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PEACH PRODUCTION

Agriculture Handbook No. 463

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Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

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This handbook is a revision of and supersedes Agriculture Handbook 280, "Peach Production East of the Rocky Mountains."

PEACH PRODUCTION

By H. W. FOGLE and H. L. KEIL, *Fruit Laboratory*, and W. L. SMITH, *Horticultural Crops Marketing Laboratory, Northeastern Region*, and S. M. MIRCETICH, *Western Region, Agricultural Research Service;* L. C. COCHRAN, *Plant Pathology Department, Oregon State University;* and H. BAKER (*retired*), *formerly Entomology Research Division, Agricultural Research Service*

HISTORY

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, peach cultivars 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 cultivars now grown in the United States originated in this country. The most important new cultivars 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 cultivars had been selected from seedlings and propagated by budding. By 1850, more than 400 cultivars were listed by nurseries in this country.

From 1800 to 1850, commercial peach production expanded rapidly. Peaches were transported by rail, boat, and 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

cultivars 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 'Elberta' and 'Belle (of Georgia)' and development of the refrigerated railcar 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 disease, which became serious in the Philadelphia area about 1800, caused greater loss of peach trees in the Northeastern United States than did any other disorder. 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 disease caused no damage to the developing peach areas in the Southeast. In 1892, the San Jose scale insect appeared in Virginia. 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 was 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 cultivars selected between 1850 and 1900 that are still grown commercially include 'Elberta', 'Belle', and 'Champion' and to a less 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. Commercial production reached its peak 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 many 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.

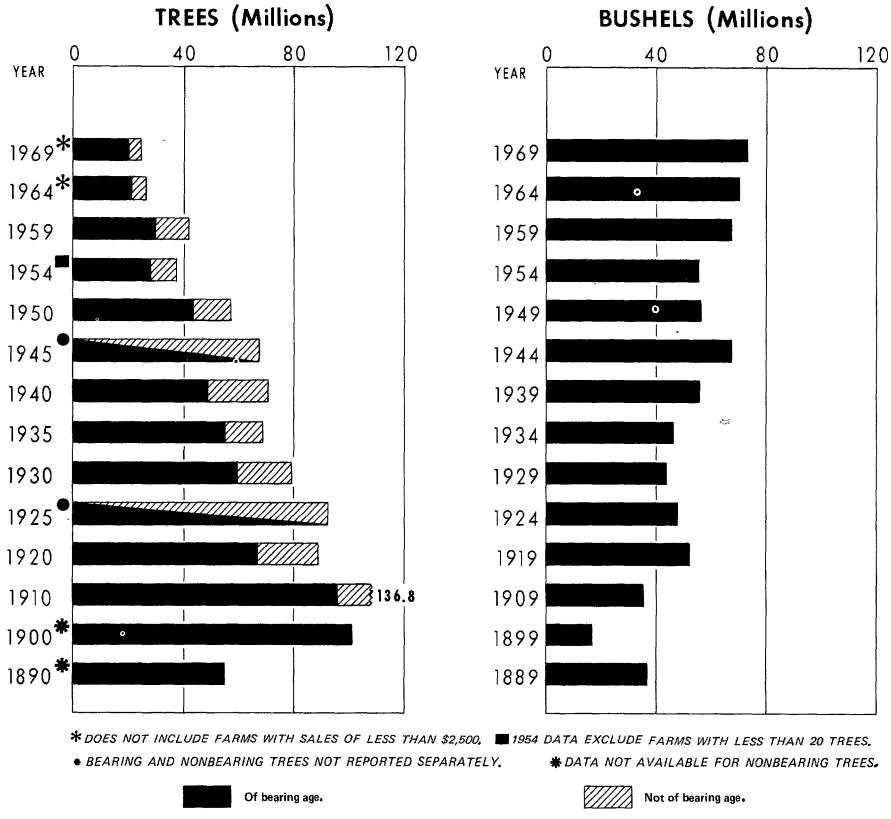

FIGURE 1.—Number of peach trees in the United States and annual production, 1889–1969.

GEOGRAPHIC DISTRIBUTION

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 extending from New Jersey into central Florida and reaching into western 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 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, which are exceptionally favorable to commercial peach production, have stimulated heavy planting. Peaches are also grown under irrigation in western

Colorado, northern Utah, southern Idaho, and central Washington (fig. 2).

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 cultivars survive, and even these often fail to bear fruit. In extreme south Georgia, in Florida, and in the southern parts of the States bordering the Gulf of Mexico, few of the leading peach cultivars produce 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, they fail to develop at all. Most leading peach cultivars require chilling below 45° F for 600 to 1,400 hours.

Flowerbuds of most cultivars 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

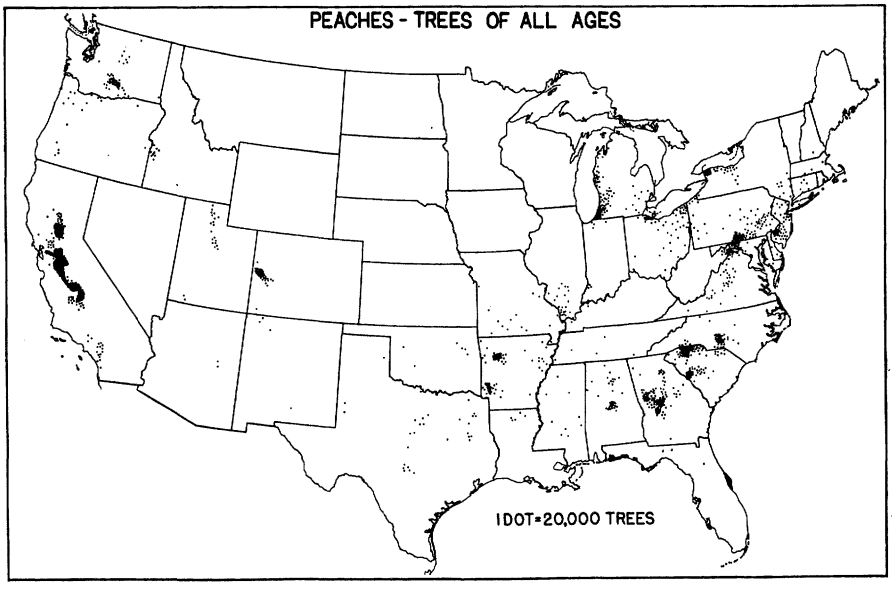

FIGURE 2.—Location of principal peach tree plantings in the United States in 1969. Greatest concentration of plantings are in California, South Carolina, Georgia, and Michigan.

during the winter, and develop rapidly in warm weather after the required chilling time.

During 1962–71, annual peach production averaged 70 million bushels. From 1958 to 1969, this average was exceeded each year except in 1967. Crops in 1970 and 1971 were 10 and 15 percent below the average because of heavy fruit bud losses in some areas. Commercial production reached its highest average for a 5-year period in 1944–48 – 75,442,000 bushels. The 1959–63 crops also averaged more than 75 million bushels.

The States with the highest production and their approximate average yields since 1963 are as follows:

	Million bushels
California	32 (clingstones) and 11 (freestones)
South Carolina	6
Georgia	4
Michigan	2
Pennsylvania	2
New Jersey	2
Washington	1
Arkansas	1
Virginia	1
North Carolina	1
Alabama	over ½
Colorado	over ½
Texas	over ½

Improved cultivars and methods of handling, transporting, and processing have increased the potential consumption of peaches in the United States.

SELECTING ORCHARD SITES

In selecting a peach orchard site, carefully consider not only the elevation, topography, and slope of the land but also the depth, moisture-holding capacity, and other physical features of the soil. 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 blossomingtime. 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. Orchards 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 a 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 temperatures.

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 foliage 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 readily available water supply.

An ideal soil for peaches has 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 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 CULTIVARS[1]

U. P. Hedrick described 2,181 peach cultivars in "The Peaches of New York" (J. B. Lyon Co., N.Y., 1917). An additional 700 peaches introduced after 1920 are described in the "Register of New Fruit and Nut Varieties," second edition, by R. M. Brooks and H. P. Olmo (Univ. Calif. Press, Berkeley, 1972).

'Elberta', which developed from a seed of a clingstone peach planted in 1870 in Georgia, quickly became the leading cultivar and maintained its prominence for well over a half century. A few cultivars have become widely accepted only to be supplanted by firmer, more attractive, or otherwise more desirable cultivars within 20 years. Many were adapted to very restricted areas. Most were never planted commercially to any extent.

In this handbook only the leading commercial and some of the most promising new cultivars are described. For specific recommendations, consult your local experiment station and cooperative extension

[1] This section was prepared by H. W. Fogle and reviewed by J. W. Weinberger and T. K. Toyama, Western Region, and V. E. Prince, Southern Region, Agricultural Research Service.

agent. Local environment and available marketing outlets determine the cultivars that can be grown profitably. Very firm peaches must be grown for distant markets, but less firm, high-quality cultivars that ripen in sequence throughout the season are best for local markets. In many sections the hardiness of flowerbuds is essential in selecting cultivars for a specific climate. Dependable annual production is necessary for successful peach growing.

Based on flesh texture, peach cultivars are classified as either melting, such as 'Elberta', or nonmelting, such as 'Ambergem'. Melting-fleshed peaches are grown for dessert and processing. Nonmelting cultivars are grown almost entirely for processing. Most early-ripening cultivars with melting flesh, such as 'Dixired', are freestone genetically, but the flesh adheres tightly until the fruit is overripe. Most late-ripening peaches are entirely freestone. Cultivars with nonmelting flesh are all clingstones.

Peach cultivars ripen in sequence for up to 4 months in specific areas and are available in some markets from various producing areas for almost 5 months. For convenience in describing cultivars, the ripening period has been arbitrarily classified into four general seasons:

(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 cultivars about 2 weeks before 'Elberta') and the 'Elberta' season.

(4) Late—all cultivars ripening after 'Elberta'. This is usually called the 'Rio Oso Gem' season.

Standard Commercial Cultivars

Standard commercial cultivars—some widely planted but not presently being planted and newer cultivars now being planted extensively—are described briefly in ripening periods about a week apart. Relative evaluations of these cultivars at Beltsville, Md., are given in table 1. The order of ripening and performance of the cultivars may differ in other producing areas.

'Springold' and 'Springcrest' ripen very early, about 2 months before 'Elberta'. These two yellow-fleshed cultivars are replacing the slightly earlier, white-fleshed 'Springtime'. 'Springold' is particularly adapted to the Southeast and 'Springcrest' to California. Early thinning is necessary, particularly with 'Springold', to insure adequate fruit size. The flesh of both cultivars is melting, but the stones cling tightly until the fruits

TABLE 1.—*Characteristics of some established peach cultivars, listed in approximate order of ripening, as grown at Beltsville, Md.*

[Ratings range from 1 to 10; higher values indicate more desirable characteristics]

Ripening season and cultivar [1]	Approximate ripening date in days before or after (+) 'Elberta'	Fruit size	Stone freeness	Attractiveness	Flesh firmness	Dessert quality	Canning quality	Bacterial spot resistance	Chilling requirement (hours below 45° F.)	Areas of adaptation
Very early:										
Springtime	61	3	3	7	3	6	3	6	650	California.
Springold	58	4	4	8	5	6	3	6	850	Southeast, California.
Springcrest	54	5	4	8	6	7	3	6	650	California.
Royal May	51	7	5	8	6	7	4	.....	.....	Do.
Earlired	50	6	5	8	6	7	4	7	850	East, Southeast.
Candor	50	6	5	7	6	7	4	8	950	Southeast.
Early Coronet	47	7	5	8	6	7	4	.....	650	California, Southeast.
Cardinal	46	6	4	8	6	7	4	7	950	Southeast, East, Northwest.
June Gold	45	6	5	7	6	5	3	5	650	Southeast, California.
Early Redhaven	45	6	5	8	7	7	5	4	.....	Northwest, Northeast.
Garnet Beauty	44	6	5	8	7	7	5	5	850	Northeast, East.
Dixired	42	6	4	7	6	7	4	8	1,050	Southeast, East, Northwest.
Maygold	42	6	4	7	6	7	4	6	650	Southeast.
Erly-Red-Fre	40	7	6	7	6	8	4	8	900	East.
Merrill Gemfree	40	7	6	6	7	7	5	6	.....	California.
Sentinel	39	7	6	7	7	7	5	9	850	Southeast.
Royalvee	37	7	6	7	6	7	5	7	950	Northeast, Southeast.

See footnote at end of table.

TABLE 1.—*Characteristics of some established peach cultivars, listed in approximate order of ripening, as grown at Beltsville, Md.*—Continued

[Ratings range from 1 to 10; higher values indicate more desirable characteristics]

Ripening season and cultivar [1]	Approximate ripening date in days before or after (+) 'Elberta'	Fruit size	Stone freeness	Attractiveness	Flesh firmness	Dessert quality	Canning quality	Bacterial spot resistance	Chilling requirement (hours below 45° F.)	Areas of adaptation
Early:										
Harbelle	35	7	7	8	7	8	7	7	.....	East.
Coronet	33	7	7	9	8	9	7	6	750	Southeast, California.
Babcock	31	5	7	7	6	7	6	.....	(low)	California.
Redhaven	30	7	7	8	8	8	7	8	950	East, Southeast, Northwest.
Regina	30	8	7	7	8	8	7	6	850	California, Northwest.
Norman	28	7	8	7	7	8	7	8	850	Southeast.
Raritan Rose	27	8	8	8	6	9	7	9	950	East.
Ranger	25	8	8	7	8	8	8	9	950	Southeast, East, Northwest.
Suwanee	24	8	8	8	8	8	.....	5	650	Southeast.
Washington	23	8	8	7	7	8	8	.....	950	East.
Redtop	23	8	8	8	8	8	8	6	850	California.
Velvet	22	8	7	7	7	7	7	5	750	Northeast.
Triogem	22	8	8	7	7	8	7	6	850	East.
Envoy	22	8	7	8	8	7	7	6	750	Northwest.

Midseason:										
Sunhigh	17	9	8	8	8	9	9	4	750	East.
Glohaven	16	8	8	8	9	8	.....	7	850	Central.
Redglobe	14	9	9	10	10	9	9	7	850	East, Southeast.
Southland	14	9	9	9	9	9	9	6	750	Southeast.
Roza	14	9	8	8	8	9	8	4	.....	Northwest.
Earlihale	13	9	9	9	9	9	8	4	750	Do.
Canadian Harmony	12	8	8	8	8	8	8	.....	.....	Central.
Loring	11	9	9	9	9	9	9	8	800	Central, East, Southeast.
Summergold	10	8	9	8	9	9	10	.....	750	Southeast.
Suncrest	8	9	9	9	10	9	9	4	650	California, Northwest.
Cresthaven	7	9	8	8	8	9	6	.....	850	Central.
Madison	7	7	8	8	9	9	8	.....	850	East.
Merrill Fortyniner	5	8	8	8	8	8	8	5	.....	California.
Sullivan Early Elberta	5	9	9	7	8	8	8	6	900	East, Northwest.
Blake	3	9	9	10	8	8	7	6	750	Southeast, East.
Early Elberta (Gleason strain).	3	9	9	8	9	9	10	8	850	Northwest, East.
Redskin	1	9	9	9	9	8	8	9	750	East, Southeast.
Elberta	0	9	9	7	8	9	9	7	900	Northwest, Colorado.
Dixiland	0	9	9	9	9	9	7	8	750	Southeast, East.
J. H. Hale	+1	10	9	9	10	9	7	6	900	Northwest, Colorado.
Fay Elberta	+2	9	9	8	9	9	10	.....	750	California, Northwest.
Jefferson	+2	9	9	9	10	9	8	.....	950	East.
Jerseyqueen	+3	9	9	9	8	9	7	5	850	Do.
Late:										
Shippers Late Red	+4	10	9	9	10	9	7	5	850	California.
Fayette	+6	9	9	10	9	9	8	6	850	California, Northwest.
Tyler	+7	8	9	8	8	8	7	.....	950	East.
Rio Oso Gem	+8	10	9	8	10	9	8	5	900	East, Northwest, Southeast, California.

See footnote at end of table.

TABLE 1.—*Characteristics of some established peach cultivars, listed in approximate order of ripening, as grown at Beltsville, Md.*—Continued

[Ratings range from 1 to 10; higher values indicate more desirable characteristics]

Ripening season and cultivar [1]	Approximate ripening date in days before or after (—) 'Elberta'	Fruit size	Stone freeness	Attractiveness	Flesh firmness	Dessert quality	Canning quality	Bacterial spot resistance	Chilling requirement (hours below 45° F.)	Areas of adaptation
Late—Con.										
Monroe	+12	8	9	9	9	8	8	7	850	East.
Kirkman Gem	+25	9	9	8	9	9	7	7	(low)	California.
Marsun	+26	9	8	9	9	9	7	8	(high)	East.
Summerset	+30	9	9	8	8	8	6	7	750	California.
Fairtime	+37	9	8	8	8	7	6	6	(low)	Do.

[1] All cultivars have yellow flesh except 'Springtime', Erly-Red-Fre', 'Babcock', and 'Raritan Rose', which have white flesh.

are ripe. Both adapt to the very early shipping market or to local marketing where earliness is of prime importance and freeness of the pit is not required. 'Royal May' is also yellow fleshed and practically clingstone, and its fruits ripen after those of 'Springold' and 'Springcrest' in most areas.

'Earlired' has attractive yellow-fleshed fruit ripening about a week after 'Springold'. Early thinning is necessary to produce acceptable fruit size. Split pits may be excessive if the crop is light or if trees are overthinned. 'Earlired' seems to adapt to widely different environments. 'Candor' may be preferable in parts of the Southeast because of rounder fruit, slightly better resistance to bacterial spot disease, and fewer split pits. 'Collins' may be used in areas relatively free of bacterial spot disease. Each of these cultivars adapts only to early shipping or local marketing.

'Cardinal' and 'Dixired' are alternative, yellow-fleshed, semiclingstone cultivars. They ripen about 6 weeks before 'Elberta' and adapt to distant fresh marketing or local market use. 'Cardinal' is about 4 days earlier than 'Dixired' and is preferred where this earliness gives a fresh-market price advantage. 'Early Coronet', an early-ripening mutation of 'Coronet', brings the near-ideal fruit characteristics of that cultivar into this ripening period and is replacing 'Cardinal' in California and some southeastern plantings. 'June Gold' and 'Maygold' are preferred in southern areas where relatively low chilling cultivars are needed.

'Early Redhaven' and 'Garnet Beauty' are very similar early mutations of 'Redhaven' with the attractiveness of that cultivar. The former is being planted in the Pacific Northwest and the latter is slightly preferred in eastern areas. 'Erly-Red-Fre' is a high-quality white-fleshed cultivar in the later part of this very early ripening period. 'Sentinel' is being planted in areas where bacterial spot disease is a serious problem. It has firm, yellow flesh and is almost freestone. Planting of 'Sunhaven' has essentially ceased.

'Redhaven' has very attractive, semifreestone, yellow-fleshed, firm fruit. The cultivar is widely adapted. In southern areas, fruits become elongated. 'Redhaven' requires early and heavy fruit thinning to develop marketable size in eastern areas particularly. The tree is moderately hardy and very productive. The flesh is nonbrowning and adapts well to canning and freezing. In California, 'Regina' is preferred to 'Redhaven' because of its rounder, firmer fruit. 'Raritan Rose' is a high-quality white-fleshed peach in this ripening period—about 1 month before 'Elberta'—in eastern areas. 'Babcock', another white-fleshed peach, is grown extensively in California. 'Coronet', despite its inconsistent bearing, is widely planted and has very desirable fruit characteristics.

'Triogem' ripens about 3 weeks before 'Elberta'. It produces medium-sized, yellow-fleshed, fine-textured,

freestone fruits with very attractive skin. The fruit buds are relatively tender. Fruit may be small unless trees are thinned early and heavily. 'Redtop' is a very attractive, firm peach in this early-ripening period, grown extensively in California, and being tested widely in other western areas. It is too susceptible to bacterial spot for most eastern areas. 'Ranger' is a high-quality peach, with bacterial spot resistance and moderate hardiness, which has been overshadowed by the attractiveness of 'Redhaven'. It produces more consistently than most cultivars in the Southeast. 'Suwanee' is a relatively low-chilling peach, which is being planted extensively in the lower Southeast. 'Washington' is adapted particularly to its area of origin, Virginia, but is erratic in other producing areas.

'Sunhigh' is a high-quality freestone peach ripening about 2½ weeks before 'Elberta'. It lacks some of the intense blush of newer cultivars but has very attractive undercolor. It is very susceptible to bacterial spot disease. It has fine-textured flesh and processes well. 'Glohaven' has better fruit bud hardiness and resistance to bacterial spot than does 'Sunhigh'.

In the 'July Elberta'-'Halehaven' season, about 2 weeks before 'Elberta', these very useful interim cultivars are no longer being planted extensively. 'Redglobe' with its large, firm, yellow-fleshed freestone fruits adapts to many peach-producing areas. It has a dependable producing tree and the fruits withstand long-distance shipping well. It has lost favor in California because of softening around the stylar scar, but this has not been noted in other producing areas. 'Earlihale', although slightly later ripening, is preferred in the Pacific Northwest because the fruits approach the 'J. H. Hale' type. 'Southland', which requires relatively low chilling, is extensively planted in the Southeast but is not being replanted. 'Canadian Harmony', which appears to have improved hardiness and bacterial spot resistance, has been planted to a considerable extent but is relatively untested in most areas.

'Loring', ripening about 1½ weeks before 'Elberta', is outstanding in many areas, particularly the Southeastern and Midcentral States, but it is mediocre in others. 'Suncrest' is a very firm-fleshed, attractive peach, well adapted to western conditions. It is very susceptible to bacterial spot disease. 'Yakima Hale' is preferred by some growers in the Northwest. 'Summergold' is being planted in the Southeast because it adapts to both fresh-market and processing use.

In the week preceding 'Elberta' ripening, no completely satisfactory cultivar is available. 'Sullivan Early Elberta' extends the season of Elberta-type peaches about 5 days earlier but lacks the exterior attractiveness of newer cultivars. 'Merrill Fortyniner' is more attractive and

slightly firmer but does not process so well. 'Blake' has an extremely attractive exterior but often has too much red streaking in the flesh and erratic production. 'Madison' is very productive and frost hardy. 'Early Elberta (Gleason strain)' probably is the best freestone canning peach available but lacks the extensive, bright blush now expected in fresh-market peaches.

'Redskin', because of better exterior attractiveness, has been steadily replacing 'Elberta' in most areas. However, it does not process quite so well as 'Elberta'. 'J. H. Hale' remains a principal cultivar in the Pacific Northwest and Colorado. 'Fay Elberta' in California and 'Gold Medal' in the Pacific Northwest are preferred freestone canning cultivars. 'Dixiland' appears to be replacing considerable 'Elberta' acreage in the Southeast. 'Jefferson' and 'Jerseyqueen' have been erratic in their general performance but are very attractive, relatively firm cultivars, best adapted to their area of origin, Virginia and New Jersey, respectively.

'Rio Oso Gem', because of its almost ideal fruit type, is still recommended in most areas for the ripening period about 1 week after 'Elberta'. Poor tree characteristics—low vigor, brachytic type of growth, and low productivity—limit the usefulness of this cultivar. 'Fayette' overlaps the 'Fay Elberta' and 'Rio Oso Gem' seasons and is replacing acreage of both cultivars in California.

Completely satisfactory cultivars for the 2 weeks following 'Rio Oso Gem' have not emerged. In some eastern areas, 'Monroe' is productive and has attractive yellow-fleshed fruits, ripening about 4 days after 'Rio Oso Gem'. 'O Henry' is increasing in California plantings.

Late cultivars generally are deficient in exterior color. 'Kirkman Gem' is still an important variety in California but is not being planted extensively. 'Summerset', ripening almost a month later than 'Elberta', and 'Fairtime', 1 week later than 'Summerset', are increasing in California plantings.

All the preceding cultivars are melting fleshed and some are adaptable to processing. Peaches with nonmelting flesh, usually called clingstones, account for nearly half of the total peach production, and essentially all this production is in California. Nearly all are canned. Cultivars have been developed by institutional and private breeders for highly specialized production in the California interior valleys. Therefore the cultivars used are not described in this handbook.

In a few areas other than California, processors, primarily of baby food, contract limited acreages of clingstone cultivars. These are cultivars developed in, and adapted to, eastern areas. Initially nearly all the acreage was of 'Ambergem', an early-midseason, productive, relatively hardy, but small-fruited cultivar. Most of the 'Ambergem' acreage gradually was replaced by a sequence of numbered

Babygold clingstones developed also by the New Jersey Agricultural Experiment Station. The Michigan Agricultural Experiment Station introduced 'Suncling' in 1961 and the Virginia Agricultural Experiment Station introduced 'Mountaingold' and 'Piedmontgold' in 1968. The grower should not attempt to select one of these without consulting the processor for adaptability and acceptability of specific cultivars.

Because the grower has no alternative market for clingstones, he should have a long-time arrangement for disposing of the fruit before he plants the trees. Also, he should adapt his cultural practices to production of maximum tonnage of fruit sizes acceptable to the processor.

Special-Purpose and Promising New Cultivars

Some cultivars have very limited adaptation to small areas or specific uses and do not represent major acreage. However, these are also included in table 1 because they are important to the industry in those areas where they are well adapted. Examples are 'J. H. Hale' or 'Earlihale' in the Pacific Northwest, 'Springcrest' or 'Regina' in California, and 'Washington' in Virginia.

Some of the newer peaches tentatively evaluated in table 2 also have limited adaptation; for example, 'Desertgold', 'Flordared', 'Delp Early Hale', and 'Harken'. It is essential that plantings of any of these newer peaches be based on their performance under *local* conditions.[2] Other cultivars, not listed, may best fit the local climatic and market requirements. In general, however, those listed represent the combination of firm flesh and exterior attractiveness needed in their ripening period for fresh-market acceptance.

A few genetic dwarf peaches are available. These are extreme dwarfs even on standard rootstocks. They are particularly adapted to ornamental use. The trees have extremely short internodal growth, which gives dense foliage and blossoms. Most have showy petals. These dwarfs are single-factor recessives, which apparently arose by mutation in China many years ago. The 'Flory' or 'Dwarf Mandarin' apparently was the main introduction of dwarf peaches from China. 'Tom Thumb' was introduced from France in the 1920's. From these white-fleshed peaches, several patented yellow-fleshed cultivars, notably 'Bonanza' and 'Empress', have been developed.

'Elbertita' has a semidwarfed tree, which grows from one-third to one-half the size of normal peach trees. 'Golden Treasure' is a similar patented cultivar. Other cultivars, such as 'Rio Oso Gem', show a tendency to brachytic growth, or short internodes, but are essentially full-sized trees.

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[2] For example, see "Performance of Peach Cultivars in Georgia" by E. F. Savage and V. E. Prince, Ga. Agr. Expt. Sta. Res. Bul. 114, which describes many of these newer peaches in greater detail.

TABLE 2.— *Tentative evaluations of promising cultivars introduced since 1960, listed in approximate order of ripening* [1]

Ripening season and cultivar [1]	Introduced: By [2]	Introduced: Year	Aproximate ripening date in days before or after (+) 'Elberta'	Fruit size	Stone freeness	Attractiveness	Flesh firmness	Bacterial spot resistance	Approximate chilling requirement (hours below 45° F.)	Suggested areas of adaptation
Very early:										
Flordared	Florida	1970	66	Medium small	Semifree	Fair-good	Medium		50–100	Central Florida.
Whynot	North Carolina	1968	65	Small	Semicling	do	do	Moderate-good	900–1,000	Southeast.
Early Amber	Peaches of Florida [3]	1964	64	Medium small	do	Fair	do		350	Florida, Southeast.
Royal Gold	Zaiger, Calif.[3]	1967	63	Medium	Semifree	Good	do			California.
Armgold	Armstrong, Calif.[3]	1964	60	Small	do	Fair-good	do		650	Do.
Camden	USDA (Byron) and South Carolina	1972	60	Medium small	do	Good	do	Good	750	South Carolina sandhills.
Desertgold	USDA (Fresno)	1969	58	do	Semicling	do	do		350–400	Lower California.
Springbrite	USDA (Byron)	1972	54	do	Semifree	do	do	Fair	650	Southeast.
Flordabelle	Florida	1970	50	Medium	do	Fair	do		150	Central Florida.
May Lady	Merrill, Calif.[3]	1968	50	do	Semicling	Good	Medium firm			California.
Fillette	New Jersey	1966	50	Small	do	Fair-good	Medium soft			East.
Bonjour	Merrill, Calif.[3]	1966	44	Medium	Semifree	Good	Medium firm			California.
Magnolia	Wilson, Ga.	1970	42	do	Semicling	do	do		650	Southeast.
Golden Monarch	Pratt, Wash.[3]	1971	40	Medium large	Free	do	Firm			Northwest.
Early:										
Somerset	Kemp, Md.	1966	35	do	do	do	Medium firm		850	East.
LaGem	Louisiana	1965	35	do	Semifree	do	do	Good	850–900	Louisiana.
June Lady	Merrill, Calif.[3]	1968	33	do	Semicling	do	do			California.
Pekin	North Carolina	1968	31	do	Semifree	do	do	Good	950	North Carolina sandhills.
Compact Redhaven	Pratt, Wash.[3]	1971	30	do	do	do	Firm			Northwest.
Norman	North Carolina	1968	28	do	Free	do	do	Moderate-good	850–950	North Carolina sandhills.
Harbrite	Harrow, Ontario	1969	26	Medium	do	do	do	Good		Ontario.
Harken	Harrow, Ontario, and Kentucky	1970	26	do	do	do	do	Moderate-good		Ontario and Midwest.
LaGold	Louisiana	1967	25	Medium large	do	do	do	Good	700–750	Louisiana.

See footnotes at end of table.

TABLE 2.—*Tentative evaluations of promising cultivars introduced since 1960, listed in approximate order of ripening*[1]—Continued

Ripening season and cultivar[1]	Introduced: By[2]	Introduced: Year	Approximate ripening date in days before or after (+) 'Elberta'	Fruit size	Stone freeness	Attractiveness	Flesh firmness	Bacterial spot resistance	Approximate chilling requirement (hours below 45°F.)	Suggested areas of adaptation
Early—Con.										
Reliance	New Hampshire	1964	25	Medium	do	Fair-good	Medium			North.
Troy	North Carolina	1968	24	Medium large	do	do	Firm	Moderate-good	850–900	North Carolina sandhills.
Harrison	Virginia	1972	24	do	do	do	do			Virginia.
Midseason:										
McNeely	USDA (Beltsville) and South Carolina	1972	21	do	do	do	do	Fair-moderate	900	South Carolina.
Sunqueen	New Jersey	1966	17	do	do	Good	Medium			East.
Sam Houston	Texas	1965	17	do	do	do	Medium firm	Fair	500	Texas.
LaRed	Louisiana	1967	16	do	do	do	Firm	Good	850–900	Louisiana.
Delp Early Hale	Delp, Wash.[3]	1963	15	Large	do	do	do			Northwest.
Redqueen	New Jersey	1964	14	Medium large	do	do	Medium firm			North.
Zachary Taylor	Virginia	1972	14	do	do	do	Firm			Virginia.
Canadian Harmony	Harrow, Ontario	1968	13	do	do	do	do	Moderate-good		Southwest Ontario.
LaPremiere	Louisiana	1965	12	do	do	do	do	Good	1,050	North Louisiana.
Winblo	North Carolina	1972	11	do	do	do	do	Moderate-good	800–850	Southeast.
Vanity	Vineland, Ontario	1965	9	do	do	do	do			Ontario.
July Lady	Merrill, Calif.[3]	1970	8	do	do	do	do			California.
Sparkle	Merrill, Calif.[3]	1971	5	do	do	do	do			Do.
Olinda	Whaley, Ontario	1962	4	do	do	do	do	Moderate-good	950	East.
Biscoe	North Carolina	1968	3	do	do	do	do	Good	850–900	Southeast.
Early O'Henry	Merrill, Calif.[3]	1971	3	Medium	do	do	do			California.
FrostKing	Ponchalek, N.Y.[3]	1969	3	Medium large	do	do	do			North.
Late:										
Marglow	Maryland	1966	+ 2	do	do	do	do			East.
Marhigh	do	1966	+ 5	Large	do	do	do		650	Do.
Tyler	Virginia	1970	+ 6	do	do	Moderate-good	do			Virginia.
Marland	Maryland	1966	+ 7	do	do	Good	do			East.

Robison	Robison, S.C.[3]	1962	+7	Medium large	do	do	do		850	Southeast.
Emery	North Carolina	1968	+7	Medium	do	Moderate-good	do	Moderate-good	950	Do.
O'Henry	Merrill, Calif.[3]	1968	+8	Medium large	do	do	do			California.
Improved Pacifica	Merrill, Calif.[3]	1964	+8	Large	do	Good	do		850	Do.
Marqueen	Maryland	1966	+10	do	do	do	do		650	East.
Sogood	do	1961	+10	do	do	Moderate-good	do		750	Do.
Monroe	Virginia	1966	+11	Moderate large	do	do	do	Moderate-good	850	Virginia.
Kenlate Elberta	Kendall, N.C.	1969	+14	do	do	do	do			Southeast.
Marpride	Maryland	1971	+15	Large	do	Good	do			Mid-Atlantic.
Treasure	Merrill, Calif.[3]	1969	+18	do	do	Moderate-good	do			California.
Marsun	Maryland	1966	+28	do	do	do	do			East.
Improved Mardigras	Merrill, Calif.[3]	1968	+30	do	do	do	do			California.
Autumn Gem	Merrill, Calif.[3]	1971	+35	do	do	do	do			Do.

[1] All cultivars have yellow flesh except 'Flordared', which has white flesh.
[2] State agricultural experiment station if State only is given.
[3] Patent assigned or applied for.

PROPAGATING AND SELECTING ROOTSTOCKS

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

A peach generally cannot be reproduced true to name 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 cultivars are more uniform than those of others. In reliable nurseries the main purpose of germinating peach seeds is to grow understocks, on which to bud or graft desired cultivars.

Peaches may be propagated on most *Prunus* species (peach, plum, apricot, or almond). Compatibility and top growth vary among clones of these species. In general, buds of desired cultivars are compatible when budded to seedlings of the common peach cultivars. 'Elberta' and 'Halehaven' budded on seedlings of 55 peach cultivars gave trees of similar size and yield.

For rootstock, peach seeds should be available in large quantity, be economical, and germinate well in the nursery. Initially most rootstock seeds came from seedling trees (naturals) in the Carolinas, Tennessee, and other southern States. When the supply of reliable seeds dwindled, nurserymen turned to 'Lovell', a cultivar used in California for drying. It gives uniform seedlings and makes satisfactory stocks unless nematodes are numerous. Since 'Lovell' was replaced by better drying cultivars, supplies of seeds have become limited. 'Halford' and other clingstones have replaced 'Lovell' as seed sources. 'Elberta' and other midseason or late cultivar seeds are available from canneries but usually give more variable germination and less uniform seedlings. Seeds from red-leaved peaches are used by some nurseries for spotting missed propagations.

Nematode injury to peach roots in some areas has led to importing, selecting, and breeding for resistant rootstocks (fig. 3). 'Shalil' from India and 'Yunnan' from China resist the cotton root-knot nematode. 'S–37' gives some resistance to the Javanese root-knot species. 'Okinawa' gives high resistance to both nematodes usually but lacks vigor. 'Nemaguard' combines vigorous growth with dual resistance and high germination. None of these has been adequate under certain southeastern conditions.

Understocks that combine greater resistance, high seed yields, better germination, increased hardiness, and red-leaf character are being tested.

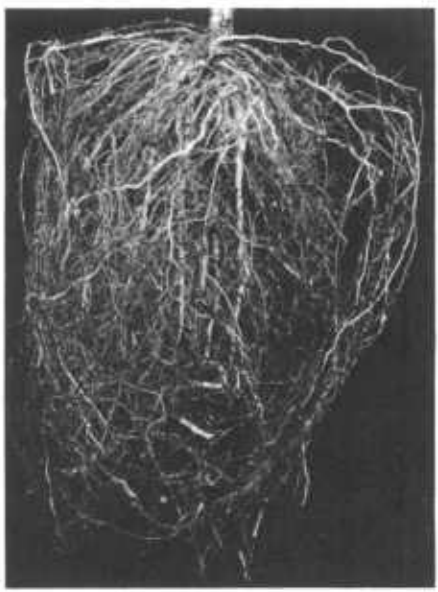
Plum, apricot, and almond stocks usually have given inconsistent

results. *Prunus besseyi* Bailey and other dwarfing stocks usually give short-lived trees. Heavy pruning and restricted nitrogen give semidwarf trees on standard stocks. A peach-almond hybrid is a promising stock in California.

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 cultivar. The seeds should be stored over winter in damp peat or sand, or in a mixture of the two, at 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 a high percentage of germination. Special precautions must sometimes be taken to protect the seeds from rodents.

Budding desired peach cultivars onto young seedlings is done during the first year of seedling growth.



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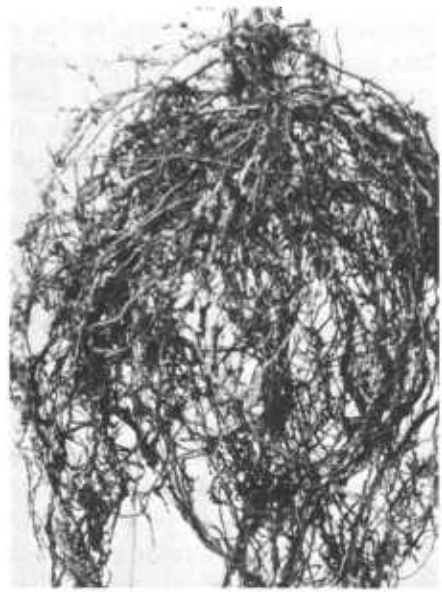

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FIGURE 3.—Differences in root-knot nematode resistance of peach stocks: *Left*, nematode-resistant stock; *right*, susceptible stock.

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 cultivar 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 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 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, set the trees 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 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.

PN-3699

FIGURE 4.—Peach orchard without sufficient space between rows. This makes spraying, cultivating, harvesting, and other operations difficult and inefficient.

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).

Detailed 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.

PN-3700

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

Setting Out the Trees

Before planting peach trees, remove any broken or diseased roots. Additional root pruning is not necessary or desirable. If the roots have dried out in storage or in transit, soak them 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, plant it 1 or 2 inches deeper than it was planted in the nursery. Fill the space around the roots with topsoil and tamp the soil. Add more topsoil if it is available and water if the soil is dry. Do not apply nitrogen fertilizer 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. Where nematodes are numerous, especially those of the root-knot type, soil fumigation 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, prune the tree 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, thin the branches and head back more severely to the 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, select and train the scaffold branches 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, cut back its lateral shoots 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 7/16- to 9/16-inch diameters, 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. Remove all other branches that are weak and crooked and that have sharp-angled crotches. 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

8N-19182

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

BN-19180

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.

so that 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. 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. Prun-

ing 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.

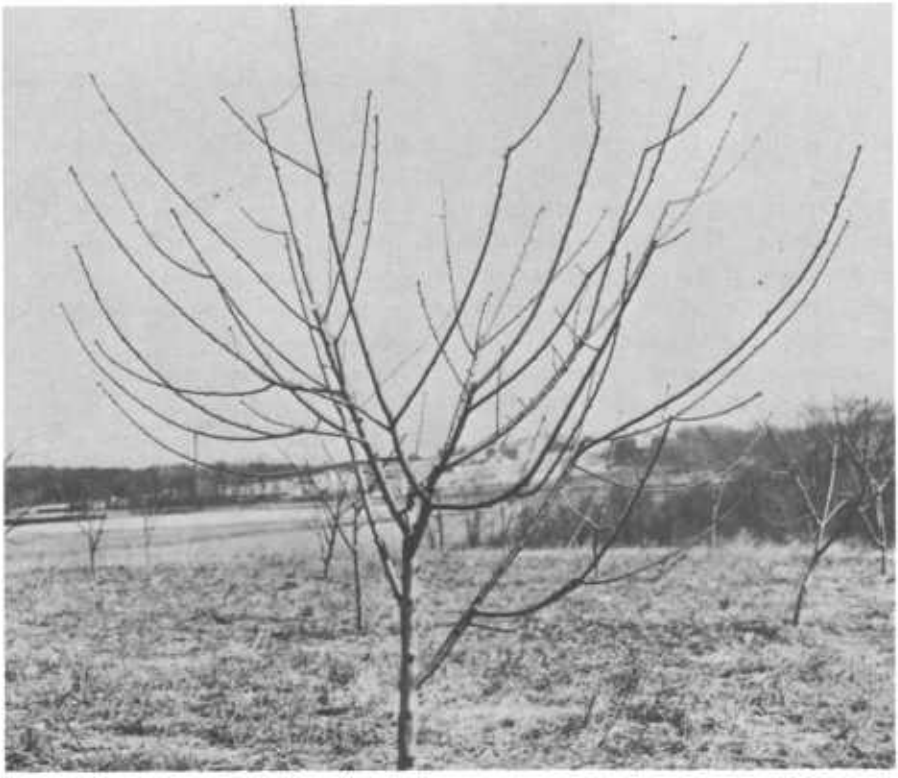
Some peach growers use a deshooting method of summer training during the first season in the orchard. This method is not used as commonly now as it was a few years ago. Deshooting requires much time and care. With this method, the tree should be at least 4 feet tall when planted. The tree is first headed 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 remove new shoots growing from the trunk 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 they are usually the first twigs to



PN-3701

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

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

After fruiting begins throughout the tree, thin out and shorten the inside twigs 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. 9–11). 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. Further-

8N-19183

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

more, 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 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 bud killing, 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, con-

PN-3702

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

trol 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

PN-3703

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

twigs in the center of the tree, the tree should be thinned out or some branches removed.

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 obtaining 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

PN-3704 and PN-3705

FIGURE 12.—Strong, vigorous, productive, 5-year-old 'Redhaven' peach tree: *Above*, before pruning; *below*, as pruning is completed.

8N-19181

FIGURE 13. – Strong, mature 'Elberta' peach tree pruned to about 10 feet high. Growth renewal points are established throughout the tree.

more pruning than does any other fruit tree. Pruning is largely a renewal process and is done by removing upright branches, by thinning 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 treetop. 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 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. Trees pruned dormant or during full bloom produced the most flowerbuds per foot (table 3).

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

TABLE 3.—*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
		Number per			
	Bushels	*bushel*	*Percent*	*Inches*	*Number*
Dormant	7.7	171	22.0	11.6	15.1
Full bloom	6.2	188	39.7	9.7	15.3
Shuck fall	5.3	167	43.9	9.0	11.1
3 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 first 2 of 4 picking dates.

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 blossomingtime 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.

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 re-

duces 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 cultivars with little red develop more color with reduced pruning or reduced application of nitrogen to the soil. Fruits of bright red cultivars, 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. 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. 14–16). 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 tem-

PN-3706

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

peratures. On these upland sites 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. 17–19). 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. Keep the soil around the trunks free from weeds during the growing season, especially in nonirrigated orchards. In the larger orchards, cultivate the soil along each side of each row to a

PN-3707

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

PN-3708

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

distance of at least 5 feet (fig. 14). It is not necessary to cultivate all the area between tree rows. An 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 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 in the 1930's 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

PN-3709

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

BN-19185

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

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

PN-3710

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

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 cultivars 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 cultivars. 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.

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.

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 sod 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 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, consider the needs of each orchard individually.

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, manganese, 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 required 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, add only those materials needed by the trees that are not supplied by the soil. 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 most peach orchards. 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 Early Elberta', and 'Belle'; but 'Redglobe', 'Dixired', and certain other cultivars color well when relatively high soil and tree nitrogen is 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. Avoid treatments that supply abundant nitrogen in midsummer.

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 required. 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 are 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' cultivars at Beltsville, Md., emphasized the interrelations of

variety, time of nitrogen application, and time of disking the cover crop.

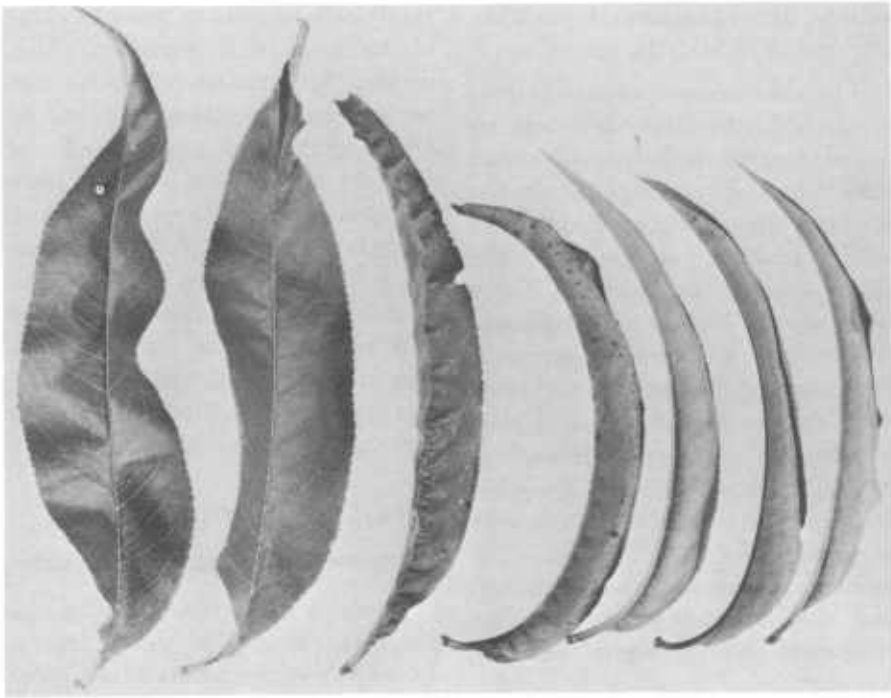
When nitrogen was applied to trees in the fall, the fruit yield was reduced and the fruit ripened earlier than when it was applied in the spring or when it was applied in three equal amounts in the fall, the spring, and the early summer. Yields were usually highest when nitrogen was applied in three equal amounts. The time of disking the rye cover crop had little effect on fruit yield of any of the three cultivars studied. A full crop of 'Elberta' peaches weighed more than did a full crop of '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 cultivars. 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.



PN-3711

FIGURE 20.—*Left to right:* Peach leaves with increasingly severe symptoms of potassium deficiency.

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.

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 by adding limestone according to local recommendations.

Minor Nutrient Elements

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 the Eastern United States.

Manganese deficiency causes light-

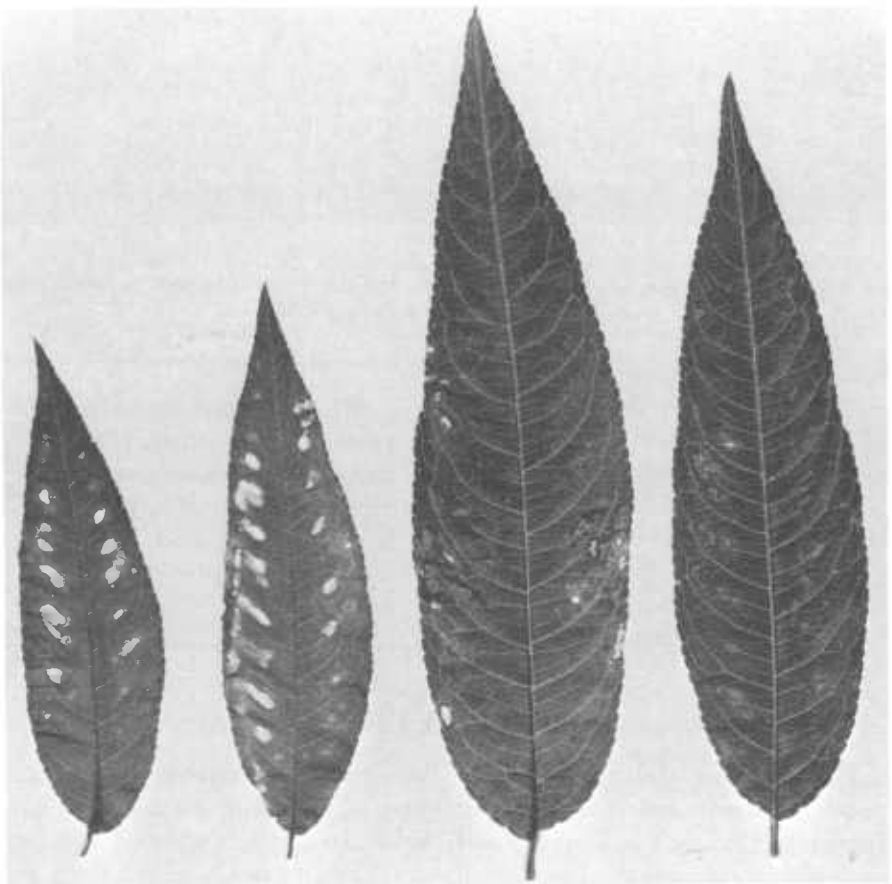


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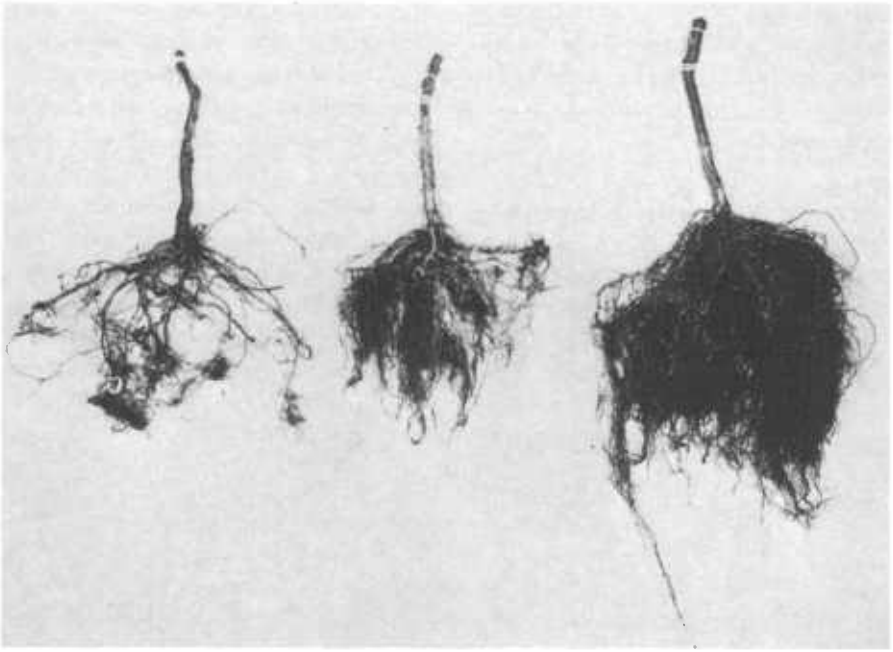
FIGURE 21.—*Left to right:* Decreasingly severe symptoms of magnesium deficiency in peach leaves.



PN–3713

FIGURE 22.—*Left to right:* Effects of low, medium, and high levels of calcium on peach roots grown in orchard soils at Beltsville, Md.

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

Most western and many eastern peach orchards 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, about 6 acre-inches of water will be available in the spring. Since peach orchards use about 3 acre-inches of water per month during the growing season, 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 cultivar 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 cultivar. 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, leave only one peach 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 Cultivar

With the early-ripening peach cultivars 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 cultivars have a much shorter period of fruit development than do 'Elberta' and the later ripening cultivars. Cultivars that particularly benefit from early thinning include 'Mayflower', 'Earlired', 'Cardinal', 'Coronet', 'Red-

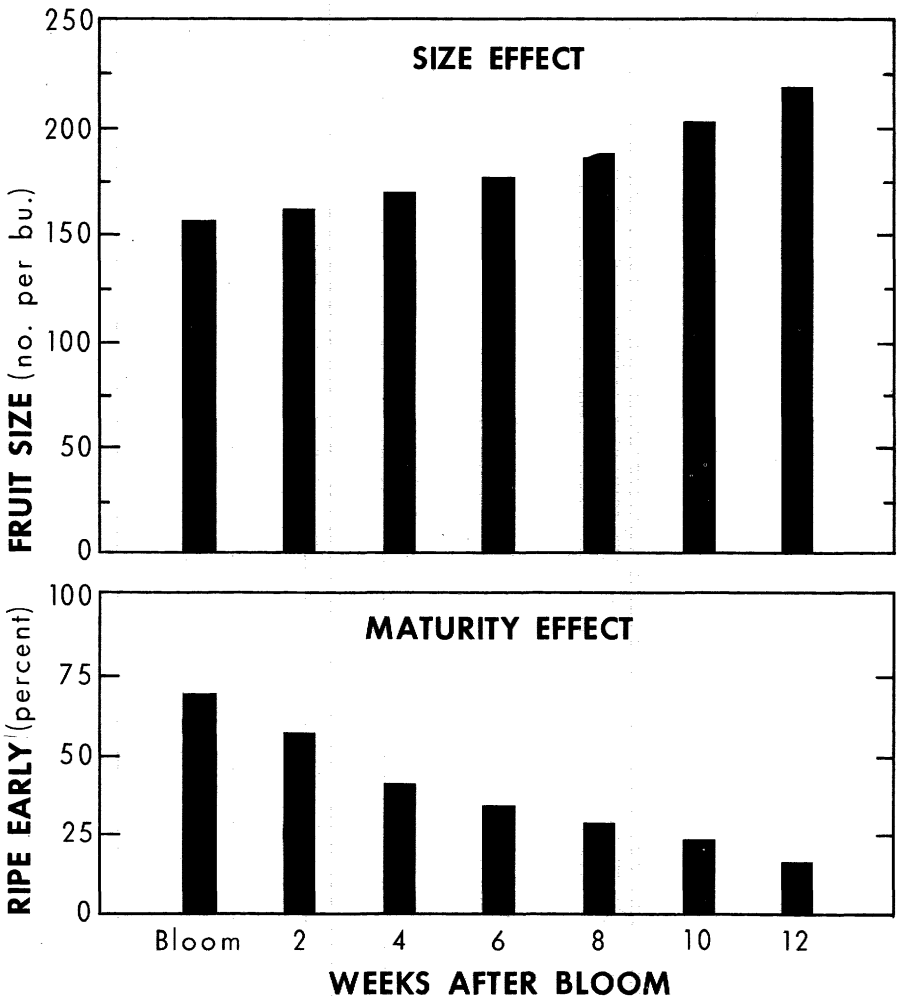


FIGURE 23.—Effects of time of thinning on fruit size and maturity of 'Redhaven' peaches. Each successive thinning period caused smaller and later ripening peaches.

haven', 'Golden Jubilee', and 'Triogem'. With these early-ripening cultivars, early thinning of fruit increases not only the fruit size but also the quantity of young shoot growth and leaf size.

For many early-ripening cultivars, 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 whether the greater value of the larger fruits justifies the expense of early thinning.

With midseason and later cultivars, 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.

Because of high labor costs, considerable thinning is done by rapid mechnical 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 cultivars. Blossoms may be removed selectively by water jets.

Several chemicals, some effective on blossoms and others on developing fruits, thin peaches under specific conditions. Each fails to thin consistently. Most cause foliar chlorosis and some defoliation at effective rates. None is dependable enough to be recommended. Try only those currently approved for use on peaches and carefully follow local recommendations for concentration and timing of sprays. 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° at night have severely damaged peach tree wood in southern areas. In northern areas the damage is likely to occur only at much lower temperatures. Dormant flowerbuds are affected before the wood is. A rapid drop to below −15° 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 diseases.

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 season, age and vigor of the tree, variety, stage 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 below −10° F. However, a rapid drop in temperature after a warm period can lead to bud killing at temperatures much

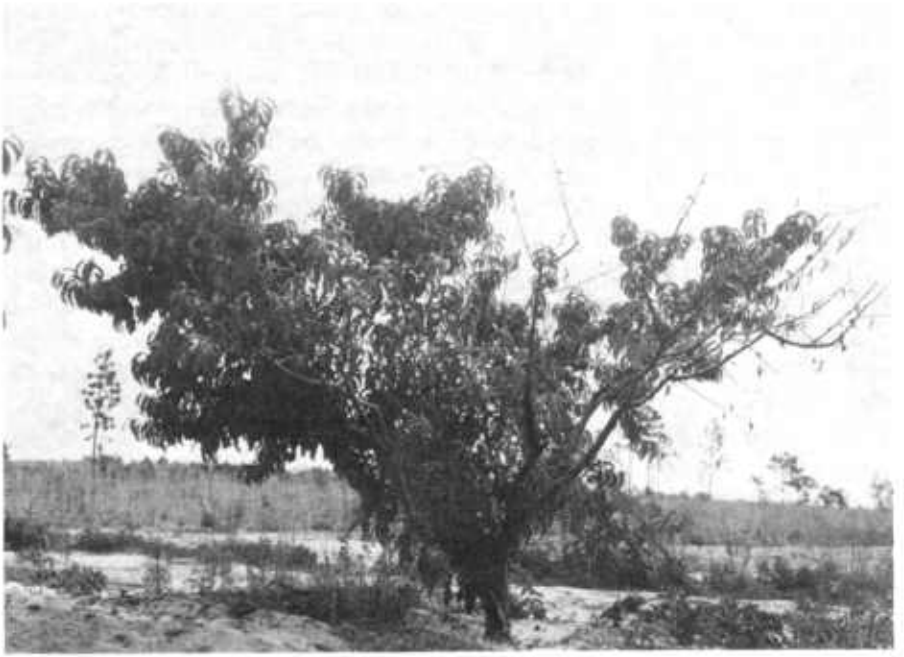


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FIGURE 24.—Winter damage, primarily on the southwest side of the tree trunk and lower parts of scaffold limbs, caused by rapid temperature changes. Reflection of sun by snow causes surface temperatures considerably above the air temperature.

higher than −10°. Conversely, buds have sometimes 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 cultivars sometimes mean the difference between a good peach crop and no peach crop. 'Elberta' and 'J. H. Hale' are two of the more tender cultivars. 'Rochester', 'Veteran', 'Cumberland', and 'Erly-Red-Fre' are among the more hardy cultivars. 'Halehaven', 'Golden Jubilee', and 'Redhaven' may be classed as fairly hardy. Some cultivars 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 cultivars have so few buds that killing even a small percentage may make a good crop impossible.

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

In many parts of the country, especially in the Central and South-

ern 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 at 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 slope is usually much warmer than 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 a 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 at −20° F. 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 slightly 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.

MARKETING, TRANSPORTING, AND STORING FRUIT[3]

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 allowed 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.

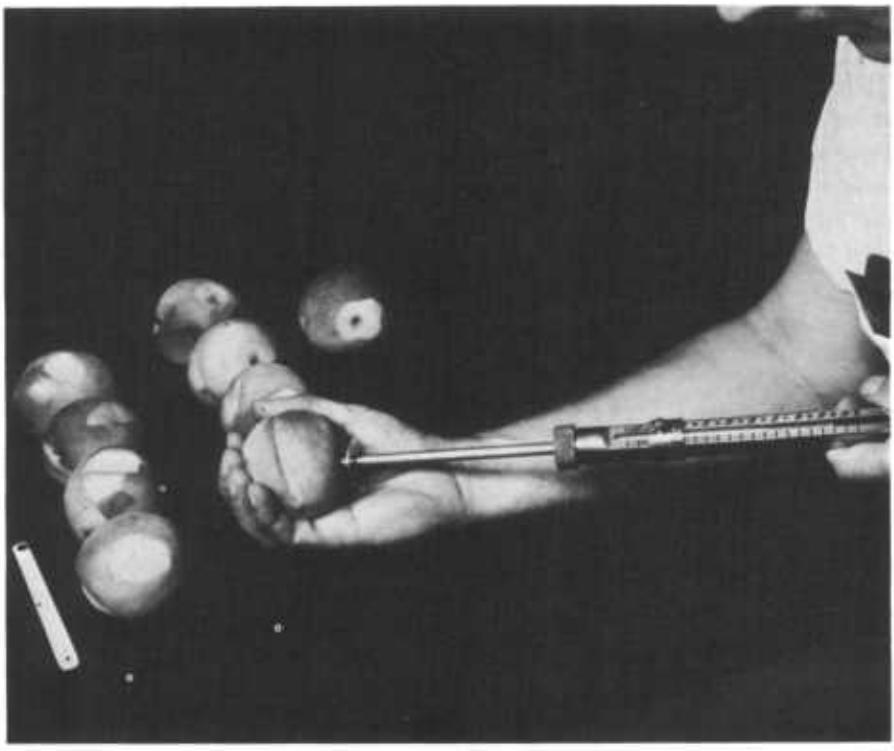
For freestone cultivars, standards of maturity are based on the change of ground color from green to yellow and on flesh firmness, as determined by using a Magness-Taylor pressure tester (fig. 25). 'Elberta' peaches testing 10 to 14 pounds with a 5/16-inch-diameter plunger applied to the pared cheeks 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 cultivars other than 'Elberta'.

Harvesting and Shipping Containers

Drop-bottom picking bags are now widely used for peaches. Padded, drop-bottom picking buckets 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 or bins.

In many orchards large bins holding about 20 bushels have replaced the customary field crates. These

[3] This section was originally prepared by M. H. Haller (retired), formerly Market Quality Research Division, Agricultural Research Service. It has been revised by W. L. Smith, Jr., and R. W. Penney, Horticultural Crops Marketing Laboratory.



PN-3715

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

bins are loaded by forklift tractors onto flat-bottomed trucks and moved rapidly from the fields to the packing sheds. The use of these bins is especially applicable to mechanical harvesting. In this operation the fruits are shaken from the trees, caught on a cushioned platform (fig. 26), and then moved rapidly by conveyor belts from the harvester into the bins. Mechanical harvesting is used to some extent commercially with clingstone cultivars for canning on the west coast but only experimentally with freestones for the fresh market.

Generally mechanical harvesting does not increase cuts and bruises as compared with hand harvesting, but it may increase the amount of decay.

Tub baskets, once the most popular container for shipping peaches, have been replaced by wirebound crates and fiberboard cartons. These have advantages over the baskets because the fruits are packed in bulk without facing and thus labor and bruising are reduced.

The Spartan wirebound crate was the first of this type crate used, but it is now largely replaced by the Du-All box. This box has sides and bottom lined with chipboard. The ends and partially telescopic cover

are made of paraffin-impregnated fiberboard. It is light to handle and holds up well during hydrocooling and shipping.

Most fiberboard cartons with telescopic lids will not withstand hydrocooling. This has necessitated hydrocooling the fruit in field boxes or bins or in bulk before it is packed for shipment. Possibly because of the use of these cartons, air cooling after packing is replacing hydrocooling in some instances. Other cartons are impregnated with a water repellent and reportedly will withstand hydrocooling.

PN-3716

PN-3717

FIGURE 26.—Experimental mechanical harvester developed by Clemson University engineers: *A*, Shaker arm and catching frame; *B*, canvas catcher and conveyor.

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

Storage and Shipping Temperatures

Because of the high outdoor temperatures 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 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.

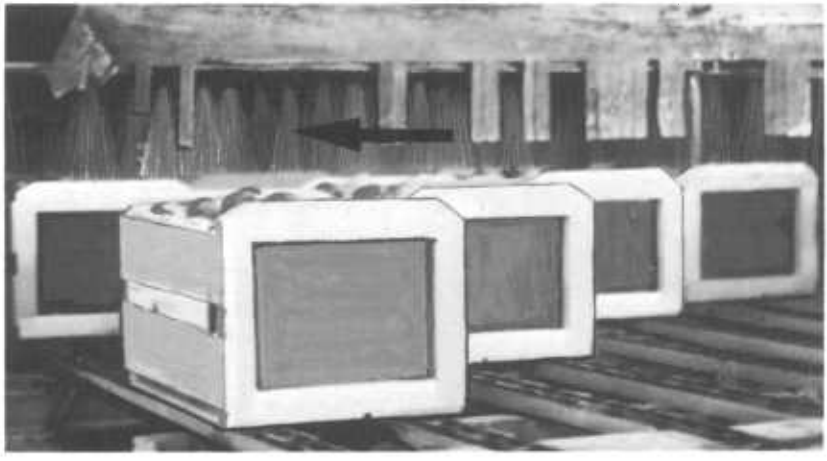
Peaches sometimes are stored for short periods to extend the marketing and commercial canning season. Before storage, fruit should be precooled to about the storage temperature. Most cultivars can be stored successfully for 10 days to 2 weeks in air at 40° F. or 2 to 3 weeks at 32°. Since peaches freeze at about 30°, careful temperature controls are necessary, particularly in the 32°

storage, to avoid freezing injury. When peaches are stored longer in air at 32° or 40°, various types of internal breakdown occur. Often this injury is not apparent until after the stored peaches have been ripened at higher temperatures. Storing in an atmosphere of 1 percent oxygen plus 5 percent carbon dioxide at 32° rather than in air at 21 percent oxygen plus a trace of carbon dioxide has extended the acceptable life of many cultivars up to 6 and sometimes 9 weeks.

Because of the effect of temperature on ripening, peaches should be moved to market rapidly and under the coolest possible conditions. Nearly all peaches shipped to distant markets are cooled prior to shipping. Cooling may be by means of hydrocoolers or more recently by air-cooling rooms.

Peach hydrocoolers may be refrigerated mechanically or with ice. They are installed in the packinghouses as part of the packing line. Peach containers are moved through the hydrocooler under a flood of cold water (fig. 27). The water should be maintained as close to 32° F. as possible by proper refrigeration. The rate of cooling is affected by the size and initial temperature of the fruit, by the water temperature, and by the time in the cooler, which is controlled by varying the conveyer speed. Fruit temperatures can be reduced 20° to 30° in 10 to 15 minutes.

Wooden containers, such as wire-bound crates and field crates or boxes, are satisfactory for hydrocooling. Fiberboard cartons must be treated or made of moisture-resistant materials to successfully withstand wetting. Bulk hydrocoolers are sometimes used when peaches are to be packed in the plastic cup trays or in fiberboard boxes.



PN-3718

FIGURE 27.—Typical hydrocooler in operation, showing boxes of peaches being conveyed under cold water sprays (arrow).

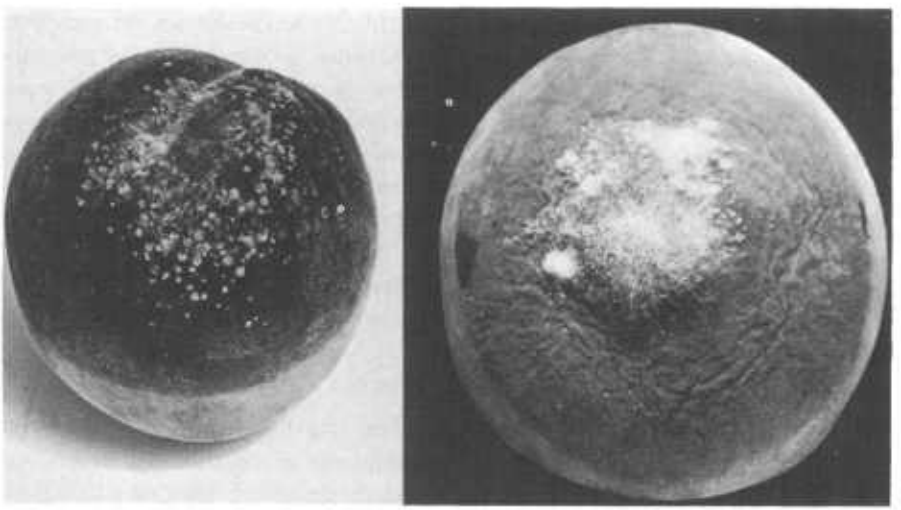
Air-cooling is used with fiberboard cartons where space with sufficient air movement and refrigeration is available.

Peaches are shipped in refrigerated trucks, trailers, or railcars at 32° to 45° F. The lower temperature delays ripening and decay better during transit. It is important that the vehicles are precooled to the desired transit temperature prior to loading. Loading should be in a manner to promote ample air circulation throughout the load.[4] When precooling is not available at the packinghouse, peaches are precooled in the vehicle. Since precooling may require 24 hours, it may extend into the transit time. When the fruit is precooled in the vehicle, it is imperative in loading that air circulation is adequate to reduce the fruit temperature as rapidly as possible.

[4] Recommendations for loading are found in U.S. Dept. Agr. Handb. 105 and 195, "Protecting Perishable Fruits During Transport by Motortruck" and "Protection of Rail Shipments of Fruits and Vegetables," respectively.

Controlling Postharvest Decay

In most peach-producing regions the development of decay during marketing is a serious problem, particularly 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), which are caused by fungi. Brown rot occurs chiefly in the orchard. How much occurs after harvest depends on how well the rot is controlled in the orchard by spraying and sanitary measures. Also, unless the hydrocooler and hydrocooling water are kept clean, the hydrocooling opera-



PN-3719 PN-3720

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

tion may serve as a method of inoculating peaches with spores of the brown rot and rhizopus rot organisms. Rhizopus usually occurs during harvest, in packinghouses, or in transit and marketing.

At 60° to 80° F. both brown rot and rhizopus rot develop and spread rapidly. They can usually be checked by cooling the peaches as soon as possible after harvest and keeping them below 50° throughout the marketing period. Since ripening also is retarded at 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 or from chlorine gas at concentrations of 100 to 120 p.p.m. 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 become dirty.

More recently captan, DCNA (Botran), and benomyl (Benlate) alone or in combination have been added to commercial hydrocoolers in many areas. The value of these chemicals when used in this fashion to control postharvest decay has not been determined accurately in most instances. DCNA and benomyl also have been added to commercial wax formulations to reduce postharvest decays. Some tests have shown that the chemicals are more effective in controlling decay when they are incorporated in wax formulations than when they are used in water suspensions.

Preharvest sprays also have shown promise of controlling postharvest decays. In areas where blossom blight due to the brown rot organism is serious, a complete spray program often is necessary to control postharvest decay. In other areas, sprays 1 or 1 and 2 weeks before harvest have effectively controlled the development of brown rot after harvest. DCNA and benomyl are the fungicides most extensively tested as preharvest sprays. Attempts to control rhizopus rot with preharvest sprays have not always been successful.

For fresh-market peaches, development of postharvest brown rot and rhizopus rot also can be effectively reduced by dipping the fruit in 125° F. water for 2 to 3 minutes.

This treatment has advantages over most postharvest chemical treatments since it destroys organisms just under the skin as well as those on the surface and it leaves no chemical residue. Sanitation is necessary after this heat treatment and when the fruits are packed to prevent recontamination with decay-producing organisms. Exposure times and water temperatures must be carefully controlled to avoid fruit injury. The treatment is not recommended for peaches to be stored. This hot water treatment is being used in several peach-packing sheds in this country and one in France.

When fungicides are added to 115° F. water and fruit is dipped for 2 to 3 minutes, decay control of fresh-market peaches was as good as that obtained with 125° water and better than that obtained when the same fungicide was used in water at room temperature. The 115° water treatment with the addition of benomyl gives excellent decay control during storage.

FUNGAL AND BACTERIAL DISEASES[5]

The principal fungal and bacterial diseases of peaches grown in the United States are brown rot, scab, and bacterial spot. These three widely distributed diseases frequently cause heavy losses to peach growers, shippers, and consumers. Other fungal and bacterial diseases of peaches include leaf curl, rust, constriction, crown gall, powdery mildew, root rots of various types, and dieback.

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 and give 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

PN-3721

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

[5] This section was prepared by H. L. Keil.

nearby healthy peaches, which they infect.

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). These

PN-3722

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

PN-3723

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

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 (fig. 32) and causes the blighted blossom to adhere to the twig. 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.

PN-3724

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

Brown rot may be controlled by removing rotten 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 the 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 best way to control brown rot is by spraying or dusting at regular intervals during the season.

Until several years ago, sulfur was the most widely recommended chemical for control of brown rot. However, it has been replaced by organic chemicals such as dichlone, captan, and benomyl. Dichlone applied during early blossom at one-eighth to one-fourth pound of active ingredient per 100 gallons of water effectively reduces blossom blight infection and the resulting twig cankers. It should not be used after bloom because it sometimes injures fruit. Captan is more expensive than sulfur, but it has proved less injurious and more effective for control of brown rot. Benomyl, a relatively new compound, is very effective for control of brown rot and should come into general use when the price becomes more competitive. The materials, concentrations, and number of applications suggested vary in the different fruit-growing areas. Growers should consult their State agricultural colleges for local recommendations.

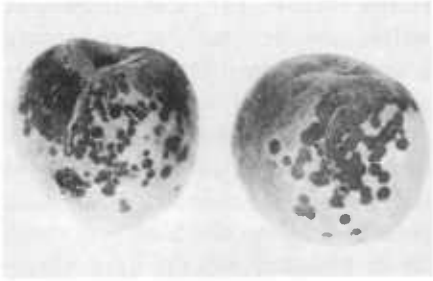
In general, sulfur at 6 pounds per 100 gallons of water, captan at 1 pound active per 100 gallons of water, or benomyl at one-fourth pound active per 100 gallons of water may be sprayed or dusted five to eight times a season depending on the cultivar and on the weather at the following intervals: (1) During pink bud before the blossoms open, (2) at blossomtime, (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. Apply sprays or dust 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.

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.)

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 coalesce and form a large, black, scablike area involving as much as half the surface of the peach. The scabby area frequently splits open and exposes the flesh, which may then be infected by 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.



BN-27404

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

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 undersurfaces 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 one-half pound active material per 100 gallons of water. For this reason, use sulfur when feasible.

Bacterial Spot

Bacterial spot, sometimes called bacteriosis, bacterial shothole, or just shothole, 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, which are generally angular in shape (fig. 34, *A*). 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, shothole appearance—hence the name "shothole." 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 in fertility. Although sometimes nearly all the fruit of susceptible cultivars may be discarded because of bacterial spot, the greatest loss is usually 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.

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

Of the many materials evaluated for bacterial spot control since the 1940's, oxytetracycline was the best. Until this antibiotic is registered for use on peaches we must rely on a 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 filling the tank with water. If other fungicides and insecticides are used in combination with zinc sulfate, they should be added at this time. Do not use captan 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 scab, may be safely 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, never apply copper 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. 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 bloomingtime, 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 1½ pounds per 100 gallons, or dichlone (50-percent wettable powder) at the rate of 1 pound active ingredient 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. Add the oil 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.

Constriction

Constriction, sometimes referred to as *Fusicoccum* canker or peach canker, is a fungus disease that has become economically important since 1950 in the North Atlantic and Middle Atlantic States. This disease affects twigs, blossoms, leaves, and fruit. Dark-brown can-

kers, 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 cultivars severely affected by the disease are 'Golden Jubilee', 'Raritan Rose', 'Cardinal', 'Jerseyland', 'Triogem', 'J. H. Hale', and 'Redhaven'. Studies have been made in New Jersey on controlling late-season infection by postharvest applications of magnesium arsenate. Further tests are necessary, however, before this material 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, most prevalent in the Southern States, is found in all peach-growing areas. 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, and the bacteria are likely to spread to other trees. Removing the galls does not free the tree of infection. Little can be done to control the disease once it becomes established in an orchard.

Powdery Mildew

Powdery mildew, a fungus disease, was seldom a serious problem until organic chemical sprays replaced sulfur sprays. When sulfur is used, powdery mildew 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 fruits. 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 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 part or the whole surface of the fruit is involved. The affected area may become dull reddish to pinkish and may later turn brown. Where powdery mildew becomes serious, use sulfur sprays or organic compound sprays that include a small amount of sulfur. Benomyl also controls powdery mildew.

Root and Crown Rots

Root and crown rots due to several different fungi may cause death of peach trees. The first evidence of these rots may be the appearance of small, yellowish leaves throughout the entire tree or on 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. Growers finding an appreciable number of trees affected

with root or crown rot should consult their State agricultural extension service.

Dieback

"Dieback" is a general name for several conditions that cause death of peach twigs and branches. It may be caused by various fungi and also by bacteria. 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 become yellowish and 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, follow practices that cause the least damage to the tree.

Rhizopus Fruit Rot

Rhizopus rot, caused by the common bread mold fungus, is sometimes serious in peach-growing areas. It is referred to as "whiskers" because of the mycelial growth on the fruit. This rot is likely to be found in orchards where ripe fruits are allowed to fall and remain on the ground. It is controlled by sanitation and by one or two sprays, 7 to 10 days apart, of 2,6-dichloro-4-nitroaniline (DCNA, Botran) just prior to harvest.

VIRUS AND VIRUSLIKE DISEASES[6]

Virus and viruslike diseases were first associated with peach culture in the 19th century. Stories of the losses resulting from epidemics of peach yellows in the Northeastern United States during the 1800's serve as reminders that such diseases can be serious if they are left uncontrolled. Little peach, another disease thought to be related to yellows, became damaging in the same geographical area in the late 1800's and now causes more losses than does yellows.

In the Southeastern United States, peach rosette and phony peach diseases have been common since the early 1900's and cause serious crop losses. Since the 1930's, the following additional virus and viruslike diseases have appeared in the Northeastern United States: Red suture, X-disease, rosette mosaic, nectrotic leaf spot, ring spot, stem pitting, and line pattern. Peach mosaic, yellow band mosaic, and asteroid spot occur in the Western United States as far east as eastern Texas, southern Oklahoma, and western Arkansas.

A virus is an extremely small organism, too small to be seen

[6] This section was prepared by L. C. Cochran except the stem pitting disease portion, which was prepared by S. M. Mircetich.

through the ordinary compound microscope. It lives and multiplies in living tissue. Evidence indicates that mycoplasma-like organisms cause some diseases formerly attributed to viruses. A mycoplasma also is an extremely small organism, which is intermediate between viruses and bacteria. It parasitizes plants.

These agents 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, nematodes, and mites. These insects, which suck juice from infected plants, lose some of it while feeding on healthy plants and thereby infect them. Only yellow bud mosaic virus has been transmitted mechanically from peach to peach with infected juice. Only ring spot has been found transmissible through seeds. It passes through some of the seeds of mazzard and mahaleb cherries and occasionally through peach seeds.

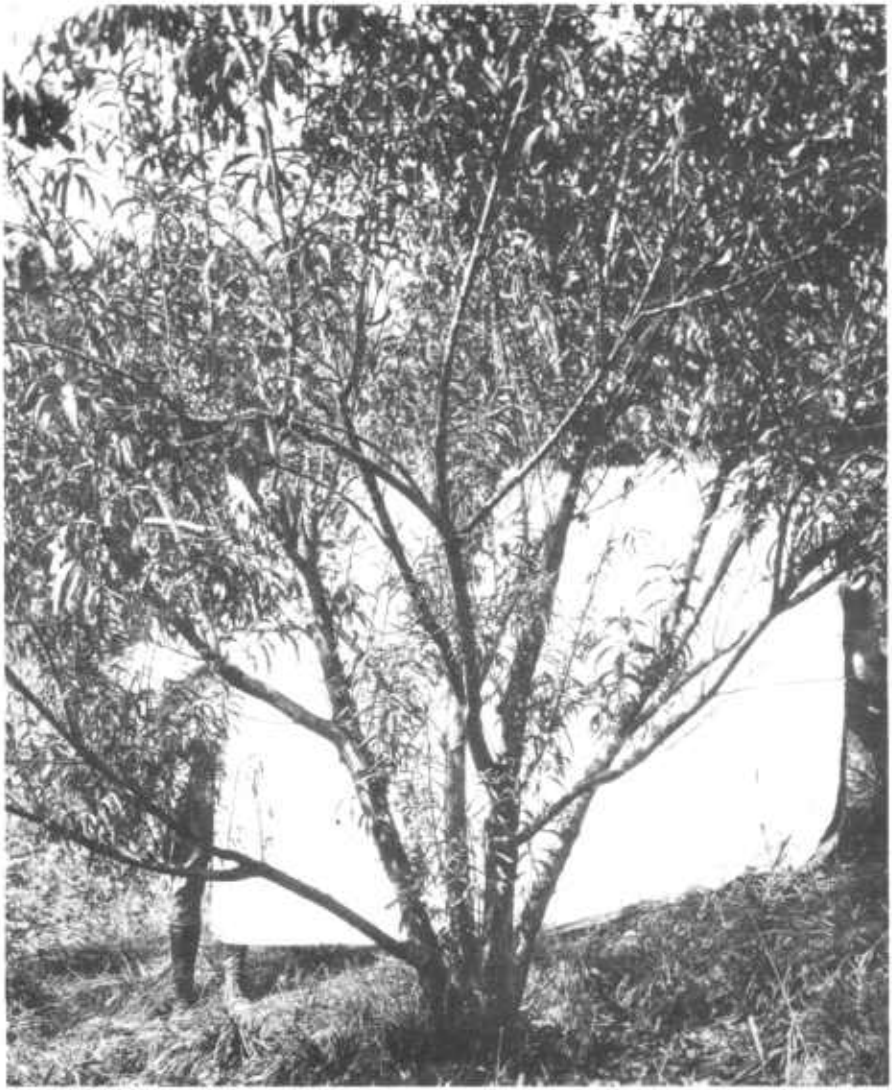
It is highly improbable that any of these organisms can be spread by cultural procedures, such as pruning, spraying, or thinning. They can be spread into new areas by use of infected nursery stock. Within orchards they can be spread by insects or nematodes and through use of infected propagation material. Peach yellow bud mosaic, known to occur only in California, and peach rosette mosaic, which occurs in Michigan, New York, and possibly 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 infected soil.

Peach Yellows

The symptoms of peach yellows are premature ripening of fruit; inward rolling, drooping leaves, pale green to yellow; 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 cultivars 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 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 cultivars produce more wire shoots than others. Affected trees usually die in 2 to 6 years.

Plum trees, both cultivated and wild, have been naturally infected with the yellows agent, but most plums are not injured by it and do



PN-3725

FIGURE 35.—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.)

not show any easily recognized symptoms. The agent is spread by the plum leafhopper (*Macropsis trimaculata*) (Fitch), which prefers to feed on plums and migrates from them to peaches. In localities where the disease has become widespread, peaches should not be grown within 1 mile of plums.

Remove yellows-affected trees 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 neigh-

boring 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 yellows. Plum trees considered as a source of material for budding or as rootstocks should be checked for yellows before they are used. The yellows agent can be killed in peach budwood or in nursery trees with heat, but there is no known method of curing infected orchard trees.

PN-3726

FIGURE 36.—Willowy growth arising from main limb of peach tree affected with yellows. Note slender twigs; light-colored, small, abundant leaves; and dark spots on leaves. An almost normal water sprout is at base of limb on right (arrow). (Courtesy of Illinois Natural History Survey.)

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 yellows. 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 agent of little peach is killed by heat at the same temperature that inactivates yellows.

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 the leaves are closer together 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 so

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 cultivars 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 part 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 difficult 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. Mycoplasma-like bodies have been found in trees affected by this disease. Diseased trees appear normal until midsummer. Within a few days, leaves near the base of affected shoots become pale, usually roll upward, become brittle, and develop irregular yellow and red spots. Some spots shrink and fall out. The number of leaves affected and the size of spots on individual leaves increase rapidly and shoots appear highly colored. Leaves on affected twigs are usually shed progressively from the base to the top. Tip leaves seldom become affected and remain on the tree. In hot weather the leaves drop before the spots are well formed. Fruits usually shrivel and fall soon after leaf symptoms develop. Fruits may remain on twigs that develop

symptoms late in the season. They ripen prematurely and are bitter; their seeds fail to develop.

Diseased twigs or branches, even though they shed leaves, do not always die. If they survive, they leaf out normally the following spring; then the sequence of symptoms is repeated. The disease spreads irregularly through the tree. It often takes several years to affect most of the tree. Unlike some viruses of peaches, the causal agent of X-disease seldom becomes distributed through the entire tree. Normal-appearing twigs on diseased trees are free of the agent 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.

A severe form of X-disease in Central California, locally termed yellow leaf roll, develops earlier in the growing season and often kills peach trees in 1 to 2 years.

Besides peaches, X-disease affects cultivated sweet and sour cherries and several wild plum and cherry species. The commonly affected wild host is chokecherry (*Prunus virginiana* L.) and its western form *P. virginiana* var. *demissa* (Nutt.) Sarg. This plant is widespread in the Northern 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, into New York, Ohio, Wisconsin, Illinois, Iowa, and the Northwestern States. Diseased chokecherries prematurely develop varying degrees of autumnal yellow and red foliage, beginning as early as June. In lower elevations they die in 3 to 4 years.

In Eastern North America, X-disease is spread by the leafhopper *Colladonus clitellarius* (Say), which lives principally on chokecherries but occasionally migrates to other nearby plants. If it has fed first on diseased chokecherries, it can carry the agent 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.

In western North America several leafhoppers are active in the spread of X-disease. Some of these breed on peaches and cherries and are important in spreading the disease within orchards. Sweet cherries grown on mazzard rootstock are good hosts and can be good reservoirs from which spread can take place to other hosts. Control in these areas consists of (1) isolation of new plantings from all orchards or native stands of chokecherries and (2) prompt removal of infected trees should they occur. Chokecherries should be removed from the vicinity of new sites prior to planting. Once the disease is well established, no practical means of control is known.

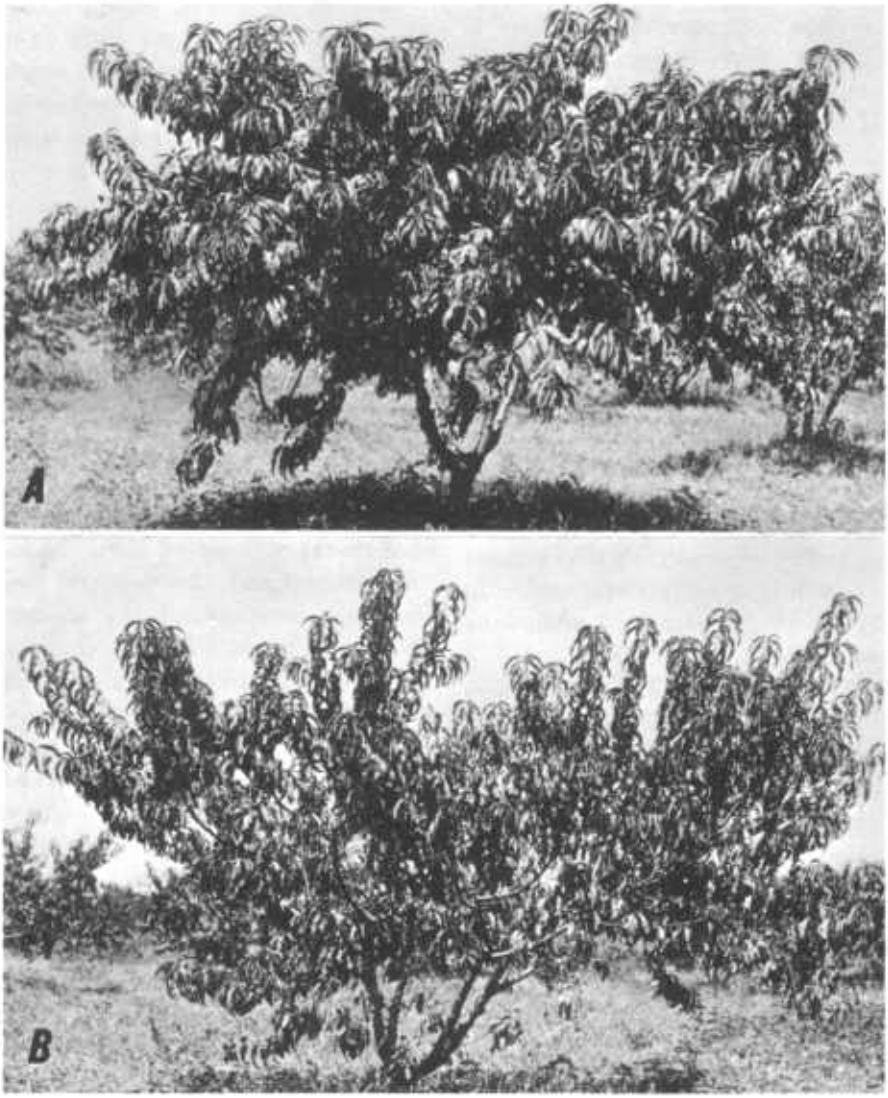
Chokecherries can be effectively eradicated by chemical brush killers.

Follow local recommendations and the manufacturer's directions.

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



PN-3727 and PN-3728

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

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 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 problems. Trees that become diseased when young never reach productive orchard size.

Phony disease affects all peach cultivars 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 chickasaw plum *Prunus angustifolia* Marsh., which occurs in thickets all through the Southern United States, has been found naturally infected near phony-affected peach orchards in Georgia.

Destroy phony-affected peach trees promptly. Surveys have shown that the disease spreads less rapidly among the remaining trees when diseased trees have been removed. In infected areas eradicate wild plums 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 a viruslike disease affecting peaches in the Southeastern United States. It kills rapidly and has caused severe losses in areas where diseased trees were left standing into late summer.

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 peach and plum trees near the orchard.

Stem Pitting

Stem pitting was recognized as a specific disease of peach in 1967, but

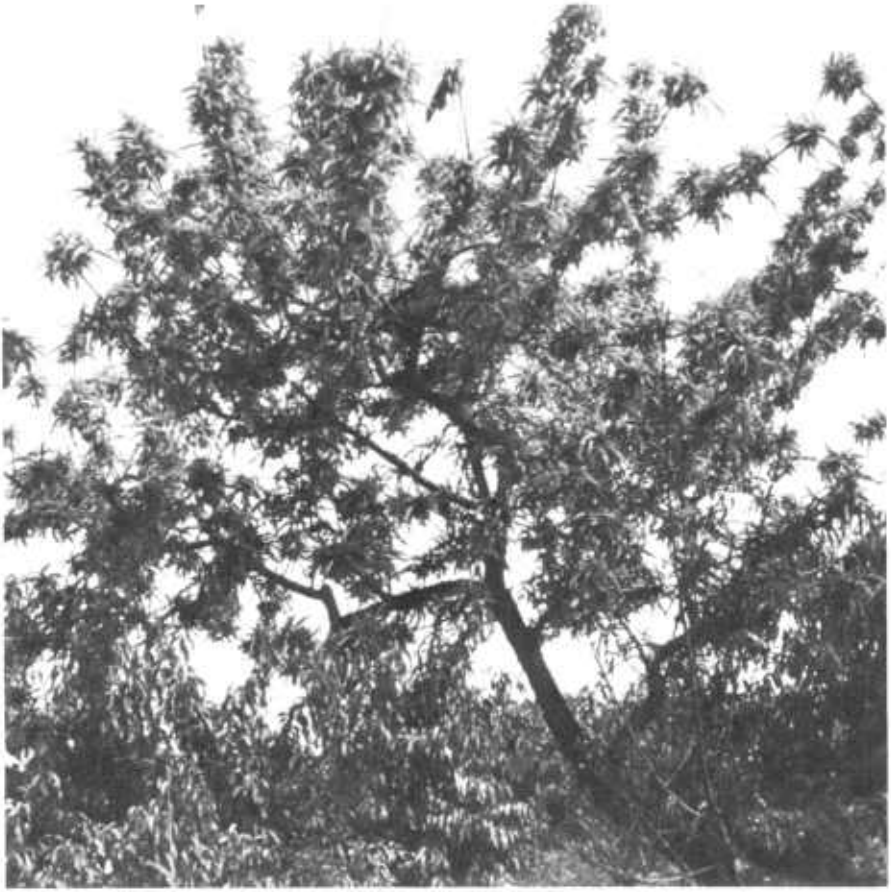


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FIGURE 38.—Orchard tree affected with peach rosette and showing typically rosetted foliage. Such a tree usually dies before the next season.

it may have been present for a long time. This disease has wide geographical distribution; however, the highest incidence of stem pitting is in several Middle Atlantic States.

Peach trees affected by stem pitting have the appearance of girdled trees. In general, affected trees are stunted and have brachytic terminal growth. Leaves droop, curl upward lengthwise, and may be chlorotic (fig. 39, *A*). In late summer, leaves may become increasingly chlorotic, often turning reddish to purplish in the fall. Intensity of leaf color may vary with stage of the disease, cultivar, or climatic conditions during the growing season. In early spring, unfolding of leaf buds is delayed; but in the fall, leaf abscission occurs earlier than on comparable unaffected trees. Fruits on affected trees may have insipid flavor and fail to size properly; they may be more

PN-3730

PN-3731

FIGURE 39.—Terminal growth on stem pitted (*A*) and apparently healthy (*B*) peach seedlings. Leaves are curled and internodes shortened on the pitted tree.

highly blushed than normal, and they ripen and drop prematurely.

Although these symptoms are associated with trees affected by stem pitting, similar symptoms may be associated with trees affected by several common orchard problems, notably incompatibility, various soil-borne root rot pathogens, drought, nutrient deficiency, and injury by mice, implements, or herbicides.

The most diagnostic symptoms of stem pitting are the presence of pitting and grooving in the woody cylinder, thickened spongy bark, and slightly enlarged lower trunk of infected peach trees (fig. 40, *A*). The enlargement of the lower trunk usually is noticeable as soon as foliar symptoms occur and becomes more pronounced as the disease progresses. The enlarged area has spongy bark that is often two to four times the thickness of bark in comparable healthy trees (fig. 40, *C*). The thick bark is usually first detected at or below ground level.

Removal of the bark from the affected lower trunk reveals pits and grooves in the woody cylinder accompanied occasionally be enations, gall-like growths, and necrotic areas in the cambium (fig. 40, *B*). Corresponding ridges of inner bark are usually embedded in the wood. Wood pitting in naturally infected orchard trees begins below ground, then gradually spreads into the roots and short distances into the trunk above ground. The tissue within the woody cylinder of the affected lower trunk may be highly disorganized. It may

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FIGURE 40.—Lower trunks of pitted (*A*) and apparently healthy (*C*) peach seedlings, and trunks of 'Suncling' and 'Babygold 6' scions on severely pitted rootstocks (*B*). Note thickened bark (*A*, arrow), triangular depression in scions, and necrosis of cambium in rootstocks (*B*).

have wide xylem rays, large inclusion of phloem tissue, and incompletely lignified xylem cells. Trees with a high proportion of such disorganized tissue break easily at ground level, exposing highly disorganized tissue in the woody cylinder.

Peach stem pitting occurs naturally in over 30 commercially important peach cultivars and in seedlings. The severity of symptoms, particularly the extent and severity of pitting, enation, and cambial necrosis, may vary with the cultivar and the stage of the disease. Affected trees become worthless commercially. In general, younger trees infected by stem pitting may die within 2 to 3 years, but older trees may continue to produce inferior fruit for some time. Recovery of infected trees has not been observed. The same disease causes serious damage to other stone fruits.

Stem pitting spreads naturally in orchards. Newly infected trees often occur in clusters. The disease usually spreads from diseased to adjacent trees, suggesting soilborne vectors, assumed to be nematodes. The virus, a strain of tomato ring spot virus, infects replants where pitted trees have been replaced.

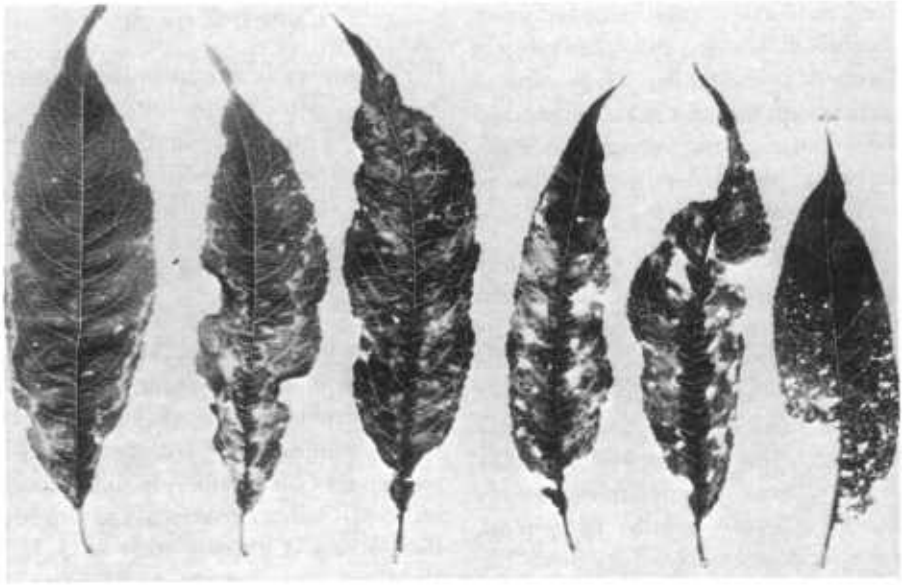
Control measures include the use of nursery stocks free of stem pitting, use of propagating material from healthy trees, and prompt roguing of pitted trees in nursery and orchard. Avoid replanting of infested orchard sites or repeated use of infested nurseries.

Peach Mosaic

Peach mosaic occurs in the 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 diagnostic symptom of peach mosaic disease is the mottled pattern of yellow and green in the leaves. All peach cultivars are susceptible to infection, but some are more seriously damaged than others. Cultivars such as 'J. H. Hale' or its derivatives, 'Elberta', 'Rio Oso Gem', and 'Fay Elberta' are severely injured. But most clingstone cultivars endure the most severe forms of the virus with only moderate damage. Newly infected trees of 'J. H. Hale' are retarded in the spring and develop small, narrow, deformed leaves with various irregular, mottled patterns (fig. 41). As the season progresses, the mottling becomes 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, wild goose plum (*Prunus munsoniana* Wight and Hedr.), and American plum (*P. americana* Marsh.), as well as in



PN-3735

FIGURE 41.—Leaves of 'J. H. Hale' peach affected with peach mosaic. Symptoms vary from marginal bands in first leaf at left to shothole and veinlet clearing in leaf at extreme right.

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* Keifer and Wilson, which lives exclusively within retarded buds and which is moved by wind to healthy trees as the buds open.

In areas where very susceptible cultivars are grown, losses from peach mosaic can be reduced to less than 1 percent per year by removing diseased trees and excluding tolerant cultivars in which symptoms are obscure and diagnosis is difficult. In areas where the disease spreads rapidly, where wild hosts are prevalent, or where the cost of removing diseased trees is uneconomical, tolerant cultivars can be grown. Since orchards of 'Elberta', 'J. H. Hale', and other nontolerant cultivars 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.

Yellow Bud Mosaic

Peach yellow bud mosaic is caused by a strain of the tomato ring spot virus and occurs sporadically in

orchards in California. Buds on affected parts of trees push out in the spring small yellow leaves, which stop growth when they are less than 1 inch in length. Symptoms subsequently develop in other parts of the tree and consist of pale-green and yellow, feather-edged blotches in leaves with accompanying distortion. Leaves relatively mature at the time of invasion may develop only small chlorotic flecks. Many of the affected leaves drop, and the affected part of the tree is bare by midsummer. These parts usually die and entire trees are often killed in 2 to 3 years. The causal virus also affects other stone fruits causing various degrees of blotchy mottle but less killing of arms and twigs than on peach.

Yellow bud mosaic is transmitted by the nematode *Xiphinema americanum* Cobb. Thus soils must be fumigated after diseased trees have been removed to destroy the nematodes before new trees are planted. The virus can be spread by movement of the nematodes in soil or in water from areas around diseased trees.

Other Viruslike Diseases

Several virus diseases affecting peaches in the 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 is nematode transmitted and thus 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.

The symptoms of peach wart are confined to the fruit. Blisterlike excrescences form on the surface of the fruit just prior to the pit hardening stage of maturity. These are composed of the same kind of tissue as in the pit and harden at the same time. Most of the fruit on diseased trees is affected and is commercially worthless. No natural spread occurs in orchards, but the disease has been distributed in infected propagation materials. Wart is potentially a serious disease, but without a natural vector it is easily eliminated.

Asteroid spot in peaches is com-

mon in Texas and the Western States. It produces small, star-shaped spots of varying size scattered over the leaves.

Peach calico occurs sporadically in orchards in the Western United States. Symptoms consist of white blotches on leaves and fruit. White streaks often occur on the current season's twigs. Affected leaves are usually not distorted, but fruits are small and flattened.

PEACH INSECTS[7]

The common insect pests of peaches are the plum curculio, the peachtree borer, the lesser peachtree 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 stink bugs.

Plum Curculio

The plum curculio is a small, humpbacked beetle with a brownish snout. It hibernates in trash in or near the orchard and early in the spring moves into the trees. If these beetles 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. 42). 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 cultivars such as 'Elberta'.

PN-3736

FIGURE 42.—Curculio grub and its injury to ripe peach.

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 harvest.

[7] For complete general information on peach insects and their control, see "Insects on Deciduous Fruit and Tree Nuts in the Home Orchard," U.S. Dept. Agr. Home and Garden Bul. 190. For more detailed information on various peach insects and on new insecticides, consult your local State agricultural college or extension service or your county agricultural agent or farm adviser.

Peachtree Borer

The peachtree 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 clearwinged 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. 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 generally enter it at the soil surface. Usually there is only one generation a year.

Lesser Peachtree Borer

The lesser peachtree borer is similar to the peachtree borer but mainly attacks the trunk and limbs, particularly in injured areas and in crotches. It overwinters as a larva in injured areas on the tree. It pupates early in the spring and emerges as a clearwinged moth, which lays its eggs along the trunk and limbs of the tree. One generation occurs in the North and two 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 partly grown scales survive the winter best. They complete their growth in the spring. The insect remains in one place except during the first few hours of 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, causing them to wilt and dry up (fig. 43). Usually near harvest the larvae bore into the fruit. Infestation of fruit is heaviest in midseason and in the later maturing peach cultivars. The insects overwinter 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

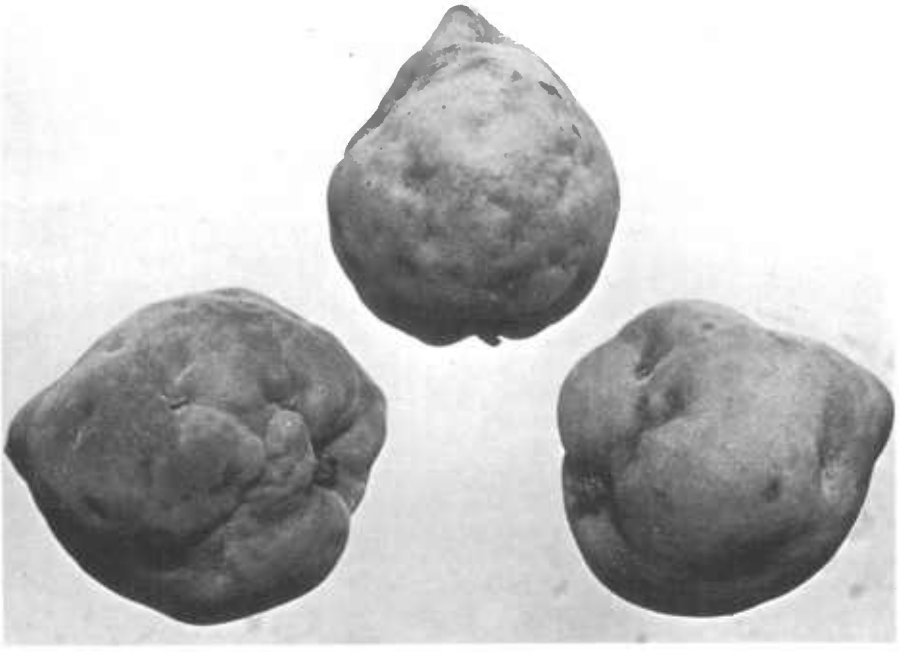
PN-3737

FIGURE 43.—Oriental fruit moth injury to peach twigs.

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. 44). 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



PN-3738

FIGURE 44.—Peach injury caused by sucking bugs.

consistent with good horticultural practice, the elimination of weeds and certain cover crops aids considerably in controlling them.

LIST OF SCIENTIFIC NAMES

Diseases

	Causal organism
bacterial spot	*Xanthomonas pruni* (E. F. Sm.) Dows.
brown rot	*Monilinia fructicola* (Wint.) Honey
constriction	*Fusicoccum amygdali* Del.
crown gall	*Agrobacterium tumefaciens* (E. F. Sm. & Towns.) Conn.
dieback	*Polyporus palustris* Berk. & Curt., *Stereum complicatum* (Fr.) Fr., and *Valsa leucostoma* (Pers.) Fr.
leaf curl	*Taphrina deformans* (Berk.) Tul.
powdery mildew	*Podosphaera oxyacanthae* (DC) DBy. and *Sphaerotheca pannosa* (Wallr. ex Fr.) Lév.
rhizopus rot	*Rhizopus stolonifer* (Ehr. ex Fr.) Vuill.
root and crown rots	*Armillaria mellea* (Vahl ex Fr.) Kummer and *Clitocybe tabescens* (Scop. ex Fr.) Bres.
rust	*Tranzschelia discolor* (Fckl.) Tranz. & Litv.
scab	*Cladosporium carpophilum* Thuem.

Insects

Common name	*Scientific name*
lesser peachtree borer	*Synanthedon pictipes* (Grote & Robinson)
oriental fruit moth	*Grapholitha molesta* (Busck)
peachtree borer	*Sanninoidea exitiosa* (Say)
plum curculio	*Conotrachelus nenuphar* (Herbst)
San Jose scale	*Quadraspidiotus perniciosus* (Comstock)
stink bugs	*Euschistus* spp.
tarnished plant bug	*Lygus lineolaris* (Palisot de Beauvois)

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