PEACH PRODUCTION EAST OF THE ROCKY MOUNTAINS

Agriculture Handbook No. 280

Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

PRECAUTIONS

Pesticides are poisonous to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Keep pesticides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and pets cannot reach them.

Avoid repeated or prolonged contact of pesticides with the skin. Avoid inhalation of pesticide dusts or mists.

Avoid spilling pesticides on your skin, and keep them out of the eyes, nose, and mouth. If any is spilled on skin or clothing, wash it off the skin and change clothing immediately.

When handling pesticides, wear clean, dry clothing.

Wash your hands and face before eating or smoking and immediately after completing pesticide application.

To protect fish and wildlife, do not contaminate lakes, streams, or ponds with pesticide. Do not clean spraying equipment or dump excess spray material near such water.

To minimize losses of honey bees and other pollinating insects, make pesticide applications, when possible, during hours when the insects are not visiting the plants. Avoid drift of pesticide sprays to nearby crops or livestock. Avoid drift of pesticides into bee yards.

Empty containers are particularly hazardous. Burn empty bags and cardboard containers in the open or bury them. Crush and bury bottles or cans.

Credit for preparation of the basic information in this handbook on culture of peaches and compilation of the initial draft of the handbook is due A. Leon Havis, formerly horticulturist, Crops Research Division, Agricultural Research Service. Dr. Havis died in 1962.

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PEACH PRODUCTION EAST OF THE ROCKY MOUNTAINS

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HISTORY OF THE PEACH

The peach (*Prunus persica* (L) Batsch) originated in China and was taken from there into Persia, Greece, Italy, and other temperate areas of Europe.

Probably the earliest introduction of peaches into the Western Hemisphere was by the Spaniards, who brought them to Mexico. In 1565, Spanish settlers brought peaches to St. Augustine, Fla. The early English and French settlers also brought peach seeds with them to the Eastern United States. Later, Indians planted peach seeds over a wide area.

Until about 1910, most peach varieties originated as chance seedlings. The first peaches grown in this country were probably white fleshed. They were later crossed with yellow-fleshed peaches brought from Mexico. All commercial varieties now grown in the United States originated in this country. The most important new varieties originated from controlled crosses made at State or Federal experiment stations or by private fruit breeders.

For 200 years after their introduction into the United States, seedling peaches were grown mostly for brandy, for fresh fruit for the home, or for hog feed. Almost every farm and plantation in the Middle Atlantic States had a peach orchard. No spraying was done, but the trees evidently produced well. By about 1800, several good varieties had been selected from seedlings and propagated by budding. By 1850, more than 400 varieties were listed by nurseries in this country.

From 1800 to 1850, commercial peach production expanded rapidly. Peaches were transported by rail, by boat, and by wagon to supply the demand for fresh peaches in the cities. Peach production mostly was for family use, although commercial orchards were being developed near Richmond, Norfolk, and Baltimore. Peach seedlings, as well as budded varieties for home use, were carried west by settlers during the 19th century.

Commercial shipment of peaches to terminal markets developed gradually from 1870 to 1900. Selection of the Elberta and Belle varieties and development of the refrigerated rail car were important in market expansion. Commercial peach growing increased in Virginia, Maryland, Delaware, New Jersey, and southeastern New York.

Throughout the 19th century, disease and insect problems multiplied as commercial peach production in America expanded. Peach yellows and brown rot diseases and insect borers became increasingly destructive. The yellows virus, which became serious in the Philadelphia area about 1800, caused greater loss of peach trees in Northeastern

[1] Crops Research Division.
[2] Market Quality Research Division.
[3] Entomology Research Division; now retired.

United States than did any other trouble. The most serious losses occurred between 1850 and 1900 in New Jersey, in Delaware, and on the Eastern Shore of Maryland. Thousands of trees and many large plantings were completely destroyed. Serious losses also occurred as far west as Ohio and Michigan, but the virus caused no damage to the developing peach areas in the Southeast. In 1892, the San Jose scale insect appeared in Virginia and quickly spread to other fruit areas. Spring frosts were a major hazard to the growing commercial peach industry. The appearance of San Jose scale in 1892 in Virginia and its rapid spread to other fruit areas led to the adoption of spraying as an orchard practice. A realization of the value of spraying for other insects and diseases soon developed.

Most of the early commercial orchards were clean cultivated. Pruning methods were variable and sometimes severe. Before the use of nitrogenous fertilizers in orchards, clean cultivating and heavy pruning were practiced in some locations to stimulate vigorous annual growth. Peach varieties selected between 1850 and 1900 that are still grown commercially include Elberta, Belle, and Champion, and, to a lesser extent, Carman and Hiley.

From 1900 to 1920, the peach industry in the United States expanded, especially in Georgia, South Carolina, Arkansas, Texas, and California. Production reached its peak economically in the United States during this period. Then fruit prices suddenly fell, and thousands of acres of peach trees were abandoned.

The economic recovery was slow and irregular, even for the most efficient growers and at the best cultural locations. World War II brought high peach prices, but it also brought shortages of labor, equipment, and supplies. In the postwar period, the high cost of labor, equipment, sprays, fertilizers, and land made profits uncertain in most areas. Although high production per acre of high-quality fruit over a long period of years has usually been profitable, such hazards as spring frost, winter injury, insects, diseases, and hail continued to plague fruit growers.

Since 1890, the number of peach trees in the United States has fluctuated but has generally declined (fig. 1). However, during the same period production has increased.

GEOGRAPHIC DISTRIBUTION OF PEACHES IN THE UNITED STATES

Commercial culture of peaches is more widespread in the United States than that of any other tree fruit, even though in many areas annual production is uncertain and variable. Peaches are produced commercially over a wide area that begins in New Jersey, extends into the South Atlantic States, and reaches into central Texas. Peach-producing sections within this area include parts of the Piedmont and the Coastal Plain. The Piedmont extends from south-central Georgia through the Carolinas and Virginia and into Maryland, and includes parts of the Coastal Plain in the Carolinas, Maryland's Eastern Shore, Delaware, and New Jersey. Many large plantings border the Great Lakes in western New York, northern Ohio, and southwestern Michigan.

In the Far West, climate and soil in the San Joaquin and Sacramento River Valleys of California are exceptionally favorable to commercial peach production. This fact has stimulated heavy planting. Peaches are also grown under irrigation in western Colorado, northern Utah, southern Idaho, and central Washington (fig. 2).

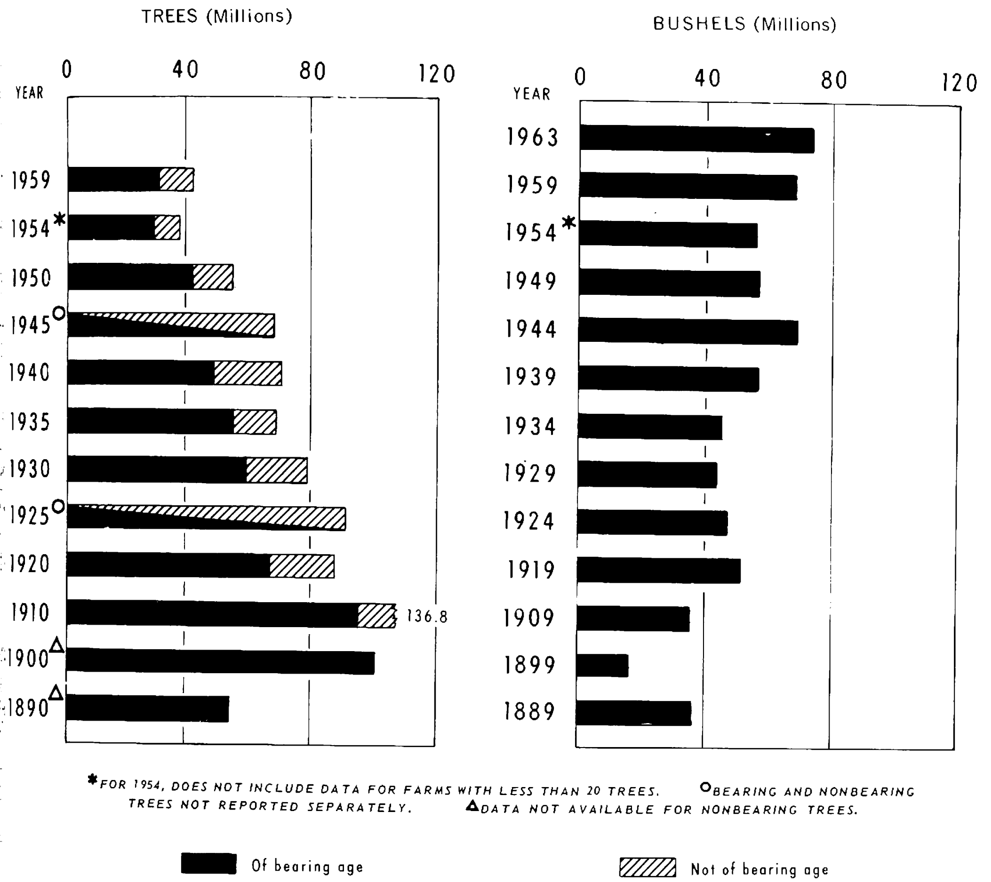

FIGURE 1.—Number of peach trees in the United States and annual production, 1889–1963.

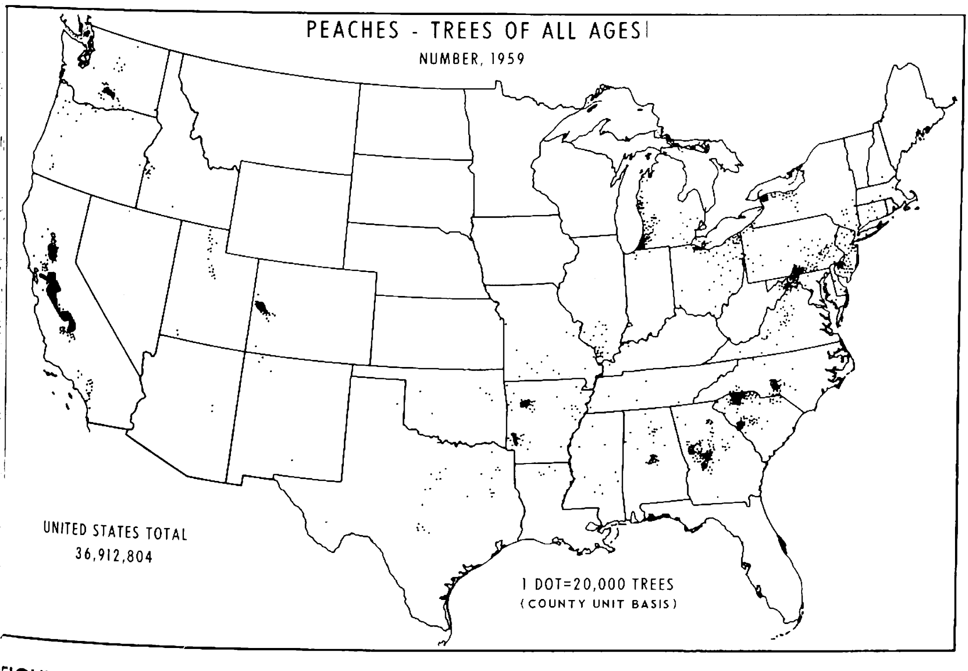

FIGURE 2.—Location of principal peach tree plantings in the United States in 1959. Greatest concentrations of plantings are in California, South Carolina, Georgia, and Michigan.

Large-scale peach production in a given locality may mean that peaches grow especially well there, or it may mean only that they grow better there than do other crops.

Some areas in this country are not suitable for peach growing. Many States in the North and several States in the Great Plains and the Rocky Mountain region have such cold winters that only the hardiest peach varieties survive, and even those varieties often fail to bear fruit. In extreme south Georgia, in Florida, and in the southern parts of the States bordering the Gulf of Mexico, none of the leading peach varieties produces well enough to be grown commercially because the winters are too warm. Although peach trees do not thrive where winter weather is severe, their buds do require some winter chilling. If a peach tree does not have enough chilling during the winter, its shoot growth and blossoming are delayed the next spring and, after particularly mild winters, fail to develop at all. Most leading peach varieties require chilling below 45° F. for 600 to 1,400 hours.

Flowerbuds of most varieties require slightly less chilling than do leafbuds. Flowerbuds of peaches are formed only in axils of leaves, and they vary from none to three. Usually at least one leafbud occurs in the axil of each leaf, and the terminal bud on the twig is always a leafbud. Leafbuds and flowerbuds are formed during the summer, develop slowly during the winter, and develop rapidly in warm weather after the required chilling time.

For the 10-year period 1951–60, annual peach production in the United States averaged 65,650,000 bushels. From 1944 to 1948, commercial peach production reached its highest average for a 5-year period—75,442,000 bushels. The 1959–63 crops also averaged more than 75 million bushels. Production from 1956 to 1963 averaged 72 million bushels annually. The States having the highest production and their approximate average yields, for this 8-year period were: California—40 million bushels (including 28 million clingstones and 12 million freestones); South Carolina—5 million bushels; Georgia—4 million bushels; Michigan—3 million bushels; Pennsylvania—2,700,000 bushels; New Jersey—2,300,000 bushels; Washington—1,750,000 bushels; Arkansas, Virginia, Colorado, and North Carolina—about 1,500,000 bushels each. Improved peach varieties and improved methods of canning, freezing, and transporting are increasing the potential consumption of high-quality peaches in the United States.

SELECTING ORCHARD SITES

In selecting a peach orchard site, not only the elevation, topography, and slope of the land but also the depth, moisture-holding capacity, and other physical features of the soil should be carefully considered. Satisfactory sites are found on both hilly and level land.

In the peach-producing areas of the South Atlantic and South Central States, few sites have winter temperatures low enough to injure dormant flowerbuds. But on many sites, fruit crops may be lost because of frost at blossoming time. In the New England, Middle Atlantic, and East Central States, peach orchard sites should be selected that offer protection from occasional spring frosts and from severe winter cold.

Orchards on sites having poor air drainage are most likely to suffer from winter cold and spring frost. On clear, cold, still nights, heat is lost from the earth by radiation. Warm air rises and is replaced by a layer of cold air near the ground. At higher levels, the corresponding layer of air is warmer. A difference of only a few feet in elevation may mean a difference of one to several degrees in temperature during the critical period of a frosty night. If air movement is slowed down by a ridge or by trees, cold air may accumulate behind them in pockets on the slopes. In most localities, therefore, the site for a peach orchard should be on land elevated above adjacent land and free of obstructions to air movement, so that cold air can settle to the lower levels. Gently sloping or level land may be satisfactory where the climate is mild or where a nearby body of water affords natural protection from cold.

An orchard on the leeward side of a large body of water is often protected from spring frost because the temperature of the water has a modifying effect that prevents sudden, severe drops in air temperature. Ochards planted near bodies of water are found on strips of land 10 to 15 miles wide along the eastern shore of Lake Michigan and the southern shore of Lake Ontario. Masses of cold air blowing over these lakes are warmed by the water. Also, air movement across the cold water in early spring tends to prevent sudden rises in air temperature that would cause peach blossoms to open too early and be injured later by low temperatures.

Although a peach orchard site usually should be at an elevation higher than that of the adjoining land, a hilltop location has a disadvantage if it exposes trees to cold, drying winds during winter. Peach trees planted on sites exposed to strong, prevailing winds not only may be damaged by cold but also may be permanently dislodged. This is especially true in young orchards where high winds accompany heavy rains that have softened the soil.

Before selecting his peach orchard site, an orchardist should determine the lowest winter and spring temperatures for that location. This he can do by placing, at different elevations on the site, thermometers that will automatically record minimum daily air temperature.

Peach trees grow well on a variety of soils, ranging from coarse sand or shale to fine-textured clay loams. Nevertheless, they will not grow so well on heavy soils as will apple and pear trees. Soils poorly drained or poorly aerated are not satisfactory for peach trees. During their growing season, peach trees are very likely to be injured if the orchard water table is temporarily raised by heavy rains or by accumulation of irrigation water. Where excess water does not pass through the soil quickly but accumulates and fills the pore spaces between soil particles, it shuts off the oxygen supply to the tree roots, which die. Tree injury caused by excess water is often indicated by yellowing of the foilage in early summer, especially where soil becomes saturated with water soon after peach trees start growing in the spring. Winter injury to peach trees in water-saturated soil, as well as trunk and root disease injury, is frequently severe and may result in early death of the trees. The best peach orchards are on well-drained sandy or gravelly loam soils.

Although the lighter soils (such as the coarse sands, gravels, and shales) usually have better aeration and drainage, they may not drain well if underlaid by impervious clay, hardpan, or rock. Too much water may accumulate near the root zone of the trees after heavy summer and fall rains. The low water-retention characteristic of lighter soils is not always an advantage in localities where summer droughts occur and irrigation is not practiced. For satisfactory growth and fruit production, peach trees require a water supply that is readily available.

An ideal soil for peaches is one

having about 8 feet of sandy loam underlaid by a clay loam capable of retaining and storing most of the rainfall.

Hillside sites, besides having good air drainage, often have satisfactory surface drainage of excess rainwater. On some hillsides the soil is only 3 or 4 feet deep. Trees will grow in shallow soil in the humid regions where the rainfall averages 4 or 5 inches a month during the growing season, or where the trees are irrigated. In regions where rainfall may be deficient for periods of from 4 to 6 weeks in the summer or where there is no irrigation, shallow coarse soils cannot store enough water to meet the needs of the trees.

Since selecting a peach site is so important, prospective growers should consult their local experiment station and extension specialists. In general, the following factors should be considered:

1. Spring frost protection on higher locations and from nearby lakes.
2. Protection from wind and low temperatures by planting on least exposed locations.
3. Soil-water drainage in deep loam soils.
4. Soil-moisture capacity desired for best fruit development.

SELECTING VARIETIES

Since 1940, many new peach varieties have been developed. In this handbook, only the leading commercial and certain outstanding, new special-purpose varieties are described (table 1). For specific varietal recommendations, consult your local experiment stations and cooperative extension personnel. Local environment and marketing outlets determine the varieties grown. For example, if peaches are grown for a nearby market, high-quality varieties that ripen in sequence during the season rather than varieties especially suited for shipping to distant markets should be grown. In many sections, the hardiness of flowerbuds is important in selecting a variety for a specific climate. Dependable annual production is necessary for successful peach growing.

Based on flesh texture, peach varieties are classified as either melting (such as Elberta), or nonmelting (such as Ambergem). Melting varieties are grown for dessert and for processing. Nonmelting varieties are grown almost entirely for processing. Most early-ripening varieties with melting flesh such as Dixired are freestones genetically but the flesh adheres tightly until the fruit is overripe. Most late-ripening varieties, however, are entirely freestones. Varieties with nonmelting flesh are all clingstones.

Peaches ripen over a period of about 3 months. For convenience in describing varieties, the ripening period has been arbitrarily classified into four general seasons of ripening:

1. Very early—more than 5 weeks earlier than Elberta and generally referred to as the Dixired season.

2. Early—from 3 to 5 weeks earlier than Elberta and referred to as the Redhaven season.

3. Midseason—less than 3 weeks earlier than Elberta. This season is usually divided into the Halehaven or July Elberta season (or varieties about 2 weeks before Elberta), and the Elberta season.

4. Late—all varieties ripening after Elberta. This is usually called the Rio Oso Gem season.

Comparative ratings of economically important varietal characteristics are given in table 1. The varietal descriptions that follow give the ripening period and certain outstanding strong or weak characteristics of (1) standard commercial varieties, (2) special-purpose varieties, and (3) promising new varieties.

Elberta is still the leading peach variety, although it has become less popular in recent years. Varieties with high quality and attractiveness, such as M. A. Blake and Redskin, are replacing Elberta for the Elberta season of ripening. Likewise, Golden Jubilee and Halehaven, which were very popular a few years ago, are being replaced in their ripening season by such varieties as Redhaven, Sunhigh, Richhaven, and Redglobe. Firmness and attractiveness are the chief merits of these newer varieties.

Standard Commercial Varieties

The following peach varieties, listed in approximate order of ripening, are suitable for general commercial production east of the Rocky Mountains:

Dixired.—Very early, ripening 5 to 6 weeks before Elberta. Fruits medium sized. Blush bright red. Flesh yellow, medium firm; melting, with strong tendency to cling. Promising for very early shipping or for local marketing where earliness is of prime importance and where freeness of the pit is not required. Considerable acreage planted in the Southeast.

Redhaven.—Early, ripening 4 to 5 weeks before Elberta. Fruits require early and heavy thinning to develop best size. Skin bright red, attractive; flesh yellow. Usually freestone when ripe. Flowerbuds moderately hardy. Variety becoming more and more popular because of fruit's firmness, attractiveness, and earliness. Excellent for canning and freezing.

Golden Jubilee.—Early, ripening 3 to 4 weeks before Elberta. Fruits medium sized, attractive red blush and yellow undercolor. Shape compressed, especially in southern areas. Flesh yellow and medium soft; freestone. Flowerbuds fairly hardy. Fruits should be thinned early and well. Valuable where hardiness is important and market is nearby. Not firm enough for distance shipping.

Triogem.—Early, ripening about 3 weeks before Elberta. Fruits medium sized, with attractive skin color. Flesh yellow, fine textured, and firm; usually freestone. Flowerbuds tender to low temperatures. Fruit may be small unless thinned well and early.

Sunhigh.—Early midseason. Fruits large. Skin attractive, light, solid red. Flesh attractive, fine texture, yellow, firm; usually freestone. Buds fairly hardy to low winter temperature, but apparently sensitive to low temperature in early spring. Susceptible to bacterial spot. Relatively short chilling period required.

July Elberta.—Midseason, ripening about 2 weeks before Elberta. Fruits large, round. Flesh yellow and fairly firm; freestone. Trees productive. Chilling period short. One of the best commercial varieties for its season in several peach areas.

Halehaven.—Midseason, ripening 2 weeks before Elberta. Fruits large, round. Skin color sometimes dull. Flesh yellow and fairly firm for season; freestone. Flowerbuds fairly hardy. Trees vigorous and productive. Fruit set often heavy, making detailed thinning necessary.

Belle (Belle of Georgia).—Midseason. Flesh white, or high quality; usually freestone. Skin sometimes lacks color. Flowerbuds hardy. Usually preferred as a white variety ripening just before Elberta, but not planted extensively.

Sullivan's Early Elberta.—Midseason, ripening 1 week before Elberta. Similar to Elberta in all respects except earlier ripening. One of the most extensively planted varieties several years ago, especially in the Southeast.

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TABLE 1.—*Characteristics of some peach varieties for use east of the Rocky Mountains, listed in approximate order of ripening*

[Numerical ratings of quality characteristics range from 1 to 10; the higher values indicate more desirable characteristics]

Ripening season and variety	Approximate ripening date, in days before or after Elberta [1]	Color of flesh	Fruit size	Stone freeness	Attractiveness	Flesh firmness	Dessert quality	Canning quality	Bacterial spot resistance	Chilling requirements (hours below 45° F.)	Principal value [2]
Very early:											
Redwin	−63	White	5	4	6	4	6	4		800	HLC
Marcus	−63	Yellow	5	4	6	4	6	4	5	800	HLC
Springtime	−61	White	3	3	7	3	6	3	6	650	HLC
Earligold	−60	Yellow	4	3	6	3	6	3		600	HLC
Mayflower	−58	White	3	3	6	3	5	3	7	1,200	HLC
Earlired	−50	Yellow	6	5	8	6	7	4	7	850	HLC
Collins	−49	Yellow	5	5	8	6	7	4			HLC
Sunrise	−48	Yellow	5	5	7	5	6	4	8	900	HL
Cardinal	−46	Yellow	6	4	8	6	7	4	7	950	LC
June Gold	−45	Yellow	6	5	7	6	5	3	5	700	HL
Early Redhaven	−44	Yellow	6	5	8	7	7				LC
Dixired	−42	Yellow	6	4	7	6	7	4	8	1,000	LC
Maygold	−42	Yellow	6	4	7	6	7	4	6	650	LC
Redcap	−42	Yellow	6	4	8	6	8	4	7	750	LC
Erly-Red-Fre	−40	White	7	6	7	6	8	4	8	900	HL
Merrill Gemfree	−38	Yellow	7	6	6	7	7	5	6		LC
Sunhaven	−38	Yellow	7	6	7	7	8	5	8	900	HLC
Early:											
Starking Delicious	−35	Yellow	7	6	7	7	8	6	6	800	HL
Coronet	−33	Yellow	7	7	9	8	9	7	6	750	HLC
Jerseyland	−33	Yellow	8	8	6	8	8	7	4	850	LC
Dixigem	−32	Yellow	7	7	7	7	9	7	7	850	LC
Redhaven	−30	Yellow	7	7	8	8	8	7	8	950	HLC
Regina	−30	Yellow	8	7	7	8	8	7	6	850	LC
Raritan Rose	−27	White	8	8	8	6	9	7	9	950	HL
Golden Jubilee	−25	Yellow	8	8	7	6	8	8	8	850	HL
Goldgem	−25	Yellow	8	6	7	8	7	7	7		L

Ranger	−25	Yellow	8	8	7	8	8	8	9	950	LC
Suwanee	−25	Yellow	8	8	8	8	8		5	650	LC
Washington	−24	Yellow	8	8	8	8	8	8			LC
Keystone	−22	Yellow	9	8	8	9	8	8	7	700	C
Triogem	−22	Yellow	8	8	7	8	8	7	6	850	HLC
Midseason:											
Fairhaven	−19	Yellow	8	8	7	7	8	8	7	850	L
Sunhigh	−17	Yellow	9	8	8	8	9	9	4	750	C
Richhaven	−16	Yellow	9	9	9	9	9	9	4	1, 000	LC
July Elberta	−15	Yellow	8	9	7	8	9	9	5	750	HL
Ambergem	−14	Yellow	7	1	7	10	7	9	6	800	C
Southland	−14	Yellow	9	9	9	9	9	9	6	750	HLC
Halehaven	−14	Yellow	9	9	6	7	9	8	7	850	LC
Redglobe	−14	Yellow	9	9	10	10	9	9	7	850	HLC
Loring	−11	Yellow	9	9	9	9	9	9	8	800	LC
Veteran	−11	Yellow	8	8	8	7	9	8	8	1, 100	HL
Belle	−8	White	8	9	6	7	9	8	9	850	HL
Suncrest	−8	Yellow	9	9	9	10	9	9	4	850	LC
Sullivan's Early Elberta.	−7	Yellow	9	9	7	8	8	8	6	900	C
Allred Elberta	−4	Yellow	9	9	7	9	9			900	LC
M. A. Blake	−3	Yellow	9	9	9	9	8	7	7	750	LC
Early Elberta	−3	Yellow	9	9	8	9	9	9	8	850	LC
Redskin	0	Yellow	9	9	9	9	9	8	9	650	HLC
H. H. Brilliant	0	Yellow	9	9	9	9	9	8	5	750	LC
Elberta	0	Yellow	9	9	8	9	8	8	7	900	C
Dixiland	0	Yellow	9	9	9	9	9		8	750	C
J. H. Hale	+1	Yellow	10	9	9	10	9	7	6	900	C
Jefferson	+2	Yellow	9	9	9	10	9				C
Late:											
Shippers Late Red	+3	Yellow	10	9	9	10	9	7	5	850	C
Afterglow	+5	Yellow	9	9	7	9	8	7	7	750	C
Rio Oso Gem	+6	Yellow	10	9	8	10	9	8	7	900	C
Kimbo	+8	Yellow	9	9	8	9	9				LC
Laterose	+8	White	9	9	8	8	9	7	7	850	LC
Constitution	+10	Yellow	9	9	7	8	8	7	7	750	C
Autumn	+12	Yellow	9	9	7	8	7	7	8	850	C
Salwey	+18	Yellow	9	9	7	8	7	7	7	1, 050	C
Krummel	+27	Yellow	9	9	7	9	7	7	7	900	C

[1] At Beltsville, Md. [2] H=home; L=local market; C=commercial market.

Elberta.—Fruits large, with red blush. Flesh yellow, firm, of fair to good quality; freestone. Flowerbuds sensitive to low temperature. Trees productive. By far the leading peach variety in the United States. Its popularity with growers is due to the large size, firmness, attractiveness, and shipping quality of its fruit; the vigor of the trees; and its suitability to many soil and climatic conditions. Although Elberta is still considered the principal commercial midseason variety, midseason varieties superior to it in quality, hardiness, and skin color are being planted in many orchards.

Rio Oso Gem.—Late, ripening nearly a week after Elberta. Fruits large, of good quality. Medium to bright blush. Flesh yellow, firm; freestone. Flowerbuds sensitive to low temperature. Trees rather weak, moderately productive. Susceptible to bacterial spot. Popular with many growers because of size, firmness, attractiveness of fruit, and time of ripening.

Special-Purpose Varieties

The following peach varieties are suitable for certain localities for special purposes, or for extending the ripening season. These varieties are listed in the approximate order of ripening:

Mayflower.—Very early, ripening about 8 weeks before Elberta. Fruits small. Skin mostly red. Flesh white, soft, juicy; clingstone. Yields usually low. Early ripening the only merit.

Hiland.—Very early, ripening about 6 weeks before Elberta, about 2 weeks before Redhaven, and a few days before Redcap. Fruits medium to large. Flesh yellow, medium firm, melting; clingstone. For very early shipping in present southern commercial peach areas. Chilling requirement low.

Cardinal.—Very early, ripening about same time as Hiland. Fruits medium sized. Skin bright and attractive. Flesh yellow, firm, melting; clingstone. For very early shipment in areas where there is enough winter chilling for varieties such as Elberta.

Redcap.—Very early, ripening a few days later than Hiland and same time as Dixired. Fruits medium sized. Skin bright red. Flesh yellow, firm, melting; clingstone. Used for early shipping variety in southern areas. Chilling requirement fairly low.

Maygold.—Very early, ripening same time as Redcap and Dixired. Fruits medium sized, and well colored. Flesh yellow, medium firm, melting; clingstone. Used for early shipping in southernmost commercial peach-growing areas. Will grow slightly farther south than either Hiland or Redcap.

Erly-Red-Fre.—Very early, ripening 5 to 6 weeks before Elberta. Fruits large for early season. Skin partly red. Flesh white; often freestone when fully ripe. Trees productive and winter hardy. Flowerbuds hardy to low winter temperatures.

Prairie Dawn.—Very early, ripening 5 weeks before Elberta, or about 1 week before Redhaven. Fruits medium to large. Skin partly red. Flesh yellow, medium firm; usually freestone when ripe. Resistant to bacterial leaf spot. Flowerbuds hardy to low winter temperatures.

Coronet.—Early, ripening 4 to 5 weeks before Elberta. Fruits medium sized. Skin mostly red and very bright. Flesh yellow, firm; usually freestone. Low chilling requirement similar to that of Redcap. Early flower development sometimes damaged by spring frost. An attractive shipping peach, often used to follow Redcap harvest in the South.

Jerseyland.—Early, ripening 4 to 5 weeks before Elberta. Fruits medium to large. Skin often solid red. Flesh yellow, firm; usually freestone. Dependable production over wide area. Susceptible to bacterial spot disease.

Dixigem.—Early, ripening 4 to 5 weeks before Elberta and about 1 week before Golden Jubilee. Fruits medium sized. Bright yellow, with light-to-medium red over about half the skin surface. Flesh yellow, firm, fine textured; usually freestone when ripe.

Raritan Rose.—Early, ripening 4 weeks before Elberta. Skin a bright, attractive red. Flesh white, fine textured; freestone. Hardy and productive. Has special merit for local sale where an early white variety is desired.

Ranger.—Early, ripening same time as Golden Jubilee, or 3 to 4 weeks before Elberta. Fruits medium to large. Flesh yellow, firm; freestone. Dependable producer over wide area. Blooms late and requires considerable chilling. Resistant to bacterial spot disease.

Redglobe.—Early midseason, ripening same time as July Elberta. Fruits medium to large and attractive. Flesh yellow, especially firm and fine textured; freestone. Dependable producer. Good shipping peach.

Southland.—Early midseason, ripening 2 to 3 weeks before Elberta, or with July Elberta. Fruits medium to large, round, firm, and attractive. Skin has medium blush. Chilling requirement low. Has been planted for a shipping variety in Southeastern United States.

Ambergem.—Early midseason. Fruits medium sized, round. Flesh yellow, nonmelting, firm, fine textured; clingstone. Flowerbuds hardy to low winter temperature—slightly more hardy than those of Halehaven. Trees productive. Usually planted for canning purposes. Preferable to western clingstone varieties for planting east of Rocky Mountains.

Champion.—Midseason. Flesh white, fine textured, and of excellent dessert quality; usually freestone. Fruits lack firmness. Flowerbuds very hardy to low temperature. Susceptible to brown rot.

Redskin.—Midseason, ripening about same time as Elberta. Fruits large, round. Skin attractive and almost solid bright red. Flesh yellow, free, firm. Popular variety planted to replace Elberta in many areas because of its attractiveness and quality. Good for freezing and canning.

J. H. Hale.—Midseason, ripening same time as Elberta. Fruits large. Skin an attractive red. Flesh yellow, firm, fine textured, and of high dessert quality; freestone. Flowerbuds sensitive to low temperature. Cross-pollination necessary to fruit setting. Trees lacking in vigor, often not productive, and very susceptible to bacterial spot. Often unprofitable to grow in Eastern States, although fruit may bring a premium because of high quality.

Afterglow.—Late, ripening nearly 1 week after Elberta. Fruits large. Skin medium to light blush. Flesh yellow and firm. Flowerbuds fairly sensitive to low temperature. Trees moderately vigorous and productive. Although usually not so highly colored as Rio Oso Gem, Afterglow is sometimes preferred to it because of greater tree vigor and slightly greater flowerbud hardiness.

Laterose.—Late, ripening about 10 days after Elberta. Fruits medium to large. Skin attractive red blush. Flesh white, medium firm, and fine textured; freestone. Trees vigorous and productive. A good white variety to follow the Elberta season.

Lizzie.—Late, ripening about 2 weeks after Elberta. Fruits medium sized and lacking in skin color. Flesh medium firm, yellow, of fair-to-good quality. Flowerbuds sensitive to low temperature. Greatest disadvantage, lack of skin color. Limited plantings.

Autumn.—Very late, ripening 3 to 4 weeks after Elberta. Fruits medium to large. Skin color often slightly dull. Flesh yellow, firm; freestone. Often lacks attractiveness and good flavor but is fairly satisfactory for a late peach.

Promising New Varieties

Many new peach varieties are promising but have not been tested thoroughly enough to be described accurately. Descriptions of some of the most promising new varieties follow in the approximate order of ripening.

Redwin.—Very early. Evidently a sport of Erly-Red-Fre, ripening at least 2 to 3 weeks earlier. Flesh white; semifreestone when fully ripe.

Marcus.—Very early, ripening a few days before Mayflower. Attractive yellow and red skin. Yellow flesh. Fruit medium sized.

Springtime.—Very early, ripening 2 to 3 days before Mayflower. Fruits small to medium sized. Skin usually almost solid red. Flesh white and juicy.

Dawne.—Very early. Attractive, yellow flesh.

Earlired.—Very early, ripening a few days before Cardinal and about 8 days before Sunhaven. Attractive, firm, with good flavor. Fruits medium sized and semifreestone.

Collins.—Very early, ripening just before Cardinal. Attractive skin color and relatively firm flesh. Fruits medium sized and semifreestone. Susceptible to bacterial spot disease.

Early Redhaven.—Very early, ripening about with Dixired. Attractive undercolor. Fruits firm and semifreestone.

Sunhaven.—Very early, ripening with Dixired or about 10 days before Redhaven. Fruits medium sized, round, but rough in more southern areas. Skin attractive, bright red. Flesh yellow, firm; semifreestone when ripe.

Goldenred.—Early, ripening several days after start of Redhaven season. Attractive yellow ground color. Fruits medium to large, round, and of good quality. Flesh yellow, medium firm; freestone.

Washington.—Early, ripening with Golden Jubilee. Fruits large, round, attractive. Flesh yellow, firm, and of good quality; freestone. Early tests indicate frost hardiness.

Keystone.—Early, ripening with Golden Jubilee. Fruits medium to large sized, round. Skin attractive, red and yellow. Flesh yellow, firm; freestone. Now being tested commercially to replace early white varieties with a yellow peach.

Goldgem.—Early, ripening in Golden Jubilee season. Flesh yellow, medium firm; freestone.

Suwanee.—Early, ripening between Golden Jubilee and Keystone seasons. Flesh yellow, firm, freestone. Low chilling requirement. Light pubescence.

Richhaven.—Midseason, ripening with Sunhigh and July Elberta, or often 2 days before Halehaven. Fruits medium sized to large and round. Skin color similar to Halehaven except brighter red and yellow. Flesh yellow, firm; freestone.

Summerqueen.—Midseason, ripening about same time as Sunhigh and July Elberta. Fruits medium sized to large. Flesh yellow, firm; freestone. Requires cross-pollination.

Loring. — Midseason, ripening during latter part of Halehaven season and extending that season. Fruits medium sized to large and round. Skin attractive red with yellow undercolor. Flesh yellow, firm; freestone. Resistant to bacterial spot disease. Most promising variety to extend the July Elberta-Halehaven season.

Suncrest.—Midseason, ripening with Sullivan Elberta. Fruits large, round. Skin bright red if trees are very vigorous; otherwise red blush dull sometimes in Southeastern United States. Flesh yellow, firm; freestone. Very susceptible to bacterial spot.

M. A. Blake.—Midseason, usually ripens a few days before Elberta but after Sullivan Elberta. Fruits medium to large, round. Skin attractive, almost entirely red. Flesh yellow, firm, and of good quality; freestone.

Dixiland.—Midseason, ripening with or just before Elberta. Fruits large, ovate, freestone. Light pubescence. Low chilling requirement. Resistant to bacterial spot.

Jefferson.—Midseason, ripening same time as or just after Elberta. Fruits large, round. Skin attractive, bright yellow and red. Flesh yellow, very firm, and of good quality; freestone. Reported to withstand spring frosts well.

PROPAGATING AND SELECTING ROOTSTOCKS

Nurserymen offer a choice of sizes and grades of the popular and promising new varieties, guaranteed to grow and to be true to variety. Most peach growers, therefore, purchase their trees directly from reliable nurseries rather than propagate their own trees. Nevertheless, some peach growers may want to propagate their own trees for some special purpose such as reproducing a variety prized for jam or canning but not obtainable commercially.

A peach generally cannot be reproduced true to variety from seeds. Plants grown from seeds of a given peach tree may differ considerably in tree and fruit characteristics from the parent tree, even though there has been no cross-pollination. Seedlings of some varieties are more uniform than those of others. In reliable nurseries, the main purpose of germinating peach seeds is to grow young trees, called understocks, on which to bud or graft desired varieties.

Peaches may be propagated on most fruit trees in the *Prunus* genus, such as peach, plum, apricot, or almond. Compatibility and top growth vary among varieties of these species, however. In general, buds of desired varieties are compatible when budded to seedlings of the common peach varieties. Elberta and Halehaven peaches budded to seedlings grown from seeds of about 50 peach varieties showed little difference in tree size and yield.

For general rootstock purposes, peach seeds should be available in large quantity, should be economical, and should germinate well in the nursery. Previously, most seeds used for peach understocks came from seedling peach trees in the Carolinas, Kentucky, Tennessee, and elsewhere in the South. The supply of reliable seeds from these sources has dwindled, and understocks are now largely from seeds of Lovell, a variety used in California for drying. Lovell seeds make satisfactory understocks except where nematodes are numerous. The future supply of Lovell seeds is questionable because of reduced planting of this variety. Seeds of Elberta are available in large quantities, from canneries, but germination varies from year to year. Satisfactory germination of seeds of Elberta and other midseason and late varieties is usually obtained when the seeds are kept moist and given a longer chilling period than Lovell seeds. Trees on these rootstocks usually are very satisfactory. Seeds from red-leaved varieties are used by a few nurseries because this practice permits easy spotting of red-leaved trees developing from the rootstock seedling rather than the scion variety. Rogueing out the red-leaved trees eliminates this source of error in producing true-to-variety trees.

Nematode injury to peach roots in some areas has resulted in importing, selecting, and breeding for nematode-resistant rootstock varieties (fig. 3). The Shalil variety from India and Yunnan from China gave resistance to the *acrita* nematode. The S–37 rootstock in addition gave slight resistance to the *javanica* species. Okinawa gave high resistance to both nematodes but lacked vigor. Nemaguard, introduced by the Department in 1961, combined vigorous seedling growth with dual resistance and high germination.

Understocks are being bred and tested for improved nematode resistance, higher seed yields, higher percentage of germination, vigorous top growth, and greater hardiness.

Peaches have been budded to many varieties and types of plum, apricot, and almond trees to test such characters as nematode resistance, winter hardiness, dwarfing, scion-stock compatibility, and tolerance to wet and dry soils. Results with some of the St. Julian or Damson plum varieties were encouraging but were not consistent. In other plum varieties, the bud onions usually were not compatible, or the trees were weak, dwarfed, and short lived for some other reason. Peaches budded on the western sand cherry (*Prunus besseyi*) are often sold as dwarf peach trees. They usually grow about 6 feet high and bear early, normal-sized fruit; but they are short lived. Heavy annual pruning of peaches grafted onto peach rootstocks, together with little nitogen fertilization, will produce a more satisfactory semidwarf peach tree.

Peach seeds should receive an afterripening treatment for about 3 months to insure high germination and normal seedling growth. The length of dormancy depends on the variety. The seeds should be stored over winter in damp peat or sand, or in a mixture of the two, at a tem-

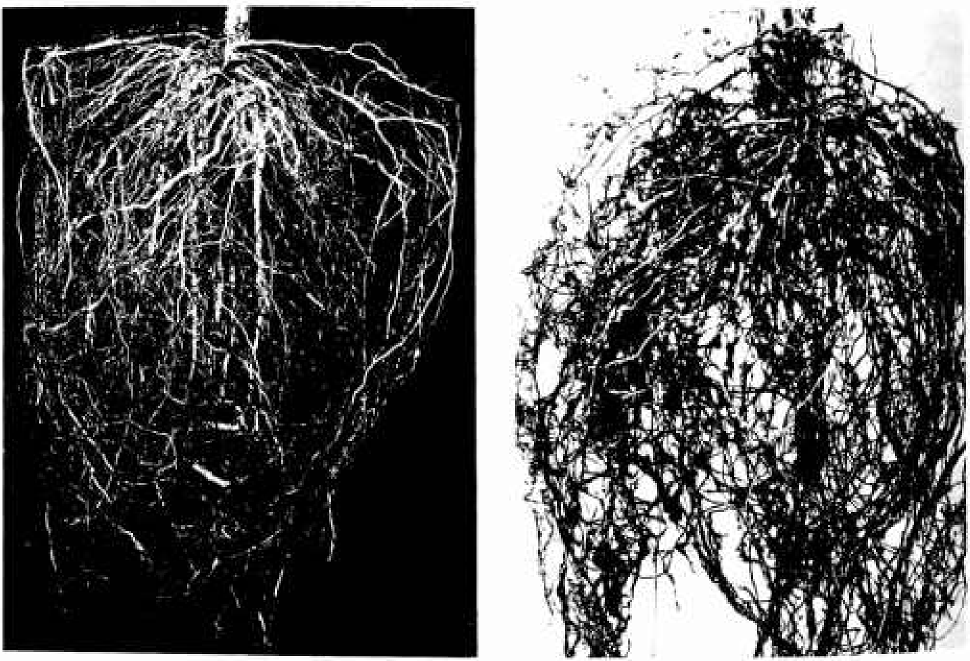

FIGURE 3.—Differences in root-knot nematode resistance of peach stocks. Left, nematode-resistant stock; right, susceptible stock.

perature of 35° to 40° F. This treatment is called afterripening or stratification. Sometimes the seeds are afterripened outdoors in the fall in moist sand. Some nurseries afterripen the seeds in underground pits. It is not necessary that the seeds freeze, but it is necessary that they be kept cool and moist. Early in the spring, after sufficient afterripening, the seeds are planted in the nursery or garden.

Planting peach seeds in the field in the fall about 2 inches deep and in rows about 4 feet apart is a more common practice than is stratification. Seeds so planted germinate the following spring. Too much moisture, which occurs when the soil is poorly drained, injures the seeds and prevents high percentage of germination. Special precautions must sometimes be taken to protect the seeds from rodents.

Budding desired peach varieties onto young seedlings is done during the first year of seedling growth. The time for peach budding in the South is usually June; in the North, it is usually late July or August.

The shield, or T-budding, method is used. A T-shaped cut is made near the base of the seedling. A shield-shaped section of the bark of a tree of the desired variety containing one bud is inserted into the cut. The bud is then bound firmly into position with rubberbands, strips of raffia, or string. In about 2 weeks, or as soon as the bud has set, the strips or rubberbands are cut to prevent girdling. When the inserted bud starts growing, the seedling is cut off just above it. This is done soon after June budding and again early the next spring after late-summer budding. All growth except that from the desired bud is removed.

PLANTING THE ORCHARD

Age and Size of Trees

One-year-old nursery-grown peach trees are usually the most satisfactory to plant. A 1-year-old tree is a tree that has had one complete season's growth in the nursery after being budded. A tree that is budded early the first summer, as many are in the South, is dug at the end of the same season and is commonly referred to as a June-budded tree. June-budded trees are usually smaller than most 1-year-old trees but are satisfactory for planting, especially in regions that have long growing seasons. They may be straight, unbranched whips, or they may have a few branches. One-year-old nursery-grown trees are usually well branched.

Nurserymen who propagate large numbers of peach trees grade them according to height in feet, or diameter in fractions of an inch. Well-grown June-budded trees are usually 2 to 3 feet tall and sometimes taller. For general-purpose planting, the medium-sized (4- to 5-foot), 1-year-old tree or the largest June-budded tree is satisfactory.

Time To Plant

Well-hardened, dormant peach trees may be transplanted from the nursery to the orchard in late fall, winter, or early spring. Generally, in the Southeast and the Southwest, the best time for transplanting the trees is during late fall or early winter. In the Middle Atlantic and Middle South Central States, the best time is late fall; and in the New England and North Central States, late winter or early spring.

Where below-zero temperatures occur, accompanied by high winds, and where soil without a snow cover freezes to a considerable depth, fall-planted trees may dry out considerably and be injured by cold. Trees planted in late winter or early spring should be set out as soon as

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the soil is dry enough to be worked, so that new roots can become established while soil temperatures and moisture are favorable. Trees planted late in the spring, especially large trees, may become desiccated and have a high mortality. Leafbuds of the transplanted trees develop when temperatures become warm. It is important, therefore, that spring-planted trees be set out 3 or 4 weeks before the leafbuds start growth.

If trees are transplanted late in the spring, small- and medium-sized trees may have a lower rate of mortality than large trees at the end of the first season in the orchard. If large trees (5 to 7 feet) are planted in the fall or late winter (at least a month before growth starts), their mortality rate will be no higher than that of smaller trees planted at the same time. They will grow more during their first year in the orchard than will the smaller trees.

If trees are received from the nursery at an unsuitable time for planting because of soil or weather conditions, they should be placed in cool storage or "heeled in" outdoors to prevent drying out. "Heeling in" means laying the trees on the side of a trench in a sloping position and covering their roots with soil. If planting must be delayed, the soil should be packed tightly around the roots. If the trees are to be planted shortly, they may be protected sufficiently by wrapping some material such as burlap, excelsior, or old straw around their roots, thoroughly moistening this cover with water, and shielding the trees from wind and sun. Roots must be kept moist and cool but not allowed to freeze.

Planting Patterns and Spacings

Peach trees are usually set out in some rectangular pattern to permit tillage and other cultural work in any direction. Where the land is level or slopes no more than 5 feet in 100, a square pattern is commonly used; that is, the distance between trees in the row is the same as the distance between rows.

Contour planting and terracing to conserve soil and water in peach orchards is good practice where the soil erodes easily. On steep slopes or irregular land, trees should be contour planted. In contour planting, the trees are set about the same distance apart within the row; but each row follows a true contour line or else a line sloping so little that the soil drains but does not erode. The distance between rows in a contour-planted orchard varies with the degree of slope of the land. In such an orchard, cultivation and other operations are carried on only along the rows—never up and down the slope. By cultivating in one direction and working the soil toward the trees, a contour ridge is built up along each tree row.

The principal advantage of the contour method of planting is that soil erosion, which is often serious in cultivated orchards planted on the square system on sloping sites, is reduced to a minimum. Where the slope is steep, or where there is a broad watershed above the orchard from which a large amount of water may flow down into the orchard during heavy rains, it may be desirable to build terraces. Terraces check the flow of water down the slope, cause much of it to percolate into the soil, and divert the remainder into drainage ditches or flumes. A system of terraces should be planned before, rather than after, the orchard is planted.

For commercial peach production, the trees should be set no closer than 20 by 20 feet if the orchard is planted on the square. Even trees planted this far apart are frequently crowded by the time they are 8 years old (fig. 4). On fertile soils capable of producing vigorous trees, a spacing of 24 by 24 feet, 20 by 25

FIGURE 4.—Peach orchard that lacks enough space between rows. This makes spraying, cultivating, harvesting, and other operations difficult and inefficient.

feet, or 25 by 25 feet or more is better than a spacing of 20 by 20 feet. The wider spacing permits use of tractors and other power-driven machinery for hauling harrows and spray equipment without damaging trees and scarring branches. Where trees are planted on the contour, greater distance between rows permits better tree spacing. Where modern speed sprayers and other power equipment are used in only one direction through an orchard, trees are sometimes set only 16 to 18 feet apart in the rows.

Trees planted for home use or in other limited areas may be spaced as close as 15 feet apart. With the closer spacing, tree growth may be controlled by pruning. Pruning will reduce the amount of fruit produced, but many trees may still yield satisfactorily for home use or local marketing.

Preparing the Site

On infertile soils it is good practice to use a green-manure crop before planting a peach orchard.

If the site is level or only gently sloping, the soil may be disked or plowed before the trees are planted. Where trees are planted on the contour or where terracing between rows is necessary, only the narrow strips of land for planting the tree rows need be prepared. The land between these strips may be left uncultivated. Often in large peach orchards, a deep furrow is prepared for each row of trees. The furrow is filled after the trees are planted.

When the rows have been laid out for planting, holes are dug for the trees. This digging requires little effort in an area that has been furrowed for planting. The holes should be 18 inches or more in diameter and deep enough to accommodate the root systems of the trees.

Soil augers operated from power takeoff of a tractor are now used for large plantings (fig. 5).

FIGURE 5.—Hole-digging auger used for tree planting. Power is from the takeoff on the tractor.

Details of methods for laying out and terracing an orchard on the contour can be obtained from your local county agricultural agent or Soil Conservation Service office.

Setting Out the Trees

Before planting peach trees, any broken or diseased roots should be removed. Additional root pruning is not necessary or desirable. If the roots have dried out in storage or in transit, they should be soaked in water for several hours, or overnight. Special care should be taken to keep the roots from drying out or freezing while they are being planted.

In setting out a tree, it should be planted 1 or 2 inches deeper than it was planted in the nursery. The space around the roots should be filled with topsoil and the soil tamped. More topsoil should be added if it is available and water if the soil is dry. Nitrogen fertilizer should not be applied to the soil at planting time.

Replanting the Orchard

Growing young peach trees on old peach orchard sites is often unsatisfactory. Some young trees planted on old sites die the first summer after planting. Some survive the first season but make weak growth and die the second or third summer. Growth failure may be caused by nematodes, root aphids, diseases, poor soil drainage, low nutrient supply, low soil pH, or poor tree condition at planting time. Often, however, the reason for failure is not clear. The replanting problem seems specific to peaches. For example, apple or plum trees may follow peach trees in rotation without replanting difficulty, and peach trees may follow apple or plum trees satisfactorily.

Special care of young replanted trees and use of fertilizer, especially nitrogen, in the early summer are sometimes helpful.

At Beltsville, Md., applying about 1 ton of lime per acre to the old field soil has been satisfactory. Fumigating the old field with methyl bromide has also helped. Some root damage to replanted trees, especially in the Southeast, is due to mushroom root rot (*Clitocybe tabescens*). Where nematodes are numerous, especially those of the root-knot type, soil fumigation with Nemagon is helpful. In addition, use of nematode-resistant rootstocks is advisable. More research is needed on replanting because of necessary reuse of good peach sites.

TRAINING AND PRUNING

In the United States, the trend is toward less severe pruning of young peach trees and more severe pruning of old trees. After the scaffold limbs have been selected, the tree should be pruned only lightly until it starts to bear fruit. Even then, to obtain highest yields of high-quality fruit, pruning should be very light during the early bearing years. As the tree grows older and dead twigs appear, the branches should be thinned and headed back more severely to vigorous, outward-growing, lateral shoots.

The Young Tree

When planted.—Pruning cuts on the young tree from the time it is set in the orchard to its early fruiting years are mainly for training purposes. Early training is necessary to obtain a productive, long-lived tree that may be sprayed, thinned, cultivated, harvested, and otherwise handled economically. Not all growers train their trees in the same way because of differences in soil or other conditions. To develop a strong, winter-hardy, long-lived tree, the scaffold branches should be selected and trained to form wide angles with the tree trunk.

When obtained from the nursery, a 1-year-old peach tree is usually 2 to 6 feet tall and has few lateral branches uniform enough to be used as scaffold or framework branches. After the tree is set out, its lateral shoots should be cut back to short stubs having one or two buds each (fig. 6). This brings the top into balance with the root system and forces the tree to develop strong shoots, some of which will be selected as scaffold branches.

Spring-planted trees should be cut back immediately after they are set out. Where winters are severe, fall-planted trees should not be cut back until late winter or early spring.

The height to which a tree is headed back depends partly on its size and how well it is branched, and partly on the grower's preference. Also where winds are strong, low-heading is desirable. Occasionally a 1-year-old nursery tree has well-developed laterals that can be headed back to 6 or 8 inches and spaced to form the head. If a low, spreading tree form is desired, the central stems of 1-year-old trees may be cut to a height of 12 to 18 inches if buds are present that low on the trunk. To facilitate cultivation and other necessary orchard work, a higher framework of branches is sometimes preferable. Where trees are headed back to a height of 12 to 20 inches, the scaffold branches are usually close together on the trunk. If the tree stem is about 36 inches long when it is planted, scaffold branches can be spaced farther apart on the trunk.

Nursery trees 4 or more feet tall, with diameters of 7⁄16 to 9⁄16 inch, have a potentially better scaffold system. They should be cut back to about 36 inches, and their lateral shoots cut back to a few buds (fig. 6). June-budded trees may not be tall enough to need heading back. The terminal cut should be made just above a live bud or a vigorous lateral branch that forms a sharp angle with the main trunk. If the cut is made at a lateral branch, this branch should also be cut back to a vigorous bud toward the outside; and 4 to 6 inches of the branch should be left on the trunk. All other branches that are weak and crooked and that have sharp-angled crotches, should be removed. All branches below the lowest selected scaffold limb should also be removed.

First and second years.—Two to four scaffold limbs should be selected in early summer of the first growing season (fig. 7). Some growers prefer only two scaffold limbs opposite each other and forming a wide crotch about 20 inches high. Others prefer three or four scaffold limbs no closer than 5 inches apart on the main trunk. Furthermore, the scaffold branches should be spaced around the trunk so that

FIGURE 6.—Pruning the young peach tree just after planting. Tree is headed at about 36 inches, and all branches are cut back to short stubs.

FIGURE 7.—New growth on young peach tree about 3 weeks after planting. Scaffold limbs may now be selected and other shoots pinched back. Tree may also be fertilized if necessary.

none is immediately above another. It is essential that these scaffold limbs form and maintain wide angles with the central trunk.

Some summer training is desirable the first season of growth. Shoots arising near the ground can be removed during the summer. Undesirable shoots and lateral branches arising in addition to the selected scaffold limbs should be pinched back by hand or clipped back. Any shoots on scaffold limbs within about 10 inches of the trunk should also be shortened. Cutting back these shoots, rather than removing them entirely, causes wide-angled crotches in the selected scaffold limbs.

If there is no summer training the first season, scaffold limbs should be selected during the dormant period before the second growing season. Training or corrective pruning at this time necessitates removing a large amount of the previous season's growth. All limbs except those selected for the scaffold branches should be removed entirely or severely cut back. The wide-angled limbs selected as scaffolds may need heading back only if they are disproportionately vigorous compared to others. Where summer pinching removed parts of limbs during the previous growing season, the entire limbs can now be removed. Lateral branches on the scaffold limbs within a foot of the trunk should also be removed.

Early training of wide crotches is essential to obtain long-lived, productive trees with strong branches free from winter injury to the crotch.

The topmost scaffold (or modified leader), either as a bud or a shoot limb just after planting, may require further training after 1 year's growth. Like the other scaffold limbs, it should be trained to grow in an outward and upward direction. This can best be done by removing or cutting back all branches not growing in the desired direction. The purpose of this training is to develop an open, spreading, symmetrical, and strong tree. Pruning after 1 year's growth in the orchard is the best time to start training a tree.

Occasionally much of the treetop grows poorly the first season in the orchard. Often a strong, vigorous shoot arises during the summer near the base of the tree above the grafted bud. If this shoot is upright and forms a sharp angle with the trunk, the original top of the tree may be removed just above the base of the new shoot. Thus, this shoot assumes the position and function of a main stem or tree trunk. Scaffold limbs on this shoot then are selected as described for the original tree after 1 year's growth.

Some peach growers use a deshooting method of summer training during the first season in the orchard. This method is not used as commonly now as it was a few years ago. Deshooting requires much time and care. With this method, the tree should be at least 4 feet tall when planted. The tree is first headed to about 38 inches, and all branches are removed below 14 inches from the tree base. The other branches are cut back to one or two buds from the trunk. During early summer, when the new shoots are about 6 inches long, four or five of the most vigorous, wide-angled shoots spaced about 6 inches apart are selected. All other shoots are removed.

A modification of this method is to remove only those shoots that will obviously make poor scaffold limbs. This would include removing the very weak shoots, those with narrow crotches, and those growing in the wrong direction. The remaining branches (possibly 8 or 10) are allowed to grow during the first summer, and scaffolds are selected when the trees are pruned the following winter. When using the deshooting method, it is preferable to prune the tree several times during the summer and remove undesirable shoots that develop.

During early summer of the second year, new shoots growing from the trunk should be removed except where one is necessary for a scaffold limb. Only light thinning out of limbs and only occasional cutting back to outward growing limbs are required to obtain a well-opened tree the third year.

The Bearing Tree

The young bearing tree.—After carefully pruning and training the peach tree the first 2 years, little pruning should be necessary for several seasons. A good scaffold system will be well established, and a spreading-branch habit will be encouraged by the weight of the fruit on the limbs. After the second growing season, only light, corrective pruning will be required to keep the center open and the main branches well spaced (fig. 8). The short branches bear the large fruit buds growing near the base of the large scaffold limbs. Where there are a large number of branches, they may be thinned out to permit light to reach the tree center. Not all should be removed, however, since

FIGURE 8.—A 2-year-old peach tree after pruning. Vigorous branch growth is pruned lightly to outside shoots or not at all.

they are usually the first twigs to bear fruit. If they are all removed, the fruit-bearing potential of the tree is delayed unnecessarily.

After fruiting begins throughout the tree, the inside twigs should be thinned out and shortened to prevent shading of the tree center. Shading prevents desirable new shoot growth in the tree head as well as development of highly colored fruits.

A well-trained peach tree will often bear a few fruits the second year, and a peck to a bushel of good fruits the third year. Pruning the fourth and fifth years should still be light enough to train the tree to a spreading, symmetrical shape (figs. 9, 10, and 11). Pruning is not done in the summer, although a small number of shoots may be removed to prevent dense inside growth.

When pruning peach trees, remember that the flowers and fruit are borne on wood produced the previous year. This fruiting wood tends to grow farther out on the ends of the branches each year. Thus it is best to prune every year to keep the trees within bounds and to prevent the branches from breaking. Furthermore, there is no better way to stimulate the growth of the 1-year fruiting wood in the center of the tree than by thinning out and heading back the inside branches (fig. 12).

Peach pruning after the third and fourth growing seasons is mainly correctional. Removing or cutting back branches that interfere

FIGURE 9.—Strong, wide-angled crotch in a 4-year-old peach tree. This type of crotch is resistant to winter injury and to breakage by weight of the fruit.

with the upward and outward spread of the main scaffold limbs is necessary. Emphasis is on light pruning and framework development. Where it is necessary to head back a scaffold limb to change its direction, the cut should always be made to an outside lateral branch growing away from the center of the tree. A 4- to 5-year-old tree pruned in this way is open and has fruiting wood throughout (fig. 12).

When the number of flowerbuds is small, as on very vigorous young trees or following winter budkilling, pruning should be light. If, however, all flowerbuds have been killed, young bearing trees may require fairly severe pruning to maintain a spreading growth. Because fruit crops aid in spreading the branches, young trees with many flowerbuds need little or no heading of scaffold limbs. No pruning at all the first 5 to 7 years results in the largest trees and the highest production during that period. The trees become shaded in the centers, however, and fruiting wood is confined to the outside and top of the trees. Correct pruning and training during this period develop strong, long-lived, and hardy trees. Only light heading back and moderate opening of the center of the trees are necessary to encourage spreading growth and to admit light.

The mature tree.—Pruning the mature peach tree annually is desirable to keep it relatively low, to encourage well-distributed fruiting wood, and to obtain high-quality fruit. Bearing peach trees are pruned more severely than are apple, pear, cherry, or plum trees. Enough branches must be removed to permit light and air to reach the tree. First remove dead, injured, and weak branches. Then remove enough healthy branches to give the desired spacing of branches. Pruning, however, is only one of several factors that help produce satisfactory tree growth and fruit quality. Other important factors are soil fertility, soil moisture, control of insects and diseases, and fruit thinning.

During a single season, vigorous, well-grown peach trees often develop upright shoots 2 to 5 feet long in the center of the tree. These shoots should be removed entirely; otherwise, they soon shade out the more productive fruiting wood underneath. The more desirable fruiting branches in the center of the tree should usually be thinned out and headed back lightly to a vigorous shoot (fig. 13). Fruiting wood throughout the tree should be thinned out to keep the tree open enough to maintain growth of new wood each year. The amount of necessary thinning out depends on soil fertility, quality of fruit produced, and amount of dead wood in the tree. If the size and appearance of the fruit are poor and there are many dead twigs in the center of the tree, the tree should be thinned out or some branches removed.

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FIGURE 10.—Strong, wide-angled crotches in a 4-year-old peach tree trained to the modified leader system. Both this system and the system shown in figure 9 develop strong trees.

A peach tree reaches its most economical height when it is 6 to 8 years old. Trees are allowed to grow to 12 to 14 feet in some areas, and only to 7 feet in other areas. Where the soil is deep and fertile and moisture is plentiful, trees may be allowed to grow high and broad. In areas where soil moisture is often limited and soil fertility is low, small, low trees are best for securing annual vigorous renewal wood. The size and height of the tree are sometimes based on local customs; and local methods are used for pruning, thinning, and spraying the trees, and for harvesting the crop. In areas where orchard sites are relatively inexpensive, trees are often headed low in spite of the usually smaller yields produced on low trees. Orchard workers who prune, thin, and harvest fruit from high trees sometimes object to working from stepladders. In general, the most satisfactory tree height is between 8 and 10 feet.

The mature peach tree requires more pruning than does any other fruit tree. Pruning is largely a renewal process and is done by removing upright branches, by thin-

FIGURE 11.—Weak, narrow-angled crotch in a 4-year-old peach tree. This tree may split from the weight of its fruit, particularly following winter damage to the crotch.

ning out shoots, and by occasionally removing large branches of 2- to 3-year-old wood. The main branches of mature trees should never be cut back to upright or outward-extending stubs.

The practice of heading back all branches and shoots is not advisable. The renewal pruning method results in an open-topped tree capable of producing high-quality fruits.

By using the renewal pruning method, trees may be kept 8 to 10 feet tall. Only short stepladders are then needed to prune, thin, and harvest the fruit by hand. At this height, the largest branch on each well-developed crotch is removed just above or at the side of an outward branching lateral. This point at the crotch is used as a base for the renewal height (or "renewal point") of the tree top. Two or more branches usually develop the following summer at this renewal point; then all branches except one outward branching shoot are removed at the next pruning. After several years, it is necessary to change the renewal point to one slightly higher or one slightly lower on the lateral. Keeping the renewal points at varying heights helps to prevent a thick-topped tree that shades the lower inside areas.

Usually, too many flowerbuds are produced on the previous season's growth. Thus pruning the newest growth thins the fruit as well as encourages renewal of better new

FIGURE 12.—A strong, vigorous, productive, 5-year-old Redhaven peach tree. Top, before pruning; bottom, as pruning is finished.

FIGURE 13.—A strong, mature Elberta peach tree pruned to about 10 feet high. Growth renewal points are established throughout the tree.

shoots for producing high-quality fruit. New terminal growth each year should be 12 to 15 inches long throughout the mature tree. As the tree becomes older, severe pruning is necessary to maintain the most desirable fruiting wood. Sometimes a fairly large branch on the inside of the tree must be removed completely, and others must be headed back. The presence of short, slender, terminal shoots 6 to 8 inches long probably indicates too little pruning. Conversely, the presence of vigorous, annual shoots 30 to 40 inches long probably indicates too severe pruning. These conditions, however, may be caused by some other factor, such as soil fertility. Pruning, fertilizing, fruit thinning, and soil management must be interrelated to obtain the most productive tree growth.

Rejuvenation pruning. — Sometimes extra-heavy pruning is required on old or neglected trees to make them again bear profitably. There is often a tendency to "dehorn" or "dehead" the old, weak trees in order to rejuvenate them. Tests have shown, however, that trees moderately to heavily pruned made greatest total growth of new wood during the two seasons following treatment. After this moderate to heavy pruning, only a moderate type of thinning out and heading back is necessary at the end of the first season to obtain a well-shaped, spreading tree. Also, for the next several years these trees will require only moderate pruning. Rejuvenation pruning tends to lower the tree head. This greatly facilitates orchard operations and rapid regrowth of adequate fruiting wood.

Sometimes large cuts into the best available 4- to 6-year-old branches are necessary to lower the height of the fruiting wood. The method used for renewing the tops is not well suited to inner tree growth or to controlling tree extension. These are best accomplished by thinning out some branches and heading back others to vigorous laterals.

Although correct pruning will reduce the necessary amount of thinning, propping, and bracing, it will not eliminate the need for such support in years of heavy crops.

Time of Pruning

Experiments have indicated that most pruning should be done during the dormant season. However, where spring frost may injure the crop, pruning should be delayed. Some peach growers do at least a part of their pruning after the blooming period because of frost danger. If frost kills a high percentage of the flowers, little or no pruning is done that season. Of course, this practice is not best for renewing shoot growth of the tree.

Fruit yields are reduced when mature trees are pruned after the full-bloom stage. Pruning at full bloom, at "shuck fall," and even at 3 weeks after shuck fall will produce larger fruit than not pruning at all. Thus it seems that most pruning should be done no later than at full bloom. However, if no pruning has been done, it is better to prune late than not at all. In areas where frost hazard is serious, it may be preferable to prune twice: First, to make major cuts during the dormant season; and second, to thin the blossoms after the frost danger has passed. Pruning after full bloom increases twig growth, number of leaves per fruit, and fruit size. The later pruning is done, however, the less it stimulates shoot growth and the more it reduces the amount of fruit. Spring or summer pruning of mature trees results in little increase in fruit size and often reduced yield.

Pruning tests have shown that no pruning, or pruning done at shuck fall, caused earlier fruit ripening than did dormant pruning or pruning done 3 weeks after shuck fall. Dormant-pruned trees produced the longest shoot growth and the largest number of flowerbuds per foot (table 2).

In the more northern peach-growing sections of the United States, where midwinter killing of buds, branches, and tree trunks sometimes occurs, pruning should not be done until danger of winterkilling is past. Tree injury is often much more severe if the trees have been pruned before the onset of low temperatures. Furthermore, where wood injury has resulted from winter cold, pruning should be delayed until growth starts and the extent of the injury can be determined. Early and heavy heading back, or dehorning, of winter-injured trees may kill some of them. After growth has started, dead limbs can be safely removed. Limbs with live tissues and growing points should be pruned only lightly. Application of nitrogen fertilizer will be more effective in encouraging new tissue growth than heavy pruning of surviving branches that were injured by the cold.

Delayed pruning has advantages when flowerbuds only have been winterkilled, because the percentage of live buds can be determined more accurately after the buds have swelled. Pruning can then be adjusted to the bud set. If pruning is delayed until near blossoming time and few buds have been winterkilled, pruning can be heavier. The number of blossoms and the amount of fruit thinning needed later will be reduced. Pruning, fertilizing, and fruit thinning go hand in hand.

TABLE 2.—*Mature peach trees: Effects of time of pruning on yield, size of fruit, earliness of ripening, shoot length, and number of flowerbuds (Means of 4 years)*

Time of pruning	Yield per tree	Size of fruit	Time of ripening [1]	Shoot length	Flowerbuds per foot
	Bushels	*Number per bushel*	*Percent*	*Inches*	*Number*
Dormant	7. 7	171	22. 0	11. 6	15. 1
Full bloom	6. 2	188	39. 7	9. 7	13. 3
Shuck fall	5. 3	167	43. 9	9. 0	11. 1
Three weeks after shuck fall	4. 7	162	26. 7	8. 7	11. 2
Unpruned	8. 2	214	45. 0	5. 1	10. 4
L.S.D. (0.01)	1. 3	18	15. 3	1. 2	1. 5

[1] Relative time of ripening based on number of fruits harvested at the first 2 of the 4 picking dates.

Pruning in Relation to Fruit Thinning

There must be a balance between pruning and fruit-thinning practices in the peach orchard. Neither practice alone will produce the highest yield of top-quality fruit. Pruning reduces the number of fruits per tree at a time when fruit thinning is of most value—before the fruits have begun to compete with each other and with the growth of the tree.

When a pruning cut is made that removes either the entire limb or a part of it, flowerbuds and leafbuds are removed with the wood. Leafbuds near the pruning cut are stimulated and grow into long, leafy shoots. These leaves are important to the developing fruits left on the tree, since they are the food-producing organs. For largest peach size, there should be at least 35 leaves for each peach. If there are too few leaves per peach, the peaches will be small and the color and quality poor. Unpruned or lightly pruned trees produce more leaves per tree than do heavily pruned trees, although the growth may be short. Unpruned or lightly pruned trees will contain a relatively large number of flowers and young growing fruits, but there will be fewer leaves for each fruit. By the time the fruits are thinned, the potential size will already have been reduced.

Pruning done largely to thin the peaches should be well distributed. Pruning of many small twigs is desirable. Peach trees can quickly disseminate nutrients and food materials. The largest scaffold branches serve as units, so that a large leaf area anywhere on a large branch increases fruit size over the entire branch. Uniform fruit thinning is not necessary to increase peach size.

Pruning in Relation to Fertilizing

In commercial orchards, soil fertilizing and pruning are both necessary for satisfactory new shoot growth on peach trees. Pruning reduces the number of growing points on the tree and increases individual shoot length. Where space is limited and yield of fruit per tree is not a major factor, pruning can keep the tree small and maintain the desired 12 to 15 inches of annual terminal shoot growth of mature trees. Soil fertilization, especially by nitrogen, should be reduced as the severity of pruning is increased. The fruit yield per tree will also decrease with the severity of pruning.

Reduction either in pruning or in nitrogen fertilization results in short shoot growth and early fruit ripening. Fruits of varieties with little red color develop more color with reduced pruning or reduced application of nitrogen to the soil. Fruits of bright red varieties, however, often become dull and unattractive if nitrogen in the soil is low or if the trees are lightly pruned. Heavy pruning delays fruit ripening, as does too much nitrogen fertilizer. Their basic effects, however, are different. Pruning reduces the size and potential yield of the tree, whereas nitrogen fertilization tends to increase both. Heavy pruning often increases the percentage of potassium and other elements in peach leaves, probably by reducing the total leaf area in proportion to the root area per tree.

Pruning Tools and Equipment

The use of the power, compressed-air, or pneumatic pruner in many good commercial peach orchards increases working efficiency and reduces labor costs. The power pruner is most valuable when used on mature trees of uniform size. Some growers find portable platforms are especially useful with this type of pruning operation.

Usually at least one workman prunes from the ground. One of the most useful tools for general pruning is a lightweight lopper-type hand pruner about 24 inches long. This lopper is often the only pruning tool used by many successful peach growers. A small hand shear is also useful for pruning trees. Occasionally, a small saw is used.

SOIL MANAGEMENT

Good soil management is as important for keeping trees vigorous as is pruning. As mentioned earlier, a deep, well-drained soil of medium texture is highly desirable for peach growing. On nearly level orchard sites having this kind of soil and having adequate air drainage, control of soil erosion is not difficult. Soil management on more rolling sites requires careful attention (figs. 14, 15, and 16). To obtain good air drainage, peaches are usually planted on rolling to hilly sites, except in the mild climates of the Southeast, or where lakes give protection from unfavorable temperatures. On these upland sites,

FIGURE 14.—Sod strips across the slope in this young peach orchard protect the soil from erosion.

FIGURE 15.—Low soil terraces across the slope for each tree row help prevent soil erosion.

FIGURE 16.—A sod-mulch system as in this peach orchard prevents soil erosion on the steeper slopes.

the soil is frequently no more than 3 to 5 feet deep. It is customary to cultivate the soil of peach orchards early in the season to make nutrients readily available to the trees. This cultivation conserves moisture by killing weeds and other plants that compete with the trees for moisture. A ground cover of growing plants on an orchard site, however, may serve two important purposes—it supplies organic matter to the soil and it prevents loss of topsoil by erosion (figs. 17, 18, and 19). Tillage practices on any orchard site affect the soil and moisture conservation and the organic-matter content and fertility of the soil.

No fruit trees are affected more by lack of soil moisture and nitrogen than are peach trees. Peach trees root extensively, and the roots of trees planted 20 feet apart may meet after about 5 years. Cultivation breaks down the soil organic matter and thus releases the nutrients. The nitrogen released by cultivation often stimulates the trees as much as does an application of fertilizer. Before inexpensive nitrogenous fertilizers became available, cultivation for this purpose was invaluable. Now, however, it is preferable to add inorganic nitrogen and keep the organic matter on or in the soil as long as possible. This practice will control erosion most effectively, maintain soil porosity, and improve the general physical structure of the soil.

The Young Orchard

The first year after peach trees are planted, the orchard soil should be tended carefully to encourage adequate root and top growth. The soil around the trunks should be kept free from weeds during the growing season, especially in nonirrigated orchards. In the larger orchards, the soil along each side of each row should be cultivated to a distance of at least 5 feet (fig. 14). It is not necessary to cultivate all the area between tree rows. An

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FIGURE 17.—Rye cover crop in peach orchard ready for early spring disking.

FIGURE 18.—Rye cover crop disked down correctly so that much of it remains on the soil surface.

annual or biennial cover crop may be grown on the cultivated strips (fig. 17), and turned under to improve the soil. On sites that are low in soil organic matter and subject to soil loss through water runoff, cover crops in the young orchard are desirable because they check soil erosion and because incorporation of cover-crop residues makes the soil more porous. Cover crops should not seriously hinder growth of the young trees if they are confined to areas well beyond the spread of the tree branches. Avoid deep cultivation.

In orchards on level ground, it is often desirable to grow an intercrop the first 2 or 3 years. The trees are benefited by the cultivation of such a crop and by the fertilizer applied to it. In orchard sites having

FIGURE 19.—Clean cultivation during early summer often results in vigorous tree growth and large-sized fruit, but the soil can erode easily.

slopes, the intercrop should be planted across the slope, so that water collecting in and along the furrows made by tillage tools will not run off rapidly and carry away topsoil. In the second and third years, less space should be allotted to an intercrop than in the first year. Unless the trees are planted at least 25 feet apart in both directions, an intercrop should not be planted after the third year.

The Bearing Orchard

Cover crops.—Bearing peach orchards are cultivated less today than they were 25 to 30 years ago because of the use of cover crops.

Cover crops seeded in late summer that grow during fall or winter are best, because they do not compete with the trees at the seasons when the trees require the most moisture and nutrients. Rye (figs. 17 and 18) is perhaps the most commonly used cover crop for fall and winter. It resumes growing early in the spring and should be disked roughly before it begins to compete seriously with the trees. Sometimes cover crops that winterkill, such as spring oats and millet, are grown during late summer and early fall. Sometimes annual weeds are allowed to grow as cover crops during that period. The crops or weeds are allowed to remain over winter and are disked in early spring. Disking, however, should not be excessive, because it will destroy the value of a cover crop. To permit water penetration and to avoid soil erosion, as much as possible of the cover crop should be left on the soil surface (fig. 18).

In some locations and on certain soils, especially where soil erosion is likely, a summer cover crop such as soybeans, cowpeas, and crotalaria should be grown in addition to a fall or winter crop, even though it will compete with the trees and perhaps reduce the fruit crop. Summer cover crops such as late varieties of crotalaria and buckwheat make most of their growth after the Redhaven season varieties are harvested.

Cover crops should be fertilized according to the local practice. Often a "complete" fertilizer is applied when a cover crop is planted.

Although legumes have often been recommended as orchard cover crops because they add nitrogen to the soil naturally, their use for this purpose is too expensive.

Many commercial peach orchards are not seeded to cover crops, but weeds are allowed to grow in late summer and fall. Sometimes this system is fairly satisfactory, but a seeded cover crop will usually produce more organic matter for the soil.

Tests to determine the effects of disking rye cover crops at different stages of growth in a peach orchard showed that late disking intensified the red of Elberta peaches but had no significant effect on the color of some of the more highly colored peach varieties. Soil erosion was controlled more effectively by late disking of the cover crop than by early disking. Soil moisture and available nitrogen were reduced by late disking, but not enough to affect the size and yield of the fruit or the growth of the trees.

Where root-knot nematodes are harmful to peaches, nematode-susceptible cover crops such as cowpeas, vetch, rye, and Austrian winter peas should be avoided. Resistant crops, such as crotalaria in the later summer and oats in the winter, may be used. Native weeds allowed to grow during late summer after harvest and disked in midwinter are preferable to a cover crop susceptible to nematodes. Where nematodes are serious and soil erosion is not, clean cultivation throughout most of the year is recommended.

Damage from spring frost during the pink-through-bloom-and-petal-fall period is sometimes reduced by maintaining a hard, bare soil surface. In level peach-growing areas, such as the Coastal Plain, an orchard planted with a cover crop is sometimes 1° to 3° cooler than one without a cover crop. A recently cultivated orchard is just as subject to frost damage as is one planted with a cover crop. Bare, hard soil provides a heat reservoir from which heat is radiated at night. If the soil is covered by weeds, cover crop, or mulch, or if it has recently been cultivated, radiation is impaired. In level areas where spring frosts may occur, orchards are clean cultivated in midwinter or very early spring in time for rains to pack the soil well before frost danger.

Permanent or semipermanent crops.—Sod is sometimes used as a cover crop in peach orchards, but its use is not recommended because it often reduces the growth of trees and fruit. Where abundant water is available from rain, from irrigation, or from an unusually deep soil, a permanent cover is sometimes satisfactory. This is not true, however, in most of the Eastern and Southern States.

The use of soil nutrients by the sod is less serious than its use of water, since nutrients may be added as fertilizer. A nonlegume sod-covered orchard area requires about three times as much nitrogen as one under cultivation, because the soil uses so much nitrogen. A mulch helps conserve moisture in the sodded peach orchard (fig. 16). Peach trees, however, root extensively; and the sod may compete for moisture with roots as far as 12 to 15 feet away from the tree trunk.

Some peach growers use a sod cover but disk the sod well every few years. Others use sod strips across the slope between wide, cultivated peach rows (fig. 14). The sod strips control erosion, and cultivation reduces competition with the trees. The sodded strips provide useful surfaces for moving sprayers and harvesting equipment, especially during wet weather. Orchard sod should be fertilized and mowed occasionally.

In soil-management studies made at Beltsville, Md., over a 12-year period, cultivation of soil in peach orchards during the summer was more effective than use of a summer cover crop. Annual cover crops were more effective than were semipermanent sods of sweetclover or lespedeza. Soil moisture seemed to be the principal limiting factor. Either system of sod culture reduced tree growth and decreased yield and size of fruits, even in mature trees.

Some compromise between a system of clean cultivation and continuous use of sod is possible. Shallow disking two or three times a year is usually satisfactory. For best results, the needs of each orchard should be considered individually.

Soil and moisture conservation in peach orchards is very important. Contour planting is often necessary, and sometimes terraces are needed (fig. 15). Much depends on the soil type, the amount and distribution of rainfall, and the percentage of land slope. Soil and moisture losses are easily overlooked; it is wise sometimes to risk reducing tree growth for the sake of soil conservation.

FERTILIZERS

There are 12 known nutrient elements necessary for plant growth. The major nutrient elements, or macroelements, needed by peach trees include nitrogen, potassium, phosphorus, magnesium, and calcium. The minor nutrient elements, or microelements, include zinc, boron, maganese, copper, iron, sulfur, and molybdenum. A minor element is just as essential as a major one, but less of it is required.

Nitrogen remains the chief fertilizer element needed by peach orchards on most soils. Potassium is perhaps the next element most needed. The elements most needed, and the rates at which they should be applied, vary widely according to soil type and other factors.

A fertilizer program should be planned to cover the complete life of the orchard. A balance of all nutrient elements, but especially of nitrogen, potassium, and magnesium, is important. However, only those materials needed by the trees that are not supplied by the soil should be added. Usually fertilizers are applied to the soil, but some may be applied to the tree as foliar sprays.

Nitrogen

Nitrogen deficiency symptoms are small, pale-green leaves, sometimes yellow with red specks; short, thin shoot growth; and small, early-ripening, highly colored fruits. Lack of nitrogen absorption and translocation because of root or limb damage or poor soil drainage also produces these same symptoms.

For satisfactory tree growth and production, nitrogen should be added to soils in all peach orchards east of the Rocky Mountains. The amount needed varies considerably.

To obtain high-quality peaches, the soil nitrogen level should be neither extremely high nor extremely low. The level may be regulated somewhat by the use of cover crops as well as by the amount of nitrogen fertilizer applied and the time of application. For the brightest fruit color, the soil nitrogen level should never be extremely high. Where color is important, the nitrogen necessary for tree growth should be applied in the fall rather than in the late spring or early summer. The effect of nitrogen on color is important in such varieties as Elberta, Sullivan's Early Elberta, and Belle; but Redglobe, Dixired, and certain other varieties color well when relatively high soil and tree nitrogen are present. The time when nitrogen is available to the tree roots is the critical factor; this depends partly on when enough water is available to carry the soluble nitrogen to the roots. Treatments that supply abundant nitrogen in midsummer should be avoided.

A high soil nitrogen level in early spring is necessary for vigorous foliage growth and large peaches, but high available nitrogen in late spring delays fruit ripening.

In some orchards, nitrogen is the only fertilizer needed. Because the amount needed varies greatly, no specific recommendation can be made. Growth of the tree, together with yield, size, and quality of fruit, is the best criterion to determine required amounts of fertilizers, especially nitrogen. A suggested amount would be one-eighth of a pound of actual nitrogen per year of the tree's age, up to 1 pound per tree. For example, the 8-year-old tree would receive 6 pounds of nitrate of soda (16 percent nitrogen), 3 pounds of ammonium nitrate (33 percent nitrogen), or 2.2 pounds of urea (45 percent nitrogen). These nitrogen sources may be selected on the basis of availability and economy, since all are equally effective. High-nitrogen fertilizers are soluble in water and will penetrate to the tree roots soon after rain or irrigation.

The fertilizer should be spread evenly under the tree and should extend just beyond the tips of the branches. Cover crops are improved if the fertilizer is spread over a wider area throughout the orchard, but more fertilizer will be required per acre. A complete fertilizer is necessary in some areas. One pound of actual nitrogen is obtained in 10 pounds of a 10–10–10 fertilizer. Careful observation and advice of local extension or experiment station workers will help determine whether the phosphorus and potassium contained in such a fertilizer is economical.

Foliage sprays containing nitrogen for fertilizing peaches have been tested with little success. Peach leaves evidently do not absorb the nutrient as efficiently as do apple leaves.

Some successful peach growers apply nitrogen only in the late summer or fall. Others apply all the nitrogen early in the spring. Still others apply part in the fall and part in the spring. The loss of fruit color resulting from the second method depends on the variety, the soil type, and the amount of nitrogen used. With a potentially highly colored variety, a sandy soil, and a moderate amount of nitrogen, there may be no reduction in fruit color.

Tests with Elberta, Halehaven, and Triogem varieties at Beltsville, Md., emphasized the interrelations of variety, time of nitrogen application, and time of disking the cover crop.

When nitrogen was applied to trees in the fall, the fruit yield was reduced and the fruit ripened earlier than when it was applied in the spring, or when it was applied in three equal amounts in the fall, the spring, and the early summer. Yields were usually highest when nitrogen was applied in three equal amounts. The time of disking the rye cover crop had little effect on fruit yield of any of the three varieties studied. A full crop of Elberta peaches yielded more than did Halehaven or Triogem. Differences in fruit size due to fertilizer and disking treatments were not consistent. The Triogem peaches, however, were consistently smaller than those of the other two varieties. Fall fertilizing and late disking resulted in the deepest red skin color of Elberta peaches. The treatments did not seem to affect the color of Halehaven and Triogem peaches.

Fruit ripened earliest when fertilized in the fall, but time of ripening was unaffected by disking time. The leaf-nitrogen content in August was greater when fertilizer was applied in the three equal installments than when it was applied in the fall. Time of disking the rye did not affect the nitrogen content of the leaves, which was relatively high regardless of treatments.

The divided applications of nitrogen are especially useful on sandy soils subject to rapid leaching of moisture and nutrients. Also, divided applications allow for better nutrient management based on crop needs. For example, if the fruit set after bloom is heavy, more nitrogen can be applied than if there is a light set following a severe frost. In the southern areas, at least part of the annual nitrogen required can be applied just after harvest. However, in the northern areas, nitrogen applied after harvest may increase winter injury.

Potassium, Phosphorus, Magnesium, and Calcium

There is almost as much potassium as nitrogen in peach leaves. In many peach-growing areas, trees get as much potassium as they need without fertilizing. In some areas, such as much of the Atlantic Coastal Plain extending from New Jersey to Florida, trees often require additional potassium. In other areas, the need for potassium fertilizer for peaches varies. Severe potassium deficiency causes slender shoot growth, and rolling, puckering, and marginal burn of leaves (fig. 20). Mild deficiency, however, reduces fruit size and yield. In early spring, potassium may be applied to the soil surface under the tree at the rate of 2 to 4 pounds of either muriate or sulfate of potash. It can be applied also in a complete fertilizer such as 10–10–10.

Phosphorus in peach-orchard soils is often low, but it is rarely necessary to add any for the peach tree. Peaches, as well as other fruits, are able to obtain the phosphorus they require where annual crops will show a severe need for phosphorus fertilization.

FIGURE 20.—Potassium-deficient peach leaves. Left to right: Leaves with increasingly severe symptoms of potassium deficiency.

Magnesium deficiency in peaches (fig. 21) is found mainly in the sandy Coastal Plain soils, especially following heavy potassium fertilization. The first indication of this deficiency is a light yellowing between veins of the leaf. In severe cases, death of the yellowed areas is accompanied by a marginal leaf burning. Usually the more basal leaves are affected first. Foliar spraying with about 10 pounds of magnesium sulfate (Epsom salts) per 100 gallons of water usually gives prompt control. Application of dolomitic limestone to the soil at about 2 tons per acre will often control the deficiency within a few years.

Calcium is sometimes needed as a fertilizer for peaches, especially in Coastal Plain soils where large amounts of sulfur have been used to spray peaches for disease control. Calcium reduces soil acidity, and this, in turn, increases the availability of many soil elements and root growth (fig. 22). Although peach trees grow well in acid soils, the pH should not be below about 4.5. Very high soil calcium reduces absorption of potassium and magnesium by the roots. Soil acidity can be corrected

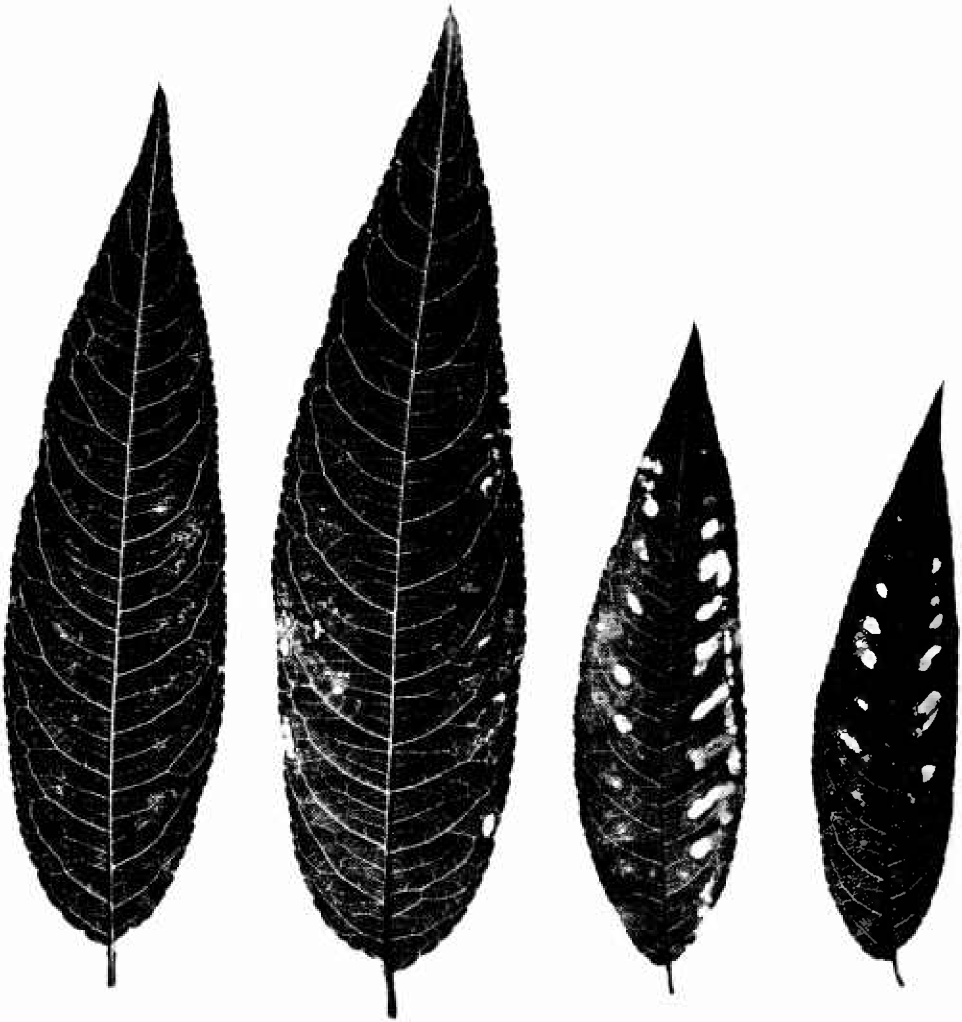

FIGURE 21.—Left to right: Increasingly severe symptoms of magnesium deficiency in peach leaves.

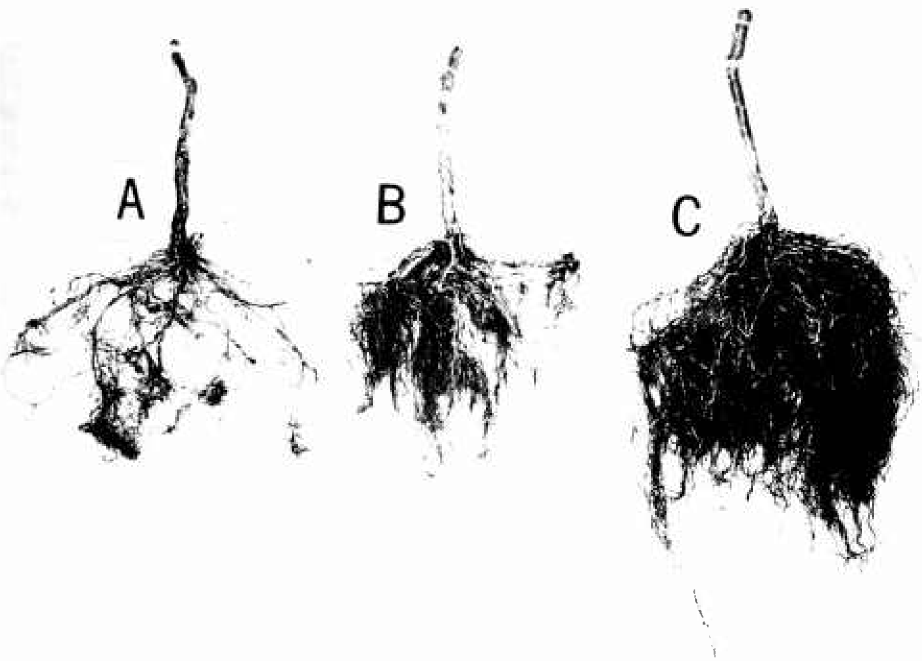

FIGURE 22.—Effects of (A) low, (B) medium, and (C) high levels of calcium on peach roots grown in orchard soils at Beltsville, Md.

by adding limestone according to local recommendations.

Zinc, Boron, and Manganese

Zinc deficiency sometimes occurs in peach trees grown in sandy soils of the Carolinas and Georgia, but it is much more common in the Western States. Symptoms of this deficiency are light yellow, wavy, and crinkled leaves, with rosettes at the tips of the twigs. In severe cases of zinc deficiency, leaves are very small.

Boron deficiency causes twig death, lack of bud growth, and sometimes dark-brown cork spots in the fruits. It occurs only occasionally in Eastern United States.

Manganese deficiency causes light-yellow areas between the veins of the younger leaves toward the tips of the shoots. Deficiencies in all these microelements can usually be corrected by foliar sprays used according to local recommendations.

Copper, iron, sulfur, and molybdenum usually occur in ample quantities in most orchard soils.

All the chemicals mentioned are assumed to be caustic and poisonous; some are flammable. They should be kept dry and handled with care to prevent fire or explosion.

IRRIGATION

Many peach orchards east of the Rocky Mountains are now irrigated. Increased efficiency in pumping and sprinkling equipment has aided greatly in making orchard irrigation economically practical. Many successful peach growers in the East now consider irrigation an essential part of their soil management program. Irrigation is planned and used according to needs of the trees and capacity of the soil.

A short period of dry weather, especially during the final month before harvest, will sharply reduce fruit size and quality of peach trees growing in shallow soil. Low soil moisture during early summer affects fruit size and yield and also affects next year's crop by reducing the terminal growth of shoots and by weakening the trees. Peaches from irrigated trees ripen a few days earlier and ripen more uniformly than do those from nonirrigated trees.

In most of the Eastern United States, winter rains fill the soil to its maximum water-holding capacity by spring. Thus, peach trees start the growing season with adequate moisture. The amount of water the soil can hold depends mostly on soil texture and depth. This varies from about 1 acre-inch of water per foot for sandy-loam soils to about 2 acre-inches per foot for clay loams. Thus, if the root-depth zone is 4 feet in a silt-loam soil, there will be about 6 acre-inches of water available in the spring. Eastern peach orchards use about 3 acre-inches of water per month during the growing season. Thus, the available soil water would last about 2 months without additional rain. Peach trees need water most during the month just before harvest, when the moisture requirement for fruit size is greatest.

Development of a water supply and cost of equipment and maintenance are expensive. Irrigation will be least economical where the root depth is great, the soil is fairly heavy, and an early ripening peach variety is grown. But where a good supply of water is available at moderate cost and the root depth is as shallow as 2 to 3 feet, irrigation should increase peach production in most years.

If rainfall has averaged less than 1 inch per week for about 3 weeks, irrigation may be needed, especially close to harvesttime. When irrigating, completely wet the soil to the root depth. Light, sandy soils may lose nutrients because of too much irrigation, but they need more frequent irrigation than do heavier soils. Irrigating any soil too much or too often can damage peach tree roots. Learning to irrigate properly requires careful study and much experience.

THINNING THE FRUIT

Fruit thinning is necessary to produce high-quality peaches, especially in years of heavy crops. The extent of thinning depends somewhat on the potential size of the mature fruit of the particular variety. In general, the smaller the normal size of the fruit at maturity, the wider the spacing to which the fruit should be thinned on the twigs. The correct thinning distance depends partly on the leaf area per fruit and the general vigor of the tree. It takes about 35 healthy, average-sized green leaves to produce a peach of good size and quality. In thinning, only one peach should be left to every 6 or 8 inches of twig. Although this may seem drastic and expensive, it must be remembered that small peaches are often hard to sell. Also, thinning lessens the harvesting work and the danger of limbs breaking under the weight of fruit.

Thinning According to Variety

With the early ripening peach varieties that tend to set a heavy load of fruit, thinning well before the June drop greatly increases fruit size and earliness of ripening (fig. 23). These early ripening varieties have a much shorter period of fruit development than do Elberta and the later ripening varieties. Varieties that particularly benefit from early thinning include Mayflower, Earlired, Cardinal, Coronet, Redhaven, Golden Jubilee, and Triogem. With these early ripening varieties, early thinning of fruit increases not only fruit size but also quantity of young-shoot growth and leaf size.

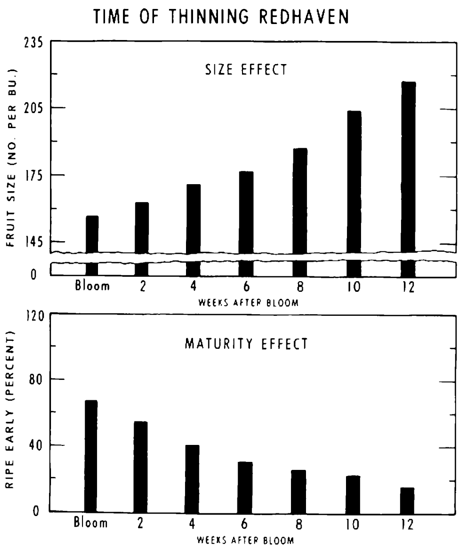

FIGURE 23.—Effects of time of thinning on fruit size (top) and maturity (bottom) of Redhaven peaches. Each successive thinning period caused smaller and later ripening peaches.

For many early ripening varieties, if thinning is delayed much after the pits begin to harden, the final size of the fruit may not be greatly increased. This is especially true if dry weather prevails during the early part of the growing season and at harvesttime. Growers must determine if the greater value of the larger fruits justifies the expense of early thinning.

With midseason and later varieties, the usual practice is to wait until after the first drop and then remove many of the small and imperfect fruits. Experiments with Elberta peach trees have shown that if the fruit set is only moderate and the drop in June is fairly heavy, thinning done as quickly as possible after the June drop usually results in fruits of good size and color. If thinning is delayed until well along in the pit-hardening period, it still has a beneficial effect on the final size of the fruit. If thinning is done as late as the period of final swell, it still increases the size of the remaining peaches.

Elberta trees bearing a large crop should be thinned just as soon as possible after the first drop. When thinning is done quickly near the end of the first growth period (before pit hardening), the result is almost as satisfactory as it is with earlier thinning. The cost is much less, because some of the peaches will drop anyway.

Amount To Thin

How many peaches should be removed from a tree by thinning depends chiefly on the size of the tree and its bearing capacity. If a tree cannot bear more than 1 or 2 bushels, only enough of the peaches that can develop to desirable size (those with a diameter of 2¼ to 2½ inches) should be left to make up this quantity. When a tree has a uniformly heavy set of fruit, it can be thinned to a fixed spacing, such as 6 to 8 inches along the twig. Usually, it is best to thin not according to a fixed spacing but according to leaf area, tree vigor, and bearing capacity. After a spring freeze, sometimes the only blossoms left alive are those at the bases of terminal shoots. When this happens, the fruits are not thinned even where they touch each other, because the leaf area is sufficient for all.

Methods of Thinning

Where labor costs are high, peach growers may choose to reduce the number of peaches that will be produced on their trees by pruning off a large number of shoots either before or at blossomtime. In localities where spring frosts occur, some detailed pruning may be postponed until blossomtime, when crop prospects are more certain.

Recently, because of high labor costs, considerable thinning has been done by rapid mechanical methods rather than by the older hand method. Some growers now use poles 4 to 8 feet long or longer, with about 12 inches of hard rubber hose over one end. With such poles, the excess fruits are removed by tapping the branch or twig first at right angles and then lengthwise. Wire or brush brooms are sometimes used to thin peach blossoms, especially those of early ripening varieties.

Several types of chemical sprays have been tested, some of which thin late and after danger of frost. However, none is dependable enough to be recommended for practical use. Elgetol is one of the chemical thinning sprays that has been used extensively, although its results are not always reliable. If Elgetol is used, spraying should be done at full blooom. The suggested strength is 1 pint of Elgetol per 100 gallons of water.

Blossoms should not be thinned by any method if it is likely that some may be killed by frost. The most experienced growers prefer to do only part of a necessary thinning by mechanical methods and then to follow up with hand thinning.

LOW-TEMPERATURE INJURY

Low-temperature injury is one of the greatest problems of peach growers in both the North and the South. Almost every year, serious winter injury of peach trees occurs in one or more sections of the country (fig. 24). Often winter injury is not recognized as such, for it can occur when temperatures have not been unusually low. For example, rapid drops in winter temperatures from about 70° F. during the day to about 18° F. at night have caused severe damage to peach tree wood in southern areas. In northern areas, the damage is likely to occur only at much lower temperatures; and dormant flowerbuds are affected before the wood is. A rapid drop to temperatures below −15° F. often injures twigs and trunks as well as buds. Sometimes, in peach orchards having no ground cover, prolonged low temperatures damage even the tree roots.

In both northern and southern peach-producing localities, winter injury seems to be least among moderately vigorous trees that grew well the previous season and that were not weakened by poor drainage, loss of leaves, borers, nematodes, or other factors.

Injury to Buds

The most common type of winter injury to peaches in the Northern States is killing of dormant flowerbuds. Leafbuds are seldom injured. There is no fixed minimum temperature at which dormant flowerbuds are destroyed. Much depends on the tree growth during the previous growing season, age and vigor of tree, variety, state of flowerbud development, rapidity of temperature drop and time of its occurrence, and duration of the low temperature. During midwinter, the critical low temperature for Elberta peaches is about −10° F. However, a rapid drop in temperature after a warm period can lead to budkilling at temperatures much higher than −10°. Conversely, buds have some-

FIGURE 24.—Winter damage, primarily on the southwest side of the tree trunk and lower parts of scaffold limbs, caused by rapid temperature changes. Reflection of sun by snow causes surface temperatures considerably above air temperature.

times survived temperatures below −15° in midwinter when the drop was slow and when it followed a period of relatively cold weather.

Differences in flowerbud hardiness between peach varieties sometimes mean the difference between a good peach crop and no peach crop. Elberta and J. H. Hale are two of the more tender varieties. Rochester, Veteran, Cumberland, and Erly-Red-Fre are among the more hardy varieties. Halehaven, Golden Jubilee, and Redhaven may be classed as fairly hardy. Some varieties such as Ranger, Redhaven, and Cumberland often bear fair-to-good crops after large percentages of the buds have been killed, because they characteristically have large numbers of buds per foot of twig length. Some varieties have so few buds that killing even a small percentage may make a good crop impossible.

Usually there is greater bud mortality on trees having weak growth. Even where there is some difference in tree growth because of different fertilization, however, there is often little or no difference in bud survival during midwinter.

In many parts of the country, especially in the Central and Southern States, damage often results from low temperatures during or after bloom. As flowerbuds develop in the spring, they quickly become more sensitive to cold. Just before they open, flowerbuds will survive temperatures of about 20° to 23° F. The lowest temperature flowers will withstand at full bloom is about 26°. Ten days to 2 weeks after bloom, they will withstand only about 28°. Buds and flowers will survive temperatures slightly lower than these if the drop is very slow and if the minimum temperature continues only for a very short time.

Accurate thermometers should be used in the orchards. Early spring temperatures, especially on hillsides, are not uniform even at points only 50 feet apart. The higher part of a sloping site is usually much warmer than is the lower part, since cold air drains downward. A 50-foot difference in elevation on a hillside may mean a difference of as much as 5° F. in minimum temperature on a still night.

Injury to Twigs, Branches, and Trunks

Even in some of the most southern peach areas, and during mild winters, wood killing is often serious. Injury is caused by rapid drop in temperature and by immaturity of new wood growth produced in late summer or early fall from the stimulation of high soil nitrogen content, recent heavy pruning, or other factors. Peach trees develop resistance to cold only if they are exposed gradually to low temperatures. Trees that have grown poorly for any reason are especially subject to winter injury to trunks and branches. Weak growth and the resulting winter injury are caused by poor soil drainage, nematode injury to roots, low soil fertility, insect damage, and disease. The critical temperature at which wood injury may occur is not specific. Serious trunk damage has resulted from −20° F. temperature in northern areas during certain years. In both northern and southern peach-growing regions, the least low-temperature damage seems to occur in trees of moderate vigor and where there are no sudden changes in temperature.

Even though wood appears to have been damaged by winter cold, much of it may survive if the trees are not pruned too early or too severely and if readily available nitrogen is applied to the soil at a somewhat heavier than usual rate. If bark on the trunk is found to be loose after a severe drop in temperature, it should be tacked in place immediately. This sometimes prevents the bark and wood from drying out, and it may hasten healing. When large branches or trunks have been severely damaged, the injured parts should be painted with a standard tree paint—white lead and raw linseed oil, or a liquid (brush) grafting wax.

Injury to Roots

Cold injury to peach tree roots is often overlooked or disregarded. Winter injury to roots is usually more severe in light, sandy soils and after prolonged cold. It is much worse where there is no snow or other covering on the ground. Cover crops are valuable in preventing this type of injury. In addition to directly insulating the roots from cold, cover crops tend to hold protective snow in place. After severe damage to roots, tops should be given a moderately heavy pruning.

Although freezing of orchard soil may not kill tree roots, it may retard their absorption of water during the winter. Trees grown in light, shallow soils in more northern States are, of course, most likely to be injured by soil freezing.

HARVESTING, TRANSPORTING, AND STORING FRUIT[6]

The peach grower's choice of a time to pick his crop depends largely on how he intends to market it. The current trend is to pick more mature peaches than formerly because their eating quality is better. If peaches are to be trucked to nearby markets, they may be al-

[6] This section was originally prepared by M. H. Haller. Revised by W. H. Redit, and W. L. Smith, Jr. Market Quality Research Division.

lowed to become nearly ripe on the trees. For shipping greater distances, most peaches are picked in the firm ripe stage and precooled before shipment. During transit, this fruit should be maintained at or below the precooling temperature to delay ripening and thus reduce bruising. Because peaches mature unevenly, it is usually advisable to make several pickings, beginning with the largest, best-colored fruit. For freestone varieties, standards of maturity are based on the change of ground color from green to yellow and on flesh firmness, as determined by using a Magness-Taylor pressure tester (fig. 25). Elberta peaches testing 10 to 14 pounds with a $5/16$-inch-diameter plunger applied to the pared cheeks will hold up in refrigerated shipment for several days and will ripen with satisfactory dessert quality. For nearby marketing, less firmness may be desirable. About the same range in pressure testing is satisfactory for many varieties other than Elberta.

Drop-bottom picking bags are now widely used for peaches. Padded, drop-bottom picking buckets (fig. 26) afford greater protection from bruising. Pickers should exercise great care in handling peaches to avoid bruising the fruit and breaking the skin. They must be careful not to drop fruit, either when placing it in picking buckets or bags or when transferring it to field crates. Picked fruit should be left in the shade of a tree until it can be hauled to the packinghouse.

Tub baskets, particularly the ¾-bushel size, with vented liners and cushioning pads are the most commonly used shipping containers for eastern peaches. However, they have these undesirable features: Peaches in the bottom, especially if they are ripe and soft, are likely to be bruised and mashed by the weight of those above them; peaches on the top are often cut and brused by the rim of the lid; and tub baskets are not rigid and do not stack well. Peaches in these baskets are usually "faced," which adds considerably to the cost. To meet the demand of "nonfacing" and to try to reduce bruising, a new type of tub

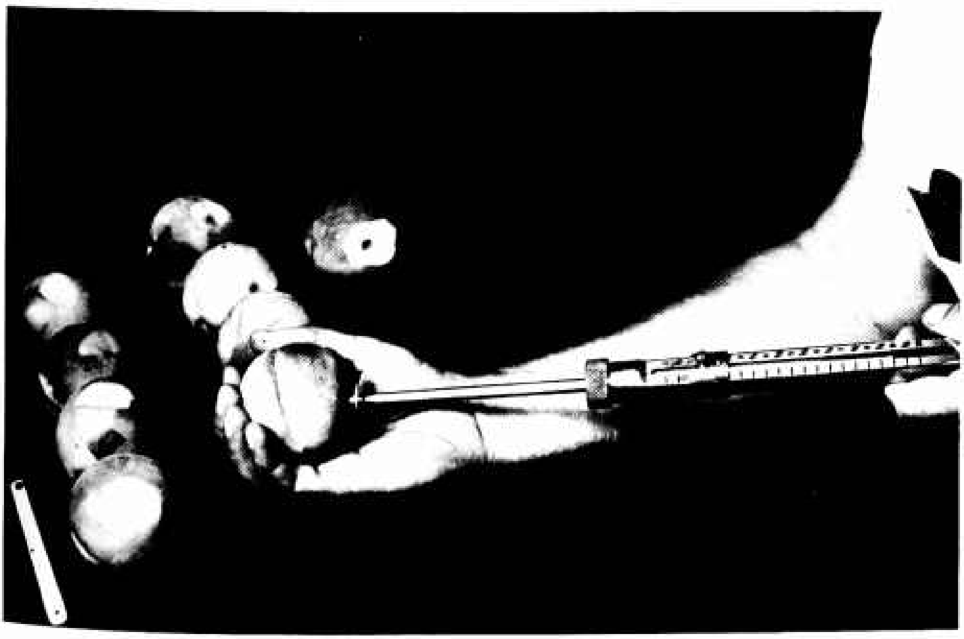

FIGURE 25.—Pressure tester used to determine maturity of peaches.

FIGURE 26.—Harvesting peaches in a drop-bottom picking bucket designed to prevent bruising.

basket, the "flat-top" or "Pallet-Pak," also has been widely tested. This basket has no handles. The sides are raised and the lid is placed so as to prevent the normal bulge present in the conventional tub basket. Stacking quality is improved, also.

Wirebound crates have been tested, and some are gaining popularity in many areas. The advantage of these containers over tub baskets, is that fruits are packed in bulk without "facing," which reduces the cost of filling. Some reports indicate there is less bruising in these containers than in tub baskets. The Spartan wirebound crate was the first of this type of container tested. Although it was once used extensively, its present use is limited. The Du-All, another type of wirebound crate, has the sides and bottom lined with chipboard. The ends and a partial telescopic cover are made of paraffin-impregnated fiberboard. At present, the Du-All is second only to the tub basket in popularity as a peach-shipping container.

Fiberboard cartons with telescopic lids also have been extensively and, in some areas, successfully tested. Most of these containers however, will not withstand hydrocooling. To eliminate the effects of wetting the fiberboard cartons currently in use, many growers are hydrocooling the fruit in field boxes or in bulk hydrocoolers before packing in shipping containers.

The use of paper or plastic cup trays in fiberboard cartons is becoming increasingly popular for shipping large and fancy peaches. These trays also reduce transit bruising of softer fruit harvested at a riper stage. Such fruit requires precooling before packing in these trays.[7]

At the high outdoor temperatures that prevail during the peach-marketing season, picked fruit ripens rapidly. Peaches picked at the shipping stage of maturity become eating ripe in 2 to 4 days at temperatures of 70° to 80° F. Ripening proceeds about half as fast at 60° as it does at 70° to 80° and about half as fast at 50° as at 60°. At 60° and above, peaches ripen with good aroma and flavor. If they are held at 50° until ripe, the flavor is undesirable. At 40°, ripening proceeds about half as fast as at 50°, and the peaches usually break down internally before they become fully ripe. Temperatures of 36° and 32° hold ripening practically at a standstill. After being exposed no longer than 1 week to 50° temperature or lower, peaches will ripen normally at room temperature. After exposure for 10 days or longer to temperatures between 36° and 50°, peaches are likely to break down internally or to become mealy or off-flavored if ripened at room temper-

[7] For detailed instructions on grading and packing peaches, see U.S. DEPT. AGR. 1960. PREPARING PEACHES FOR MARKET. Mktg. Bul. 9, 21 pp., illus.

ature. Peaches can be held somewhat longer at 32° than at 36° to 50° without losing the capacity to ripen normally when exposed to ripening temperatures.

Peaches are sometimes stored for short periods to extend the marketing season and the commercial canning season. Fruit that is to be stored should be cooled to a temperature of 31° or 32° F. promptly after picking. Even under the most favorable conditions, peaches cannot usually be stored longer than 2 to 3 weeks. Loss of the capacity of stored peaches to ripen with good dessert quality and without breakdown cannot be readily determined by casual inspection. The proper time for bringing fruit out of storage and marketing it must be determined by experience with the variety. The storage life of J. H. Hale peaches cooled promptly to a temperature between 31° and 32° may be 3 or 4 weeks. That of Elberta, Redhaven, and Golden Jubilee peaches similarly cooled is 2 to 3 weeks.

Peaches freeze at about 30° F. To allow for cold spots in the storage room and to provide a margin of safety, peaches should not be held in a room with an air temperature lower than 31° or 32°.

Because of the influence of temperature on ripening, peaches should be moved to market rapidly and under the coolest possible conditions. However, if they can be delivered to market the morning after they are picked, an unrefrigerated truck is usually satisfactory. Nearly all peaches harvested in the Southeast and a great many in the East and Middle West are now being hydrocooled before shipping. Most peach hydrocoolers are ice refrigerated, but the use of mechanical refrigeration is steadily increasing. The hydrocoolers are installed in the packinghouses as part of the packing lines. Peach containers are moved through the hydrocooler under a flood of cold water (fig. 27). The water should be maintained as close to 32° as possible by proper refrigeration. The rate of cooling is affected by size and initial temperature of the fruit, by water

FIGURE 27.—Typical peach hydrocooler in operation. (Courtesy of Food Machinery and Chemical Corporation, Lakeland, Fla.)

temperature, and by time in the cooler (controlled by varying the conveyor speed). Fruit temperatures can be reduced 20° to 30° in 10 to 15 minutes. Wooden containers, such as wirebound crates and baskets, are satisfactory for hydrocooling. But, as previously stated, fiberboard cartons must be treated or made of moisture-resistant materials to successfully withstand wetting. Bulk hydrocoolers have recently become available and are being used to a limited extent, usually when peaches are to be packed in the plastic cup trays or in fiberboard boxes.

Ice-refrigerated trucks or trailers used for shipping peaches should be equipped with proper air circulating fans or blowers. They should have floor racks or stripping, and all doors and vent covers should be fitted tightly to minimize air leakage. Floors should be cleaned before loading. From 1 to 3 inches of insulation is necessary. Enough ice must be maintained in the bunkers to insure a temperature of 50° F. or lower during transit. Fan-equipped refrigerator cars should be used and moved with the fans in operation. When a car is held on track at destination for more than a few hours, electric hold motors should be attached to operate the fans. Fan operation will maintain more uniform load temperatures and prevent undue ripening that would occur in warm spots in the load.

Mechanically refrigerated cars and trucks are more desirable because they provide better control of transit temperatures than do ice-refrigerated vehicles.

In areas where hydrocooling is not available, peaches should be room precooled or precooled in ice-refrigerated cars by operating car fans with special electric precooling motors or by the use of portable precooling fans installed temporarily in the top bunker openings. Up to 4 percent of salt should be added to the ice to increase the cooling rate. Such car precooling may be done to advantage only if facilities are available for replenishing the ice in the bunkers promptly after precooling, in order to maintain during transit the low temperatures established by the precooling. Portable, mechanically refrigerated units may also be used for precooling in cars or trucks. By these different methods, it is possible to lower the average temperature of a load of peaches about 20° to 25° F. in 5 or 6 hours.

Warm peaches loaded in mechanically refrigerated cars or in the new thermostatically controlled ice-refrigerated fan cars with continuously running, power-operated fans may be cooled in transit without being held on track at loading point for precooling, as is required with conventional ice bunker fan cars. Since mechanical cars are usually not designed for rapid cooling, it takes from 18 to 36 hours to reduce the fruit temperature to 50° F. However, with proper thermostat setting, lower temperatures can eventually be reached and maintained in transit in these cars than can be obtained in the conventional iced car.

In most peach-producing regions, the development of decay during marketing is a serious problem, particularly in seasons when rainfall and humidity are high at or near the harvest period. The two principal decays of peaches are brown rot and rhizopus rot (fig. 28). Both decays are caused by fungi. Brown rot occurs chiefly in the orchard, and how much brown rot occurs in peaches after harvest depends largely on how well the rot has been controlled in the orchard by spraying and sanitary measures. Indications also are that, unless the hydrocooler and hydrocooling water are kept clean, the hydrocooling operation may serve as a method of inoculating peaches with spores of the

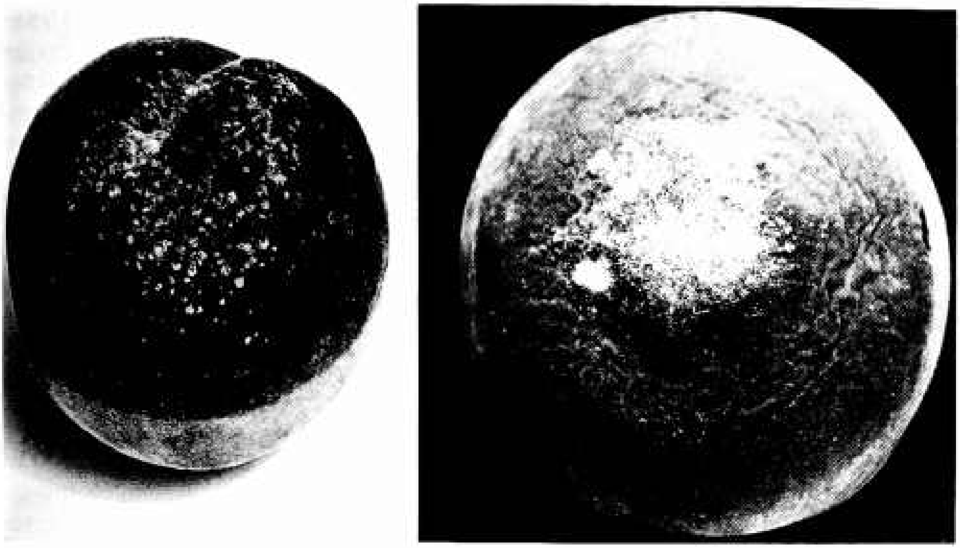

FIGURE 28.—Postharvest decays of peaches. Left, brown rot; and right, rhizopus rot.

brown rot and rhizopus rot organism. Rhizopus rot usually occurs during harvest, in packinghouses, or in transit. At temperatures of 60° to 80° F., both brown rot and rhizopus rot develop and spread rapidly. Both can usually be checked by cooling the peaches as soon as possible after harvest and keeping them at temperatures below 50° throughout the marketing period. Since ripening also is retarded by these temperatures, there must be some point during marketing or after the peaches reach the consumer when they must be exposed to temperatures high enough to ripen them. At such temperatures, decay will develop rapidly. Therefore, although low temperatures during transit and marketing may make it possible to market the fruit before decay becomes serious, they do not reduce the total amount of decay that can develop in the fruit by the time it has been ripened enough to eat. For this reason, other means of controlling decay are necessary.

During hydrocooling, the ice-water treatment by itself only temporarily slows the growth of decay-producing organisms. To prevent the increase of these organisms in the hydrocooling water, chlorine in the form of calcium or sodium hypochlorite at concentrations of 100 to 120 parts per million is usually added to the water. However, this chemical is not very effective in preventing the development of brown rot originating from orchard infection. The effectiveness of this chemical in preventing a buildup of organisms in hydrocooling water is greatly reduced if the hydrocooler and the hydrocooling water are dirty. Other chemicals that effectively reduce these rots have been found, but no satisfactory method of applying them commercially has been developed.

Recent tests have shown that both brown rot and rhizopus rot were effectively reduced when peaches were treated in water at 130° F. for 2 to 3 minutes. The use of hot water to reduce these decays, however, is still in the experimental stage, although it was used successfully in one packinghouse in 1963 and 1964. The temperature of the water and the length of exposure are critical. A long exposure or water temperature much above 130° may seriously injure the fruit. Skin mottling of some varieties occurred even with the recommended treatment. Therefore, low temperatures are still the most effective means presently available for delaying the development of decay during marketing.

DISEASES CAUSED BY FUNGI AND BACTERIA [8]

The principal fungus and bacterial diseases of peaches grown east of the Rocky Mountains are brown rot, scab, and bacterial spot. These three widely distributed diseases frequently cause heavy losses to peach growers, shippers, and consumers. Other fungus and bacterial diseases of peaches in this region include leaf curl, rust, constriction, crown gall, powdery mildew, root rots of various types, and dieback.[9]

Brown Rot

Brown rot, the common rot of peaches, starts frequently at an insect puncture as a tiny, circular, brown spot on green or ripening fruit. It is sometimes referred to as gray mold and ripe rot. The surface area affected enlarges rapidly. The rot penetrates deeply in the flesh of the peach. Although the entire peach becomes rotted, it usually retains its form and remains attached to the tree for some time. It then either falls or, if retained on the tree, gradually shrinks and dries into a hard brown to black mummy. Masses of ash-colored spores are produced on the rotted surface; this gives the peach a brownish-gray appearance (fig. 29). These spores, known as conidia, may be carried by insects, birds, wind, or splashing raindrops—or even by man—to nearby healthy peaches, which they infect.

FIGURE 29.—Peaches covered with spores of the brown rot fungus. The infection spreads to the twig from the blighted blossom still attached to it, and to the fruit from the twig.

[8] This section was prepared by H. L. Keil, Crops Research Division.

[9] The organisms causing diseases mentioned are as follows: Brown rot, *Monilinia fructicola* (Wint.) Honey; scab, *Cadosporium carpophilum* Thuem.; bacterial spot, *Xanthomonas pruni* (E.F. Sm.) Dows.; leaf curl, *Taphrina deformans* (Berk.) Tul.; rust, *Tranzschelia discolor* (Fckl.) Tranz. & Litv.; constriction *Fusicoccum amygdali* Del.; crown gall, *Agrobacterium tumefaciens* (E.F. Sm. & Towns.) Conn.; powdery mildew, *Podosphaera oxyacanthae* (DC.) DBy, and *Sphaerotheca pannosa* Wallr. ex Lev; root rots, *Armillaria mellea* Vahl ex Fr. and allied fungi. *Falsa leucostoma* Pers. ex. Fr., *Polyporus palustris* Berk. & Curt. and *Stereum complicatum* (Fr.) Fr., and other fungi are commonly associated with dieback.

If peach mummies are allowed to remain on the tree, the fungus may grow into the twigs and cause cankers, which may girdle and kill the twigs. In the South, mummies that remain on the trees rarely carry the fungus through the winter. In the North, however, mummies left on the trees over winter often produce numerous fungus spores the following spring (fig. 30).

FIGURE 30.—Peach mummies producing spores (conidia) of the brown rot fungus.

These spores may be carried to peach blossoms and may infect them. This produces the phase of the disease known as blossom blight. Mummies clinging to the tree should be removed and destroyed in the fall or winter. If mummies are allowed to accumulate under the trees and become partly buried, they frequently produce goblet-shaped fruiting bodies (fig. 31) known as apothecia, which shoot spores of another kind (ascospores) in the air. These spores, like the conidia, may infect blossoms.

Only occasionally does the brown rot fungus destroy enough blossoms in a peach orchard to thin the crop too much. But even a scattering of blighted blossoms through the trees seriously threatens the crop's safety. The fungus may attack any part of the blossom and cause it to turn gray or light brown. The blossom is soon covered with the gray spores of the fungus, if wet weather prevails. From the infected blossom, the fungus may penetrate the twig, kill twig tissues, and produce a canker. Gum oozes from the twig canker and causes the blighted blossom to adhere to the twig (fig. 32). The blighted blossom produces masses of conidia during the current growing season and sometimes even the following season. Thus, it serves as a source of infection to the ripening fruit.

FIGURE 31.—Goblet-shaped fruiting bodies (apothecia) developing from partly buried peach mummy.

Brown rot may be controlled by removing rotted fruit from the trees and by removing mummies from the ground or by cultivating underneath the tree to prevent the brown rot fungus from fruiting on old mummies left on the ground. The trees should be properly pruned so that they can be sprayed thoroughly. The fruit should be thinned to reduce spread of the disease from infected to healthy peaches. Insects such as the plum curculio and the oriental fruit moth, which puncture fruits and provide entrance for brown rot spores, should be controlled. The fruit should be sprayed or dusted at regular intervals during the season.

FIGURE 32.—Gum oozing from brown rot twig canker.

The best way to control brown rot is by spraying or dusting.

Until a few years ago, sulfur was the most widely recommended chemical for controlling brown rot. Recently, however, sulfur has been partly replaced by organic chemicals such as dichlone and captan. Dichlone (50-percent wettable powder) applied during the early bloom stage at one-fourth and one-half pound per 100 gallons of water effectively reduces blossom blight infection and the resulting twig cankers. Dichlone, however, should not be used following bloom because it may injure the fruit. Captan, although somewhat more expensive than sulfur, has proved less injurious and is more effective in controlling the disease. The materials, concentrations, and number of applications recommended vary among different localities. Growers should consult their State agricultural colleges for local recommendations.

In general, sulfur (6 pounds per 100 gallons of water) or captan (2 pounds per 100 gallons of water) should be sprayed or dusted five to eight times a season, depending on the variety and on the weather, at the following intervals: (1) During pink bud before the blossoms open; (2) at blossom time; (3) when three-fourths of the shucks have dropped; (4) 10 days after shuck spray; (5) 10 days after the fourth application; (6) 2 weeks after the fifth application; (7) 2 weeks after the sixth application; and (8) 2 to 3 weeks after the seventh application. Sprays or dusts should be applied frequently enough after the fifth application to maintain adequate protection against brown rot. Dusts are sometimes used just before harvest because they do not leave an objectionable deposit, which sprays sometimes do. Recently, growers have successfully stored peaches longer by dipping harvested fruit in a water-captan suspension.

Tests have shown that brown rot is not so much of a problem if the plum curculio and oriental fruit moth are kept under control. (See section on "Peach Insects," p. 67.)

Scab

Scab, known also as black spot or freckles, is a fungus disease of peaches in which circular spots one-sixteenth to one-eighth inch in diameter appear on the fruit usually near the stem end of the exposed surface (fig. 33). These spots are faintly green at first but soon become olive green to black, with well-defined margins. When numerous, the spots run together and form a large, black, scablike area involving as much as half the surface of the peach. The scabby area frequently splits open; this exposes the flesh, which may then be infected by

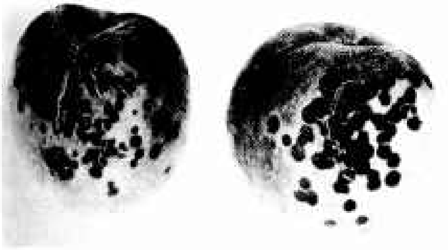

FIGURE 33.—Scab spots on peaches, showing the cracking that often develops when the spots are numerous.

spores of the brown rot fungus or rhizopus rot fungus. Where scab infections are numerous, the fruit is likely to be so stunted and misshapen that it cannot be used.

The scab fungus attacks tender green shoots of the current season, producing small, brown, oval cankers that frequently have purplish borders. These cankers are seldom more than one-eighth inch long, and they extend only slightly below the surface. They rarely cause serious weakening of twigs, but the fungus in them may remain alive during the winter and produce spores the following spring that may infect the new crop of fruit. Lesions, which at first may be pale green and eventually become dark green, may also be found on the under surfaces of leaves. Only in extremely severe cases does defoliation occur.

Scab can readily be controlled by applying sulfur as either a spray or a dust. The spray must be applied 2 weeks after the shucks have dropped from the peaches and again 2 weeks later. Because scab spots have not appeared on the fruit, growers may think their crops are safe from the disease. This is not always true, because infections occur early in the season and the fungus grows so slowly that spots are not visible until 40 to 60 days after infection. When the spots do appear, it is usually too late for spraying or dusting.

Captan will control scab, but it is not so effective as sulfur, especially if used at concentrations of less than 2 pounds per 100 gallons of water. For this reason, sulfur should be used when feasible.

Bacterial Spot

Bacterial spot, sometimes called bacteriosis, bacterial shot hole, or just shot hole, results from entrance of a certain kind of bacteria into uninjured tissues of leaves, twigs, and fruit. On leaves, the first sign of the disease is the appearance of small, water-soaked areas that develop into purple or purplish-brown spots (fig. 34), which are generally angular in shape. The individual spots are small at first, but they may run together. Eventually, the affected tissues die and separate from the healthy tissues, producing a characteristic ragged, shot-hole appearance—hence the name "shot hole." When many leaves are affected, especially on weak trees, premature leaf fall often results. The disease is first visible on the fruit as tiny, watery-looking, slightly sunken spots. As the peach grows, cracks and fissures of various sizes develop and mar the appearance of the fruit (fig. 34, *C*). The cracking around the spots of dead tissue makes the fruit unmarketable and frequently permits the entrance of brown rot or other fruit rot fungi.

Cankers are formed on the twigs at various times during the growing season. Some develop on green shoots late in summer ("summer cankers"), usually after foliage infection has become established. Some develop on young, succulent twigs in the spring ("spring cankers"), about the time the first leaves appear. Bacteria responsible for initial infection in the spring are believed to originate from spring rather than summer cankers.

Bacterial spot is present in all States east of the Rocky Mountains where peaches and plums are grown. It causes serious annual losses, chiefly where soils are light and low

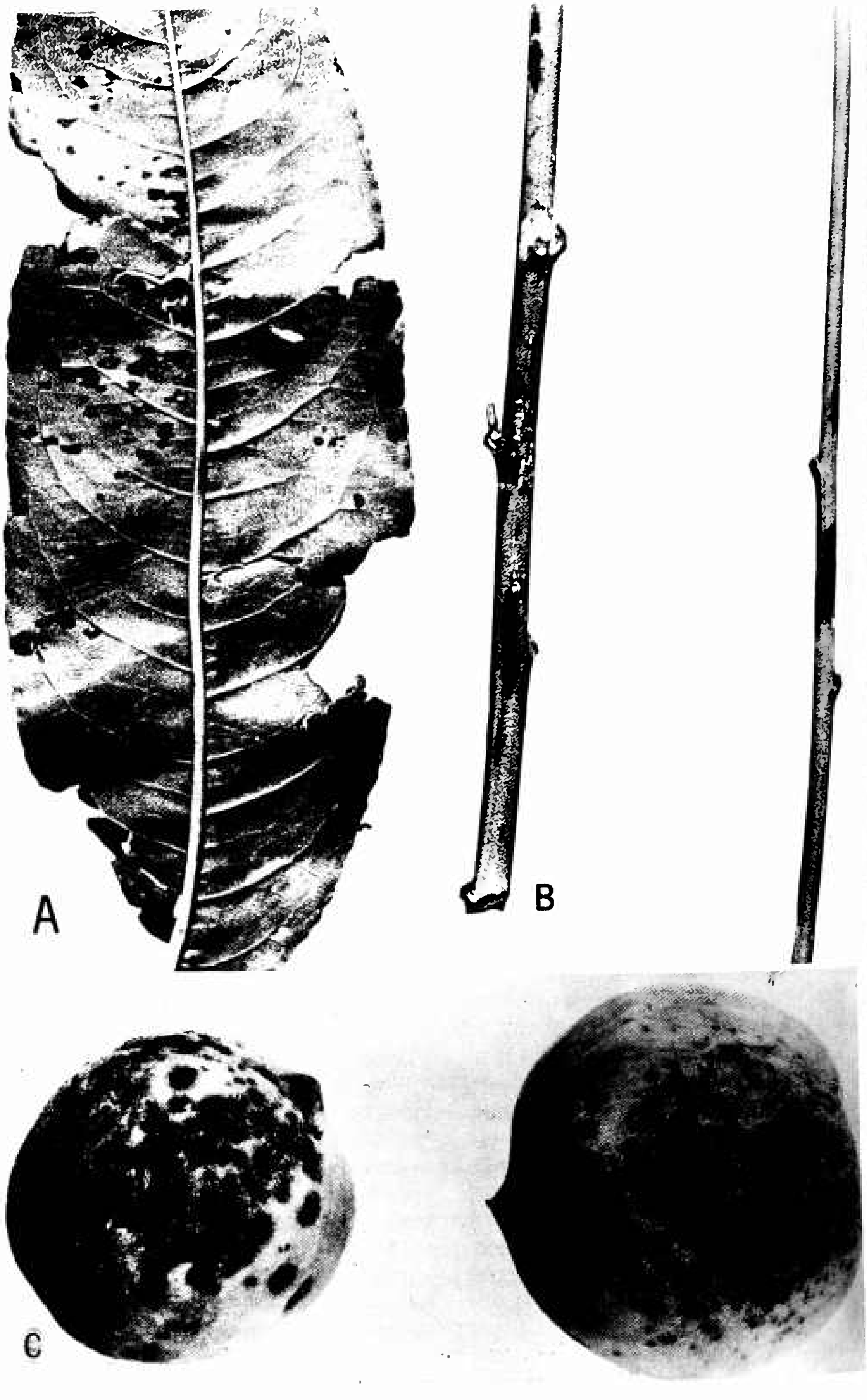

FIGURE 34.—Symptoms of bacterial spot (*A*) on peach leaf, (*B*) on young peach shoots, and (C) on mature J. H. Hale peaches.

in fertility. Although as much as 35 percent of the fruit of susceptible varieties may be discarded because of bacterial spot, the greatest loss is due to devitalization of the tree resulting from defoliation. Vigorous trees are less susceptible to the disease than are neglected trees. Proper pruning, cultivating, fertilizing, and other good orchard-management practices are recommended as control measures. But these alone will not control severe bacterial spot infection, especially where soil improvement is difficult. Removing sources of overwintering infections has not as yet been successful.

Bacterial spot has been held in check in some areas by a series of spray applications at 5- to 7-day intervals, starting at petal fall. However, when the disease is severe in other areas, the best materials available have been only about 50 percent effective. More effective materials than those now used are needed.

Many sprays for controlling bacterial spot have been tested over the past 30 years, but none can be considered successful. The most satisfactory combination used today is the zinc-lime spray. The formula recommended is:

Zinc sulfate (monohydrate)	5 pounds.
Hydrated lime	8 pounds.
Water	100 gallons.

A monohydrate zinc sulfate ($ZnSO_4.H_2O$) containing 36 percent zinc can be obtained through wholesalers and distributors who handle spray materials. This material should be stored in a dry place and kept well covered so that it cannot absorb moisture from the air and become lumpy. The hydrated lime should be fresh and of high quality. The grade known in the trade as chemical or spray is especially recommended.

The spray should be prepared as follows: Fill the tank three-fourths full of water. Start the engine and slowly sift the zinc sulfate into the water while the agitator is moving. If the zinc sulfate is not caked, it will dissolve in less than 5 minutes. After the zinc sulfate has dissolved, slowly add the hydrated lime and continue agitating while the tank fills with water. If other fungicides and insecticides are used in combination with zinc sulfate, they should be added at this time. Captan should not be used with strongly alkaline materials, such as hydrated lime.

The zinc-lime spray will not control scab and brown rot. Sulfur sprays, which are commonly used on peaches to control bacterial spot, may safely be applied to peach trees in mixture with the zinc-lime spray.

To reduce bacterial spot, some investigators have suggested the use of Bordeaux mixture spray (copper sulfate plus hydrated lime in water) applied either in the fall when the leaves are ready to drop or in the spring before the buds open. Because of its tendency to burn peaches, copper should never be applied during the growing season. If you wish to try Bordeaux mixture, do so only on recommendation of your county agent or State agricultural extension scientists.

Leaf Curl

Leaf curl, often referred to as "curl," "curl leaf," or "leaf blister," is an economically important disease occurring in all peach-growing regions east of the Rocky Mountains. It is due to a fungus that causes the early appearing peach leaves to acquire a red to purplish tint, which makes them conspicuous. These leaves become thickened, blistered, and distorted; turn reddish yellow or yellowish gray; and later turn brown and drop. The actual time of leaf fall depends on the prevailing weather conditions. Dry, hot weather usually hastens leaf fall. The spores of the fungus overwinter on the twigs and buds of the peach tree, germinate, and infect the young leaves as they begin to develop in the spring.

If only a small percentage of the leaves are affected, the fruit set will not be materially reduced and the trees will not be seriously injured. But if the number of affected leaves is large enough to cause heavy defoliation at or near blooming time, the disease may prevent fruit set and devitalize the tree so that it becomes subject to winter injury and attacks by other disease-producing organisms.

Peach leaf curl can be controlled by a single application of lime-sulfur solution, Bordeaux mixture, ferbam, or dichlone made in the fall after the trees shed their leaves; during the winter when the temperature is above freezing; or in the spring before the buds begin to swell. If application is delayed until after the leaves start to grow, the disease will not be successfully controlled and some materials applied at the suggested concentrations may seriously injure the trees.

A lime-sulfur solution usually gives satisfactory control when used at the rate of 4 to 6 gallons per 100 gallons of water. However, when leaf curl is severe, somewhat higher rates may be required. A 6–6–100 Bordeaux mixture (6 pounds of copper sulfate plus 6 pounds of hydrated lime in 100 gallons of water), ferbam at the rate of 2 pounds per 100 gallons, or dichlone (50 percent wettable powder) at the rate of 1 pound per 100 gallons of water will also give satisfactory control of peach leaf curl if applied according to directions. All buds on the tree are subject to infection and must, for complete protection, be thoroughly covered with the spray.

Bordeaux mixture may be used in combination with an oil emulsion in the dormant application to control certain insects. The oil should be added after the Bordeaux mixture is placed in the spray tank.

Rust

Rust is a disease that appears toward the end of the growing season. It usually affects the peach leaves; but sometimes, under certain climatic conditions, it appears on twigs, bark, and fruit. This disease is found most commonly in the warmer sections of the stone fruit areas. Numerous pale, yellowish spots that later become bright yellow are evident on the leaf. Directly underneath these spots on the lower leaf surface, powdery, cinnamon-brown spore masses develop. In some seasons, rust infections become so numerous that they cause premature leaf fall, which weakens the tree. At present, no measures for controlling this disease are practiced east of the Rocky Mountains.

Constriction

Constriction, sometimes referred to as Fusicoccum canker or peach canker, is a fungus disease that has become economically important the past two decades in the North Atlantic and Middle Atlantic States. This disease affects twigs, blossoms, leaves, and fruit. Dark-brown cankers, which later become grayish tan, appear at the nodes of the current season's twigs. These cankers often girdle the twig, make it wilt, and eventually kill the affected branch. Among the varieties severely affected by the disease are Golden Jubilee, Raritan Rose, Cardinal, Jerseyland, Triogem, J. H. Hale, and Redhaven. Recent studies have been made in New Jersey on control of late season infection by postharvest applications of magnesium arsenate and a certain organic mercury compound. Further tests are necessary, however, before these materials can be recommended for use by peach growers.

Crown Gall

Crown gall is a bacterial disease characterized by formation of swellings or galls on the trunks (usually at the crown) and roots of the trees. This disease, although prevalent and severe in some sections of the Southern States, may be found in all peach-growing areas east of the Rocky Mountains. In many cases, the disease has been traced back to the planting of infected nursery trees. Nursery trees showing crown gall should not be planted. They will not grow well or mature, and bacteria are likely to spread to other trees. Removing the galls does not free the tree of infection, and little can be done to control the disease once it becomes established in an orchard. Considerable research is being done to find a control for the disease in the nursery; but no practical, satisfactory control has yet been developed.

Powdery Mildew

Powdery mildew, a fungus disease, was seldom a serious problem in eastern commercial peach orchards until use of organic chemical sprays replaced use of sulfur sprays. When sulfur is used, powdery mildew occurs infrequently and is of no economic importance. However, about 2 years after the organic compounds are used, powdery mildew may often become prevalent and cause serious damage. The powdery mildew fungus attacks leaves, young shoots, and fruit. The leaves may be spotted with white to gray patches or may be entirely covered by a white, powdery layer of the fungus. The fungus may extend over the entire terminal portion of the growing shoot and may sometimes kill it. Small, white round spots first appear on the fruit. These spots may increase in size until a large portion or the whole surface of the fruit is involved. Fruits so attacked may turn a dull reddish to pinkish color, and may later turn brown. Where powdery mildew becomes serious, sulfur spray or organic compound sprays that include a small amount of sulfur should be used.

Fungus Root Rots

Root rots due to several different fungi may, at times, cause the death of peach trees. The first evidence of root rot may be the appearance of small, yellowish leaves that cover the entire tree or that are confined to one or two branches. The entire tree or the affected branches may die by the end of the summer; or they may survive the winter and die the following year. Once a tree is affected, there is little hope of saving it. Research now being conducted with certain soil fumigants may help solve this problem. Growers finding an appreciable number of trees affected with root rot should consult their State agricultural extension service.

Dieback

"Dieback" is a general name given to a number of conditions that cause the death of peach twigs and branches. Dieback may be caused by various types of fungi and also by some bacterial organisms. These organisms frequently infect the buds or wounds and produce cankers that usually enlarge slowly, sometimes girdling the affected limb or twig. When this occurs during the growing season, the leaves take on a yellowish color and then suddenly wilt and die. Sometimes a gumlike substance is produced on the surface of the canker. In many cases, infection has been associated with spray injury, frost damage, and improperly healed pruning wounds. Insofar as possible, practices should be followed that produce the maximum quantity of marketable fruit with the least damage to the tree.

DISEASES CAUSED BY VIRUSES [10]

Virus diseases were first associated with peach culture in the 19th century. Stories of the devastation and losses resulting from epidemics of peach yellows in Northeastern United States during the 1800's serve as reminders that virus diseases can be serious if they are left uncontrolled. Little peach, another virus disease, which is thought to be caused by a strain of the yellows virus, became damaging in the same geographic area as did yellows in the late 1800's, and now causes more losses than do yellows. In Southeastern United States, peach rosette and phony peach disease, both caused by viruses, have been common since the early 1900's and cause serious crop losses. Within the past 30 years, the following additional virus diseases affecting peaches have appeared in Northeastern United States: Red suture, X-disease, rosette mosaic, necrotic leaf spot, ring spot, and line pattern. Peach mosaic and asteroid spot are virus diseases that occur in Southwestern United States as far east as eastern Texas, southern Oklahoma, and western Arkansas.

For the purpose of this discussion, a virus may be considered as an extremely small organism, too small to be seen through the ordinary compound microscope, which lives and multiplies as a parasite in living tissue. Virus diseases of plants are commonly spread in one of several ways—through juice, by infected propagation material, and occasionally through seeds from infected plants. In nature, they are most commonly spread by insects and mites. These insects suck juice from infected plants and lose some of it while feeding on healthy plants, thereby infecting them. None of the viruses affecting peach trees is known to have been transmitted mechanically from peach to peach with infected juice. Only one, ring spot, has been found transmissible through seeds. Ring spot passes through some of the seeds of mazzard and mahaleb cherries and occasionally through peach seeds.

It is highly improbable that any of these viruses can be spread by cultivation procedures, such as pruning, spraying, thinning, or tillage. They can be spread into new areas by use of infected nursery stock. Within orchards they can be spread by insects and through use of infected propagation material. Peach yellow bud mosaic, known to occur only in California, and peach rosette mosaic, which occurs in Michigan, in New York, and possibly in other Eastern States, have been retained in the soil by nematode vectors where diseased trees are removed. Thus, these diseases could be spread by movement of infested soil.

Peach Yellows

The symptoms of peach yellows are premature ripening of fruit; inward rolling, drooping leaves, pale green to yellow in color; and development of small, clustered shoots with yellow leaves along the trunk and main branches of the tree (figs. 35 and 36). Fruit on affected trees ripens from a few days to 3 weeks earlier than normal, lacks sweetness, and is bitter. The peel on affected fruit is commonly spotted with red and purple, and on normally red varieties it may be solid purple. Red streaks of different lengths extend from the pit toward the peel, and in red varieties the tissue around the pit is deep red.

On young trees and vigorous older trees affected with peach yellows, buds formed in the summer do not remain dormant but put out small, yellowish leaves the same

[10] This section was prepared by L. C. Cochran Crops Research Division.

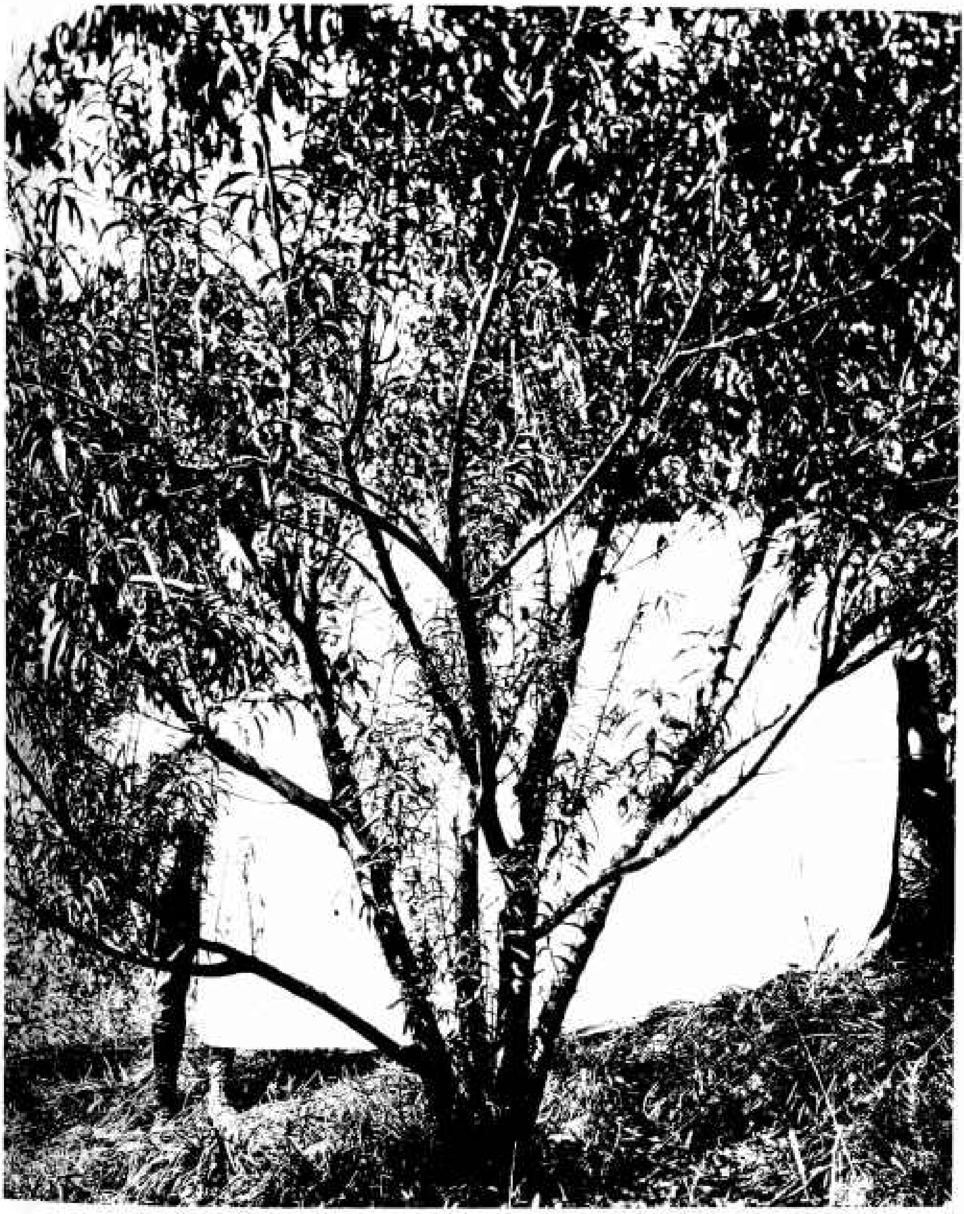

FIGURE 35.—The small, willowy growth from main limbs of this tree is a symptom of peach yellows. This growth is known as wire shoots. (Courtesy of Illinois Natural History Survey.)

season. In advanced cases, the ends of twigs and branches die; and clusters of small shoots bearing small, pale-green to yellow leaves grow from the trunk and main branches. These are known as wire shoots. Some varieties produce more wire shoots than others. Affected trees usually die in 2 to 6 years.

Plum trees, both cultivated and wild, have been found to carry the yellows virus; but most plum species are not injured by it and do not show any easily recognized symptoms. The disease is spread by the plum leafhopper (*Macropsis trimaculata*), which prefers to feed on plums and migrates from them to

FIGURE 36.—Closeup view of willowy growth arising from a main limb of a peach tree affected with yellows. Note slenderness of twigs; light color, small size, and abundance of leaves; and dark spots on leaves. An almost normal water sprout is seen at the base of the limb at the right. (Courtesy of Illinois Natural History Survey.)

peaches. In localities where the disease has become widespread, peaches should not be grown within 1 mile of plums.

Yellows-affected trees should be removed from the orchard as soon as the disease is recognized. If an infected tree is left standing in an orchard, the disease spreads rapidly to neighboring trees. Some States have laws prohibiting sale of yellows-affected fruit and requiring that yellows-affected trees be destroyed. Care should be taken to obtain peach budwood from known yellows-free sources and to grow nursery stock apart from any natural hosts of the yellows virus. Plum trees considered as a source of material for budding or as rootstocks should be checked for yellows before they are used. The yellows virus can be killed in peach budwood or in nursery trees with heat, but there is no known method of curing infected orchard trees.

Little Peach

Some symptoms of the little peach disease are enough like those of yellows to suggest that little peach is caused by a strain of the yellows virus. Trees affected with little peach, like those with yellows, have a droopy appearance. In late stages of the disease, the leaves turn pale green to yellowish. Little peach is transmitted by the same insect as is yellows. The little peach virus is killed by heat at the same temperature that inactivates the yellows virus. Little peach differs from yellows in that fruit on affected trees fails to ripen, or ripens late instead of prematurely, and there is less yellowing of foliage in the early stages of the disease. Trees affected with little peach appear stunted and compact or bushy, because there are more leaves on the short spurs along the main branches. They do not produce the slender yellow shoots (wire shoots) on the trunk and main branches that are characteristic of yellows-affected trees. Leaves on trees in advanced stages of little peach may be curled by recurving of the midrib toward the twig, but the halves of the leaves are not as closely folded as they are with yellows. Fruit is usually small and has a poor flavor. It does not have the red color on the peel or in the flesh that is characteristic of yellows.

Little peach, like yellows, affects different species and varieties of plums. Some plums show a few symptoms, but some do not.

The control for little peach is the same as for yellows.

Red Suture

Red suture, also, belongs to the yellows group. It has occurred in Michigan, Ohio, and Maryland.

The leaf and tree symptoms of red suture are more nearly like those of little peach than like those of yellows. Leaves on affected trees are recurved, terminal growth is shorter than normal, and an abnormal number of short shoots bearing clusters of leaves arise along the main branches. In advanced cases of red suture, there is some twisting of leaves. Most leaves are lighter than normal in color, and the centers of trees appear open. As with yellows, the fruits on affected trees ripen several days early, the suture ripening first. Frequently, the suture is unevenly swollen. On red fruits, the tops of the ridges and bumps have dark red or purple blotches. The flesh of the early ripening portion is usually soft and watery. The affected fruits are usually low in sweetness and insipid in flavor.

Little is known of the host range of red suture. Insufficient tests have been made to determine whether the leafhopper that spreads peach yellows can spread red suture.

The control for red suture is the same as for yellows, but is less efficient because it is harder to recognize diseased trees, especially in the early stages. Trees may be diseased for a year or longer before they develop recognizable symptoms. During that time they serve as a reservoir from which the disease can be spread.

In the infected area, red suture is becoming more serious.

X-Disease

The X-disease was named for *x*, the symbol of an unknown quantity, because of its peculiar symptoms. Diseased peach trees appear normal until midsummer (the date varies with locality). Then, within a few days, leaves on affected twigs, starting near the base of the current season's shoots, become progressively pale, commonly roll upward, become brittle, and develop irregular yellow and red spots. Some of these spots shrink and fall out. The number of leaves affected and the size of spots on individual leaves increase rapidly, causing affected shoots to become highly colored. Leaves on affected twigs are usually shed progressively from the base to the tip. Tip leaves seldom become affected, and they remain on the tree. During hot weather, leaves often drop before the spots are well formed. Fruits on affected twigs usually shrivel and fall soon after leaf symptoms develop. Fruits on twigs where leaf symptoms develop late in the season may remain on the trees. However, they ripen prematurely and are bitter, and their seeds fail to develop.

Diseased twigs or branches, even though they shed their leaves, do not always die. If they survive, they leaf out normally the following spring; then the sequence of symptoms is repeated. The disease usually begins on one or several twigs and spreads irregularly through the tree. If often takes several years to affect most of the tree. Unlike some of the other viruses affecting peaches, the virus causing X-disease seldom becomes distributed through the whole tree. Normal-appearing twigs on diseased trees are free of the virus and produce normal fruit. Affected trees under 3 years of age frequently die; older trees, although they become unproductive, usually do not die as a direct result of X-disease.

Besides peaches, the X-disease virus infects cultivated cherries (both sweet and sour) and several wild plum and cherry species. The most commonly affected wild host is the chokecherry (*Prunus virginiana*). This plant is widespread in Northeastern United States and adjacent areas of Canada and forms dense woodland and fence-row thickets. The disease appears to have spread rapidly in this host from where it was first seen in New England through New York, Ohio, and Michigan and into Wisconsin, Illinois, and Iowa. Diseased chokecherries prematurely develop varying degrees of autumnal yellow and red foliage, beginning as early as June. They usually die in 3 to 4 years.

X-disease is spread by the leafhopper *Colladonus clitellarius* (Say). This leafhopper lives principally on chokecherries but occasionally migrates to other nearby plants. If it has fed first on diseased chokecherries, it can carry the virus to peach and cherry trees. Peach nursery plantings should be at least 500 feet from chokecherries and other wild cherry or plum species. Eradication of chokecherries within 500 feet of peach orchards will protect the trees from infection. Chokecherries can be effectively eradicated by spraying them with a water solution of ammonium sulfamate when they are in full leaf. The recommended strength is three-fourths pound per gallon, and the recommended rate of application is 2 gallons of spray per 100 square feet. Sodium or calcium chlorate at the same strength is also effective. Atlacide, a proprietary material containing chlorates, is less dangerous and is effective if used according to the manufacturer's directions. Brush killers such as 2,4,5-T in kerosene, or diesel oil at the rate of 10 to 12 pounds per 100 gallons of oil sprayed around the base of the chokecherry in midsummer, has also been effective. After the sprayer is used, it must be washed thoroughly (five or six times) with a warm, soapy, soda solution in water.

Sodium and calcium chlorates must be handled with care, since they are flammable.

Phony Disease

Phony disease has caused serious losses in Georgia and Alabama. About 2 million phony-affected peach trees have been removed from orchards in Georgia alone since 1930.

Phony disease dwarfs peach trees and causes them to be darker green and more dense in appearance than normal (fig. 37). The dense appearance is due to an abnormal number of lateral twigs with shortened internodes and a closer spacing

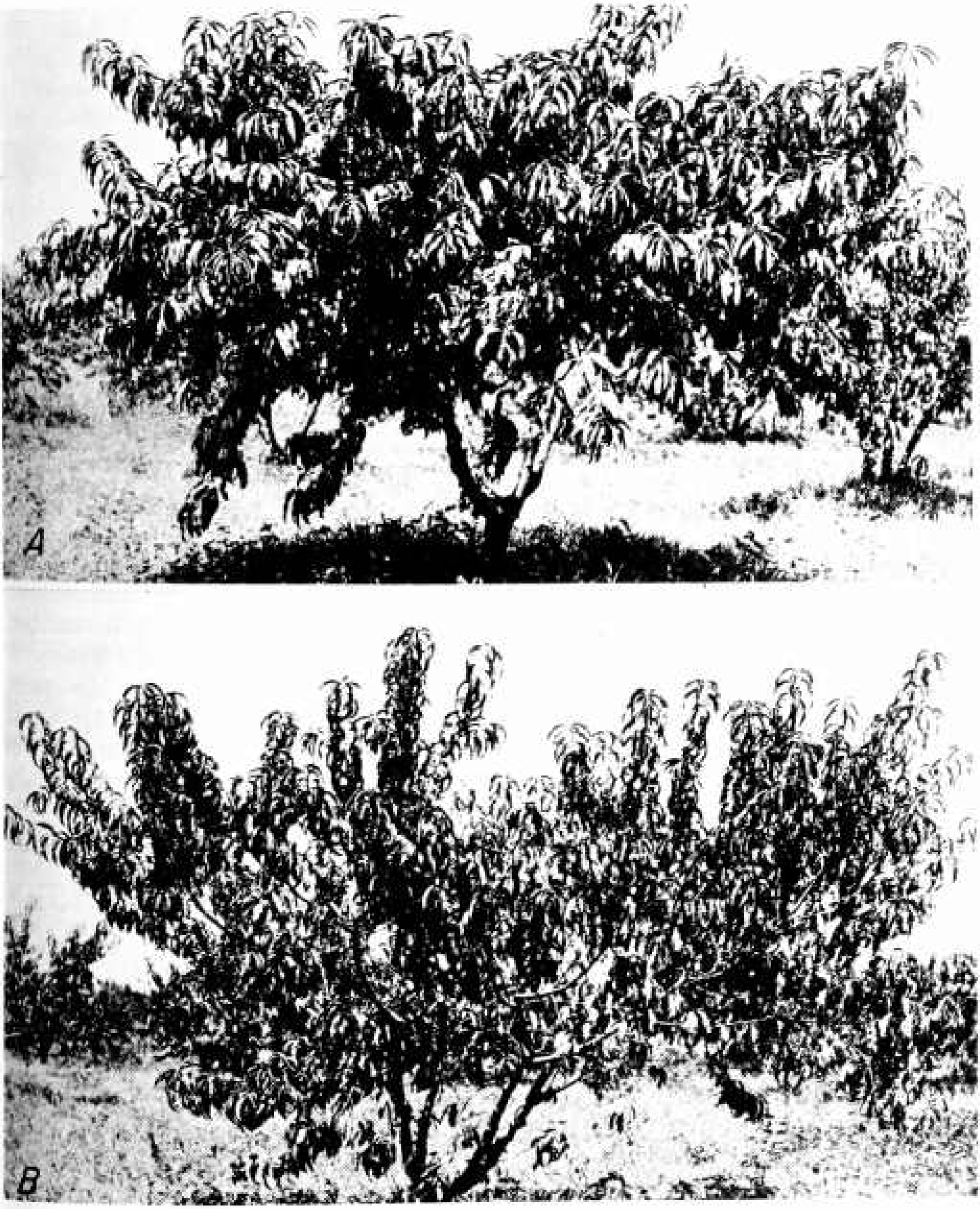

FIGURE 37.—(A) Phony-affected Elberta peach tree at Fort Valley, Ga.; (B) normal Elberta tree in the same orchard.

of fewer but flatter leaves on the twigs. The symptoms are progressive. Diseased trees become noticeable in early summer when normal trees outgrow them. By July, diseased trees are easily distinguished from normal trees. Fruit is smaller on diseased trees than on normal ones and becomes smaller each year because of the disease. Phony disease does not kill peach trees, but affected trees are weakened and are more susceptible to winter injury and other orchard troubles. Trees that become diseased when young never reach productive orchard size.

Phony disease affects all peach varieties similarly. It is spread by several species of large leafhoppers commonly known as sharpshooters. The insects prefer to feed directly in the water-conducting tubes in woody stems. Phony spreads rapidly in some areas and increases in rate in proportion to the age of the trees and the number of diseased trees present. The wild chicasaw plum *Prunus angustifolia* Marsh., which occurs in thickets all through Southern United States, has been found naturally infected near phony-affected peach orchards in Georgia.

Phony-affected peach trees should be destroyed promptly. Surveys have shown that the disease spreads less rapidly among the remaining trees when diseased trees have been removed. In infected areas, wild plums should be eradicated from the vicinity of peach orchards. Quarantines covering the infected area prohibit growing nursery stock within 1 mile of diseased trees.

Peach Rosette

Peach rosette is another virus disease affecting peaches in Southeastern United States. It kills rapidly and has caused severe losses in areas where diseased trees were left standing.

Symptoms of peach rosette generally appear in spring or early summer. The first formed leaves turn yellow, and shoots fail to elongate. Leaves formed later are small and, because of shortened stems, grow into tight rosettes (fig. 38). The older leaves turn yellow and drop first. Trees affected throughout usually die before the end of the growing season. Trees partly affected may live into the second year but die by the end of that season. The disease usually occurs in close colonies and may spread rapidly. The chickasaw plum occasionally becomes naturally infected and serves as a virus reservoir from which the disease spreads to peach trees. Symptoms on it are similar to those on peaches.

Peach rosette can be effectively controlled by prompt removal of diseased trees in and near the orchard.

Peach Mosaic

Peach mosaic occurs in Southwestern United States as far east as eastern Texas, in southern Oklahoma, in western Arkansas, and in Mexico. It has caused serious losses both directly by crop reduction and, indirectly, by necessitating removal of diseased trees.

As the name implies, the most common and noticeable symptom of peach mosaic disease is the mottled pattern of yellow and green in the leaves. All peach varieties are susceptible to infection, but some are more seriously damaged than others. Varieties such as J. H. Hale (or its derivatives), Elberta, Rio Oso Gem, and Fay Elberta are severely injured. But most clingstone varieties endure the most severe forms of the virus with only moderate damage. Newly infected trees of the J. H. Hale variety are retarded in the spring and develop small, narrow, deformed leaves with various irregular, mottled patterns (fig. 39). As the season progresses, the mottling becomes

FIGURE 38.—Orchard tree affected with peach rosette and showing typically rosetted foliage. Such a tree usually dies before the beginning of the next season.

less distinct, but the trees are dwarfed and the fruit is bumpy and misshapen. Symptoms vary because of the different forms of the virus, some of which are more damaging than others. Damage is most severe in cool climates.

Peach mosaic virus is common in certain wild stone fruits, including the chickasaw plum, wildgoose plum (*Prunus munsoniana* Wight & Hedr.), and American plum (*P. americana* Marsh.), as well as in certain cultivated stone fruits. Some of these hosts act as symptomless carriers. The rate of spread is more rapid in some areas than in others. The natural vector of peach mosaic is a microscopic eriophyid mite, *Eriophyes insidiosus* Kiefer and Wilson, which lives exclusively within retarded buds and which is removed by wind to healthy trees as the buds open.

In areas where very susceptible varieties are grown, losses from peach mosaic can be reduced to less than 1 percent per year by removing diseased trees and excluding tolerant varieties in which symptoms are absent and diagnosis is difficult. In areas where the disease spreads rapidly, where wild hosts are prevalent, or where the cost of removing

FIGURE 39.—Leaves of J. H. Hale peach affected with peach mosaic. The symptoms vary from marginal bands in the first leaf at the left to shot hole and veinlet clearing in the leaf at the extreme right.

diseased trees is uneconomical, tolerant varieties can be grown. Since orchards of Elberta and J. H. Hale and other nontolerant varieties make up a large percentage of the freestone acreage in the United States, strong safeguards should be maintained to prevent spread of the peach mosaic disease to noninfected areas. Infected areas are now under quarantine. The sale of peach nursery stock grown within 1 mile of infected trees or of budwood taken from trees within 1 mile of infected trees is prohibited.

Rosette Mosaic, Ring Spot, Necrotic Leaf Spot, Line Pattern, and Asteroid Spot

Several virus diseases affecting peaches in Eastern United States cause only minor crop losses. The most serious of these is rosette mosaic, which occurs principally in Michigan and New York. This disease causes mottling, dwarfing, and rosetting of the foliage, and a corresponding reduction of tree vigor. The causal virus sometimes remains in the soil and can infect a new tree set where a diseased tree was removed.

The ring spot virus retards spring growth and causes light-colored and necrotic ring patterns on leaves. Sometimes ring spot kills and splits peach tree bark. Symptoms of ring spot are usually present only during the first growing season after infection. Infected trees appear to recover, but they retain the virus without visible symptoms in succeeding years. In the nursery, infected buds grafted on healthy peach seedlings fail to grow. The virus exists more commonly in plums and cherries than in peaches.

Necrotic leaf spot differs from ring spot in that it produces no symptoms in the spring but produces dead spots on leaves each year in midsummer.

Although line pattern is primarily a plum disease, peaches have been infected with it through budding; and obscure, mottled leaf patterns have resulted.

Asteroid spot in peaches is common in Texas and the Western States. It produces small, star-shaped spots of varying size scattered over the leaves.

PEACH INSECTS [11]

The common insect pests of peaches grown east of the Rocky Mountains are the plum curculio, the peach tree borer, the lesser peach tree borer, the San Jose scale, the oriental fruit moth, and a group of sucking bugs, including among others the tarnished plant bug and certain species of stinkbugs.[12]

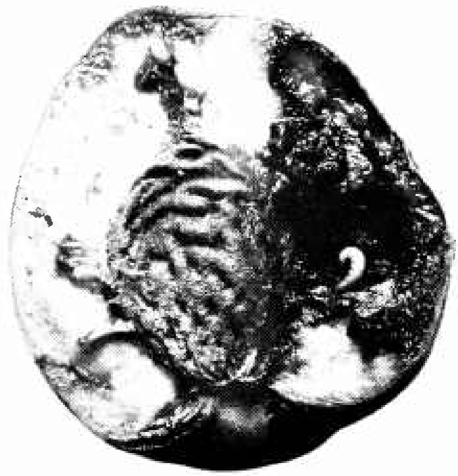

FIGURE 40.—Curculio grub and its injury to ripe peach.

Plum Curculio

The plum curculio is a small, humpbacked beetle with a brownish snout, which hibernates in trash in or near the orchard. Early in the spring, the curculios move into the trees. If they come from outside the orchard, they appear first on trees in the outer rows and later move to other parts of the orchard. They lay eggs in small peaches soon after the fruits form. The larvae, or grubs, feed within the fruit for 2 weeks or more (fig. 40). The mature grubs leave the fruit and go into the ground, where they complete their development and emerge as adult beetles. In the South, a second generation infests midseason varieties such as Elberta.

Because the development of the curculio varies according to seasonal and local conditions, the control programs vary with the season and locality. Usually, an insecticide is applied three or four times during the month following petal fall. Where two generations occur in one season, one or two additional spray applications are made, usually during the month before picking time.

Peach Tree Borer

The peach tree borer is a white worm about 1 inch long that works underneath the bark near the ground line, often injuring the tree seriously or even killing it. At maturity, the larvae change to pupae, then to adults, which are clear-winged moths. In the southern part of the Gulf States, a few moths appear as early as May or June; but heaviest emergence in the South occurs during August and September.

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[11] More complete, general information on peach insects and their control is available in U.S. DEPT. AGR. 1963. INSECT PESTS OF THE PEACH EAST OF THE ROCKY MOUNTAINS. Agr. Inf. Bul. 272, 32 pp. illus. More detailed information on various peach insects and on new insecticides should be obtained from your local State agricultural college or extension service or from your county agricultural agent or farm adviser.

[12] The scientific names of the insects listed are as follows: Plum curculio, *Conotrachelus nenuphar* (Hbst.); peach tree borer, *Sanninoidea exitiosa* (Say); lesser peach tree borer, *Synanthedon pictipes* (Grote & Robinson); San Jose scale, *Aspidiotus perniciosus* Comst.; oriental fruit moth, *Grapholitha molesta* (Busck); tarnished plant bug, *Lygus lineolaris*' (P. de B.); stinkbugs, chiefly *Euschistus* spp.

In the North, most of the moths emerge during July and August. Egg laying begins shortly after moths appear. Most eggs are placed on the tree trunk but some are placed on small branches of the tree or on the soil or weeds nearby. After the eggs hatch, the young larvae move to the lower part of the tree trunk and usually enter it at the soil surface. Usually there is only one generation a year.

Lesser Peach Tree Borer

The lesser peach tree borer is similar to the peach tree borer but mainly attacks the trunk and limbs, particularly in injured areas and in crotches. It passes the winter as a larva in injured areas on the tree. It pupates early in the spring and emerges as a clearwinged moth that lays its eggs along the trunk and limbs of the tree. One generation occurs in the North, and two occur in the South.

San Jose Scale

The San Jose scale is a tiny insect that lives under a very small, inconspicuous, grayish, scalelike covering. Small reddish discolorations are often found at the point of feeding, particularly on new, tender wood. Heavily infested trees have a roughened, grayish appearance. Other signs of infestation are dead twigs and limbs, and a lowering of the vitality of the trees. A heavy, continuing infestation may kill the trees.

All stages of the scale are present most of the year, but scales that are partly grown survive the winter best. They complete their growth in the spring. The insect remains in one place except during the first few hours of its life and during the short time adult males are active. The generations overlap; there are one or two generations a year in the more northern fruit areas and three or more farther south.

Oriental Fruit Moth

The larva of the oriental fruit moth is a pinkish-white worm with a brown head. When fully grown, it is about one-half inch long. Early in the season, the larvae tunnel into new peach shoots (fig. 41), causing them to wilt and dry up. Later, usually near harvest, the larvae bore into the fruit. Infestation of fruit is heaviest in midseason and in the later maturing peach varieties. The insects pass the winter as full-grown larvae, or worms, in cocoons in a protected place on the tree or ground. Moths first appear about the time peach trees are in bloom. The females usually lay their eggs on the leaves. The larvae feed on twigs or in the fruit until they are mature and then spin cocoons in a protected place on the tree or ground. Usually there are four or five generations each year.

Sucking Bugs

The tarnished plant bug and several other species of sucking bugs feed on peach blossoms and on newly formed peaches and cause the fruit to become seriously scarred and distorted (fig. 42). These bugs live and feed chiefly on weeds or field crops in or near the orchard. They suck on peaches for only a short period in the spring. Where it is consistent with good horticultural practice, eliminating weeds and certain cover crops aids considerably in controlling them.

FIGURE 41.—Oriental fruit moth injury to peach twigs.

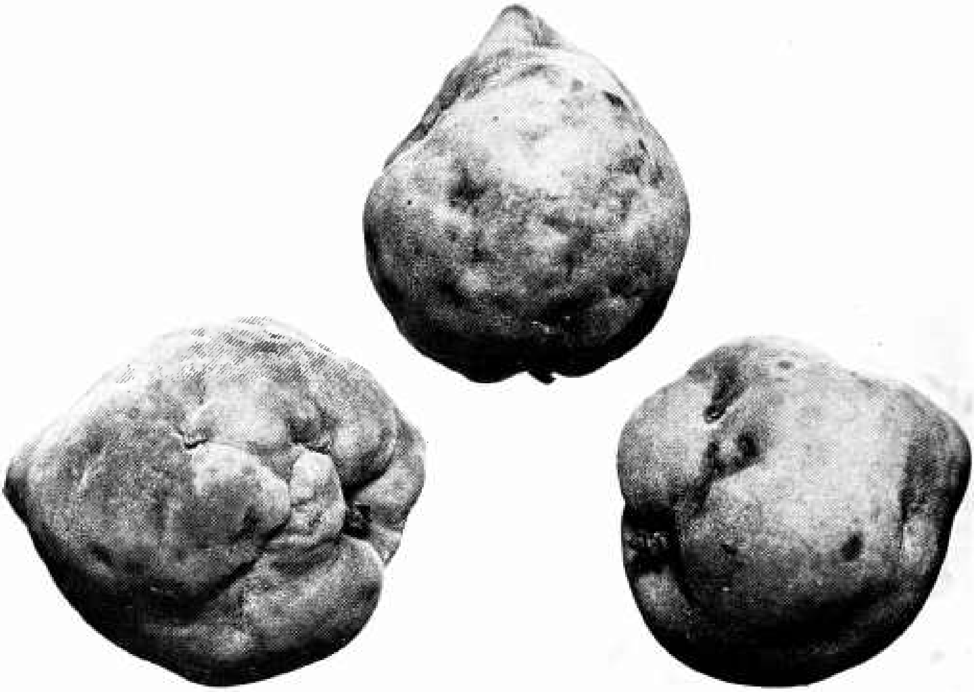

FIGURE 42.—Peach injury caused by sucking bugs.

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