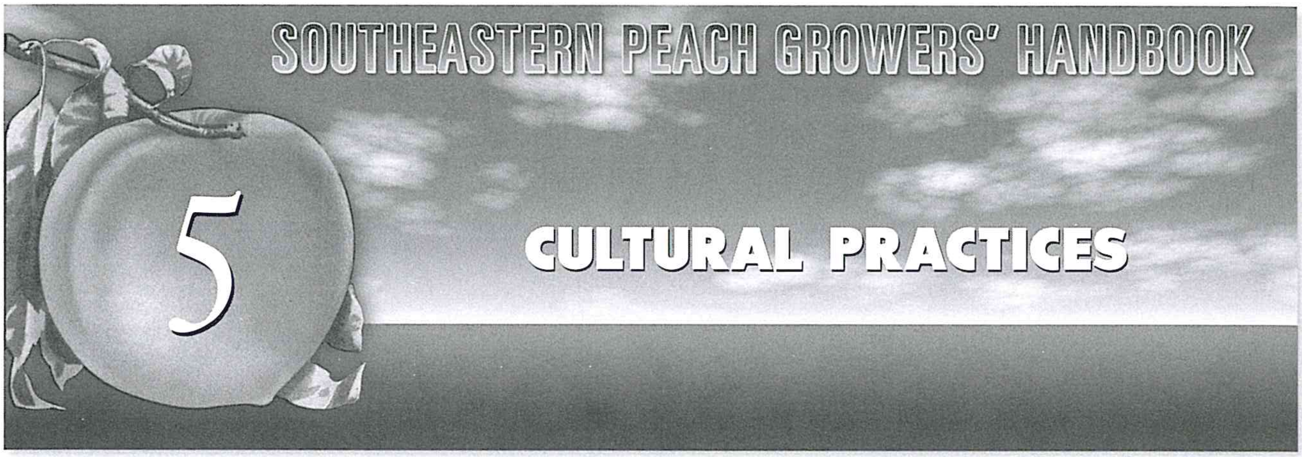

5.1 PROPAGATION

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Deciduous fruits such as peach must be propagated asexually because they do not come true from seed. Budding and grafting are the most common asexual propagation techniques for tree fruits. The interests of most growers are best served by thoroughly examining the strengths and weaknesses of each potential rootstock-scion combination before obtaining trees from a well-regarded fruit-tree nursery. Always insist on varietal trueness-to-type and freedom from viruses and nematodes. A discussion of asexual propagation of peach trees follows.

Young peach trees are commercially propagated by T-budding, a summer propagation method. T-budding propagates a bud from a desired scion variety onto the rootstock of choice. The saw-kerf grafting technique is commonly used by orchardists when a variety change for existing peach trees is desired.

T-BUDDING

Rootstock. Peaches are propagated on seedling rootstocks. Guardian is the rootstock of choice, primarily because it has given better growth and survival on peach tree short life (PTSL) sites. Lovell has been a recommended rootstock for many years and continues to be a good choice in many areas. However, Lovell seed are increasingly difficult to get. Halford rootstocks have shown themselves to be as good as Lovell, thus they are recommended for planting wherever Lovell is used. Nemaguard may be used in warmer southeastern production areas on sites where root-knot nematodes are prevalent.

Seed Germination for Rootstocks. Mature peach seed will not germinate immediately, but first require conditioning by exposure to a period of cool, moist conditions with temperatures slightly above freezing. This "after-ripening" process called **stratification** is necessary to satisfy the rest requirement of the seed embryos and to soften the stony layer surrounding the seed. Stratification may be achieved prior to planting or in the field.

Stratification Prior to Planting. To stratify peach seed, first soak them in water for 24 hours. Prepare a stratification mix of one-third peat moss and two-thirds sand (by volume). Following soaking, layer the seed in the mix by placing an inch of mix, a layer of seed, an inch of mix, a layer of seed and so on in the container. To prevent seed decay, the mix should be moist, not wet. Squeeze excess moisture out by hand.

Polyethylene bags are convenient containers for small lots of seed. The plastic prevents loss of moisture, and the beginning of germination can be observed without opening the bag. Two or three small holes should be cut into the top of the bag to allow for air exchange. The mix should be checked periodically to ensure that drying out does not occur. It is also possible to stratify seeds in a polyethylene bag and substitute a moist paper towel for the mix. In this case, do not cut holes in the bag.

Maintain peach seed at temperatures between 33° and 40°F for a period of about 90 days. As soon as sprouting begins, the seed should be planted or stored at a lower temperature (32° to 33°F) until planting is possible. Germinating seed must be planted carefully, as the young sprouts are brittle and easily broken. It is not necessary to separate the mix from the seed when planting. The sprouting seed should be planted at a rate of eight to 10 seed per foot of row in rows four feet apart. Peaches should be seeded about one and one-half inches deep. If survival is good, thin the seedlings to four or five per foot of row.

Stratification Using Fall Seeding. If after-ripening of the seed is to be done in the field, plant the seed in mid-October. A shallow, narrow furrow should be made so the seed will be planted one and one-half inches deep. In heavy soils with a tendency to crust, line the furrow with a small quantity of peat moss. After seeding, lightly cover the seed with peat moss and fill the furrow with soil. Avoid excessive mounding (more than one inch) of the furrow. The rate for direct fall seeding should be 10 to 12 seed per foot of row in rows four feet apart. If germination is good, the seedlings should be thinned to about four or five per foot of row. Well-grown seedling rootstocks should be large enough to bud by late May to early June following seeding.

Collecting Budwood. Budwood should be taken from healthy, vigorous current season shoots. Recent cooperative industry efforts are providing true-to-type, virus-tested budwood for southeastern nurseries. Clip the leaves off of budsticks with a sharp knife, leaving about 1/4 inch of the petiole. When cutting off the leaves, do not cut into the budstick with the knife. Keep the budwood moist at all times, both before and after clipping off the leaves. Where a two- or three-day supply of buds is cut at one time, wrap the budsticks in damp paper and store in a plastic bag in a cool place. Properly prepared budsticks should remain in good condition for at least three days.

Budding. T-budding, the predominant propagation technique for southeastern peaches, is done beginning in early summer (June budding). June budding is done as soon as the seedling rootstocks are large enough to bud (late May to early June), and continues through mid- to late June. Two weeks after budding, the rootstocks are cut off about 1/2 inch **above** the bud, and all suckers are removed from the stock. This process forces the bud of the desired variety to grow.

Buds for dormant budding may be taken in mid- to late summer. Dormant budding can be practiced from mid-July to early September, as long as the bark on the rootstock separates cleanly from the woody tissue beneath it, and the bud shield separates cleanly from the budstick. Buds are not forced until the following spring. In March following dormant budding, cut the rootstocks off about two inches above the bud, forcing the bud to grow.

To bud peaches yourself, select a point on the rootstock three to five inches above the groundline. Wipe the stock clean of soil and leaves that may interfere with budding. Make a T-shaped cut, first by making the vertical cut (Figure 5.1.1) then crossing the T (Figure 5.1.2). Do not cut into the wood. Select a good bud with the petiole stub intact (Figure 5.1.3). To cut the bud, begin the cut about 3/4 inch below the bud, cutting under the bud and up the bud stick (Figure 5.1.4). Cut across the top of the budstick about 1/2 inch above the bud (Figure 5.1.5), then peel the bud off (Figure 5.1.6). No wood should adhere to the bud; the bud should peel cleanly at the cambium. Gently insert the bud into the T, using the petiole stub to help protect the bud (Figure 5.1.7). Figure 5.1.8 shows a bud properly seated before tying. Figure 5.1.9 shows a tied bud. In tying, do not crush the bud or the petiole stub with the rubber band. As previously mentioned, June buds should be forced two weeks following the budding process, whereas dormant buds are not forced until the following spring.

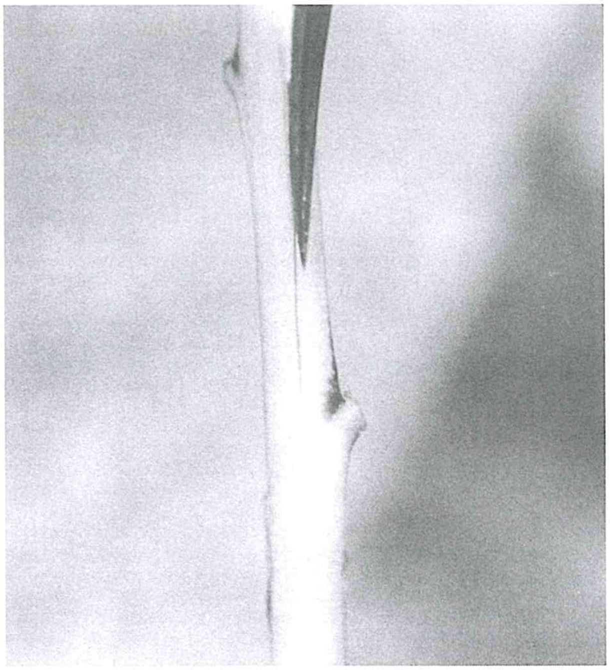


FIGURE 5.1.1. Vertical cut of T-shaped cut.

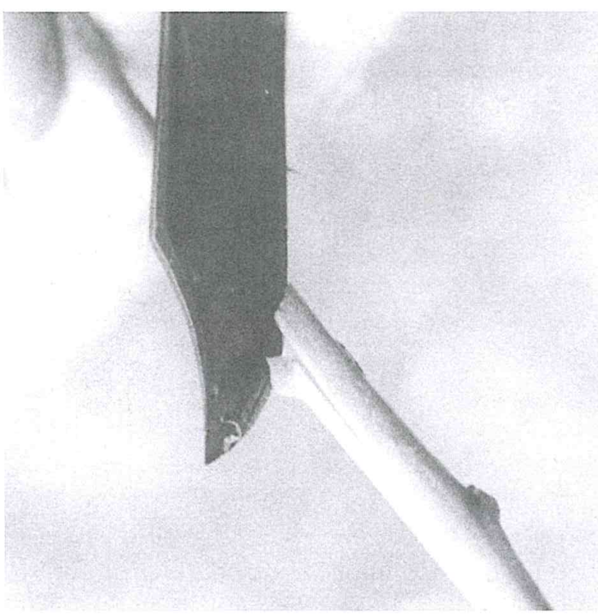


FIGURE 5.1.2. Crossing the T cut.

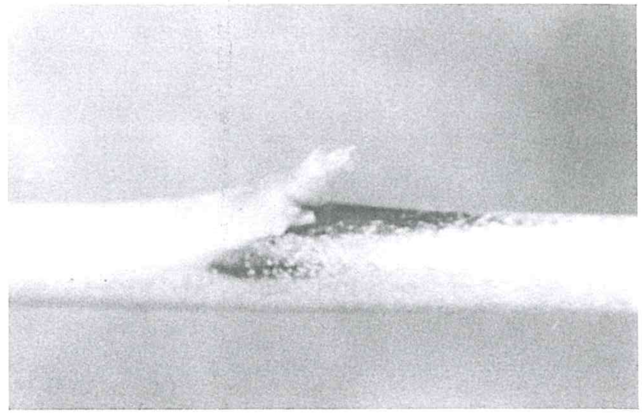


FIGURE 5.1.3. Bud with petiole stub.

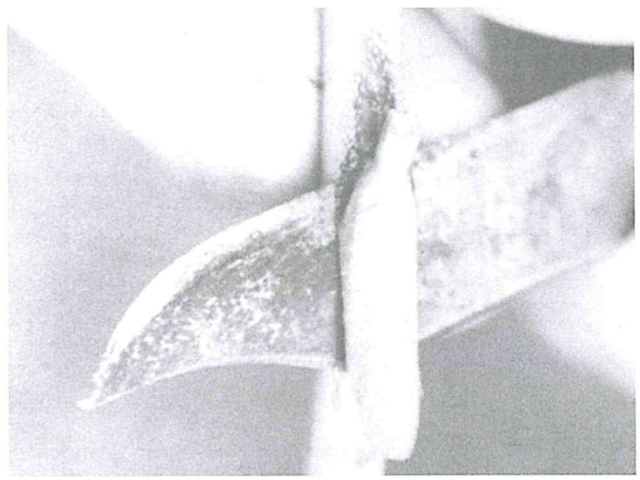


FIGURE 5.1.4. Cutting under the bud and up the bud stick.

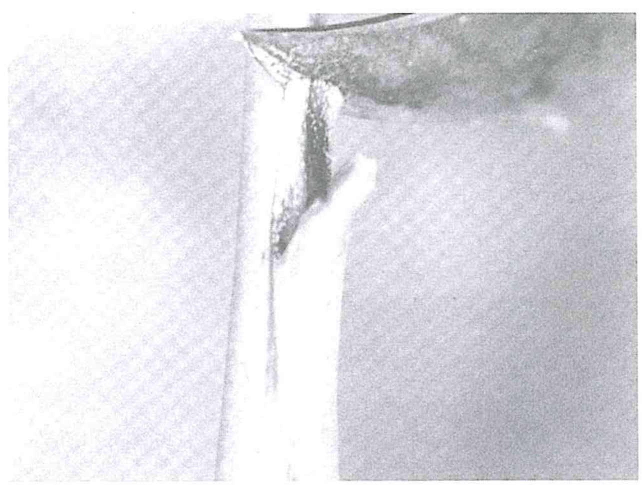


FIGURE 5.1.5. Cut 1/2 inch above the bud.

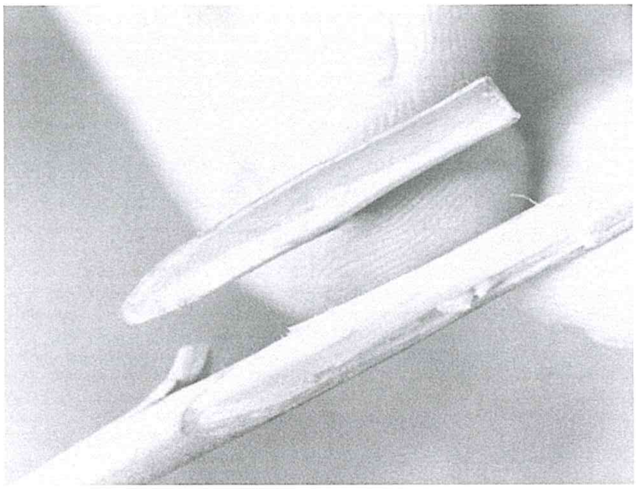


FIGURE 5.1.6. Peel the bud off.

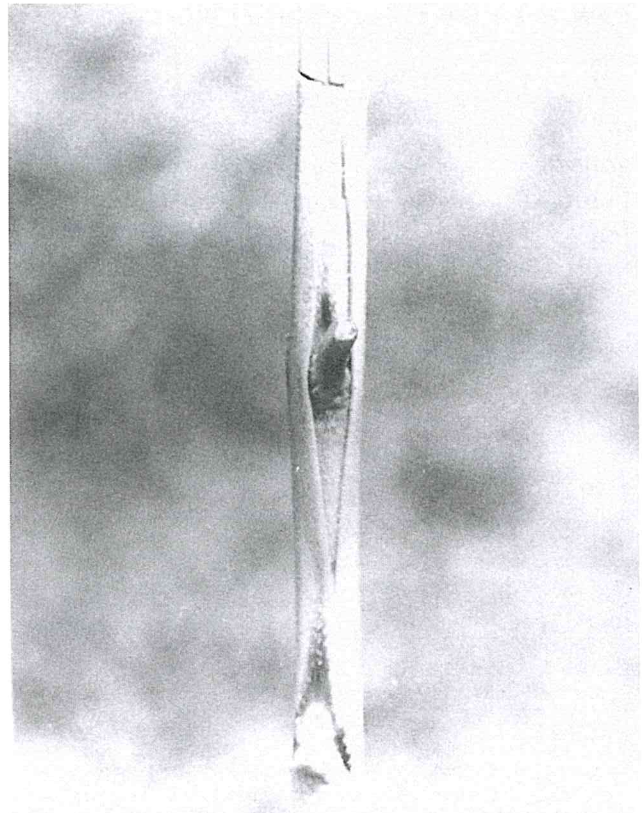


FIGURE 5.1.8. A bud properly seated before tying.

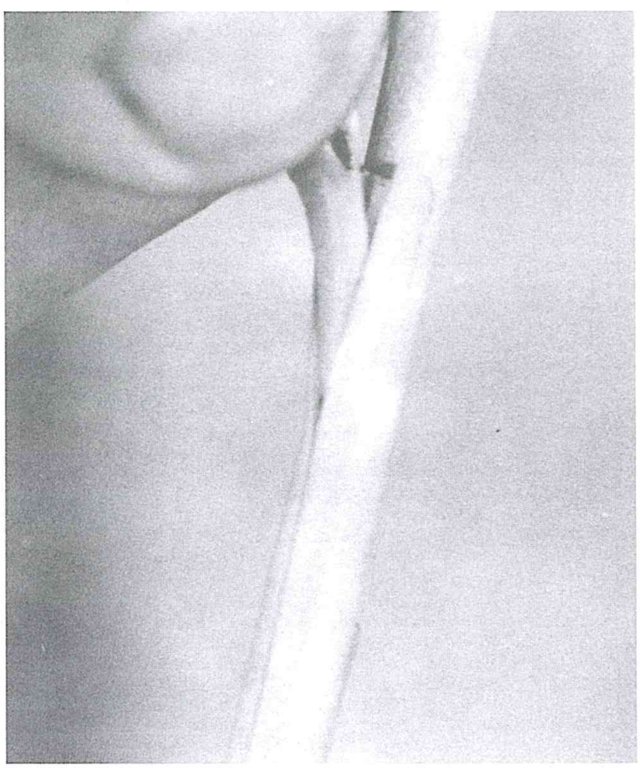


FIGURE 5.1.7. Using the petiole stub to help protect the bud.

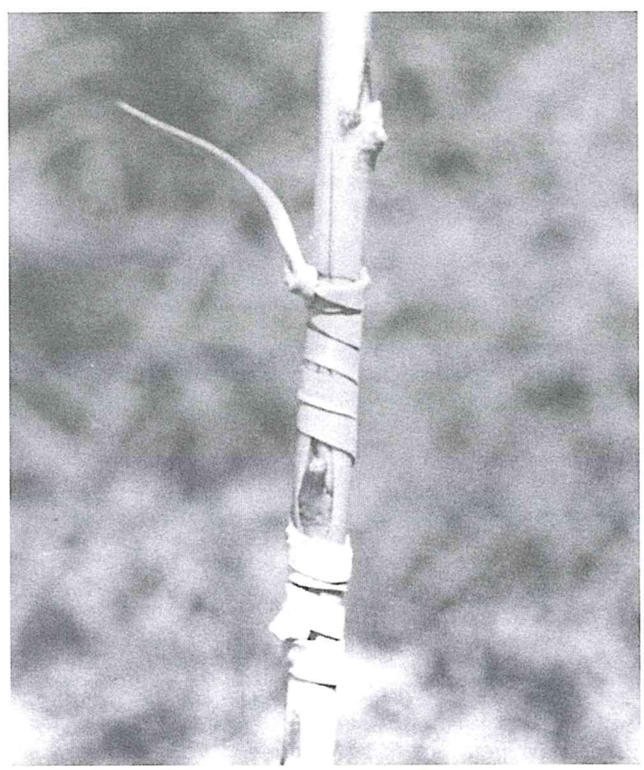


FIGURE 5.1.9. Tied buds.

SAW-KERF OR NOTCH GRAFTING

Saw-kerf grafting is used to topwork established off-type or undesirable variety trees. Saw-kerf grafting can be done over a long period, usually February and March. This grafting method requires considerable skill, but it is the accepted method of topworking knotty peach stock that very seldom splits properly for other grafting methods such as cleft grafting. Saw-kerf grafts limit the risk of infection inherent in reworking mature trees.

Scionwood used for saw-kerf grafting should be fully dormant, thus it is essential to cut all needed scion material during dormancy. Select shoots of the previous season's growth that are 3/8 to 2 inches in diameter and free of insects and diseases. Bundle the scionwood and store in green, pine sawdust in a bulk bin in cold storage. Scionwood should be held at 34° to 36°F until it is to be used. Label the scionwood with durable tags marked with a nursery marking pen. Carefully avoid mixing varieties; do not store scionwood of different varieties in the same bin.

When grafting begins, remove only as much scionwood as will be needed for that day, and do not allow the wood to dry out. Scions should be cut into a wedge shape, with the outer edge slightly thicker than the inner (Figure 5.1.10). After cutting the wedge on the bottom of the scion, cut the scion off, leaving two or three buds. The lower bud of the scion should be on the outside near the top of the wedge cut. Cut the stock with a fine-tooth saw, using approximately a 45-degree angle with the flat surface of the stock (Figure 5.1.11). The saw cut should go into the stock so that it extends four to five inches from the surface along the outside. Notch the stock to fit the scion previously cut. The notch is easiest to make using a knife with a half circle blade of the type used by leather workers (Figure 5.1.12). Insert the scion into the notch, lining up the cambium of the stock and scion (Figure 5.1.13). Because of the difficulty in getting a perfect match of the two cambiums, slant the scion slightly to make sure the cambiums touch in at least one place. Firmly, but carefully, drive the scion into the stock. Cover all exposed surfaces with tree wound dressing, including the top of the scion (Figure 5.1.14). Three or four scaffolds on each tree should be grafted with two scions per scaffold.

Always leave a nurse limb to grow and support the tree until the grafts have grown 18 inches or more long. Then, remove the nurse limb and paint over the wound. If both grafts on a scaffold grew, select one to be the new scaffold and remove the other. Remove sprouts arising from the older part of the tree as they are not the new, desired variety. Wind or birds landing on the new growth may cause it to break at the graft union. Support vigorously growing grafts with a 2-inch x 2-inch slat tacked to the stock.

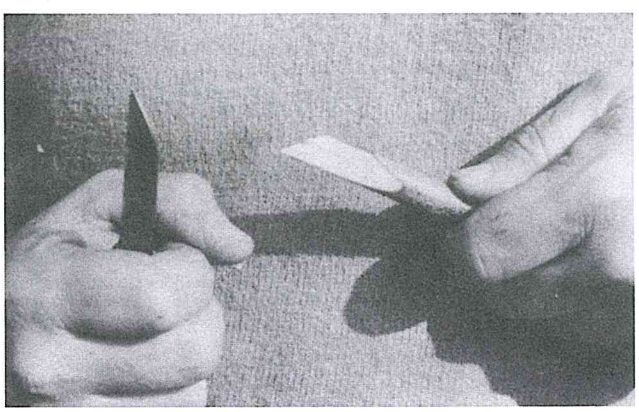


FIGURE 5.1.10. Scion cut wedge-shaped.

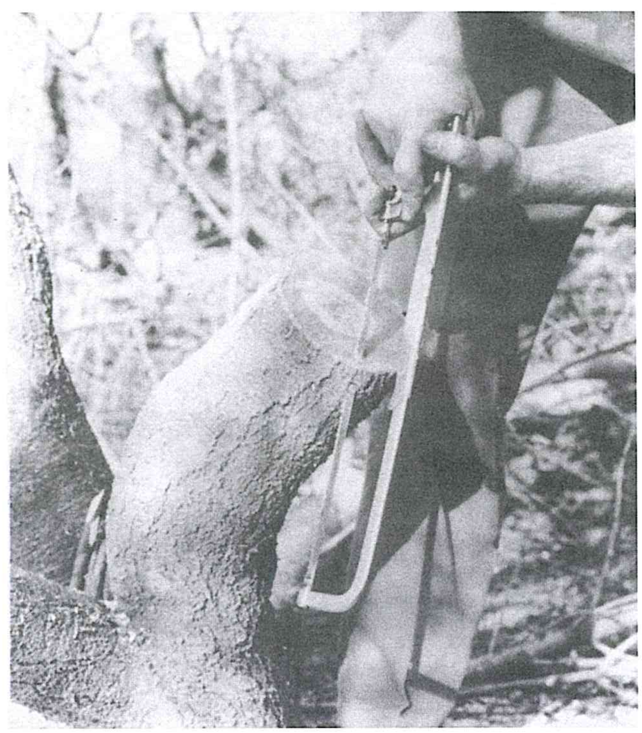


FIGURE 5.1.11. Cut stock with a fine tooth saw.

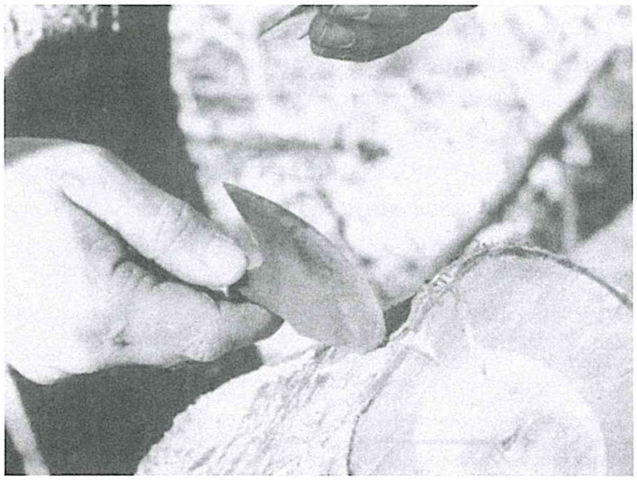


FIGURE 5.1.12. Knife with a half circle blade.

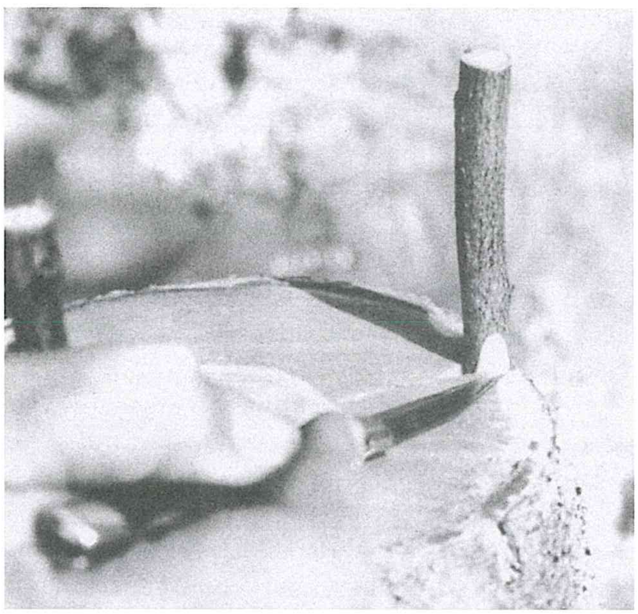
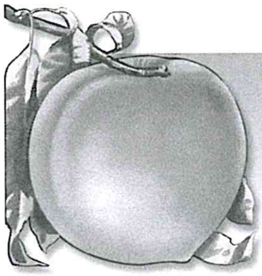


FIGURE 5.1.13. Insert scion into notch.

FIGURE 5.1.14. Cover exposed surfaces with tree wound dressing.



5.2 NUTRITION

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Sustained, high-quality production of peaches demands a well-conceived nutrition program. Peaches are grown in a wide diversity of climatic and soil conditions. In some areas, peaches are grown on deep, sandy soil, while heavy clays predominate in other production areas. Accordingly, no blanket statement can be made in regard to orchard nutrition. General nutritional recommendations must be modified and refined to meet the needs of specific orchard blocks.

Results of an orchard nutrition monitoring project in the Ridge Area of South Carolina suggest that a balance sheet approach to nutrient management may be useful. The balance sheet approach involves treating nutrient supplies in the soil as a **bank deposit**. Fertilizer and lime application rates and dates are systematically recorded as **deposits**. Soil and leaf nutrient levels are carefully determined and recorded as the **balance** at the same time each year. Leaf nutrient levels are compared to established leaf nutrient sufficiency ranges (Table 5-2-1). Fruit yields, fruit size, and fruit quality are recorded for individual blocks of trees as **withdrawals** or **dividends**.

The balance sheet allows growers to develop a detailed history of orchard nutrition. Keys to consider follow:

(1) Establish a permanent identity, preferably a numbering system, for each orchard block of trees.

(2) Collect soil and leaf samples at approximately the same time each year.

(3) Use a record-keeping system that permits arraying several (10 or more) years of soil- and leaf-monitoring results on one page in easy-to-read columns. Examples of this system are presented in Tables 5-2-5, 5-2-6, and 5-2-7.

For example, by scanning columns for potassium levels in the soil (Table 5-2-5), foliage (Table 5-2-6), and fertilizer application records (Table 5-2-7), one can readily determine whether potassium deposits are roughly in balance with withdrawals. If the trend over several years shows upward or downward movement, or if potassium and calcium levels are getting out-of-balance, appropriate fertilizer adjustments can be made.

A nutrient balance-sheet approach provides a built in auditing system. Proof of the system is in the fruit quantity and quality, and the health and vigor of the trees (Table 5-2-2). When nutrition problems are suspected, diagnosis and correction are greatly simplified when several years of systematic soil, foliar, fertilizer, and crop records are available.

Further refinement of the balance sheet approach is possible, especially for nitrogen, if the record includes rainfall and irrigation data for specific blocks, as well as annual growth data for mature, bearing trees. Records of nematode populations may explain poor tree performance even though nutrition appears adequate.

Area soil and foliar nutrient surveys enable growers to compare their nutrient balance sheets to the ranges and averages of their neighbors.

PRE-PLANT CONSIDERATIONS

The importance of proper site preparation cannot be over-emphasized. Peaches perform best on well-drained soils with a pH of 6.0 to 6.5. Monitoring by soil testing and adjusting proper soil pH to a depth of 16 inches through liming is the key to increasing tree survival and maximizing production. Lime does not readily move down through undisturbed soil, so pre-plant soil preparation is the key to deriving the benefits of liming (Table 5-2-3). Phosphorous is similarly immobile through undisturbed soil and should be included in pre-plant preparation if soil tests indicate a need. Sites should be subsoiled in two directions (cross-checked) and lime and/or fertilizer should be turned in with deep plowing. Such pre-plant site preparation helps trees develop a large root system throughout the rooting zone. Refer to other sections for discussions of nematode control and methods of planting.

FERTILIZING YOUNG TREES

First Year. Fertilizer should never be incorporated in the planting hole at planting or applied to the soil surface around newly planted trees until a drenching rain has settled the soil. Newly planted trees should be fertilized three times during their first season in the orchard as follows:

(1) March – evenly broadcast one pound of 10-10-10 fertilizer over a circle five feet in diameter around each tree;
(2) Mid-May – evenly broadcast one pound of calcium nitrate or one-half pound ammonium nitrate over a circle six feet in diameter around each tree;
(3) Early to mid-July – repeat of application made in mid-May. Do not apply after August 1, because late fertilizer application to vigorous trees increases susceptibility to cold damage.

Second Year. Second leaf peach trees should also be fertilized three times. Rates should be increased, and the area of application should also be increased to feed the larger root system. Banding of the fertilizer in the herbicide strip is recommended.

(1) Late-February – apply 10-10-10 fertilizer at a 250 pounds per acre rate, concentrated in a six-foot wide row band (three feet wide on each side of the tree row);
(2) Mid-May – apply calcium nitrate at a 150 pounds per acre rate or ammonium nitrate at a 75 pounds per acre rate as described above;
(3) Early to mid-July – repeat application of mid-May, do not apply after August 1, because late application to vigorous trees may make them susceptible to cold damage.

TABLE 5-2-1. Foliar sufficiency ranges for nutrients in peach leaves, Georgia.*

NUTRIENT	DEFICIENT LEVEL	SUFFICIENCY RANGE
N(%)	< 1.7	2.75-3.50
P(%)	< 0.11	.12-.50
K(%)	< 0.75	1.50-2.50
Ca(%)	< 1.0	1.25-2.50
Mg(%)	< 0.20	.25-.50
Mn(ppm)	< 20	20-150
Fe(ppm)	——	60-400
B(ppm)	< 20	20-45
Cu(ppm)	< 3	5-20
Zn(ppm)	< 12	15-50
S(%)	< 0.01	12-40

*Plank, C. Owen. 1988. Plant Analysis Handbook for Georgia, Cooperative Extension Service, University of Georgia.

TABLE 5-2-2. Deficiency symptoms in peach (based on sand culture).*

DEFICIENT NUTRIENT	SYMPTOMS
Nitrogen	Tree growth stops as leaves first become pale, progressing to a reddish tint with spotting as leaves fall off. The older leaves fall first; much root decay with roots slender and extensive.
Phosphorus	Leaves dark green to purple; early defoliation; no other symptoms noted.
Potassium	Spindly shoots; necrotic spots on margins of crinkled leaves; chlorotic leaves; reduced root growth; fruit buds few.
Calcium	Twig dieback and reduced growth; older leaves normal but younger ones chlorotic with necrotic area in center; subsequent leaf drop occurs; poor root growth and dead root tips.
Magnesium	Leaves with interveinal chlorosis; older leaves have necrotic spots and abscise early; root system reduced; fruit buds reduced.
Manganese	Leaves become dull, yellowish-green; darker in the veinal area; more severe on young leaves; terminal growth stunted.
Iron	Leaves show interveinal chlorosis at first, eventually becoming totally chlorotic; necrosis is followed by defoliation, starting with the younger leaves.
Boron	Dark, water-soaked spots, exuding gum, about one inch back of the growing tips, all beyond it dying; lateral bud breaks caused "witches broom" appearance; some chlorosis, early defoliation from tips to base of shoot; small corky protrusions on bark; poor root system.
Copper	Dark green leaves, interveinal chlorosis; young leaves irregular, long, and narrow; severe wilting, defoliation, and terminal die-back when deficiency severe; some rosetting.
Zinc	On younger leaves, mottling at first, new leaves small, narrow and pointed with wavy margins, chlorosis, rosetting, defoliation; deposits of gummy materials on roots; fruit misshapen.

*Based on work of Weinberger and Calliman, reported in "Fruit Nutrition," Horticultural Publications, 307-310, Norman F. Childers; and "Diagnostic Criteria for Plants and Soils," Quality Printing Co., Homer D. Chapman (ed.).

FERTILIZING BEARING TREES

With diligent young tree management, trees entering their third leaf should be capable of producing sufficient fruit to justify harvest. Accordingly, a fertilization program for bearing trees should be implemented.

Application of five plant nutrients is routinely required to produce peaches in southeastern soils; specific practices may vary in other areas. Nitrogen is needed annually, while phosphorus and potassium should be applied based on soil test and foliar analysis results. The other two plant nutrients most often needed are calcium and magnesium.

Supplemental applications of other essential plant nutrients may or may not be required. Growers are strongly encouraged to monitor these nutrients through foliar analysis to determine if such applications are needed to maximize production and maintain tree health.

MAINTENANCE OF SOIL pH (LIME)

Maintenance of soil pH at 6.0 to 6.5 increases tree survival and yield. As lime moves down through the soil slowly, deep incorporation in bearing orchards is impractical. Growers should maintain soil pH by annual or periodical liming. This maintenance liming program should be based on soil tests. If more than two tons of limestone per acre is recommended, apply half the first year and the other half the following year. Avoid applying lime when fruit and/or foliage are on the tree.

Late fall is the ideal time to lime. If soil tests indicate magnesium is not low and a faster reaction is desired, apply a fast-reacting lime source such as hydrated lime. Conversion rate for hydrated lime is in Table 5-2-4.

NITROGEN (N)

More than other elements, nitrogen controls growth and fruiting in plants. Nitrogen management requires balancing of nutritional goals. When the nitrogen level is optimum for fruiting, vegetative growth may be inadequate and vice versa. In 1980 Barker and Mills proposed an economic definition of optimum nitrogen. This system works well for all nutrients and relates to the balance sheet approach discussed at the beginning of this section.

Nitrogen interacts strongly with pruning and irrigation. For maximum fruit production, trees should be managed to produce maximum leaf area early in the season. This involves moderate pruning, establishing high nitrogen levels in the tree early in the season, early thinning, maintaining adequate soil moisture, and slowing vegetative growth just prior to harvest by depletion of nitrogen. In the Southeast, this can usually be accomplished with 45 to 90 pounds of nitrogen per acre annually, with at least half as the nitrate form.

Research shows that peach tree survival is greatly improved when the annual nitrogen fertilization of an orchard is split, with some nitrogen being applied in mid- to late August (post-harvest) and the remainder in late winter. Because the post-harvest nitrogen application is used to help maintain healthy foliage in the fall and improve winter hardiness of the tree, the late summer application should be considered food for next season's crop. The annual quantity of nitrogen applied to an orchard should be figured as that applied before harvest of next season's crop, not as the total applied during a calendar year. For example, if 15 pounds of nitrogen per acre are applied in late August to an orchard that has performed well with an annual nitrogen rate of 75 pounds per acre, then 60 pounds of N per acre (75 – 15 = 60) should be applied in late winter. A rule of thumb on the amount of nitrogen to apply in August is 15 pounds of nitrogen per acre on trees exhibiting healthy foliage and adequate (12" to 18") terminal growth, and 30 pounds of nitrogen per acre on trees exhibiting an obvious need for nitrogen. Trees growing vigorously in August should not receive the post-harvest application of nitrogen.

The post-harvest application should be banded in the herbicide strip or injected through a drip irrigation system so that the trees get most of the nitrogen. Weak areas within blocks should receive additional supplemental nitrogen. For example, if 15 pounds of nitrogen per acre are applied to the entire orchard in August, hand application of one pound of calcium nitrate or one-half pound ammonium nitrate around weak trees is also suggested.

In the Southeast, the spring nitrogen application should be made in mid- to late winter, at least six weeks before bloom for early maturing varieties. Fertilize varieties in order of ripening, completing the fertilization of late maturing varieties four to six weeks before bloom. Some growers split the spring application of nitrogen on late maturing varieties; half four to six weeks before bloom and the other half immediately after the threat of frost is over and a crop is set. If growers choose to use this practice, nitrate nitrogen (calcium nitrate) is recommended for the post-bloom application.

Plants can take up nitrogen either as nitrate or ammonium. At low pH, excess ammonium nitrogen may be toxic, causing feeder root necrosis, dark, water-soaked areas in the leaves followed by collapsed, necrotic tissue. The marginal burning may resemble potassium deficiency, but is not corrected by addition of potassium. Cool, wet soils in the spring delay microbial conversion of ammonium to nitrate and may contribute to ammonium toxicity.

When ammonium nitrogen is applied to peaches, it should be in combination with nitrates. The presence of nitrates decreases ammonium toxicity. Increasing calcium and potassium levels in the soil enhances nitrate uptake. Ammonium ions inhibit nitrate uptake.

Nitrogen Deficiency Symptoms. Leaves yellowish-green at shoot tips to reddish-yellow at base; red, brown, and necrotic spots develop; leaves shed prematurely; twigs spindly, short, stiff with brownish-red to purplish-red bark.

TABLE 5-2-3. Recommendations for pre-plant lime.*

SOIL PH		RECOMMENDATION, TONS/A BROADCAST AND	
SURFACE (0-6 IN.)	*SUBSOIL (0-6 IN.)*	*PLOWED DEEP*	*DISKED IN*
below 5.5	below 5.5	3	1
1 5.5-6.0	below 5.5	2	1
5.5-6.0	5.5-6.0	1	1
5.5-6.0	6.0 +	0	1
6.0 +	below 5.5	2	0
6.0 +	5.5-6.0	1	0
6.0 +	6.0 +	0	0
6.0 + but soil Ca less than 400 lbs/acre		0	1

*Myers, S.C., Gerard Krewer, and Thomas Crocker, 1988. Fruits and Pecans. *In* Soil Test Handbook for Georgia. C. Owen Plank (ed.). Cooperative Extension Service, University of Georgia, Athens, Georgia.

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TABLE 5-2-4. Conversion rate for hydrated lime.*

LIME RECOMMENDATION	ALTERNATE LIME SOURCE**
DOLOMITIC LIMESTONE TONS/A	HYDRATED LIME* TONS/A
1	0.75
2	1.50

*Myers, S. C., Gerard Krewer, and Thomas Crocker. 1988. Fruits and Pecans. *In* Soil Test Handbook for Georgia. C. Owen Plank (ed.). Cooperative Extension Service, University of Georgia, Athens.

**Since hydrated lime is quite fine, apply using an Easy Flow or similar applicator.

Excess Nitrogen Symptoms. Delayed ripening, decreased red color of fruit, and terminal shoot growth greater than 24 inches in mature trees. Severe excess in young trees may produce sudden leaf drop and death of tree.

Soil Testing. Laboratories at landgrant universities in the Southeast do not routinely include nitrogen in soil test results. Nitrogen levels in soil are highly variable and in a constant state of change. Ammonium and organic forms of nitrogen are converted to nitrate by soil microorganisms. Soil nitrogen has not correlated well to nitrogen levels in plant tissues. Tissue analysis coupled with careful observation of fruit quality and vegetative growth is more effective for monitoring nitrogen in peach trees.

PHOSPHORUS (P)

In peach, reports of phosphorus deficiency are very rare. Most fertilizer experiments with peaches, other than in sand culture, show little or no response to phosphorus.

Phosphorus Deficiency Symptoms. Dark green leaves, turning to bronze and purple. Progresses to narrow leaves with downward turning margins shedding prematurely.

Maintaining Phosphorus in Orchards. Peaches remove relatively little phosphorus from the soil each year. Only about 12 pounds P_2O_5 per acre are removed by a heavy fruit crop. The developing trees have been estimated to retain about three pounds P_2O_5 per acre (not returned to the soil by leaves and pruning). Therefore, no more than about 15 to 20 lbs P_2O_5 per year should be required to maintain phosphorus, once adequate levels (moderate to high) are established in the soil. Addition of phosphorus on alternate years should be a practical approach for most southeastern orchards.

Excessive Phosphorus. Many southeastern peach orchard soils test high-plus for phosphorus. Continued addition of phosphorus to these soils may cause deficiencies in zinc, iron, or copper. Foliar copper levels are marginal or low in many orchards where high levels of phosphorus are present. Do not add phosphorus to soils where soil test results read moderate or higher.

POTASSIUM (K)

The balance of nitrogen and potassium has a strong influence on red color development in fruit. Desirable skin and flesh color has been associated with relatively low nitrogen and high potassium levels in peach leaves. Both trees and fruit buds are more resistant to cold injury when adequate potassium levels are maintained. Foliar potassium levels below 1.0% may reduce fruit size. Potassium competes with magnesium and calcium for uptake in peach trees. Excessive levels of one may cause deficiencies of the others. Potassium leaches readily and may accumulate in the subsoil of some soils. In heavier soils, downward movement is minimal with movement restricted to the upper few inches.

Potassium Deficiency Symptoms. Peach trees can tolerate a wide range of potassium levels without obvious influence on total fruit production or tree growth. Potassium-deficient peach trees develop light green to pale yellow leaves rolling inward in a bean-pod shape. Severe deficiency eventually leads to necrosis of tips and margins, followed by upward curling of leaves and crinkled midribs. Fruit bud development is reduced.

Maintaining Potassium. An addition of 60 to 80 pounds of K_2O_5 per acre per year should maintain potassium in most orchards once adequate levels are established. Up to 300 pounds of K_2O_5 per acre may be applied to correct deficiencies. Occasional subsoil sampling for potassium should supplement topsoil and leaf testing for a complete potassium analysis. The source of potassium in commercial fertilizer usually should be based on economics. Potassium chloride (muriate) should be avoided where large, corrective quantities are added.

CALCIUM (Ca)

Calcium is the dominant base in the soil-exchange complex, accounting for 60 to 85 percent of the total cation exchange capacity. Calcium promotes favorable soil structure for root growth and development. Most southeastern soils are acidic. In acid soils, Ca and Mg are replaced by hydrogen ions. Under low pH conditions, the solubility of metals such as manganese and aluminum may increase to toxic levels, which is a major reason for maintaining soil pH near 6.5 for peaches. Sodium competes with calcium in the soil complex. Excess sodium slows conversion of nitrite to nitrate at high pH, and toxic levels of nitrite may result. Also, toxic amounts of sodium may be absorbed by peach trees at high pH. Peach growers should select fertilizers that are low in sodium.

Correction of Calcium Deficiency. Calcium deficiency is usually corrected with lime if soil pH is low. If soil pH is adequate and leaf calcium is still low, gypsum or calcium nitrate may be used. Where sulfur is a major component of the peach spray program and acid-forming fertilizers are used, about 1,000 pounds of lime per acre per year will be required to maintain soil pH near 6.5. If foliar levels of magnesium are low, use dolomitic lime; if magnesium levels are sufficient, use calcitic lime.

Care should be taken to maintain soil pH below 7.0 to avoid deficiencies in iron and zinc.

MAGNESIUM (Mg)

Magnesium Deficiency Symptoms. Leaves near terminals show slight chlorosis and progress to water-soaked blotches on older leaves of current season's growth. Blotches change to gray or pale

TABLE 5-2-5. Illustration of soil test results arrayed for balance sheet interpretation.

BLOCK NUMBER ______________

	SAMPLE DATES				
pH					
P					
K					
Ca					
Mg					

5

TABLE 5-2-6. Illustration of leaf nutrient test results arrayed for balance sheet interpretation.

BLOCK NUMBER ______________

ELEMENT	SUFFICIENCY RANGES	SAMPLE DATES			
N(%)	2.75-3.50				
P(%)	.12-.50				
K(%)	1.50-2.50				
Ca(%)	1.25-2.50				
Mg(%)	.20-.50				
Mn(ppm)	20-150				
Fe(ppm)	60-400				
Al(ppm)	<400				
B(ppm)	20-100				
Cu(ppm)	5-20				
Zn(ppm)	15-50				

green, then fawn to brown, followed by leaf drop. Young trees may not survive winter in cases of severe deficiency. Fruit buds are reduced.

Factors Affecting Magnesium Levels. Magnesium deficiency is not uncommon in peaches grown in sandy soils with high rainfall. High total salts will displace magnesium from topsoil to lower depths. High N levels in tissue are associated with higher Mg levels. Calcium and potassium compete with magnesium for uptake by the tree.

Correcting Magnesium Deficiency. Soil: Dolomitic lime (long-term) as indicated by soil pH. Magnesium sulfate: 100 pounds/acre for mature trees.

ZINC (Zn)

Zinc deficiency is not uncommon in peaches on lighter soils of the Southeast. However, heavy liming (high pH), excessive phosphorus, and high rates of nitrogen contribute to zinc deficiency. Symptoms sometimes appear in the spring and disappear with increasing soil and air temperatures. Heavy root-knot nematode pressure can induce spring rosetting resembling zinc deficiency.

Zinc Deficiency Symptoms. Leaves are chlorotic, mottled, narrow, and crinkled. Symptoms progress to shortened twigs with rosettes of leaves near terminals followed by defoliation and reduced fruiting. Deficiency symptoms sometimes appear in peach trees showing foliar zinc levels within the sufficiency range. Visual symptoms and poor fruiting suggest the need for foliar analysis to determine if symptoms are related to zinc deficiency.

Correction of Zinc Deficiency. The most effective treatments for zinc deficiency are sprays of chelated zinc formulations that are compatible with most insecticides and fungicides. Where no visual zinc deficiency symptoms are present, but soil pH readings are 6.5 or higher and soil phosphorus levels are high, one or two zinc sprays should be made. These sprays may include chelated liquid formulations, neutral zinc in the routine spray program, or a late fall application of zinc sulfate. The use of neutral zinc by most growers in their spray program to control bacterial spot is probably an effective maintenance treatment of southeastern peach orchards.

BORON (B)

Boron Deficiency Symptoms. Leaves are reduced in size with interveinal necrosis; dieback of twigs and branches; sometimes confused with cold injury when spring growth begins.

Correction of Deficiency. Soil: apply 10 to 15 pounds fertilizer borate or Borax per acre every three years.

Foliar: apply Solubor, one pound/100 gallons on well-developed leaves.

IRON (Fe)

Iron Deficiency Symptoms. Leaves show interveinal chlorosis with sharp distinction between green veins and yellow tissue between veins; can be confused with simazine herbicide toxicity.

Contributing Factors to Iron Deficiency. Factors include high pH (above 7.0), excess soil moisture, high concentration of heavy metals in acid soils (Zn and Cu), extremely high or low soil temperature, nematodes, and poor drainage (oxygen deficiency). Excess phosphate in the soil may be the most common cause of iron deficiency in the Southeast.

COPPER (Cu)

Copper Deficiency Symptoms. Unusually dark green foliage, advancing to yellowish-green with malformed leaves at tips; progressing to long, narrow leaves, irregular margins with terminal dieback, and rosette formation due to multiple bud break near terminals.

Correcting Copper Deficiency. High levels of nitrogen and phosphorus induce copper deficiency. There is no reliable method to assay soil for available copper. Excess copper can induce iron deficiency, usually at low pH in sandy soils. Land suffering from "reclamation sickness" had a copper content of less than 2.5 ppm as determined by *Aspergillus niger* test. This was corrected by addition of 30 pounds copper sulfate per ton to mixed fertilizer per year. Copper sulfate deficiency is most commonly seen on leached sandy soils under heavy nitrogen fertilization.

Soil: apply 50 to 100 pounds/A copper sulfate pentahydrate ($CuSO_4$-$5H_2O$) to soils followed by 50 pounds/A until 200 pounds have been applied or foliar analysis shows sufficiency.

Foliar: apply Bordeaux mixture (5 to 10 pounds copper sulfate in 100 gallons water plus a like amount of lime).

TABLE 5-2-7. Sample form for recording fertilizer application.

BLOCK NUMBER__________

SEASON (AUGUST 1– JULY 31)

Appl. Date	Anal.	Lbs/A	Appl. Date	Anal.	Lbs/A	Appl. Date	Anal.	Lbs/A

Appl. Date	Anal.	Lbs/A	Appl. Date	Anal.	Lbs/A	Appl. Date	Anal.	Lbs/A

Appl. Date	Anal.	Lbs/A	Appl. Date	Anal.	Lbs/A	Appl. Date	Anal.	Lbs/A

5

MANGANESE (Mn)

Manganese Deficiency Symptoms. Leaves become dull, yellowish-green, darker in the veinal area; more severe on young leaves; terminal growth stunted.

Correction of Deficiency. Foliar: apply two to four pounds/100 gal manganese sulfate, late dormant or early summer foliage.

CHLORINE (Cl)

Chlorine is an essential element for plant growth. However, very little research has been reported on chlorine as a peach nutrient. Peaches are extremely susceptible to high levels of chlorine. Thus, where large amounts of potassium are needed to correct low levels of potassium, potassium chloride (muriate of potash) should not be used.

ARSENIC TOXICITY

Arsenic levels in peach leaves:

Normal – 1.0 ppm
High to injurious – 5 to 20 ppm

Symptoms. Brown to red discoloration along leaf margins in mid-summer, followed by similar interveinal discoloration throughout the leaf. Tissues die and drop out, leaving a shothole appearance. Older leaves show symptoms; first terminal leaves often remain normal. Tree growth stunted. Reduced fruiting.

ADDITIONAL NOTES

Nutritional deficiency symptoms may sometimes resemble symptoms of herbicide toxicity and of certain virus diseases. Excellent color photographs of certain nutritional, herbicide, and virus symptoms are available in USDA Agricultural Handbook No. 437, "Virus Diseases and Noninfectious Disorders of Stone Fruits in North America," U. S. Government Printing Office, Washington, D.C. 20402. Where two or more elements are deficient or excessive, symptoms become less defined. Diagnosis of specific problems requires experience, laboratory support, and careful record keeping.

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5.3 PEACH THINNING

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The primary objective of flower and/or fruit thinning is to increase fruit size, maximize crop value, and maintain tree structure. To maximize crop value and marketable yield, growers must estimate their optimal crop load, the maximum number of fruits to be retained after thinning. Achieving this objective requires knowledge of market price structure, the genetic potential of a cultivar for fruit size and yield, and the effects of different cultural practices (e.g., training system, spacing, pruning, fertilization, irrigation, scoring, etc.) on fruit development.

In the Southeast, a mature, open-vase trained tree of a cultivar that has good fruit size potential, grown at an 18 by 20 foot spacing, generally will mature 4 to 5 bushels (eight to ten 25-lb. boxes) of 2.5-inch peaches when thinned correctly. Moreover, early thinning (e.g., pre-bloom, bloom) of the same cultivars when under irrigation in the Southeast may yield 5 to 6 bushels (ten to twelve 25-lb. boxes) of 2.75-inch peaches, a 20 percent volume increase.

Market price is typically linked to fruit size. Timely thinning of small- to medium-fruited cultivars not only significantly increases fruit size, the percentage of marketable fruit, and packed boxes per orchard block, it also increases per unit value by increasing overall fruit size (i.e., 2.25-inch vs. 2.5-inch peaches).

Production numbers are relative and may increase or decrease by 10 to 30 percent depending on the soil, cultivar, training system, pruning scheme, irrigation schedule, and other cultural practices. Whatever production system or cultural practices one uses, fruit thinning at the appropriate time almost always increases crop value above the expenses incurred for thinning, because orchard returns are significantly impacted by fruit size.

FLOWER BUD DIFFERENTIATION, CHILLING, AND FRUIT SET

Peach flower buds in the southeastern United States initiate and begin differentiating in late May and continue into August. Peak times in many areas are from mid-June to mid-July, varying with cultivar and latitude. The number of flower buds that eventually develop on a tree is dependent on its previous year's crop load, general tree health, and quality of the fruiting wood. When a crop is lost to a freeze or is bloom thinned, more carbohydrates are available for current season shoot growth and flower bud differentiation. As many as 50 percent more bearing shoots and 50 percent more flower buds are produced on bloom-thinned trees than hand-thinned trees 40 to 50 days after bloom. In like manner, non-cropped trees produce more shoot growth and flower buds than bloom-thinned trees. The greatest increase in flower bud numbers occurs near the base of the current season's shoots. Owing to competition, fruit that develop at this basal location often are smaller. However, these same basal flower buds are also the last to open in the spring, so they provide some protection from late season frosts.

If not thinned properly, peach trees appear to go biennial in their bearing habit. Trees that are not thinned or are thinned very late (60 days after bloom) may fail to produce an optimal number of flower buds per node or fruiting wood the following year. This condition is less prominent in regions with long growing seasons like the southeastern United States.

Additionally, overcropping with commensurate reduction in tree vigor can increase susceptibility to disease, cold injury, shorter tree life, and produce smaller crops and/or undersized fruit in subsequent years. Extra fertilization following an overcropped year cannot compensate for the reduction in carbohydrate reserves stored in the tree from the previous season.

Cultural practices, particularly prudent thinning, are extremely important in assuring level production of flower buds and profitable fruit size. Keep good records of crop load, yield, and fruit size. In years following bloom thinning or crop loss due to spring weather, counting flower bud numbers prior to thinning is especially helpful in determining the best thinning strategy.

Adequate winter chilling is important for activating dormant flower buds from rest. When flower buds receive enough cold, buds emerge normally in response to warming temperatures. In contrast, if the chilling requirement of a cultivar is not met, flower bud development can be retarded, extending the flowering period and increasing flower bud abortion. After winters of low chilling, higher chilling cultivars may not flower or set viable fruit. Trees that have experienced inadequate chill should be treated similarly to those suffering a crop loss.

Peaches typically set far more fruit than the trees will carry to harvest. Periods of natural fruit drops are normal, but insufficient to assure optimal fruit size. Natural drops typically stem from unfertilized seed, cold injury, competition between fruit, or excessive shading. Most peach cultivars are self-fertile and can be pollinated by wind action, gravity, or insects. Pollination and fertilization of the flower's ovule are required for fruit to adequately mature.

Unfertilized fruit, if retained until harvest, are undersized and referred to as buttons. If the weather during bloom is unfavorable (e.g., rain, cold) for pollination and fertilization, some peach fruit will not be fertilized but will continue to grow normally for another 25 to 50 days before slowing in growth rate and abscising before phase II, the pit hardening period. For the first 25 days after full bloom (AFB) neither the fruit nor the seeds of unfertilized ovules are distinguishable from those of fertilized fruit. When fruit are hand thinned 40 days AFB, a size difference is usually evident between those that will naturally fall and those being retained by the tree. Ovules of unfertilized fruits may or may not have turned brown by this time. Unfertilized fruit may be easily confused with fruit destined to fall during June drop, particularly during the period from bloom to about 30 days AFB, because the seeds and fruit size are similar to fertilized fruit.

June drop is the most important of the various fruit drops that occur annually (Table 5-3-1). In most of the Southeast, this natural wave of fruit drop actually occurs in May. It is a natural shedding of fertilized fruit as a result of competition between fruitlets for current season's and stored photosynthates. Competition forces the tree to shed smaller, weaker fruit, but not until after the ultimate size of remaining fruit is reduced. The size reduction is from loss of stored root carbohydrates and early season photosynthates used to provision fruit that were subsequently dropped. This reduction in fruit size cannot be reversed because dropped fruit used stored and manufactured carbohydrates, limiting resources available to fuel cell division in all fruit during phase I. Even the best cultural practices can only maximize cell size for the cells present.

Another factor that may affect fruit drop (Table 5-3-1) is poor or inadequate light in the form of three to four days of substantially cloudy weather during the period of 35 to 50 days AFB. Fortunately, prolonged cloudy periods seldom occur at this time of the season in the Southeast. Shade-induced drop may be difficult to separate from June drop, which takes place from 30 to 50 days AFB, as fruit dropping due to a cloudy event would not occur until a week or more after shading. In addition, fruit drop related to poor pollination and fertilization may occur at 30 to 45 days AFB, which can be easily confused with a true June drop. Finally, if an orchard has a light bloom or bloom thinning has occurred, no June drop would be expected.

TIMES AND METHODS TO THIN FRUIT

Thinning influences potential fruit size by promoting increased cell division by early removal of competing flowers/fruits during phase I, the cell-division period.

The longer unwanted fruits remain on a tree, the greater adverse effect they will have on fruit size, tree vigor, flower bud differentiation, leaf size, tree health, and next season's crop potential. The grower's goal should be to thin as early as practical by using the most cost-effective method available. No thinning time or method works best for every cultivar, location, or grower.

Preseason Flower Bud Inhibition

In areas where winter cold or spring frost are not a concern, usually not the case in the southeastern United States, flower bud density can be regulated (i.e., decreased) by timely sprays of gibberellic acid (GA) during the flower bud initiation period in the summer months. In more frost-free areas, selected but not currently labeled, GAs can significantly reduce both the number of flower buds and the location of the flower buds on fruiting shoots when sprayed from late May to early July. This reduction of flower bud numbers can subsequently decrease hand thinning costs and improve fruit quality.

Dormant Season Bud Thinning

Thinning flower buds during the winter prior to bloom effectively reduces hand thinning costs and increases potential fruit size. Experimental application of ethephon (i.e., breaks down to ethylene) in the fall has reduced flower bud numbers. This process is concentration and temperature dependent. Ethephon is not registered, possibly because ethephon's variable release and absorption under fluctuating environmental conditions can lead to excessive bud kill (over-thinning) during unseasonably warm temperatures. Another chemical, hydrogen cyanamide, which is applied in the dormant season to augment inadequate chill, has also been examined experimentally as a thinner. It can effectively thin flower buds, but the timing and rate are quite critical or over-thinning can occur.

An experimental method of dormant bud thinning still being researched is the application of high rates of dormant oils. With petroleum-based oils, a rate-dependent thinning response has been difficult to obtain, and phytotoxicity to the tree can occur when rates exceed those recommended for insect control. In other trials, some edible oils, such as soybean oil, have thinned flower buds in relative proportion to the rate of application. Soybean oil combined with an emulsifier appears reasonably safe and seems to provide dormant

TABLE 5-3-1. Naturally occurring fruit drop in peach.

	Cause of Fruit Drop	Days After Full Bloom (AFB) when Drop Occurs
Weak Flower Buds	Competition among buds for light and carbohydrates from late May into August during initiation and differentiation, particularly among basal buds reduces flower bud quality.	Environmental stresses such as cold can kill or affect pollination of weak flowers, thereby reducing fruit set after bloom.
Weak Seeds – due to poor pollination, insect feeding, and cold injury	Weak or dead seeds (i.e., embryos) fail to provide plant hormones to stimulate fruit retention and growth.	30 to 45 days AFB.
June Drop	Fruitlets compete for available in-season and reserve carbohydrates.	30 to 50 days AFB; in most of the Southeast June drop occurs during May.
Inadequate Light – 3 to 4 days of cloudy weather 35 to 50 days AFB	Environmental shading creates competition for in-season carbohydrates, reducing fruit growth rate and prompting fruit drop.	35 to 50 days AFB.

insect control with an additional benefit of flower bud thinning. However, more research is needed on these plant-based oils before labeling for commercial utilization can proceed.

One simple method to manage the flower bud crop is by removing excess fruiting wood via pruning. Detailed pruning, such as removing watersprouts and weak or short fruiting shoots, reduces the number of potential fruit that would likely be thinned off later due to their inferior location and likely smaller fruit size. Dormant removal of these flower buds also leaves more of the tree's reserves to go to the remaining buds for rapid cell division during phase I.

Pink Flower Bud and Open Blossom Thinning

Flower thinning from pink bud through early post-bloom effectively increases fruit size and can be done by mechanical, chemical, or hand means. Mechanical thinning, with either high pressure streams of water or six-foot long, two-inch thick ropes, four inches apart, suspended like a curtain from rotating arms attached and operated from a tractor, has performed inconsistently and been met with little commercial acceptance in southeastern peaches. Rope thinning is significantly influenced by tree form and bark cambial activity. Rope curtains have been effective where orchards are pruned to allow the ropes to freely rotate within the zones of fruiting wood. Rope thinning also tends to over-thin in some zones of the tree canopy and under-thin in others. Where rope thinning works, adjustments to the number of passes and the height of the rotating rope curtain are often necessary. Thinning with water requires ample water and has been inconsistent in the Southeast where bark damage on fruiting wood can occur.

Bloom-applied chemicals have been observed to impede pollination and fertilization. A number of caustic chemicals, herbicides, and surfactants have been examined as bloom thinners. Ammonium thiosulfate (ATS), a liquid fertilizer, has been widely researched as a means of "burning" or desiccating reproductive parts of the flower to reduce flower numbers and fruit set. However, no label to thin peach flowers exists for ATS. ATS's inconsistent performance likely accounts for company disinterest in pursuit of a peach-thinning label.

Sulfcarbamide, a caustic chemical labeled for use as a thinner, has performed erratically and requires close attention to the handling and application procedures listed on the label. Experimentally, many surfactants have been tested for thinning properties. One presently under investigation is a dodecyl ether of polyethylene glycol. It has shown promise in thinning flowers in southeastern orchard trials but is not labeled.

If new chemicals and surfactants receive labels for thinning, it should be kept in mind that effectiveness of airblast applications of any potential thinning agent is expected to vary with the amount of water applied, air temperature, humidity, surfactants, stage of flower/fruit development, orchard training system, or other factors.

As chemical thinning options expand in peach, it will be important to keep detailed records of floral development, tree vigor, weather, and other environmental factors. Thinning by non-manual methods should be viewed as part art, part science – a skill learned with considerable trial and error.

Hand thinning at bloom is very effective. Workers use toilet bowl brushes and other innovative tools to remove flowers at bloom time. Manual blossom thinning gives the best results, but is more expensive and probably should be restricted to high value cultivars or ones that have genetically low to medium fruit size potential.

Fruitlet Thinning

Plant hormone sprays have been very effective for apple thinning and have been examined for use with peaches. Ethephon (ethylene), naphthaleneacetic acid (NAA) salts, and similar hormone formulations applied during early fruit development cause weaker fruitlets to abscise. However, results with peaches have been inconsistent compared to apples and, thus, these hormones are no longer used for peach thinning. In similar fashion, inconsistent performance has plagued experimental application of low rates of foliar-applied herbicides to temporarily inhibit photosynthesis and promote fruitlet drop within 40 days AFB. Over-thinning and leaf necrosis may occur; labels to permit use of herbicides as thinners have not been pursued.

Mechanical and manual removal of immature fruit starting at approximately 40 days AFB when fruit are approaching the size of a hen's egg are the most common practices currently used in the Southeast. Tree shakers will reduce the crop load, but shakers may remove more of the larger fruit and shakers often damage the trunk. Shakers are erratic because of the wide variation of shaking intensity, limb stiffness, and tree structure. Damage to trees or limbs can be prohibitive. Adjusting a tree shaker's oscillation frequency can sometimes lessen these unwanted effects.

Manual fruit removal is often done by hitting unwanted fruit with children's plastic bats, rubber hoses, or just by hand picking. Hand thinning is generally superior to plastic bat, rubber hose, or mechanical shaking methods because better spacing and removal of smaller fruit sizes can be done. All of these methods are very effective but labor intensive.

FRUIT VERSUS FLOWER THINNING

Bloom thinning peaches can result in a 10 to 30 percent increase in fruit size and yield when compared to hand thinning 40 to 50 days after bloom. The magnitude of the effect on the following year's crop has not been closely studied, but some increase in yield and size may be expected in the following year. Cultivars that (1) naturally produce smaller fruit, (2) produce more flower buds per tree, or (3) ripen early in the season usually have a greater economic benefit from pre-bloom and bloom thinning.

Costs of bloom thinning, by hand or other means, plus follow-up hand thinning of fruit should be compared to costs of careful hand thinning one time 40 to 50 days AFB. The crop value of early thinned trees may increase from one to three times due to increases in fruit size, yield, and price of fruit. Although it is unrealistic to expect all fruit to reach the optimal market size and yield when thinned early, the increased crop value from timely and thorough thinning should be significantly larger than the thinning costs.

Combining Thinning Practices

To achieve adequate and timely thinning of the peach crop, one pragmatic option is to thin a percentage of the flowers on each shoot early (pre-bloom or bloom), but leave the late blooming basal shoot flowers as insurance against late freezes. After the risk of frost is gone, manual thinning by bats, hoses, or hand can be used to further reduce and space the crop to the desired fruit number and distribution. Incorporating early thinning as part of a thinning strategy increases the size potential of the fruit and reduces labor costs later without necessarily increasing crop loss from freezes.

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5.4 GIRDLING

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Girdling is a selective wounding process that removes strips of bark and the underlying cambial tissue from the trunk or scaffold branches to promote larger fruit size and earlier maturity. As a wounding process, girdling is not without risks. For optimum results with the least detrimental effect, girdling must be done correctly.

Girdling has been practiced on fruit trees for centuries to increase fruit size. In an optimal circumstance, girdling can: (1) increase fruit size (sometimes yield); (2) promote earliness of harvest (usually advancing harvest by three to five days); (3) result in fewer pickings (from four to three, or three to two); (4) increase the percentage crop harvested during the first picking; and (5) increase red skin color (enhanced marketability).

USING THE PRACTICE

Girdling is achieved with a specially designed girdling knife (Figure 5.4.1). Scoring, a related cultural practice, involves cutting, severing of bark and underlying vascular tissue (to the wood) with a knife, but scoring does not remove bark tissue. Large-bladed knives of several types are satisfactory for scoring.

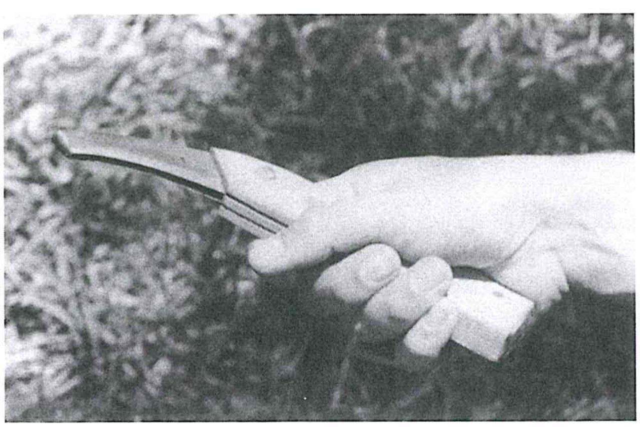

FIGURE 5.4.1. Girdling knife.

Growers who wish to evaluate girdling in their orchards should:

1. **Girdle only early season peach varieties** (generally those ripening 40 or more days ahead of Elberta), which includes varieties ripening as late as the Redcap-Maygold-Surecrop season. Girdling will work on later maturing varieties but generally is not needed. It is best not to girdle varieties that have a pronounced split pit problem such as Junegold because this practice may increase the problem.

2. **Only girdle trees that are in their fourth leaf or older.** Younger trees may recover poorly.

3. **Girdle only vigorous, healthy trees.** Avoid girdling trees that appear weak or are under stress of any kind, which includes trees with gummosis or severe insect damage.

4. **Only girdle trees that have full fruit crops.** Girdling trees that have reduced crops due to over-thinning, frost damage, or hail is not advisable. Girdling of such trees may cause an increased problem with split pits.

5. **Girdling knives are available in varying widths of cut: 1/8 inch, 3/16 inch, and 1/4 inch.** One-eighth inch knives are recommended for scaffold girdling, while the 3/16-inch knives are suggested for trunk girdling.

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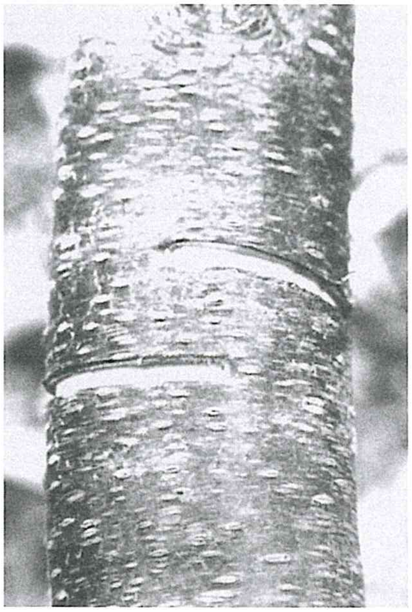


FIGURE 5.4.2. "S" girdle cut.

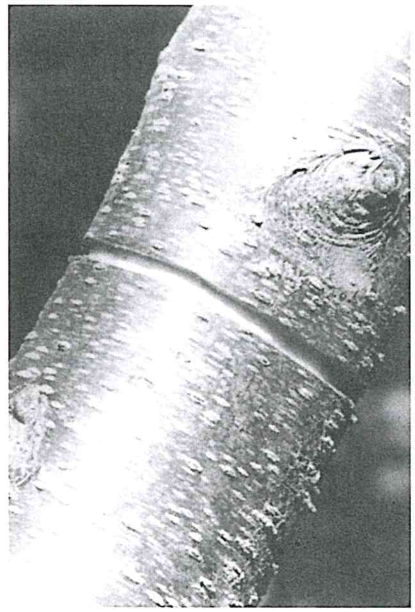


FIGURE 5.4.3. Complete girdle cut.

6. **Girdling of scaffold branches is preferred over trunks.** Girdle the lower portions of the primary scaffold branches. Girdle branches only 1-1/2 inches in diameter or larger.

7. **In blocks where machine thinning is practiced, DO NOT trunk girdle.** Limb girdling is recommended on such trees.

8. **Do not make fresh girdle cuts over old girdle cuts.**

9. **There are two types of girdle cuts: the "S" girdle and the complete girdle.** "S" girdles start cuts at one point on the branch and end cuts one to two inches above or below the starting point (Figure 5.4.2). There should be a slight overlap with the "S" cut.

   Complete girdles begin and end cuts at the same point (Figure 5.4.3).

   "S" girdle cuts are less severe than complete girdle cuts and offer a higher degree of safety and recovery for the tree. However, the "S" girdle does have the disadvantage of using too much of the branch (or trunk) area for future girdling. Because girdling should not be done in the same place where a previous cut was made, many growers prefer the complete girdle in order to conserve branch (or trunk) area for future girdling.

10. **Extreme care should be taken so that only the prescribed strip of bark is removed.** Cuts should be made to the wood, no deeper. Deeper cutting should be avoided, as damage to the xylem (wood) may result in death of the branch involved. Conversely, if the entire bark strip is not removed all the way to the cambium, the girdling effect on the fruit will not be as dramatic as expected.

11. **Proper timing optimizes girdling responses.** Girdling should be done four to six weeks before normal harvest time. Seven to 10 days ahead of complete pit hardening is ideal. However, very early varieties, such as Springold and Camden, should be girdled four weeks before normal harvest.

12. **Ideally, trees should be thinned and then girdled several days later (allow at least four to five days between thinning and girdling).** However, if it becomes necessary, trees may be girdled first, followed by fruit thinning a few days later. Do not thin fruit and girdle at the same time. This action could cause an undesirable increase in the number of fruits with split pits.

13. **Girdling wounds are sometimes infested by the lesser peachtree borer.** Once harvest is completed, a borer spray should be applied to lower portions of branches and trunk.

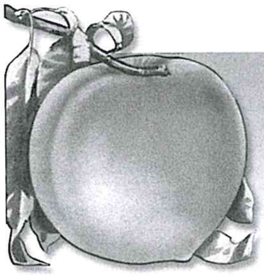
14. **Trees under drought stress will fail to size their fruit adequately even if girdled.** Irrigation (or rainfall) is essential in realizing the maximum effect from girdling.

15. **Girdling places trees under considerable stress while they are maturing their crop.** Therefore, it is recommended that mature, bearing trees receive at least 60 to 80 pounds of nitrogen per acre (such as 600 to 800 pounds of 10-0-10 fertilizer) during late January-February. Following harvest, girdled trees may need an additional 20 to 40 pounds of nitrogen per acre. The above fertilizer rates may be adjusted upward or downward based on previous fertilization experience, tree size, crop load, and soil type involved.

Accelerated ripening will occur in girdled orchards. Growers should pay special attention to timing of the initial harvest. The bulk of the fruit will be harvested from girdled trees in the first two pickings. Usually all fruits will be harvested within a five- to seven-day period or less (from first to last picking). On girdled trees, good thinning further shortens the harvest period.

Growers are encouraged to experiment before they girdle on a large scale. Experience gained from girdling several trees of suitable early varieties over a two- or three-year period will be invaluable in helping growers decide on the utility of girdling in their orchards.

Done correctly, girdling can be of great benefit. However, because girdling induces an additional stress on the tree, it can result in death of the tree. Therefore, learn how to girdle properly.



5.5 IRRIGATION FOR PEACHES

5.5.1 Irrigation Systems for Peaches

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Irrigation improves fruit size and yield, while reducing year-to-year variation in the production of southeastern peaches. Irrigation is a major investment; systems should be carefully planned and designed. Consult with growers who have experience irrigating orchard crops, with university personnel, and with several irrigation vendors. This process usually requires many months of preparation. Therefore, planning and installation schedules should begin early enough to assure systems will be operational for the coming season. Purchase irrigation equipment from a respected dealer or distributor who carries a good supply of repair and replacement parts.

Irrigation systems for peach fall into one of several categories. Over-tree systems may be center pivots; traveling guns, either cable or hose tow; or solid set. Under-tree systems are either microsprinkler or drip. Flood or furrow irrigation systems that use gravity to distribute surface water to precision-graded orchards are rarely used in the Southeast. One irrigation system may fit a given orchard or use better than another. An overview of irrigation system options for southeastern peaches follows.

OVER-TREE IRRIGATION SYSTEMS

Center pivots are self-propelled irrigation systems that rotate around a central pivot point, hence the name center pivot. Rotation time varies with system size, pump or well capacity, and the amount of water that is to be applied. A larger system generally requires more time to make a revolution than a smaller system. Orchard pivots are tall units (up to 18 feet) specifically designed to pass over the trees.

Pivot sprinklers take water from the pivot mainline and distribute it in droplet form uniformly over an area. A range of sprinkler options is available; sprinklers with a low run-off and erosion potential require higher pressures and are more expensive to operate. Pivot systems apply a certain depth of water (inches) over the entire irrigated area. Soil erosion potential must be considered when selecting pivot nozzles. If the application rate is greater than the soil's intake rate, run-off and possibly erosion will occur. To cover large areas and reduce erosion potential, sprinklers must throw water a considerable distance, which requires high operating pressure and considerable energy in the form of pump horsepower.

Low-pressure sprinklers operate at less than 30 PSI. Commonly called spray nozzles, they deliver water in either 180-degree or 360-degree patterns. They operate upright or upside down on extension pipes or drops. Low-pressure sprinklers usually have the lowest energy (horsepower) requirements. They wet small areas with a high application rate. Low-pressure sprinklers should be used only on sites with coarse (sandy, sandy loam, loamy sand) soils that provide excellent water infiltration. Sites should be relatively flat (slopes not greater than four to five percent) to minimize run-off.

Intermediate-pressure sprinklers (low-pressure, low-angle impact sprinklers) operate at pressures of 30 to 65 PSI. Energy requirements and operating pressures are moderate. Intermediate-pressure sprinklers are widely used on soil textures and fields that are too erodible for low-pressure sprinklers.

High-pressure sprinklers are high-energy components that operate at pressures greater than 65 PSI. On center-pivot systems, their use is limited to the finer textured (clay) soils and fields that have slopes exceeding 10 to 15 percent.

Irrigation manufacturers typically offer computer programs to custom fit the site with a system and sprinkler package, and cost of operation estimates. With most center-pivot installations, the cost of operation will be the major expense associated with the system.

Traveling gun irrigation systems feature a single large, high pressure (~80 PSI) sprinkler that pulls itself through the orchard. **Cable-tow travelers** have a large gun (sprinkler) mounted on a two-, three-, or four-wheel chassis. One end of the hose is attached to this chassis and the other end to a riser in the field. Cable-tow travelers propel themselves through the field by winding a steel cable around a drum or pulley on the machine. An auxiliary engine, water motor, water piston, or water turbine can supply the power to propel the power unit. Hoses come in sizes from two and one-half to six inches in diameter. Hose lengths vary from around 300 to 1,200 feet, with the shorter hoses usually having the largest diameters. The hose is stored by winding it onto a reel on the machine. The multi-strand, high-strength cables must be attached to an immovable object for operation, usually a tractor or "deadman" at the far end of the row. Use of a tractor for the static chore of anchoring a cable-tow system can be a major disadvantage. Cable-tow systems water approximately an acre of orchard per hour.

Hose-pull travelers have a large trailer-mounted hose reel, which is stationary at the end of the field. Water is pumped through the hose to an over-tree, gun-type sprinkler on a cart. The sprinkler cart is pulled along by the hose. The trailer-mounted hose reel winds itself up while irrigation water is being applied. The hose reel is driven by a turbine, a "bellows" water piston, or an auxiliary engine. The hoses are hard, usually polyethylene, from two to five inches in diameter and from 600 to 1,200 feet in length. Hose-pull travelers use large, top-heavy hose reels, some having a height of 12 feet. Transport speeds should not exceed three miles per hour under the best field conditions.

The following comparisons can be made of the cable-tow traveler and hose-pull travelers:

(1) Cable-tow travelers take longer to move because the hose must be reeled in and the cable unwound.
(2) Hose-pull travelers require more pressure to operate at comparable gallonages and hose lengths.
(3) Uniform speed throughout the run may be more difficult to obtain with the hose-pull traveler. Speed compensation options are sometimes available.
(4) Hose-pull travelers are easier to use on short runs, because only the amount of hose that is needed must be wound off the reel, whereas all of the hose of the cable-tow machine must be wound off the reel and the hose stretched out to allow free flow of water.
(5) Cable-tow travelers require an anchor, such as a tree, tractor, or deadman, to which the cable is attached.
(6) Hose-pull machines are pulled in a relatively straight line. On the cable-tow machine, the hose is pulled in a loop, which can make orchard operation more tedious.
(7) Connecting or disconnecting the hose to the supply line is faster with hose-pull units.

Solid-set irrigation systems consist of permanent, above-ground sprinkler risers connected by aluminum or PVC pipe. Solid-set orchard irrigation systems are typically engineered to provide frost/freeze protection, as well as irrigation. Frost/freeze protection requirements are considerably more stringent than irrigation requirements. Frost/freeze protection irrigation must be applied to the entire area continuously until temperatures rise above critical levels following the cold event.

The sprinkler spacing for solid-set irrigation is critical for uniform delivery of water. Solid-set systems are quite energy intensive and they can require very high volumes of water. Solid-set systems are normally used on small acreages and/or crops that have a high cash value. The labor requirements for a solid-set system are usually low (unless a portable pipe system is used).

UNDER-TREE IRRIGATION SYSTEMS

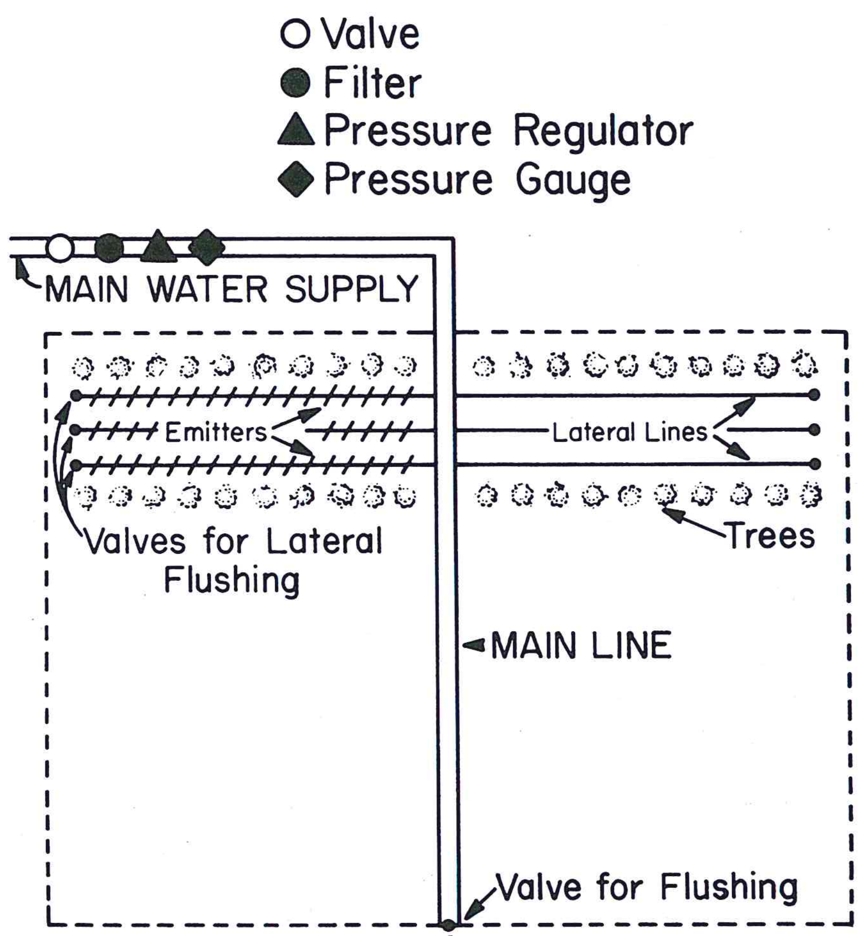
Under-tree irrigation systems, either microsprinkler or drip, distribute water directly to the soil in the root zone of the tree. Under-tree systems provide needed irrigation without the increased disease pressure that often comes with wetting of foliage and fruit. In peaches, under-tree sprinkler systems use microsprinklers; drip systems use emitters. The pumping plant and water source are critical components of under-tree systems.

Microsprinkler irrigation is the system of choice for most southeastern peach production sites. Small, under-tree sprinklers strategically target large portions of each tree's root zone. In peaches, microsprinklers normally apply 8 to 14 gallons per hour, providing some four to seven times greater gallons per hour (GPH) than is applied by drip irrigation. This allows for less frequent applications and longer drying periods between applications, which can offer advantages to long-term tree health. Microsprinklers can also be modified to provide as needed above-tree frost/freeze protection. Dual-purpose systems that provide irrigation and frost/freeze protection must have considerably more capacity than those being used to just supplement natural rainfall.

Drip irrigation systems make frequent, slow applications of water to the soil through emitters (drippers or applicators) located along the water delivery line (Figure 5.5.1.1). To meet the tree's moisture requirement, drip systems frequently must be run for long periods of time. Unfortunately, this allows limited opportunity for soil to dry between waterings, which can be detrimental to long-term tree health. The percent of the root system covered by drip irrigation depends on the number of emitters per tree.

Drip irrigation eliminates spraying and supplies filtered water under low pressure directly onto or into the soil. Water is carried through a pipe network to each tree. Emitters dissipate pressure, thereby discharging at low volumes of water per hour. Water is distributed by its normal movement through the soil profile, primarily downward. The area wetted from each emitter is small, being limited by the water's modest horizontal movement in the soil and may vary among soil types.

FIGURE 5.5.1.1 Schematic layout for drip irrigation.



COMPONENTS COMMON TO MICROSPRINKLER AND DRIP SYSTEMS

Lateral lines are small, 3/8- to 3/4-inch diameter, polyethylene (PE) material placed one or two per tree row. Lateral lines may be buried prior to planting or run on the surface of the soil.

Main lines are large PVC pipes that carry water to the lateral lines from the pump. Because PVC is rigid, it must be installed deep enough to withstand heavy surface loads such as sprayers. It should also be below the frost-line so that the stress of freezing and thawing water will not burst the pipe. The frost-line in much of the Southeast is shallower than the depth required for withstanding heavy surface loads. Main lines are usually placed deeper than the lateral lines.

Control valves of several types are used in drip and microsprinkler systems. Pressure regulator valves (either brass or plastic) are often required to regulate and maintain the system near the design pressure. On/Off valves control the flow of water from one zone to another. Clean-out valves at the ends of PVC lines are used to flush out sediment.

Screens and filters are imperative in drip and microsprinkler systems, as sand, algae, and other contaminants can plug lines and emitters. Drip systems require exceptionally clean water. Screens and filters are generally used in a sequential, complementary fashion.

Screens, which are the simplest filters, efficiently remove very fine sand from the irrigation water but will rapidly become clogged by algae and other organic material. They should be cleaned whenever the pressure drops more than 7 to 10 PSI. Regardless of the cleaning method you use, extreme caution must be taken to prevent dirt from bypassing the screen during cleaning. Cleaning options include: (1) manually removing the screen and washing; (2) repeatedly washing (blowing-off) the screen without dismantling; and (3) automatic cleaning on a time schedule or whenever the pressure loss reaches a certain level.

Media filters consist of fine gravel and sand particles of selected sizes placed inside a cylindrical tank. Media filters remove heavy loads of very fine sand and organic material. They can be automatically backwashed as needed. Media filters are almost always recommended when surface water, such as from a pond or stream, is used for drip irrigation. A screen should be placed downstream from the media filter to pick up particles that escape during backwashing.

Vortex (centrifugal) sand separators remove up to 98 percent of the sand particles that would be retained by a 200-mesh screen. They depend on centrifugal force to remove and eject high-density particles from the water. Vortex separators do not remove organic materials. They are typically used to eject large quantities of very fine sand before further screening.

Settling ponds or reservoirs serve to remove extra-large volumes of sand and silt. However, algae growth and windblown contaminants cause other filtration problems. Avoid open water areas if possible.

Maintenance. Filters and screens must be kept clean to function properly. Cleaning schedules vary with system, but must be adhered to. The clamp or valve at the end of each lateral line should be released to flush out accumulated sediment monthly.

WATER SOURCES

Surface water and groundwater are used for irrigation. System design should carefully assess water sources, because irrigation water is needed most when supplies are lowest.

Surface water is available from ponds and streams (rivers). Irrigation from streams is less common because they are seldom located near orchards. "Riparian rights" may govern the use of the stream water. This doctrine gives property owners adjacent to a stream reasonable use of that stream, but irrigation may not appreciably diminish the flow of water. Volume requirements for irrigation often exceed flow rates of streams during periods of drought.

Ponds are often used for irrigation. Recharge rate and pond size are key considerations. The general rule is one acre-foot of water storage for each acre of land to be irrigated. Thus, a 10-acre pond with an average depth of 10 feet would be needed to irrigate 100 acres. This example assumes no recharge to the pond.

Groundwater is an important resource for irrigation. Depending on the location and well type and size, capacities up to 3,000 gallons per minute are possible. In the Southeast's coastal plain, groundwater is generally available in large quantities. In piedmont and mountain areas, groundwater is often less available.

Wells are expensive. There are generally two purchase options. Lump sum contracts guarantee a certain quantity of water for a fixed cost. The driller takes all the risk. Unit price contracts are less expensive because the purchaser pays for the capacity provided. However, it is imperative to know the driller's performance record and reputation. Although it is an extra cost, well testing is advised to determine well capacity, pumping depth, and the correct size of pump to install. An inefficient pump or one that is too large can add greatly to the cost of the system. The horsepower required to operate the unit can be reduced if a high-efficiency pump is used.

The following are some ways to save money when constructing a well:

(1) Have the work done in the off season; avoid rush jobs.
(2) Provide a road to the site, water for drilling, and mud pits.
(3) Contract only for the quantity of water needed. A 1,000 gallon per minute (GPM) well is of questionable merit when only 500 GPM is required.
(4) If possible, have several neighbors drill wells at one time. This will reduce the travel time for the driller.
(5) Do not ask for a guarantee of quality. This is expensive insurance.
(6) Contract with a reputable driller.

Once the well is completed and before the irrigation season starts, check out the pump and power unit. A well without an operational pump is of little value. Work closely with your irrigation dealer and well driller to make sure these specifications are met so that the system will operate properly.

IRRIGATION PLANNING SUMMARY

To adequately plan and design an irrigation system, certain basic information is needed. The basic steps include evaluation of the following:

1. Field Information

This is best determined by a visual inspection of the area along with a map showing field boundaries, water sources, natural or man-made obstructions, and relative elevation points.

After evaluation of this basic field information, the most desirable irrigation system may be selected.

2. Soil and Water Data

Include:

a. Soil profile and texture classification,
b. Soil depth,
c. Water intake rate, and
d. Soil water holding capacity or available soil moisture.

3. Plant Data

Include:

a. The type of cropping system,
b. Crop rotation plans, and
c. Peak rate of water use by crops.

The peak water use usually occurs during the maximum growth-foliage cover period, particularly during hot, dry periods. This peak water use rate or design moisture withdrawal rate is used to determine the irrigation frequency and maximum water requirements of the irrigation system. Peak water use rates vary for different crops but usually range between .25- and .30-inch per day for peaches.

4. Water Availability/Legal Concerns

The water source must be evaluated to determine if adequate water is available to meet the requirements of the irrigation system. Large water withdrawals in some states are regulated. A water use permit must be obtained from the regulatory agency before pumping can begin. Check with local sources (county agent, NRCS, etc.) to determine what is required in your state.

5

5. System Design

After determining the basic information described in 1 through 4, the system may be selected and designed. Water and horsepower requirements can be determined using the following formulas:

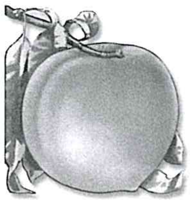
$$Q = \frac{453 \times A \times D}{F \times H}$$

where: Q = flowrate in gallons per minute
A = area to be irrigated in acres
D = depth of water applied in inches (usually peak water demand)
F = frequency of depth applied in days
H = hours per day that system can operate

Once the water requirements have been determined, the horsepower (HP) needed to pump the water can be calculated from the following equation:

$$HP = \frac{Q \times H_{ft}}{3960 \times P_{eff}}$$

where: HP = Continuous horsepower needed
H_{ft} = Total dynamic head in feet
P_{eff} = Pump efficiency in decimal form



5.5.2 Irrigation Scheduling

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In the southeastern United States, peach yields and tree growth respond very favorably to irrigation. Daniell in 1982 and Chesness and Couvillon in 1989 showed yield increases of 29% to 54% with drip irrigation of peach in Georgia, while year-to-year yield variation decreased by up to 35% using irrigation rates of 6 to 11 inches per season. Numerous other peach irrigation studies have shown similar results.

Irrigation scheduling is an important aspect of peach orchard management and attempts to answer two management questions—when to irrigate and how much to apply. In peach, optimal productivity is experienced with rain or irrigation at intervals of no longer than one week. During peak water use periods, individual peach trees consume 36-45 gallons per tree per day. On a weekly basis, this is 252-315 gallons per tree; at a tree spacing of 16 ft. x 20 ft. (136 trees/acre) this comes to 34,272 to 42,840 gallons of water per acre of orchard. One acre-inch of water equals approximately 27,000 gallons. Therefore, actual water consumption for one acre of peach trees during peak water usage is between 1.3 and 1.6 acre-inches of water per week.

Assessing Moisture Needs

Optimal use of irrigation enhances yield and tree performance by closely approximating tree needs without overwatering. The objective is to apply just enough water to provide for optimal yield and tree health. It is important to know how droughty soils become before trees experience stress. Irrigation scheduling relies on measuring the soil water status and/or the tree's moisture utilization and needs. Table 5-5-2-1 lists instruments and techniques used to assess these parameters, along with the pros and cons of each.

Soil moisture measurements estimate how much water trees have available to them. Variables such as soil type, slope, vegetation on the orchard floor, variety, tree age, and crop load make it complicated, even problematic, to rely solely on soil moisture status to schedule irrigation. Multiple instruments in representative sites within each block are needed. Instruments must be read frequently and records kept to facilitate efficient irrigation.

Direct measurement of tree water status is the conceptual alternative to measuring soil water status to schedule irrigation. Evaluating plant moisture utilization is also fraught with complexity. **Stem water potential** directly measures the water tension in the tree and gives an index of tree stress. As with soil water status measurements, stem water potential thresholds must be established and a number of trees must be sampled to obtain a meaningful average. **Crop water stress indexes (CWSI)** use infrared thermometry to measure leaf temperature; stressed leaves will be warmer than non-stressed leaves due to insufficient transpirational cooling. Repeated sampling of representative trees is necessary, and thresholds may change with weather conditions.

Crop moisture utilization models, initially developed in the 1990s, offer the promise of simplified irrigation scheduling and more effective water use. Moisture utilization models rely on weather monitoring and crop-specific potential evapotranspiration (PET) coefficients. PET estimates daily water utilization relative to a base or reference crop. Naturally, the actual water utilization for a peach orchard differs from the well-studied reference crop, but the southeastern peach PET crop coefficient customizes peach's moisture

TABLE 5-5-2-1. Orchard irrigation scheduling methods and their characteristics.

Method	Principle	Advantages	Disadvantages
Tensiometer	measures soil water tension directly	rapid, easy to use; inexpensive	sensitive to placement; requires frequent servicing; limited measurement range
TDR (time domain reflectometry)	estimates soil water from dielectric potential	accurate; requires no calibration	sensitive to placement; expensive
Porous blocks (gypsum)	estimates soil water from electrical resistance	rapid, easy to use; inexpensive	sensitive to placement; insensitive in critical range; requires calibration
Neutron probe	estimates soil water from neutron absorption	accurate	sensitive to placement; expensive; requires calibration; radioactivity
Stem water potential	measures plant water potential directly	plant-based index; accurate; relatively simple	moderately expensive; time consuming
CWSI (crop water stress index)	measures leaf temperature; index of transpiration rate	plant-based index; rapid, easy to use	extensive calibration; moderately expensive; sensitive to placement, time of day, weather
Weather station-derived estimates of water use	calculates potential evapotranspiration (PET) from weather data	accurate, validated, proven method; requires no field measurements; internet-based; amenable to large acreage	requires crop coefficient

utilization relative to the reference species. The PET value is multiplied by the peach coefficient to estimate actual in-orchard water consumption. Actual water loss is what must be replaced through irrigation. Crop moisture utilization models have been validated for crops worldwide. For example, the California Avocado Growers Association has developed a website that calculates irrigation requirement based on a statewide weather monitoring network and a few simple inputs (http://www.avocado.org/static/growerres/cimiscalculator.php). In the avocado, the crop coefficient is 0.65. This means that a mature avocado orchard uses about 65% of daily water consumption in the reference crop. Accordingly, a PET of 0.22 inches per day in the reference crop indicates actual water lost in avocado would be 0.65 x 0.22 = 0.14 inches.

Southeastern Peach PET Moisture Utilization Model. A basic moisture utilization model has been developed for southeastern peaches. The interim scheduling model is available under "Irrigation" on the Georgia Peach website at http://www.griffin.peachnet.edu/caes/gapeach/. The University of Georgia's Automated Environmental Monitoring Network, a statewide weather-monitoring network accessible through its College of Agricultural and Environmental Sciences website, continuously records temperatures, rainfall, and potential PET for multiple sites in Georgia and adjacent states. It provides peach growers with the data necessary for irrigation scheduling.

FIGURE 5.5.2.1. Tensiometer.

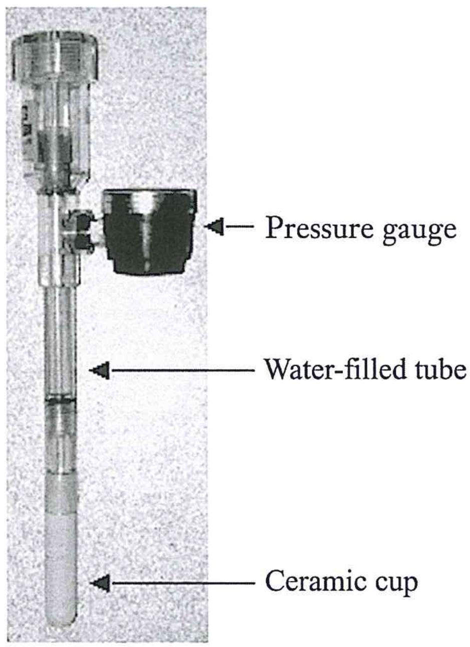
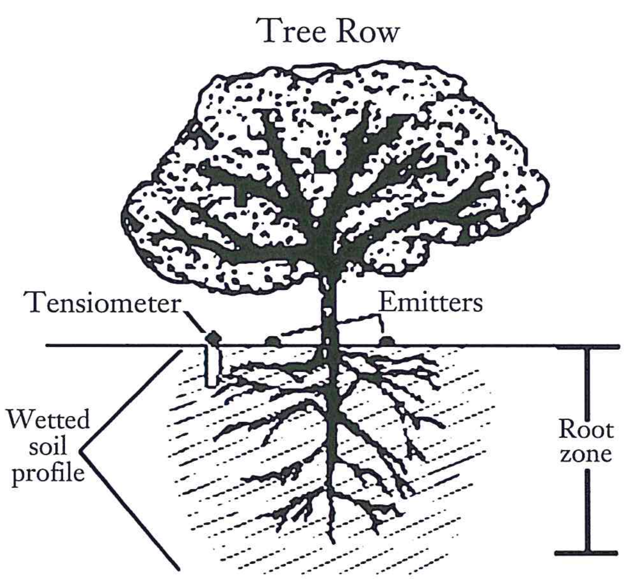


FIGURE 5.5.2.2. Tensiometer placement in the root zone.



Refinement of southeastern peach PET crop coefficients is ongoing, but the system provides reliable daily estimates of peach moisture utilization. Mature peaches have a standard range of crop coefficient values (0.4 to 1.0). These coefficients are multiplied times the reference crop's daily PET. Peach's crop coefficient varies with time of year and other factors. Base peach coefficients are reduced 10% to 35% when tree canopies cover less than 70% of the orchard surface, as with young trees that haven't filled their allotted space or in blocks with unusually wide spacing or high tree mortality. Coefficients are also reduced by 20% to 30% if the orchard floor is vegetation-free (cultivated or chemically mowed) versus a typical sod middle/herbicide strip system. Rieger and Taylor are researching crop coefficients to better guide irrigation of Georgia peach orchards.

In-Orchard Validation. Peach irrigation scheduling based on the region's PET moisture utilization model offers simplicity, accuracy, flexibility, and low cost. However, periodic "ground truth" determination of in-orchard soil moisture conditions remains important. Tensiometers and theta probes are the most practical instruments for cross-checking orchard irrigation efficiency by measurement of soil moisture. Pressure bombs provide direct assessment of tree status. When properly used, each of these instruments is a complementary tool to check and refine scheduling of orchard irrigation.

Tensiometers are sealed, water-filled tubes with porous ceramic tips at the lower end and a vacuum gauge on the upper end (Figure 5.5.2.1). In peaches, two tensiometers should be installed with the ceramic tips placed in the root zone at depths of 8 and 12 inches (Figure 5.5.2.2). As the soil dries, water is drawn through the ceramic tip out of the tensiometer, creating a partial vacuum that is registered on the gauge in centibars (bars). The drier the soil, the greater the vacuum and the higher the reading. When the soil receives moisture through rainfall or irrigation, the action is reversed. The vacuum inside the tube is reduced as water moves back into the instrument, reducing the gauge reading. Table 5-5-2-2 provides interpretive guides for tensiometer use in peaches.

TABLE 5-5-2-2. Soil moisture status with accompanying tensiometer ranges. Guidelines to interpret tensiometer gauge readings.

Soil Moisture Status	Tensiometer Reading
Nearly saturated soil. May occur 1-2 days following rain or irrigation. Roots may suffer for lack of oxygen if readings in this range persist longer.	0–10 centibars
Field capacity. Irrigations discontinued in this range to prevent waste of water by percolation and leaching of nutrients below the root zone.	10–20 centibars
Irrigation range. Early stress for peach trees at 40-50 centibars. Trees should be irrigated.	20–60 centibars
In this range, the vacuum column will be broken in coarse soils. The tensiometer may need maintenance to reestablish the vacuum in the tensiometer tube.	> 70 centibars

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Tree growth, yield, and fruit size are significantly increased when rain or supplemental irrigation keeps tensiometer readings (8-inch depth) below 50 centibars from April through harvest.

Preparation and service of tensiometers is very important. The ceramic tip should be in close contact with undisturbed soil and roots. Prepare the hole by driving a steel rod or pipe of the same diameter as the instrument tube to the desired depth. Carefully remove the rod and push the tensiometer to the bottom of the hole. Press the soil around the tensiometer at the surface and pile it slightly so water will not collect and seep down along the tube of the tensiometer. Another method for installing tensiometers with good results is to bore the hole with a soil auger (1-1/4 inches) to the desired depth. Next make a slurry in the bottom of the hole with screened soil, place the tensiometer, and backfill with screened soil, tamping the soil firmly around the tube with a 1/2-inch dowel.

Theta probes measure the dielectric potential across two probes in the soil relative to a reference probe (Figure 5.5.2.3). Dielectric potential is governed primarily by soil water content, and probes indicate the percent soil water on a volume basis. Although expensive, only a single unit is necessary compared to the purchase of at least two tensiometers per monitoring site. The unit probes three inches into root zone soil at depths of 8 to 12 inches. Readings are taken at representative locations in each block. Monitoring stations are constructed using PVC pipe placed into the root zone to depths of 8 and 12 inches. Soil within the pipes is excavated to these depths. The pipe remains capped until the probe is inserted three inches into the soil at each depth.

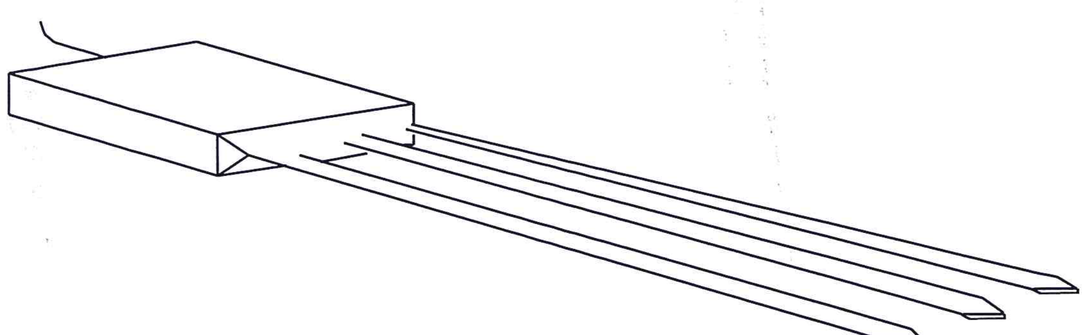

FIGURE 5.5.2.3. Dielectric potential probe.

Stem pressure potential is an assessment of evapotranspiration. Stem pressure potential is an accurate, direct measurement that has been validated in *Prunus*, providing peach irrigation threshold values. Aside from time and expense, it is difficult to sample enough representative trees for a given orchard. Tree age, crop load, bearing status, and health should be considered when selecting which trees to evaluate.

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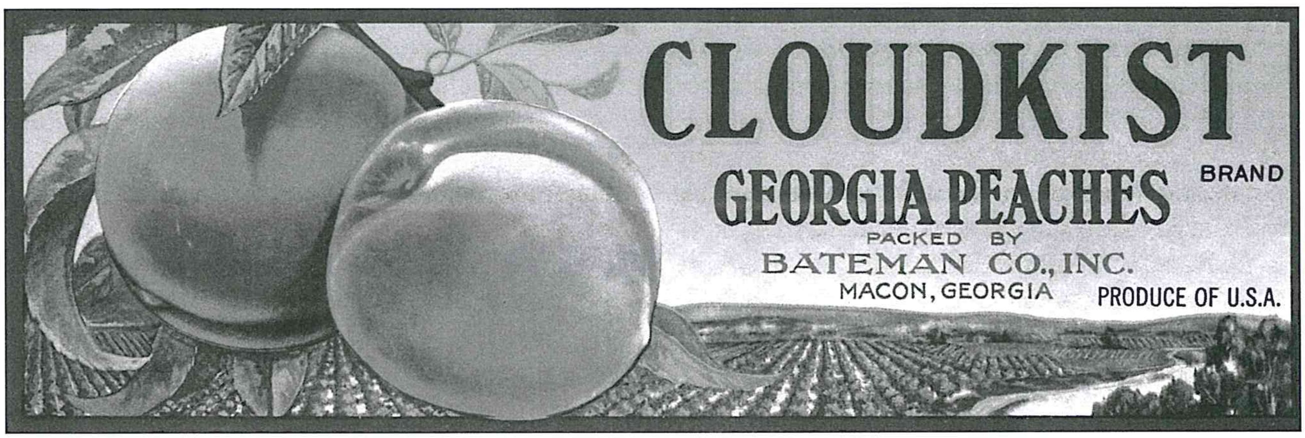
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