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H. J. Wheeler

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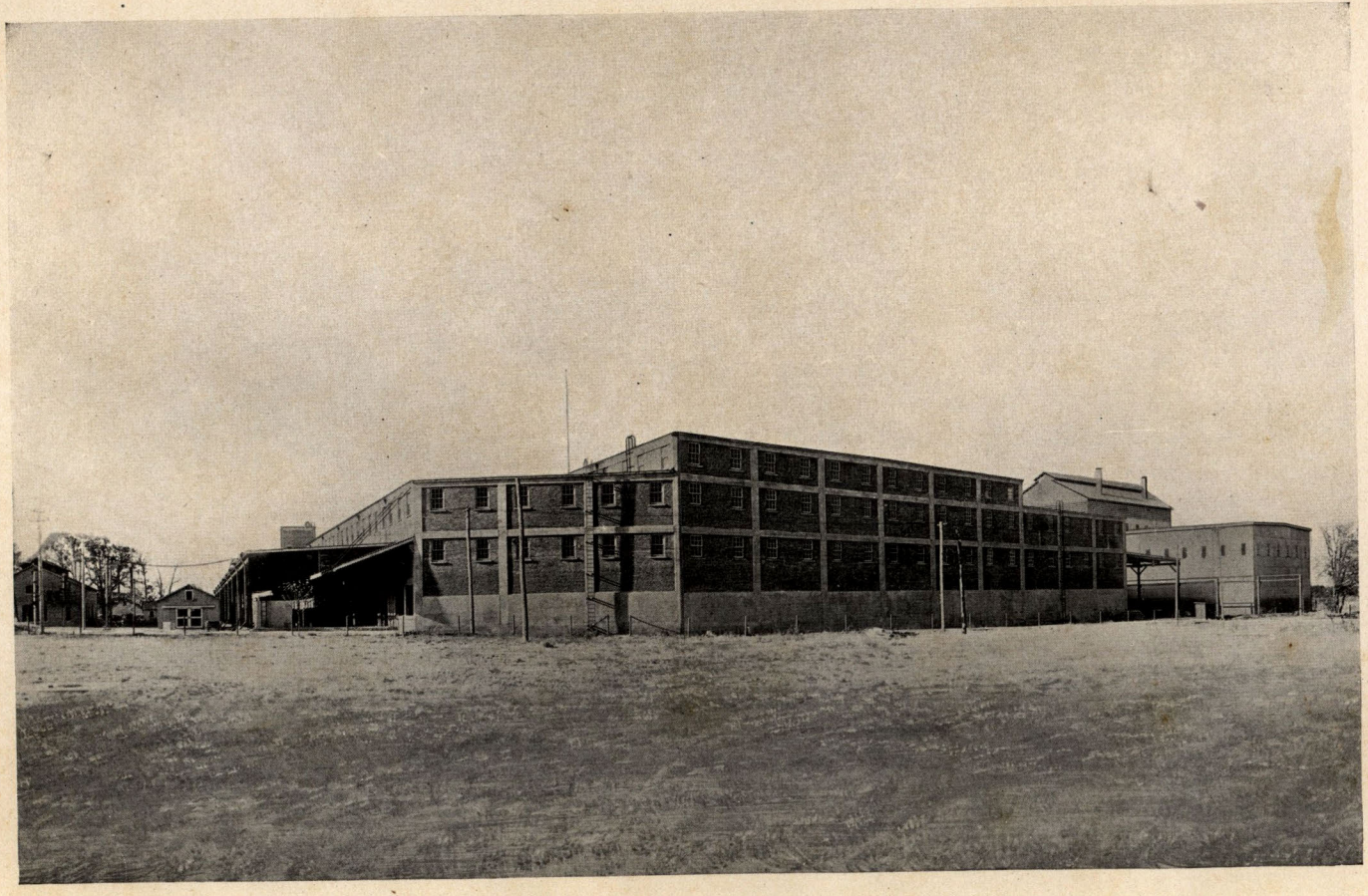

The American Agricultural Chemical Company factory at Jacksonville, Florida.

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CITRUS CULTURE

IN

FLORIDA

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Citrus Culture in Florida

Historical Introduction

Citrus fruits are of tropical origin and are thought to have been natives of the Malay Peninsula. The "citron" of the Medes and Persians is the citrus fruit which has probably been known and cultivated longest. The term *Citrus* was first applied to this fruit by Pliny, and later was adopted by Linnaeus as the generic name for this and other closely related fruits. Previously, the citron had been described by the Greek Theophrastus (about 300 B. C.). Virgil mentions it, and the Romans had imported it from Asia long before they began its cultivation. Once introduced into the countries bordering the Mediterranean, it became permanently established there, and from that time until the present the citron peel has continued to be an article of export. It is commonly known in its candied form.

Sweet oranges in Europe date from the early part of the fifteenth century, though the "golden apples" that Hercules sought suggest a remote antiquity. The Portuguese are said to have brought this fruit from southern China.

The family of plants to which the citrus belongs, *Rutaceae*, is widely scattered over the warmer temperate regions of the

earth—India, Malaya, Australia, South Africa, and tropical America. The order is characterized by the presence of a bitter, odorous, essential oil contained in the glands scattered over the leaves, bark, and rind of the fruit; and a mild tonic principle throughout.

The "Rue" (*Ruta graveolens*) of the old herb gardens of Europe; "Buchu" leaves from several species of Barosma in South Africa, used medicinally as a stimulating tonic; Toddalia bark used in India, Java, and Ceylon, for the same purpose; and Angostura Bitters obtained from *Galipea cusparia* of Venezuela—all have their place in commerce as tonic medicines and all are derived from the same family.

It is curious, also, that the European breakfast is not considered complete without marmalade, made mostly from the sour, or "Seville," orange, while in America grapefruit serves for toning one up for the day.

To the Spaniards belongs the credit of having introduced into America tropical and semi-tropical fruits, just when or where is not known; but from the voyage of Ponce de Leon in 1513, undertaken to discover the "Fountain of Youth," down to 1763, the date of the English occupation, they never lost sight of the land of blossoms, and took formal possession of Florida when St. Augustine was founded in 1565. They farmed the tract along the seacoast south to Matanzas Inlet, raising what they needed for food, such crops as corn, beans, melons, pumpkins, and sugar cane. Their gardens contained fruit trees, "including the fig, guava, plantain [a kind of banana], pomegranate, lemon, lime, citron, shaddock, bergamot [a variety of orange], and Chinese and Seville oranges." Indians also carried fruit on the trail; and as the seeds were dropped, they took root where the conditions were favorable. The oranges thus scattered were of the Bigarade, or Sour, group. Doubtless sweet oranges were similarly distributed, but were less able than the sour to withstand the severe conditions of wild life especially on account of their great susceptibility to foot rot.

The cultivation of citrus fruits was continued in Florida and, estimated at the rate of 150 oranges to the box, more than 13,300

boxes of the Chinese variety were exported from St. Augustine before 1835, when a severe freeze killed most of the citrus trees of that section. Since then, the groves for the most part have been planted farther south. In 1895, occurred another disastrous freeze. As a result, in 1895-1896 only 75,000 boxes were marketed in comparison with 6,000,000 the previous year.

The sweet seedling orange was introduced into California by the Franciscan Fathers about 1769. It was carried north by these missionaries into what is the present state of California for cultivation in their orchards and gardens together with figs, grapes, and olives; and the visitor to California may still see some of the olive trees which they set out. The San Gabriel Mission has the credit for having planted, about 1805, the first large orange grove in that state. This covered six acres and numbered about 400 trees, a few of which still bore fruit 80 years later.

Among citrus fruits, sweet oranges easily lead. Early travelers in the West Indies and Brazil found them growing there before 1648. Probably the sour orange predominated; but groves of sweet ones were well established and taken care of early in the nineteenth century.

Besides sweet oranges, the so-called "Mandarin" is successfully grown in America. As its name indicates, it is a native of China, and was introduced into England in 1805. It was known on the European continent almost a quarter of a century later, finding its way probably from southern Europe into Egypt and from there into India. It reached America, it is supposed, through the Italian consul at New Orleans between 1840 and 1850. Thence it was taken to Florida. Its best-known representative is the Satsuma, which is ready for market in the late autumn, when it does not come into competition with the Pineapple and Valencia varieties. Tangerine is the trade name given to the Dancy variety of mandarins.

Our supply of lemons still comes largely from the Mediterranean countries, although California shipped 4,722,000 boxes during the year ended October 31, 1921. As this tree is more

Grapefruit produced with A. A.

Grapefruit produced with A. A. Quality Citrus Fertilizers.

tender than the orange, it is more likely to suffer serious injury at low temperatures and, in fact, the lemon industry in Florida has never recovered from the severe freeze of 1895. The lemon, like the orange, was introduced into Florida by the Spaniards, whereas in the West Indies it still grows wild at altitudes of 3,000 to 5,000 feet. The "rough," or wild, lemon is very useful as stock upon which to bud oranges since it is especially adapted to the higher and drier soils.

The "grapefruit," so named, first in the West Indies perhaps, because it often hangs in clusters, is known in scientific circles as the pomelo. Two explanations of the name are given: one, that the fruit may have first been found at Pompelmousses in the Mauritius; second, that it means melon-apple, *Pomum melo.* The shaddock is closely related to the pomelo, and often confused with it though differing from it in several respects. It is much larger than the pomelo, sometimes weighing 15 to 20 pounds. It also has a thick rind and comparatively little juice, which is bitter, although some individual trees have been known to yield fairly acceptable fruit. Grapefruit, like the orange and lemon, owes to the Spaniard its introduction into America. Although long eaten by the inhabitants of Florida, and admired for its showy characteristics, its commercial possibilities were not realized until about 1880, when visitors from the north discovered its good qualities, whereupon a demand for it soon developed. The pomelo also suffered from the freeze of 1895, the worst since 1835. Up to this time, the supply, though steadily increasing, has not usually equalled the demand. As the years pass and the public becomes more accustomed to its use, it is likely to prove a formidable rival of the orange. Fortunately for Florida, she has been able thus far to produce a more acceptable grapefruit than California.

However, California has to its special credit the development of the Washington Navel orange, which is not a success in Florida. This orange was introduced from Brazil through the aid of the United States Department of Agriculture. The present production of this variety in California is estimated at approximately 32,000 carloads in a normal year, or about two-

thirds of the total orange shipments of the state. It has, in fact, become the most important citrus-fruit variety in the world. It should be added that the first two trees of the Washington Navel orange in California are still to be seen at Riverside, carefully preserved. They were carried there from the Department of Agriculture in Washington by Mrs. Luther C. Tibbet in 1873 and planted on her home grounds. The original budwood was obtained from a single branch which had "sported" in a sweet orange tree at Bahia; the seedless condition being largely due to the fasciation of the pistil in the flower, persisting as the navel at the end of the placenta in the mature fruit. In Florida the navel orange becomes coarse; it has little flavor; and the tree though a strong grower is not so fruitful as in California. An improved variety, known as the Petersfield Navel, originated from the Washington Navel in Jamaica, B. W. I. about 1895, has an exclusive position in the European markets and brings high prices.

Other citrus fruits, less well known than those already mentioned, are the kumquat, lime, limequat, and tangelo. The first of these, the kumquat, or "gold orange," is of Chinese origin and was brought to London from southeastern China in 1846, by Mr. Fortune, who collected plants for the London Horticultural Society. This fruit, about the size of a small plum, which it often resembles in shape, grows on a shrub from eight to ten feet high. The fruit may be eaten either raw or as a preserve. The demand for it as yet is not large. Various nurserymen in Florida have experimented with the kumquat; but neither there nor in California has the fruit become an important commercial product. Its chief value, therefore, is as an ornamental tree.

The lime somewhat resembles a small lemon. As it thrives on the Florida Keys and on sandy soils too poor for other forms of citrus, it would seem to deserve more attention than it has thus far received. The Mexican lime is found wild in Southern Florida. Since the lime is even more sensitive to cold than the lemon, it has never been of commercial value in California. The juice of most varieties is used in the preparation of cooling drinks, though the Sweet lime may be eaten like an orange.

The limequat and the tangelo are recent products of plant breeding. The former is a cross between the kumquat and lime; the latter, between the tangerine and pomelo.

In all the Gulf States except Florida, citrus fruits can be grown only in the southernmost counties; and even then the hardiest varieties of oranges, like the satsuma, are recommended. The groves in the Gulf States have suffered so often from severe freezes that growers are urged to plant citrus fruits only as one of several crops and always to select sheltered sites, or to plant a small area for home use rather than for commercial purposes.

The history of the orange, as the leading citrus fruit, is one of great interest. A native of the East, it traveled westward to the shores of the Mediterranean, where climate and soil proved congenial. Later, it crossed the Atlantic and found a new home in Florida and California, becoming of great commercial value. Still more promising are its possibilities in Brazil, where it can be grown in a territory 1800 miles long and reaching west as far as civilization extends. Though the South American oranges have received little attention from the plant breeders, many of them have a delicious flavor and a low acid content. The pomelo is not yet raised in Brazil; and the lemon, though the fruit is of good quality, is but lightly esteemed, since lemonade is an unappreciated drink in that country. When one recalls the fact that citrus fruits are also grown in Japan and Australia, it is evident that the industry has encircled the globe. The United States and Spain produce each about 30 per cent of the annual crop; Italy, 25 per cent; and Japan and Palestine, each less than 5 per cent.

CITRUS FRUITS GROWN IN FLORIDA

SWEET ORANGES

All oranges belonging in this general group are by no means to be considered as especially sweet. The name merely represents a matter of usage for many centuries. They were classed by Ferrari as *Aurantium vulgare medulla dulci,* and in 1713 by

Fla Orange Crop

An old Florida grove fertilized with A. A. Quality Citrus Fertilizers.

Volckamer as *Aurantium fructu dulci* (*Citrus aurantium sinensis, Citrus sinensis* (L.) Osbeck, *Citrus aurantium,* Risso).

SPANISH. Varieties embraced in this group are Acme (Beach's Acme); Arcadia; Boone (Boone's Early); Dummitt; Early Oblong (St. Michael's Egg); Enterprise (Enterprise Seedless); Foster; Hick (Hick's Sweet Seville); Homosassa; Indian River; Madam Vinous; Magnum Bonum; May (Dr. May's Best); Nonpareil, Old Vini (Beach's No. 4 Buena Vista); Osceola; Parson Brown; Stark (Stark's Favorite); and Whitaker.

MEDITERRANEAN. Varieties included in this group are: Bessie; Centennial; Circassian; Du Roi; Exquisite; Everbearing; Jaffa; Joppa (Joppa Late); Lue Gim Gong; Majorca; Maltese Ovals; Marquis; Paper Rind (Paper Rind St. Michael); Pineapple; Prata; Star Calyx; Temple; Valencia (Hart, Hart's Late, Hart's Tardiff, Valencia Late); and White.

BLOOD. This group includes Maltese; Ruby; Sanford Blood (Sanford's Sweet Blood); Saul Blood (John Saul's Sweet Blood); St. Michael (Blood); Australian; Bahia (Washington Navel, Riverside Navel); Double (Imperial); Egyptian; Melitensis; Parson; Surprise; and Sustain.

In the West Indies as well as in Brazil there are numerous hybrids and varieties, many of them growing wild; the result of natural crossings of the citrus fruits. These are often of excellent quality and are worthy of special names, which might be added to the list almost without limit.

MANDARIN, OR "KID-GLOVE," ORANGES

The Mandarin oranges have been referred to *Citrus aurantium* L.; yet recent American authorities, in view of the character of the species grown here, classify them as belonging to *Citrus nobilis.*

Certain writers assign the tangerines to a separate group or sub-group, though in some parts of the world the names tangerine and mandarin are used interchangeably; but the designation "mandarin" more properly applies to those species grown in Florida.

These oranges are often referred to as "fancy fruit," bringing good prices in their season, but are never likely to displace the standard sweet oranges. The trees bear heavily, but require great care in cultivation and abundant fertilization in order to produce fruit of the highest quality. In the Gulf States and in Northern and Northwestern Florida, the satsuma on trifoliate stock is the hardiest and one of the best citrus fruits, and in fact the only strictly commercial variety which can be grown successfully. For a time the satsuma was sold under the name mandarin, or tangerine. The following are some of the Mandarin oranges: Beauty (Beauty of Glen Retreat); China (China Celestial, China Mandarin, Kid-Glove, Tangerine, Willow Leaved); Cleopatra (Spice Tangerine); Dancy (Dancy's Tangerine, Bijou, Tangerine, Moragne's Tangerine); King (King of Siam); Kinneloa; Kinokuni; Mikado; Oneco; Satsuma; and Temple. A hybrid variety is the so-called "Tangerona."

POMELOS (GRAPEFRUIT), *Citrus decumana*, L.

The pomelo was described by the Dutch writer Volckamer in 1713 and it was probably referred to still earlier by Ferrari. It was introduced into Florida by Ponce de Leon when he first landed, in 1513, on the East Coast. Some of the prominent varieties of pomelo are *Pink Flesh*—Tresca, produced from seed from the Bahamas; *Light-Colored Flesh*—Aurantium (Orange), supposed to be a hybrid of the sweet orange and pomelo; De Soto, discovered on the banks of the Peace River; Duncan; Excelsior (Excelsior Late); Hall (Silver Cluster, Hall's, Klemm's Silver Cluster); Inman Late; Josselyn; Leonardy; Manville (Manville's Improved); Marsh (Marsh's Seedless); May (May's); McCarty; McKinley; Nocatee; Pernambuco; Standard (Indian River); Triumph; and Walters (Walter).

SHADDOCKS

This fruit, though botanically of the same species as the pomelo, is considered distinct, horticulturally. It was introduced into the Barbados by Captain Shaddock, and found its way eventually to Florida. It is, however, not common here and is

valued chiefly as a curiosity and for ornamental purposes. Two species are grown in the state, known as the Mammoth, which has coarse white flesh; and the Pink, which has a pink to reddish flesh. Neither variety can compare with the pomelos in eating quality.

KUMQUATS, *Citrus japonica*, Thunb.
C. aurantium, Var. *japonicum*, Hook

The kumquat has been blessed with many names in different countries. That used here is the common designation in India. It has had at least four different generic and five specific Latin names. It was introduced into Florida in 1885. Its habit of growth is more nearly like a bush than a tree, and it is usually as broad as it is tall. Seven years after budding, the kumquat has been known to attain a practically equal height and width, exceeding 10 feet.

The kumquat may be considered solely as a fancy fruit, for which no extensive commercial demand seems likely to develop. There are three leading varieties: the Negami, 8 to 12 feet high; the Marumi (Round), slightly thorny but similar to Negami in flavor; and the Neiwa, which is larger, has sweet pulp when ripe, and is the best of all for direct eating. A fourth variety, the Sour, has an odor when cut which resembles that of the mandarin orange. This last variety is, however, subject to scab and has little value except for ornamental purposes, whereas the others are better for domestic use.

CITRONS, *Citrus medica*, L.

This fruit, the candied peel of which is used in cake and for other purposes, originated in the Orient with Smyrna as the market center. It was probably brought to this country soon after the Europeans discovered it. It has been grown in Florida but is not favorably considered from a commercial standpoint. In California, however, it is receiving some attention, and candied peel of excellent quality has been produced there. The three well-known varieties are the Lemon (Sorrento), grown there and to some extent in Florida, often fruiting throughout the season; Lyman; and Orange.

Grapefruit Grove

A seven-year old grapefruit grove on which A. A. Quality Citrus Fertilizers are used.

LEMONS, *Citrus limonum,* Risso, *Citrus limonia,* Osbeck

The lemon was early introduced into Florida by the Spaniards, and prior to the great freeze of 1895 it was grown here somewhat extensively. In California it is still a commercial success. The following are some of the principal varieties: Eureka; Everbearing, a valuable variety for domestic use because of the continuous succession of fruit, though it contains too many seeds for commercial purposes; Genoa, a thornless variety of excellent quality; Lisbon, a thorny variety of good quality; Ponderosa, advertised by northern nurserymen as a novelty for pot culture; Rough (Florida Rough, French) found in forests in southern Florida, worthless as a commercial variety, reaches a height of 25 feet, widely used as a budding stock; Sicily; Sweet; and Villafranca, which has few thorns and is the most commonly-planted variety grown in Florida.

LIMES, *Citrus limetta,* Risso; *C. medica acida,* Brand; *Citrus aurantifolia,* (Christmann) Swingle

Since limes are even more sensitive to cold than lemons, they are grown chiefly in southern Florida. The following are some of the more common varieties: Mexican, grown from seeds and widely variable in character, is found wild in forests in the southern part of the state; Rangpur (Rungpur, Rungpore), derived from seed from northwestern India. The fruit, and in some respects the tree, somewhat resembles the mandarin group; Tahiti, a round-topped tree, which may attain a height of twelve to fifteen feet. In Florida, the fruit unfortunately tends to decay as maturity is reached.

A FEW OF THE NEW OR UNUSUAL CITRUS FRUITS

EUSTIS LIMEQUAT. This new fruit was produced by Walter T. Swingle of the United States Department of Agriculture by crossing the Negami kumquat and a lime. The fruit is somewhat larger than the Mexican, or Key, lime, with skin resembling the grapefruit in color and texture. It has an entirely distinctive flavor. It furnishes an acid fruit of fine character, which is believed to be hardy throughout the sweet-orange belt and possibly even farther north.

FOSTER GRAPEFRUIT. This fruit, having a purplish-pink flesh of excellent quality and ranked as one of the best of the early grapefruits, was introduced by Mr. E. N. Reasoner of Oneco, Florida. It is highly esteemed by those who know it.

THORNTON TANGELO. This fruit is the result of a cross made several years ago by Swingle and Webber of the United States Department of Agriculture. It is smaller than the usual grapefruit. The skin is easily removed from the flesh, which is a tangerine characteristic. It has a sprightly, pleasing, and sweet taste unlike any of the other citrus fruits, and it furnishes an agreeable change and variety of flavor for the home table.

CITRUS TREES FOR DIFFERENT PARTS OF FLORIDA

NORTHERN FLORIDA. In northern and northwestern Florida, where danger of injury by cold is greatest, the most hardy of the commercially practical citrus fruits is the satsuma orange budded on *Citrus trifoliata.* This stock is, in fact, the only one on which certain of the Florida nurserymen now bud the satsuma.

CENTRAL AND SOUTHERN FLORIDA. Here where the climatic conditions are less severe than farther north, practically all citrus varieties can be grown successfully, provided proper attention is paid to the selection of a budding stock suited to the particular soil conditions and to the variety grown.

Included in the list is the group of sweet oranges, comprising the Spanish, Mediterranean, and Blood oranges; the Mandarin, or Kid-Glove, group, embracing the Satsuma, King, and Dancy (Tangerine); the Pomelo, or Grapefruit, group; and the Shaddock, Kumquat, Citron, Lemon, and Lime groups.

STANDARD COMMERCIAL CITRUS FRUITS FOR FLORIDA

ORANGES

PARSON (Parson Brown), of Spanish origin, is generally

considered the best of Florida's early oranges for commercial purposes. It originated at Webster, Florida, in the grove of Parson Brown, and was introduced in 1878 by Captain J. L. Carney of Lake Weir. The fruit is of good quality, of medium to large size, and can be marketed in October and November.

HOMOSASSA. This orange is a Florida seedling, also of Spanish origin. It is large, prolific, of good color, has a vinous, sprightly flavor, abundant juice, and is of excellent quality. The peel is thin, smooth, and tough. This orange is a good shipper and can be marketed from late November to late January.

PINEAPPLE. This orange originated in the grove of Dr. James B. Owens near Citra, Florida. Its pleasing odor suggested to a Florida citrus grower that of the pineapple, and this gave rise to the name. The oranges are of good size, and are more reddish in color than any of the other round varieties. They also have a pleasing, sprightly taste, which causes them to command a ready sale. They are ripe and ready for the January and February market.

VALENCIA (Hart, Hart's Late, Hart's Tardiff, and Valencia Late). This orange, introduced from Spain, is one of the most widely-grown varieties and has practically no competitor as an orange of excellent quality to be marketed from late March to early June. It reaches the market at a time when prices are usually high and, therefore, often returns large profits. Valencias should be planted where there is little danger from injury by cold, because the fruit must remain on the trees all winter. The oranges are of medium size, of good color; and have a thin skin and firm, deep-orange flesh of splendid quality. They contain but few seeds. The trees are vigorous growers and show little variation in character.

LUE GIM GONG. This orange was produced by Mr. Lue Gim Gong of De Land, Florida, by pollinating Hart's Late with pollen from a Mediterranean sweet orange. When fully ripe, the quality is excellent and the fruit is nearly seedless. It is said to be one of the hardiest, if not the hardiest, of all the

The American Agricultural Chemical Company warehouse at Cocoanut Grove.

sweet oranges. While already edible in March and April, it is not really ripe until June, and can be marketed as a late spring, early summer, or early autumn orange; since it remains in good condition, even when left on the tree for several months. It is reported that the fruit has been held on trees even from one to two years after it was ripe without serious deterioration, except a possible thickening of the skin. This variety is usually included in extensive plantings, especially where a regular succession of market fruit is desired, since it fills a place unoccupied by any other strictly commercial variety.

TEMPLE. In addition to the five standard varieties given above, the Temple is a promising new variety of the mandarin type, which deserves very careful consideration as an orange that can be marketed from February to May. The segments of the Temple can be readily separated, the flesh has good color, the fruit is very juicy, and it contains fewer seeds than most budded varieties. It stands storage well, and the aroma and flavor are said to improve with keeping. One should maintain a close watch of other new varieties that may be brought out from time to time; and when their merit has been established beyond question, it is possible that some of them should be added to or substituted for some of those in the standard grove list.

SATSUMA. This is a mandarin orange, and the hardiest and best citrus variety for Northern and Northwestern Florida, provided it is budded on stock of *Citrus trifoliata.*

DANCY TANGERINE. This is also one of the kid-glove, or mandarin, oranges. The trees are very prolific; the fruit is flattened and of medium size; the skin is easily removed and the segments separate readily; the rind is smooth and highly colored; the flesh is dark orange and very juicy. This tangerine is ornamental and distinctive.

A committee appointed at the Citrus Seminar, held in Gainesville in 1916 to recommend a select list of varieties of sweet oranges for commercial purposes, chose the Parson Brown, Homosassa, Pineapple, Valencia, and Lue Gim Gong.

POMELO, OR GRAPEFRUIT

Among the varieties of grapefruit, the following are those usually most highly recommended by the best and most experienced growers:

DUNCAN. This variety is from a seedling raised by a Spanish nobleman, Don Phillippi, near Safety Harbor (formerly Green Springs), Pinellas County, Florida, and was brought to public notice by Mr. A. L. Duncan of Dunedin in 1895. It is especially hardy and usually ranges in size from 54's to 70's. It is light yellow, "round, slightly oblate and packs well." It is extremely juicy and has that desirable combination of bitter, sweet, and acid. It can be marketed from December to late May.

MARSH (Marsh's Seedless). This variety originated in Lakeland, Florida, and was introduced to the public by Mr. C. M. Marsh in 1895. The trees have a spreading top, and are heavy, regular bearers. The fruit has a smooth yellow appearance, is of good quality, and the size meets the market requirements. It can be marketed as early as January; and because it is so nearly seedless, it can be held on the trees later than most varieties.

McCARTY. This excellent, late-ripening grapefruit, even following Marsh, has a tendency to produce its fruit singly rather than in clusters, thus avoiding the blemishes resulting from one fruit resting against another. The fruit is of good size, color, and quality, and can be held on the trees as late as the Marsh.

INMAN LATE. The trees bear regularly and abundantly. The fruit is of medium size and flattened, running 46 to 64 to the box, and averaging 54 to 60. It is a good shipper throughout the season; and as long as conditions favor leaving the fruit on the trees, it improves in quality by hanging.

WALTERS (Walter). This grapefruit bears heavily, is of good market size, and can be picked from November until May.

EXCELSIOR. This variety is similar to the Walters; but is

a little later, and can usually be held on the trees until nearly the middle of May.

HALL (SILVER CLUSTER). This variety produces well; but much of the fruit is borne in clusters, especially when the trees are young. It ripens medium early. Its clustering habit of fruiting is its chief drawback as a commercial variety.

KUMQUATS *Citrus, japonica,* Thunb.

The three leading varieties are Marumi (Round), Nagami, and Neiwa. The first is about an inch in diameter, with sweet rind, and sprightly pulp and juice. The Nagami is from 1½ to 2 inches long, of the same diameter as Marumi, and is likewise similar to it in flavor. The Neiwa is rather larger than the Marumi; and when fully ripe, the pulp is sweet. This is usually considered the best of all the kumquats for direct eating.

LEMONS AND LIMES

VILLAFRANCA (VILLA FRANCA) LEMON. This is the most common, most popular, and for domestic use probably the best lemon thus far grown in Florida.

TAHITI LIME. This tree reaches a height of twelve to fifteen feet. The fruit is large and seedless, and has become especially popular in recent years because of its melting pulp, plentiful juice, and agreeable flavor. It is harvested in the fall and winter. The fruit tends to spot and decay about the time it matures, which is its only important fault.

MEXICAN LIME. This lime, probably of Spanish origin, grows wild in southern Florida. The trees, of shrubby character, reach a height of ten to fifteen feet. Since these limes are propagated from seed, they vary widely in size and quality, thus failing to show the fixed character of budded fruits.

CHEMICAL ELEMENTS ESSENTIAL TO PLANT GROWTH

Among the more than eighty elements already recognized by

A ten-year old orange grove on which A. A. Quality Citrus Fertilizers are used.

the chemist but fourteen are usually considered essential to plant life, and of these only a part are of mineral, or rock, origin. These fourteen essential elements are nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, iron, carbon, oxygen, hydrogen, manganese, sodium, silicon, and chlorine. Only the first three of these are usually deficient in soils as plant foods, although soils exist on which more sulphur, calcium, magnesium, sodium, manganese, or iron may be helpful.

Lime and magnesia as carbonates or in burned, air-slaked, or hydrated form are often needed for the correction or lessening of soil acidity; and each may sometimes be required as direct plant food or to counteract an excess of the other, or a lack of balance between the two.

ESSENTIAL ELEMENTS USUALLY SUPPLIED BY FERTILIZERS

NITROGEN, often referred to in terms of ammonia, is essential to cell formation and to the building up of the plant proteins. It is indispensable to vigorous growth. Without it all plant life is impossible. Nitrogen is contained in both organic and inorganic ammoniates. It is usually very deficient in sandy soils and is likely to be needed on most others which have long been under cultivation. It is also the most costly ingredient in commercial fertilizers. Nitrogen exists in the soil in three forms: in nitrates, ammonium salts, and organic matter, all usually referred to in fertilizer analyses in terms of ammonia. While most plants take up their chief supply of nitrogen in nitrates, it is desirable that fertilizers should contain some nitrogen in all three forms so that one will become available after the other; the ammonium salts and organic ammoniates following the nitrates in the order named. In the case of the organic ammoniates, ammonia is first formed and is changed later into nitrates. Nitrates may be readily leached away by heavy rains in case the soil is sandy; whereas ammonium salts are not so readily washed out and organic nitrogen practically not at all. By using a fertilizer containing all three

forms of nitrogen, the danger is avoided of having too much immediately available at one time and too little at others.

PHOSPHORUS, commonly referred to in terms of phosphoric acid, is an essential ingredient of the plant proteins, and it has an especially invigorating effect on both root and seed development. It performs highly important functions, and nothing can replace it. Farmers buy phosphoric acid in complete fertilizers for the sake of the phosphorus, but the combined sulphur and lime which they contain are also sometimes helpful. Phosphoric acid is generally greatly needed on most cultivated soils throughout the United States, and Florida is no exception.

THE ASSIMILATION OF FOOD BY PLANTS

POTASSIUM, commonly referred to in terms of potash or potassium oxide (K_20), is absolutely required by plants. It aids in the formation and movement of starch within the plant, and in the building up of its woody structure. It is also necessary in the formation of the juices, sugars, and fleshy parts of fruits. It is of great importance in citrus culture.

Plants obtain their food through both leaves and roots. The leaves absorb gases from the air and the roots take up water and mineral salts from the soil.

The solution of mineral salts is passed to the leaves through the vascular system of the plant, where it meets the carbonic-acid gas absorbed from the air. Under the influence of sunlight chemical reactions take place, resulting in the formation of sugars, starches, and protein substances. These are then passed to all parts of the plant where growth is taking place, and are there built up into the plant tissues or stored in the plant cells. By day oxygen from the decomposition of carbonic-acid gas is given off through the leaves, though at night the leaves may exhale some carbonic-acid gas. It will therefore be readily understood that it is desirable to preserve as large an area of leaf surface as possible. The leaves should also be kept clean or they cannot function properly, for the entrance of sunlight into the leaf to effect the necessary chemical changes is

just as important as sunlight is to the sensitized film within the camera.

The water with its dissolved mineral substances enters the plant through delicate hairs, which are found only near the tips of the growing roots. The absorbed water after passing to the leaves is transpired, or vaporized, through the leaf pores into the air. As fast as the leaves transpire under normal conditions, more water, carrying mineral food, is passed up from the soil through the roots to take the place of the water vaporized.

The process of assimilation, or the formation of sugar, starches, and proteins in the leaves, continues as long as the leaves remain green. This necessitates a constant supply of available mineral substances in the soil. As these mineral substances in soluble or readily available form are not present in most soils in sufficient quantities, and especially in sandy soils, the frequent and regular application of suitable fertilizers becomes imperative.

It was erroneously asserted, a few years ago, by one or two American writers, that the soil solution is always replenished rapidly enough by the natural solution of the soil particles to keep it supplied with an abundance of all the necessary mineral ingredients. This has, however, been shown by the work of the late Professor King, of Wisconsin, to be a mistake. Still more recently Sir A. Daniel Hall, then Director of the Rothamsted Experimental Station, Harpenden, England, and his coworkers have proved beyond question by the most careful and elaborate experiments that this view was wrong. In fact, Ex-Director Hall has shown that an adequate strength of the soil solution in necessary mineral elements is a most powerful factor in promoting vigorous growth; also, that soil solutions do become seriously weakened by constant cropping. Experiments have demonstrated that with the exception of ammoniates, if more plant food is added to the soil in a given season than the plant can use at once, it is largely conserved in forms which plants can readily utilize later. Taking soils and climates as a whole, the lack of a sufficient supply of plant food is generally a most important factor in limiting the size of the crop. As

Thinning an old grove. The pruning and removal of eight-year old grapefruit trees to a new location.

the weakest link in a chain determines its strength, so a deficiency of any one of the essential plant-food elements may result in stopping the growth of the plant or in so seriously checking it that economic crop production is impossible. The important principle to be borne in mind is that *there must be present in the soil during the entire growing season a sufficient amount of all of the necessary elements, in an immediately available form, to meet the fullest requirements of the plant.* Only fertilizers which are so compounded as to furnish all of the lacking plant-food elements in the necessary forms throughout the entire growing season, can be expected to give the best results.

THE SOIL

Soil consists of more or less finely divided mineral particles associated with residues from the decay of animal and vegetable matter, usually referred to as humus; and various forms of plant and animal life such as amoebae, ciliates, fungi, and bacteria, many of which are of only microscopic size, but some of which nevertheless are often of the greatest importance in connection with soil fertility, or the power to produce.

HUMUS. The word, "humus," as generally used, relates to the total amount of organic matter in the soil. This consists primarily of residues of higher plants, in various stages of decomposition, also of innumerable bacteria, and often includes products of the decay of insects, earthworms, ciliates, amoebae, and other low forms of animal life. In very fine soils, and also in those which are very open, it is especially important to introduce stable manure or vegetable matter; such as leaves, straw, grass or clover sod, alfalfa roots, catch crops, weeds, vegetable refuse of other kinds, or green crops grown for the the specific purpose.

In fine soils, humus improves their aëration, their absorptive capacity for fertilizers, and the movement and conservation of the soil water.

In the case of open, sandy, and gravelly soils, humus aids the

retention of fertilizers and water, thus not only lessening the necessary amount, but also the frequency with which water must be supplied by irrigation, as well as the total volume in rain required for successful crop production.

When all of the humus has progressed far in the stage of decomposition, it becomes exceedingly fine and then fails to maintain the soil in proper physical condition, especially in wet locations. It is for this reason that the periodic introduction of coarse vegetable matter is so essential.

MICROSCOPIC LIFE. Soils contain earthworms, nematodes, and numberless transitional forms of insects. Many animals of microscopic size are also present, some of which it is claimed devour in vast numbers certain useful microscopic plants known as bacteria. There are great numbers of other bacteria in soils, which sometimes act injuriously.

Certain beneficial types of bacteria and other plant organisms effect the change of the nitrogen of fertilizers, manures, green crops, and plant residues, into ammonia and nitrates, so that plants can make the fullest use of it. If the soil is kept very wet for too long a period of time, other bacteria begin to undo the work of the foregoing and destroy the nitrates. If this process of denitrification goes far, much of the nitrogen escapes into the air again as gas, while the remainder is changed into slowly available humus compounds.

The groups of bacteria which shall gain the upper hand in this battle for supremacy are determined by the drainage, shading, aëration, cultivation, humus, temperature, sourness, or alkalinity, and by the kinds and amounts of organic and mineral plant-foods available for them in the soil, or supplied in the fertilizer.

It is now generally conceded by soil bacteriologists that soluble phosphates and other ingredients, such as are supplied by fertilizers, are great promoters of the growth of certain of these beneficial forms of bacteria.

IRON PYRITES, or "fool's gold," if present in considerable

quantities in certain soils, may be oxidized by contact with air and water to such an extent as to lead to the formation of ferrous sulphate, or copperas, which, like iron carbonate, may become poisonous to plants. Where such accumulations have taken place, slaked lime may be applied as a remedy. In some instances, better soil drainage and aëration may be essential to the full success of this treatment. Doubtless other compounds of ferrous oxide, the lower oxide of iron, in the soil may also exert a poisonous effect on plants.

MANGANESE COMPOUNDS are present in such large quantities in some Hawaiian soils as to be injurious. Usually, however, soils are more likely to be benefited by its presence in very small amounts.

ALUMINUM SALTS have been found in some soils in injurious amounts. In such cases, liming is the best and cheapest remedy.

PALMETTO ROOTS. On many flat pinelands in Florida, large amounts of unrotted palmetto roots have an unfavorable effect upon citrus trees.

BUDDING STOCKS

The stocks generally used for propagating citrus fruits are the trifoliate orange; pomelo; sour orange (*Citrus aurantium* L.; *Citrus vulgaris,* Risso); rough lemon (*C. medica,* var. *limonum,* Brand; *C. limonum,* Risso); the common sweet orange; the lime; and the Otaheite orange, which is used for producing dwarfs. They have special adaptations as regards soil, climate, and the kinds of buds used, which will be mentioned in the discussion of each.

CITRUS TRIFOLIATA. This citrus species, which bears an inedible fruit and is frequently used as a hedge plant in the South, is deciduous and becomes dormant in the autumn. On this account it imparts special cold-resistant properties to at least many other citrus varieties when budded upon it, as in the case of the satsuma designed to be grown in Northern and Northwestern Florida.

The process of resetting an eight-year old grapefruit tree.

It proved a failure in California as a stock for lemons and is quite useless in the Ridge section of Central Florida; but has given good results in the Gulf States as well as in Florida as a stock for the satsuma and other mandarin varieties, even apart from its cold-resisting qualities, although its use as a budding stock is not confined to them. It seems to impart a tendency to bear heavily at an early age; and if trees are frozen to the bank, they are often renewed with sufficient rapidity to bear a crop two years later.

The *Citrus trifoliata* is a native of China or Japan. The first printed description of it was in 1712, and it is said to have been introduced into the United States in 1869 by William Saunders of the United States Department of Agriculture.

Among the great number of hybrids produced by crossing *C. trifoliata* with the sweet orange, all types, ranging from deciduous to evergreen, have been secured. The fruit of this cross varies in size between the extremes represented by the two parents, and it is often bitter as well as generally more acid than that of the sweet orange. Many of these hybrids are very ornamental and effective in landscape gardening. One of the most experienced and best informed nurserymen in Florida reports that oranges budded on trifoliate stock possess three special advantages: (1) early bearing; (2) as good quality of fruit as if grown on sour oranges; (3) earlier ripening than on sour-orange stock.

POMELO (Grapefruit). This has been used in Florida as a budding stock, chiefly on the southwestern coast, but is not sufficiently hardy for the northern citrus sections. It is best adapted to soils which are too moist for sour stock and particularly to such as are well supplied with humus. Thus far in Florida it has not been affected by foot rot. Grapefruit on grapefruit stock produces shy-bearing trees, although the texture of the fruit is excellent.

SOUR ORANGE. The Seville, Bigarade, or Sour Orange, a native of southeastern Asia, and perhaps of Cochin China, was taken to Florida at a very early period, and it still exists in

a wild state in many of the forests. Because of its hardiness, which ranks next below *Citrus trifoliata*, it is a good stock on which to bud sweet oranges to be grown on high or low hammocks or flatwoods, or for grapefruit if the soil is moist and well supplied with humus. The roots of the sour orange are abundant and extend deeply into the soil, so that it is superior in many locations to the more shallow-rooting sweet orange, which may not be able to reach permanent moisture. The sour stock, furthermore, is not subject to foot rot. Notwithstanding that the sour orange is exceedingly susceptible to scab, it does not transmit this tendency to scab-resistant varieties which are budded upon it; also if the tops are frozen back, it quickly produces sprouts which can be budded.

The fruit of young trees on sour stock is usually of good quality, which is not always true of that grown on the rough lemon, although on the latter, as well as on trifoliate stock, the oranges come into heavy bearing more quickly. Sometimes very old sweet oranges on sour stock will grow faster and larger than the stock, resulting in an appearance of constriction at the base of the tree; the root system, however, remains adequate for all requirements.

The sour orange is not a suitable stock on which to bud the satsuma, the growth of which becomes seriously stunted. The same tendency, but in a less degree, is observed when the kumquat is budded upon it. Where the conditions are reasonably favorable for both stocks, sweet oranges budded on sour stock are likely to be longer lived than on the rough lemon.

ROUGH LEMON. This fruit, so called from the appearance of its rind, is supposed to have been introduced into Florida by the Spaniards, and it is still found wild only in the southern part of the state. It is many-seeded, juicy, and, though very sour, has a pleasing flavor. Though utilized somewhat locally, it has as yet no commercial value, and is used chiefly as a stock on which to bud other citrus varieties.

The rough lemon, though more or less resistant to foot rot, is less hardy than the sweet orange and is more subject to injury

by severe cold than the pomelo, a quality which it seems to impart to whatever top is budded upon it. Its lateral roots extend widely, and a good tap root is usually produced. Most of the feeding roots are in the upper fifteen inches of soil. Most citrus varieties when worked on this stock have well distributed roots. The widely-extended root system adapts the rough lemon to dry soils or those needing irrigation. For the same reason it promotes much more rapid growth of the top budded upon it than the other kinds of stock. On low ground, the sour orange is preferable.

The rough lemon has been said not to be adapted, as a budding stock, for the kumquats, especially on moist land, because of a tendency to suffer from an abundant flow of gum from just above the point of union. It has therefore been recommended, when budding on rough-lemon stock, to bud upon sprouts from roots which are already supporting a sweet or mandarin orange top, for in such cases gumming is not likely to occur. According to Ralph Robinson of the United States Department of Agriculture, however, though some gumming occasionally results when the kumquat is budded on rough lemon, "it seems to be the only practical stock for southern and central Florida. The kumquat is totally unsuited to the sour stock while grape fruit and sweet orange stocks are not satisfactory in many places. Of course the sweet orange stock is too subject to foot rot." He also says, "The Royal Palm Nurseries in recent years have propagated kumquat extensively on the Cleopatra mandarin which seems to be a very promising stock." He does not know, however, how it would do on high pine soil, but mentions the good root system and the ideal bud union which results with the Cleopatra stock.

Citrus trees on rough-lemon stock tend at the outset to shoot up tall branches in the center of the top, which may be cut back, if necessary. This feature often disappears later, just as does the early tendency to produce dry and thick-skinned fruit.

It is believed that fruit on this stock will be larger and rather more acid than on certain other kinds of stock. The rough

Watering an eight-year old grapefruit tree after pruning and transplanting.

lemon is known in Florida to increase the fruitfulness of the Bahia navel orange, and the trifoliate is the only other stock suitable for use for this orange in this state. Many growers prefer the rough lemon to all other stocks for the pomelo, and also for the mandarin group of oranges when the latter are grown where great danger of freezing is not to be feared.

SWEET ORANGE. The sweet orange, in California, has a tendency to develop a shallow root system. In Florida it is extremely subject to foot rot, wherever the disease occurs, and it should not be used in moist hammocks and flatwoods, either itself or as a stock to be budded upon. On light, well drained soils, trees on sweet stock develop well and more rapidly than on sour or trifoliate stock, but not so fast as on rough lemon. If frozen back, sweet stock produces new shoots quickly, which can then be budded; nevertheless it has practically been discarded as a stock in Florida because of its susceptibility to foot rot.

Old seedling trees when planted closely in the grove, or when so large as to completely shade the ground, are especially liable to foot rot, necessitating the inarching to them of seedling sour-orange stocks to replace wholly or in part the original trunks. But this must be done before a complete circle of bark around the base is destroyed.

LIME. The lime has been used successfully as a stock on the lower East Coast of Florida where other stocks might have failed. It is better adapted to tropical regions than trifoliate stock and its use may result in extending citrus culture still farther south. All lime buds have a tendency to outgrow the stock.

SELECTION OF A GROVE SITE

In selecting a location for a grove, the following points are important:

(1) Nearness to shipping-point or packing-house.

(2) Good roads over which to haul fertilizer and fruit.

(3) Location and soil adapted to the special kind of citrus fruit to be grown.

(4) Avoidance of poor land or those soils, wet at certain seasons, which cannot be adequately drained and which are likely to develop into a liability rather than an asset or real investment.

(5) The selection of varieties of citrus trees and citrus stocks well adapted to the particular land, whether high pinelands, high hammocks, flatwoods, or prairies.

(6) Avoidance of hardpan, if possible, since it must be broken up by explosives before the trees are set; also of impervious layers of clay near the surface.

It is claimed that citrus fruits keep better if grown on the higher lands, but that the quality of the fruit is superior if grown on the lowlands.

Uplands are well adapted to citrus fruits budded on rough-lemon stock, and such fruit comes into bearing earlier than if budded on sour-orange stock; the trees, however, are not likely to live for so long a time.

SELECTING TREES FOR PLANTING

In establishing a new grove, it is of the greatest importance to secure trees budded on the kind of stock best adapted to the special soil and to the particular kind of citrus tree to be grown. Furthermore, one should buy only from reliable nurserymen, who use buds from bearing trees true to name and producing fruit of certified quality, so that there may be no disappointment or failure when the trees come into bearing.

SIZE AND AGE OF GRAPEFRUIT AND STANDARD ORANGE TREES

While there may be more or less variation in size and age of citrus nursery stock, the following may be considered as fairly typical:

2 to 3-foot grade, often sold by height alone
3 to 4-foot grade, diameter of butt 1/2 to 5/8 inch
4 to 5-foot grade, diameter of butt 5/8 to 3/4 inch
5 to 7-foot grade, diameter of butt 3/4 to 1 inch
2-year grade, diameter of butt 1 to 1 1/4 inches

Typical Heights and Ages of Root and Bud

Height of tree (feet)	Age of bud (months)	Age of root (months)
2 to 3	10	30
3 to 4	12	36
4 to 5	12	48
5 to 7	15	51

In the case of two-year old trees, the bud is 24 months old and the root 60 months.

DISTANCES APART AND NUMBER OF TREES PER ACRE

The following table shows at a glance the number of trees required, *per acre*, when planted at different distances:

Feet Apart	*No. of Trees*
15 x 15	193
16 x 16	170
17 x 17	150
18 x 18	134
19 x 19	120
20 x 20	108
25 x 25	69
30 x 30	48
35 x 35	35
40 x 40	27

LAND PREPARATION AND TREE PLANTING

A good plan is to grow velvet beans or other suitable cover crop to be plowed under in the late fall in preparation for

An example of inarching on a grapefruit tree, by using young hardy stock to carry up food for the support of the old top.

the trees which are to be set a few weeks later. If so much time for preparation is not available, the land should still be prepared well in advance of the time of planting. Many of the best groves in the state have, nevertheless, been set immediately after the clearing and harrowing of the land.

The best time for setting trees is usually from the latter part of December to the latter part of February, when the trees are dormant and all other conditions are favorable. Some growers, however, set trees at the beginning of the rainy season, but this is not generally advisable.

The trees should be handled so as to expose the roots to the air as little as possible. The best plan, provided the delay in planting does not necessitate heeling them in, is not to remove them from the packing-box until the holes are ready, so that they can be set immediately; and only a few trees should be taken out at a time. If the trees must be removed from the packing-box to a wagon, the roots should be carefully covered with sacks, shavings, or moss, previously drenched with water.

The holes for the trees should be opened only as fast as the trees are set, so that the soil will not dry out. They should also be dug large enough to prevent any crowding or crushing of the roots, and broken roots and root ends should be cut off with a smooth upward-sloping cut.

Each tree should be watered abundantly when set and at about ten-day intervals until the advent of the rainy season, unless there is a sufficient fall of rain.

Since citrus trees are shallow feeders, they should not be set too deep; and they should stand from slightly above the general level of the land to six inches above on moist areas, so as to make sure that water will not collect around them. It is better to have them a few inches too high than even an inch too deep. If planted on very low, moist land, each tree must be set on a high mound. The trees should never be set lower, and preferably slightly higher, than they stood in the nursery, even when set on slight elevations or on still higher mounds.

The distance apart to plant citrus trees must be adapted to the method or means of cultivation. A frequent distance is 30 feet apart, but many of the more recently planted groves are being set 25 x 25 feet. As a rule, trees should not be set nearer the fences than 17½ feet; and if spaced 25 x 25 feet, a ten-acre tract will require 26 trees each way, or a total of 676 trees. The most common distances for planting, in addition to the one just mentioned, are 25 x 30, 30 x 30. The former plan of planting 15 x 30 is not now recommended, because of the reluctance of growers to remove at the proper time every other one in the 15-foot row.

It is generally inadvisable to fertilize trees until two to three weeks after planting. Sometimes, however, a pound of fertilizer per tree is first thoroughly mixed with the soil which is to be used about the roots.

The rows should be carefully and accurately measured and staked. The stakes usually employed for this purpose are 1½ x 1½ inches and from 18 to 24 inches in length. After the stake is driven into the mound, or slight elevation upon which the tree is to be set, begin at the top of the soil and dig away the earth, so as to leave it standing at full height immediately around the stake but sloping downward from it in a complete circle. This slope should be long and deep enough to accommodate the surface roots without cramping them. The soil where the roots are to rest is loosened, the stake removed, and the tap root of the tree is inserted in the stake hole to the proper depth. If two tap roots are present, cut one shorter than the other and make a special hole for the extra one. The lateral roots, which should be still moist when set, are next spread out as evenly as possible on this inclined bank of earth; and on bended knees one should press soil firmly under and around them, using enough water to properly settle the soil. It is asserted by some that the soil should preferably be puddled with water before the tree is set. When the setting is completed, make a cup-shaped mound about the tree large enough to hold a bucketful or more of water. After this amount of water has been added and has settled, bank the tree to the

customary height. If set early in the season, the bank should be higher than is necessary later on. Avoid getting chips, roots, or decaying wood into the hole in which the trees are set, so as not to attract wood lice. For the same reason keep wood, grass, and straw out of the mounds. Where the top of the tree is cut off, it should be coated with paraffin, paint, or soap, in order to exclude the air and prevent the top from dying back. It is usually safe to remove the bank from early-set trees by the last of February. At this time a part of the earth is scraped away and leveled around the base of the mound. The fertilizer should then be scattered in a circle, beginning at the base of the small remaining mound and extending out somewhat beyond the reach of the roots. The remaining earth in the mound is then pulled down and distributed over the fertilizer.

CARE AFTER PLANTING

When watering the trees, subsequent to the time of setting, remove enough soil to make a cup-shaped depression around each tree and pour into it six to eight gallons of water. When the water has settled, put back the dry soil which was removed, and as soon as possible run an acme harrow over the grove, repeating the harrowing at frequent intervals. If the watering of newly-set trees is infrequent or is inadequate in amount, it cannot be expected that all of them will live.

FALL BANKING OF YOUNG TREES

In addition to banking at the time of winter setting, which has already been mentioned, it is a wise precaution to have the trunks banked during December, January, and February in each of the two following winters, to a height of 18 to 20 inches. In case this is done and the tops are killed by severe cold, the trees can be cut off just above the mounds and new tops will form rapidly with little loss. In all cases, chips, roots, or similar plant rubbish, likely to attract the destructive wood lice, should be kept out of the mounds; or serious injury may result before the grower is aware of it.

A young forty-acre citrus grove at Haines City, Florida, on which A. A. Quality Fertilizers are being used.

HEADING YOUNG TREES

Usually four to six of the best sprouts are selected to form the head; and they should be well distributed so as to avoid the formation of crotches and the subsequent danger of splitting. It is the nature of citrus trees to branch rather low and fairly low branches protect the butt from sunscalding; yet if the branches are too low, there is danger that fruit may rest on the ground and be injured. On the other hand, very high heading should especially be avoided. All sprouts not needed for building the head should be carefully rubbed off early in the season, so that the real head will make proper growth; for the tendency is for the sap to flow chiefly to the lower sprouts.

Some good cultivators, however, let everything grow out above the bud that will, and allow the tree to have its own way about forming a head, which rapidly covers the ground with shade-giving branches, out of which spring the stronger branches that form the tree. The growing root system is then protected from the sun and wind and every additional branch means a further development of roots. This plan interferes to some extent with the use of the acme harrow, but the grove owner is seeking good trees rather than mere convenience in harrowing.

The stronger shoots which grow out later to form the tree come from the inner part of the young tree among the first branches and are supported by them; whereas where the other methods are followed, many of these strong shoots are blown out by the wind while they are still soft and sappy. The earlier branches, having performed their natural function, are enveloped by the later stronger ones and are eventually cut out from the inside of the tree.

REMOVAL OF FRUIT FROM YOUNG TREES

Frequently some trees will set fruit as early as the second year. If they do, it should be removed while small; for otherwise the trees which are allowed to bear are likely to be weakened to such an extent as to give an irregular or uneven ap-

pearance to the grove. If strong trees were used for planting and they are in a vigorous, healthy condition, they may be allowed to bear some fruit the third year. If they are permitted to do so, those bearing the most fruit should be more heavily fertilized than the others.

EARLY GROVE TREATMENT

FIRST-YEAR TREATMENT. Unless fertilized when set, the first application of fertilizer should be made when the mounds are removed from the trees (p. 39). Systematic cultivation of citrus groves should begin practically as soon as the trees are set or surely by March, and in dry weather should be repeated every ten days to two weeks so as to maintain a shallow dust mulch, for the purpose of conserving the moisture and preventing the growth of weeds. For this work the acme harrow has no superior, and digging or deep-cutting harrows, which tear up or cut off the roots, should not be used.

In a newly-set grove, frequent cultivation at the start need not be extended beyond a narrow strip on all sides of the tree; but the entire middles should be cultivated at least every four or five weeks, until rains become frequent. Before this time arrives, it is a good plan to cultivate within three or four days after any considerable rainfall.

About the first of June, or when the rainy season begins, the cultivation of the middles may be discontinued and these may be sown to beggarweed, cowpeas, velvet beans, or other suitable cover crops. If velvet beans are used, they should not be sown near enough to the trees to climb into them. In fact, a strip next to the trees should be kept cultivated until about November 1, and any weeds under the trees which cannot be reached in this way should be hoed out. The cover crop in summer prevents the destruction of, or interference with, the work of beneficial bacteria, by protecting the top soil from the burning sun. The cover crops also furnish the needed supply of humus.

SECOND-YEAR TREATMENT. Following the second season's banking, any weeds that start should be cut out and a careful watch should be kept for injurious insects; such as the pumpkin bugs, which are likely to appear at this season. They should be removed by hand picking; for since they are sucking insects, poison sprays are ineffective.

When the banks are removed, fertilizer is applied as described on page 39.

The cultivation the second season should be essentially the same as the first; and the acme harrow and hoe are all the implements required after the summer cover crop has been turned under.

The only pruning permissible the second season is for the removal of dead or injured branches, which should be cut back to green sound wood. Limbs resting on or likely to rest on the ground may have their ends cut off so that they will sprout upward. The detailed fertilizer treatment is given on page 53.

THIRD-YEAR TREATMENT. The mounds about the trunks of the trees may be taken down and fertilizer applied the latter part of February in the same manner as the second year after planting.

Many trees are likely to bloom the third year; but unless they are exceptionally vigorous, the fruit should be removed while still small.

Each tree in the grove should be examined carefully at sufficiently frequent intervals so that spraying, pruning, extra fertilization, or other necessary attention may be given all that require it.

If there is any evidence of dieback, either less fertilizer should be used or a brand should be selected containing less ammonia, or one otherwise better suited to the individual circumstances or conditions.

If Bermuda grass or maiden cane is present in the grove, every effort should be made to eradicate it. If the method of

A. A. Quality Citrus Fertilizer is used on this young grove, still of banking age, in Central Florida.

cultivation does not result in controlling the maiden cane, it is sometimes necessary about May 1 to replow the grove and harrow it thoroughly, for cultivation is the most effective means of destroying this plant pest. Special care must be taken in such a case to plow very shallow near the trees, although deep plowing in the middles at considerable distance from the trees will do no harm and will ensure plowing out the maiden-cane roots.

In the fall the grove may be plowed as in previous seasons, but banking can usually be safely omitted.

If through any unusual happening the cover crop is not dead, so that the grove can be plowed in November, a strip at least six to eight feet wide bordering the trees should be plowed, leaving the remainder to be plowed as soon as conditions permit.

The third season it is generally advisable to spray in the autumn with an oil emulsion for the destruction of the scale, whitefly, and other insects. Spraying for whiteflies with oil emulsion not only destroys them but also loosens the sooty mold to such an extent that rain will wash it off, leaving the foliage bright and clean.

FOURTH-YEAR TREATMENT. There will be no bank or mound to be removed the fourth year, but thorough cultivation and proper fertilization should be continued, as in previous years.

One or two sprayings for the control of whitefly and other insects are likely to be required; and in May special attention should be given to the young fruit, so that if the rust mite is present on it, a lime-sulphur spray may be applied (p. 130). From this time forward, eternal vigilance and special attention to each tree and its fruit are the price that must be paid for an ideal grove.

Watch carefully for indications of dieback; and if it occurs, modify the fertilization; and if necessary, give the proper treatment with bluestone (p. 67).

The plowing should be done in November, but shallower than before; for the roots now extend a long distance on all sides of the trees.

One box of fruit per tree, the fourth year, is an abundant yield, and much smaller crops are by no means a misfortune. There is a good chance that the fruit this season may pay for the care of the grove for the entire year; and from this time forward, much larger yields may be expected. In regard to the fertilization of the grove, see page 54.

FIFTH-YEAR TREATMENT. Cultivation and fertilization should begin early in February, and the cultivation should be continued as in previous years.

In fertilizing, the needs of individual trees should be taken into account according to the general directions given on page 55.

In November the grove should be fertilized and plowed; but the plowing must be still shallower than previously, especially as the trees are approached. The land should then be harrowed. Give careful attention to each tree as concerns whitefly, scale, rust mite, or any other insects or diseases, and consult the spray calendar. If in doubt, write for advice to your State Agricultural College, Experiment Station, or Plant-Board officials in Gainesville; or ask The American Agricultural Chemical Company, Jacksonville, Florida, to send its Agricultural Service Bureau's Field Expert to inspect your grove and advise you, without cost.

About the middle of April watch most carefully for the rust mite; and if it is present, spray promptly, since by doing so the selling value of the fruit will be materially increased.

COVER CROPS AND LATER CULTIVATION

The cultivation of citrus groves for the first five years is discussed briefly on pages 42 to 46. However, special mention should be made here of the importance, even in later years, of keeping the area immediately around the trees, or a strip beside them, free from vegetation throughout the year. It is also

equally important that the middles should be protected during the summer by a suitable cover crop. One of the favorite crops for this purpose is the beggarweed, a leguminous plant capable of assimilating atmospheric nitrogen. The cowpea and the velvet bean are other valuable summer cover crops, also capable of utilizing atmospheric nitrogen provided the necessary bacteria are present. If the latter is grown, special care must be taken to plant the seed so far away from the trees that the beans cannot climb into them, or more injury than benefit may result. If these legumes are used as cover crops, it is often desirable or highly important to leave them on the ground until they are dead, before plowing them under or disking them in; or they should be cut and allowed to dry before this is done. Whenever they are used and the conditions are such that they develop abundant nodules on their roots, and consequently fix considerable free nitrogen from the air within the soil, special care must be taken not to use fertilizers for the next one or two applications which have too high a percentage of ammonia, particularly in organic forms. If care in this particular is not taken, there may be danger that the trees will develop dieback and that serious losses from "ammoniation" of the fruit may result.

Usually an abundant crop of sandspur and other native weeds accompanies beggarweed or other cover crops which are sown broadcast, or which are reproduced by natural seeding. In many places Natal grass has been introduced into groves intentionally, while over wide areas it is rapidly being distributed by the wind or other natural agencies. There is probably no citrus-grove cover crop concerning which there exist wider differences of opinion as to its merits and demerits than Natal grass, as some growers denounce it; while others esteem it a blessing, perhaps because it will thrive and act as an effective producer of humus even on very light, poor soils.

When the cover crop is ready to be introduced into the soil, which should usually occur from late September to December as a means of conserving moisture during the dry season, special care must be taken, if it is done with a plow, to run the

An old orange grove which for many years has received only A. A. Quality Citrus Fertilizers.

plow continually shallower as young trees are approached, so as not to tear up the young feeding roots. If a disk harrow is used for this purpose instead of a plow, it should be equipped with "depth-spools" or other means of elevating it, upon nearing the feeding roots of young trees; and like care must be exercised over the entire middles in the case of older groves, since the roots after six to eight years penetrate practically every part of the middles in all directions.

The possessor of a grove on high pineland has usually found from experience that it is especially important for him to plow under or work in his cover crop in the early fall; whereas if the grove is on hammock or flatwoods land, this may often be done considerably later or in some cases may be omitted. For groves in these latter locations, the tandem disk is an excellent and economical substitute for the plow, especially in large groves; and it is recommended, provided its depth of working is capable of regulation by readily adjustable spools on the disk shafts or by other satisfactory means. In using the disk it should not be set at too great an angle, and should be sufficiently loaded so that it will cut through the cover crop into the soil. In using it, one should overlap sufficiently to cover the ground thoroughly. By the time the grove has been worked two or three times in each direction, the effectiveness of the disk will become very evident. In order to avoid working the soil too deeply, in bare spots, it will be found that a riding-disk with wheels and levers for promptly regulating the depth is far superior to the usual walking implement.

The protection during the dry fall which is afforded by the introduction, by such means, of an organic mulch into the top three to four inches of soil is often of the greatest importance to citrus trees. Where the cover crop has already been introduced and the conditions are favorable for using the acme harrow, this shallower-working implement is one of the best for grove cultivation; since by thus avoiding injury to the feeding roots, frenching and other ills resulting from deep tillage may be escaped.

FALL TREATMENT OF THE MIDDLES

The plowing under of the cover crop in the middles should be delayed until early November, or until the cover crop is dead; or it should be cut and allowed to dry before turning it under, since injury is likely to follow the plowing under of green vegetation, especially in large quantities.

One should not plow near the trees; and even when approaching them, several feet away, the depth of the plowing should be gradually lessened. The same principle holds, even if the dry or dead crop is worked in with an adjustable disk harrow; for shallower disking should be the rule as the trees are approached. Deep plowing is unnecessary in citrus groves, and it should be shallower each year as the root system increases in extent.

There are in certain districts of Florida groves of large trees that have not been plowed for over ten years and have borne no cover crops; for because of the shading of the trees and the fact that the ground is filled with their roots, there was really no opportunity to grow one, and yet they have been maintained in perfect condition merely by suitable fertilization.

IRRIGATING GROVES

Since subirrigation is not practical because of roots clogging the pipes and overhead irrigation of groves is neither practical nor economical, the citrus grower must resort to either the furrow or jointed-pipe system, depending upon the character of the soil. In the case of very open soils which wet through quickly, the jointed-pipe system must be used; whereas if the soil is composed of particles of such a character that it fails to let water pass through it readily, or if the soil does not wet through quickly, furrow irrigation is possible. Unless the citrus trees are supplied with an adequate amount of water, they cannot make the best use of the fertilizers which are applied; and shedding of leaves, inadequate bloom, and serious deterioration, or even much dropping of fruit, are likely to result.

It has been stated that in the case of loose sandy soils which are peculiarly adapted to holding water on the surface for a considerable time when dry, it is often possible to run satisfactory amounts of water 600 to 700 feet; with a head of 120 gallons per minute. It is also possible to run water 650 feet in furrows in the usual loose sandy soil. Heads of 70 gallons per minute will give satisfaction, but will not ensure running the water so far. In some citrus groves the soil is of such a character that a head of 25 gallons per minute, per furrow, will answer; but on high pinelands and other similar types of soil, such a head would be practically useless. Where the supply of water is restricted, as in many of the citrus groves in California, or where it must be pumped at considerable cost, it is seldom advisable to have the irrigation furrows more than 250 to 300 feet long because of the loss by leaching at the intake end. If run for too long a time, water will be lost through the soil even below the depth of six feet. Thus in applying water by the furrow system, both the type of soil and the quickness with which it becomes wet must be taken into account, together with the head of water and the number and length of furrows to be irrigated. The water applied in furrows usually wets a strip of soil only about three feet wide.

It is sometimes advisable to make a catch pit at the head of the water supply and fill it about half full with clay. If the clay is stirred occasionally with a hoe, it will be carried down the channel and prevent a serious loss of water while on its way to the trees. By watering the trees farthest away first and blocking up for the next two, one on each side of the channel, the clay will not need further stirring after the channel has been found to be working properly.

INTERCROPPING AND IRRIGATING

In the case of a newly planted grove on recently cleared land, the watermelon is often one of the best crops for interplanting. Other crops, such as corn, potatoes or peanuts, are also often used for the first one or two years, where the moisture conditions permit, or where the soils are not so open as to preclude

A newly planted citrus grove interplanted with watermelons grown with A. A. Quality Fertilizers.

furrow irrigation. Overhead irrigation is seldom economical or advisable in young groves.

FERTILIZING CITRUS TREES

The time to fertilize and the number of applications must be varied according to whether the tree is small or is producing fruit. The smallest number of applications per year would usually be three: one in February; one in June; for young trees, one in August; and for bearing trees, one in October or November. Formerly in some places on the east coast, as many as six to ten applications were made per year; but owing to the tendency of each application to start new growth and because of the resulting disturbance of the blooming period, this practice has been abandoned.

FERTILIZING THE FIRST YEAR. Although sometimes done, it is generally considered inadvisable to use fertilizer at the time the trees are planted; but the latter part of February when the earth bank is removed, one pound of fertilizer may be applied per tree as described on page 39. The second application, of a pound per tree, should be made about the first of June, or just before the opening of the rainy season; and the third application, at the same rate, early in August, or before the close of the rainy season. Thus the trees will be able to make good use of the third application and ample time will be afforded for the wood to harden before winter. The fertilizer should be spread in a complete circle about the tree, beginning from a few inches to a foot from the butt and extending outward somewhat beyond the probable immediate reach of the outermost roots. When the fertilizer is not covered by the earth from the bank, it should be worked into the soil as soon as it is applied.

FERTILIZING THE SECOND YEAR. The first application of fertilizer the second season after planting should be made in the same manner as in the first year, but the amount should be increased to 1½ pounds per tree. The second application, of at least two pounds per tree, should be made about June 1, the

same as in the previous year. The third, or final, application of the year should be made at the same rate as the second, but during the first week in August, so that the trees will reach a dormant stage before winter. In all cases apply the fertilizer in a circle and have it extend somewhat ahead of the roots.

FERTILIZING THE THIRD YEAR. The first application of the third year should immediately precede the removal of the banks, just as in the first and second years; but the amount should be increased to 2 or possibly 2½ pounds per tree, and it should be distributed widely enough to be slightly ahead of most of the rapidly extending roots. The second application, to be made in June, may be somewhat larger if there are no indications of dieback; otherwise, only from 2 to 2½ pounds per tree or even the smaller amount should be used then and also in August.

FERTILIZING THE FOURTH YEAR. The fourth year there will be no banking to remove and the fertilizer applications may sometimes be commenced as early as February 10. The usual amount to apply at this time is 3 to 4 pounds per tree. Attention should be given to each tree, more or less fertilizer being used according to the apparent need. By this time, the roots will reach considerably beyond the limits of the branches and the application should extend out farther than before. If dieback is in evidence, the amount of fertilizer may be lessened or a brand should be selected which contains less ammonia. What has been said of the first application as to the amount and kind of fertilizer and in regard to fitting the application to the individual need, holds equally for the June application, excepting that as a rule more fertilizer should usually be applied per tree than in February, since this is the time to promote the chief growth of the bearing wood for the next year. The fourth year, the autumn application may usually be the same in amount as in February; but instead of applying it in August, it may be applied the latter part of October, and the fertilizer used at this time should generally contain less ammonia and frequently more potash than that used in February and June.

FERTILIZING THE FIFTH YEAR. The fifth-year fertilizing may be commenced early in February; and the mistake should not be made of beginning in January, no matter how alluring the season may be. The amount of fertilizer must be gauged by the condition of each tree and its apparent needs.

If there is evidence of dieback, the quantity of fertilizer should be materially lessened or a fertilizer should be used which contains a lower percentage of ammonia chiefly in mineral forms.

One of the functions of the February fertilizer application is to promote blooming and the retention of the newly-set fruit; for if the tree lacks the necessary food for building the young fruit, there is a tendency for it to drop.

The second application should be made early in June; and unless there is need of its curtailment because of dieback, it should be larger in amount than the preceding one, since it must not only supply the plant food required for the immediate crop of fruit, but must also provide enough to ensure an adequate growth of new wood, which is essential to the production of a full crop the following year.

The third application should be made in November just before plowing or disking. At this time, a fertilizer should usually be selected containing less ammonia and generally more potash than the one used in February or in June.

GENERAL SUGGESTIONS. The total quantity of fertilizer to apply in later years may range from 8 to 50 pounds per tree according to the age, size, and individual requirements, and depending upon the soil deficiencies. This total should be divided into not less than three or four applications.

After the citrus trees have reached the age of 5 or 6 years, the roots will have penetrated the entire middles, which should then all be fertilized. The extension of the roots will take place faster in case rough-lemon stock is used than if the trees are budded on the sour orange.

A six-year old orange grove, always fertilized with A. A. Quality Citrus Fertilizers.

PICKING AND HANDLING CITRUS FRUITS

Failure to pick citrus fruits at the right time or carelessness in handling them may determine whether good profits or possible losses will result. Each picker should wear gloves, so as to avoid finger-nail scratches and the consequent introduction of the spores which cause the various kinds of rot. The clippers used should be of a kind that will permit the cutting of short stems without injury to the fruit. The receptacle used by the pickers must be so constructed that the fruit will not be subjected to pressure or squeezing during or following the picking, and the fruit should be emptied into the field-boxes with the greatest possible care, without jarring. The boxes must be filled so that none of the fruit will be bruised or chafed by the other boxes, and spring wagons or trucks should transport them to the packing-house. An up-to-date modern packing-house should be patronized, if possible, so as to ensure the most careful washing, packing, and shipment. Frequently the packing-house will assume full charge of the picking and hauling of the fruit.

GROVE PROTECTION

In some localities, the planting of windbreaks affords a helpful means of grove protection, especially where groves are exposed to high winds. For this purpose, the upland willow oak, willow-leaved oak, and other native trees may be used. In certain locations some of the original trees are left in the grove as a source of protection; but with the advent of the tractor and of the larger implements of tillage, the presence of such trees in commercial citrus groves becomes objectionable. In case heaters must be used in a grove, natural or artificial windbreaks are often very helpful.

A certain degree of winter protection is afforded by turning under the cover crop fairly early and maintaining a shallow dust mulch during the late autumn and winter, so as to avoid stimulating growth late in the season. The trees will thus better "ripen" their wood and become more resistant.

In case the irrigation waters have a temperature of from 60 degrees to 70 degrees F., applying the water in a spray, when there is danger of injury by cold, will assist materially in maintaining a safe temperature.

When planting in regions especially subject to low temperatures, the most favorable location is on the southern or southeastern side of a lake or other body of water.

Where only a few trees or important trees for budding purposes are involved, they may, in emergencies, be covered with special tents, or may be protected by artificial windbreaks or sheds.

Oil heaters, wood fires, coke heaters, and other means of protection against extreme cold, have been used from time to time; and of these, coke heaters at the rate of 100 to the acre have proved the most efficient. Whatever the system of heating, it is important that one should not wait too long before the heaters are started; for it is easier to hold a safe temperature than to attain it after the temperature has dropped below the limit of safety.

PRUNING

The usual pruning implements required are a strong, light ladder; long-handled shears; a knife; axe; and saw. The cutting implements and saw should be kept well sharpened. All cuts should be clean and close to the trunk or large branches.

Liquid grafting-wax or white-lead paint should be applied to all large cut surfaces. If trees are injured by freezing, cut back to sound wood a few weeks afterward, or as soon as the extent of the freezing can be determined.

From the time trees are set, they should be watched carefully each year in the effort to prune at the right time, so as to avoid severe pruning later and to reduce to a minimum the total amount of pruning required.

TIME OF PRUNING. Whenever any large or important branches must be removed, it should be done, if possible, while

the trees are dormant. In case of severe injury to bearing trees, the injured wood should be cut out shortly after new growth begins, special care being taken to cut behind even some of the new shoots nearest to the limit of injury on the main branches. As a rule the major part of the pruning is best done in the latter part of the summer, following the midsummer fertilization; and if not finished then, it may be continued till completed. At this time all dead wood should be removed so that it may become neither a disease harborer nor promoter; also twigs and branches with sparse foliage should be cut out, as well as seriously weakened branches that bore heavily and held their fruit late the previous season, or others injured by early summer drought. In the northern part of the citrus belt, where chiefly early and midseason varieties are grown, much of this pruning can be done in the winter or very early spring; whereas farther south, this season must be utilized for harvesting the fruit. Most groves, if properly fertilized, cultivated, and sprayed, need but little pruning unless severe injury by drought, freezing, or overbearing has resulted.

As the trees develop a larger top, following the first two or three years of bearing, many of the smaller early-bearing branches lose much of their foliage and should be cut out. The chief bearing area is thus extended farther from the center of the trees. If, later, adverse conditions or neglect lead to a lessening of the outside foliage, the entrance of the sunlight to the interior may cause the development of interior branches or actual "water sprouts", which should be removed.

If one attempts to thin materially the outer bearing branches, a considerable lessening of the yield is likely to result the succeeding year; or if opened too much, the interior branches or main trunk may be injured by sunscalding. If the previous pruning has been carried to this latter extent, every effort should be made to aid the tree in developing an exterior covering of branches and foliage as rapidly as possible.

In the case of large trees planted somewhat close, many of the lower lightly-foliaged branches should be removed for the benefit of the others, instead of leaving them until they even-

An orange tree affected with dieback. Note the crooked or S-shaped twigs and partly defoliated branches.

tually die. In doing this, however, special care should be taken not to cut off normal large branches, even if rather low; since otherwise the yields for several succeeding seasons are likely to be materially lessened.

In old seedling groves in which the branches of the trees meet or intermingle, foot rot or other bark diseases are likely to develop, resulting in decreased yields. In fact, in light, dry soils this may occur even before the branches have met. When this stage is reached, either some of the top must be removed or some of the trees must be transplanted or cut out. The pruning of such trees must be done while they are dormant, as in winter or during a severe drought; and if the fruit is of an unsatisfactory kind, grafting or budding may also be undertaken. If large trees are transplanted during periods of summer drought, they should be covered with damp moss or other suitable material during the transfer in order to protect the bark and roots from the sun.

In the case of a neglected grove, pruning must be resorted to in addition to fertilizing, cultivating, and spraying. The tops of such trees are usually too thin and are irregularly developed. Such trees can be brought quickly into the best bearing condition only by cutting back the scattering branches and by the removal of all dead or non-bearing wood. None of the living lower branches should be cut back to the trunk; they should be merely pruned back. A large production of sprouts is likely to follow such treatment, but these should be allowed to remain even on the trunks. If there is a later tendency of any of the shoots on the trunk to develop as "water sprouts", they should be bent outward, so that the tips will develop side branches and thus enlarge the bearing base of the top.

In the case of budded trees which branch low, it must be remembered that the low branches are nature's means of protecting the trunk against sunscalding; and later they can be wired, propped up, or pruned from the lower side, as necessary. If they are removed, the trunk is liable to injury and the crop-producing capacity of the tree is likely to be greatly lessened for many years.

If trees are injured by lightning so that the chances of recovery are poor, it may be possible—if half, or more, of the lower bark of the trunk is still alive—to save them by severe cutting back of the top. In some cases, if this action has been long delayed, it may be well also to cut off some of the lateral roots.

TOP-WORKING OLD TREES

Trees in old groves which are not producing good fruit or large yields may be top-worked and, if not diseased, can be made over into profitable producers, as they have a large root system with which to supply a small and growing top with an abundance of plant food. Seedling trees, top-worked to various budded varieties, may readily bear a good crop of fruit the third year after top-working. If the trees are low-headed and have satisfactory limbs leading out from the trunk, it is best to cut off the whole top, leaving merely the stubs of the larger limbs and then bud the sprouts from these. They may be sprig-budded or grafted. In either case, some of the top branches should be left for a while to shade the trunks from the summer sun, which would otherwise be likely to cause sunscald. When the trees are headed too high, the top should be cut and lopped over; then sprig-bud the old trunk.

DRONE ERADICATION

Every experienced grower knows that there are many unproductive trees in every grove which should be taken out. To determine which are the drone trees, every tree should bear a row and tree number; or if the number of trees or rows is not too great, a combination of numbers and letters may be used. A record kept for four or five years will be an accurate guide to the owner as to whether he should continue to feed certain trees suspected of being unprofitable.

These drone trees may be either cut out or top-worked. If the stock is satisfactory, it is usually better to top-work them, and the bud wood should be taken from trees whose records

are definitely known. By carefully following this plan of drone eradication, the output of many groves has been greatly increased. One year's record is not enough for the detection of "drone" trees; since sometimes a tree that is not in good condition will bear more heavily for one or two years than it normally would, in its attempt to reproduce before it dies.

THE OUTLOOK FOR CITRUS FRUITS IN FLORIDA

The recent construction in Florida of thousands of miles of unsurpassed roadways, the advent of the tractor, the building of well-equipped packing-houses, and the organization of effective selling agencies, have all aided in placing the Florida citrus industry on a sound basis.

The quality of its grapefruit is so far superior to the California fruit, heretofore produced, that it has gained a monopoly of all but the local markets of that state. Its oranges more than make up in flavor and juiciness for any slight advantage in color which the California fruit is supposed to possess, and the discriminating user prefers to please his palate rather than his eye.

Certain of the mandarin oranges, such as the King, bring top prices in northern markets and are unsurpassed in quality. The enormous plantings of new grove land on the West Coast, on the great Central Ridge, and on the East Coast, are merely an expression of a growing demand from the rest of the country for the health-imparting, vitamine-bearing, luscious citrus fruits of Florida.

DISEASES AND INJURIES OF CITRUS FRUITS

DIEBACK

This disease attacks both the fruit and young branches.

HOW RECOGNIZED. Dieback is recognized by the following characteristics:

(*a*) S-shaped, or deformed, terminal branches.

Citrus branches affected with dieback, showing multiple buds and small gum pockets.

(*b*) Gum pockets, or elevations on succulent terminal branches, usually near the base of the leaves. These contain an amber-colored liquid gum. When the wood becomes older, these disappear.

(*c*) Multiple buds, or an increase from two to several buds in the axils of leaves.

(*d*) Stained terminal branches showing a glossy brownish color, and occasionally slight elevations of the bark. Similar staining may be noticed on the petioles and base of the leaf blades of affected branches.

(*e*) Bark excrescences, appearing on nearly or fully matured terminal twigs and sometimes on older branches. They emerge from long cracks as numerous slightly elevated, narrow, reddish-brown masses.

(*f*) Ammoniated fruit, a common symptom of dieback. The fruit is stained in spots or irregular patches, which have a glossy, brownish appearance. These markings may appear from a month after the fruit sets until it is nearly of full size. Cross cracking of the affected patches is frequent, and also the splitting and dropping of the fruit during the summer when increasing rapidly in size.

(*g*) A very dark color, unusual size, thickness, or coarseness of the leaves. These are frequent indications of the beginning of dieback, especially if S-shaped or distorted angular branches are beginning to form.

CAUSE. This disease is apparently due to malnutrition rather than to infection or contagion. If not checked and if involving large numbers of trees, the results may be serious. The disease appears to be closely associated with the amount of organic matter or with the form of it in the soil, with the use of too much ammonia, or with both. Liming in conjunction with large amounts of organic fertilizers rich in ammonia and leguminous cover crops, also rich in ammonia, may still further increase dieback.

TREATMENT. No treatment will result in quickly removing the symptoms of the disease in affected trees. The climatic conditions which affect the bacterial and fungus transformations of organic materials in the soil may, according to their character, effect a cure or may further increase the difficulty. Where dieback has presumably been due to excessive growth, a cutting down for two or three successive applications of the amount of fertilizer used or the employment of a brand containing less ammonia, especially in certain organic forms, is often an effective remedy. In such cases, the entire omission of ammonia, if even for a single fertilizer application, is a practice of doubtful value.

Where dieback occurs on dry, sandy soils, presumably from over fertilizing, the use of small amounts of stable manure has been found helpful, although on moist soils it may have the opposite effect.

In some cases, omission of plowing, more shallow cultivation, or even no cultivation, the removal of the cover crop or allowing it to decay on the surface, have been suggested as remedies. Long-continued, clean cultivation is a bad practice because it is too exhaustive of the humus. Dieback is sometimes caused by using a fertilizer not adapted to citrus trees, for the crops grown between them.

Where poor or insufficient drainage, even for only a part of the year, causes dieback, the only remedy is the correction of this condition by setting the trees on mounds. Excessive cultivation of many of the lower interior hammocks, flatwoods, or pinelands is conducive to dieback; and there, as well as on shell or coquina lands, mulching should be practised. On the shell soils, the cover crops should be left on the ground.

Where trees are likely to suffer at times from lack of water, shallow surface cultivation, mulching around the trees, or irrigation, are the chief remedies; and heavy fertilizing, especially with fertilizer rich in ammonia, should be avoided immediately after a long dry period.

CHEMICAL TREATMENT. Bluestone, or copper sulphate,

is applied in crystalline or powdered form around the trees in the same manner that fertilizer would be. The usual application is about three-fourths of a pound per tree for trees one or two years from the bud, up to two pounds per tree for those several years old. For very old, large trees, as much as three to five pounds is often employed.

Injury from bluestone applications sometimes follows, especially if an overdose is used or if it is not properly distributed. It should be scattered very evenly around the trees, beginning under the farther ends of the branches and extending outward four to five feet. In the case of very large, old trees, it should be spread evenly over the entire middles. It need not be worked into the soil, for the first rain will readily dissolve it and carry it downwards. It has not yet been learned what the action of the bluestone is in such cases, but it is known to have an oxidizing effect on certain iron compounds which are sometimes poisonous to plants. It may possibly be effective by virtue of some inhibitive action on certain soil bacteria or fungi which are intimately concerned with plant growth.

The insertion of bluestone crystals under the bark of trees affected with dieback often results in severe injury to the bark and is, therefore, a very questionable practice.

SPRAYING the foliage and fruit with a 3-3-50 Bordeaux-oil mixture is an effective preventive of or cure for dieback, and it should be applied usually in late winter, late spring, and late summer.

WITHERTIP OF TWIGS AND BRANCHES, ANTHRACNOSE, TEAR STAINING OF FRUIT, AND BLOOM BLIGHT

All of these affections, except probably tear staining, are doubtless manifestations of the withertip fungus.

HOW RECOGNIZED ON THE TREE. Withertip on citrus trees is recognized by a withering and final dying of twigs and branches and a discoloration of the latter. At the same time, the leaves turn yellow and are shed, and much of the fruit drops.

Ammoniated citrus fruit. Ammoniation appears to be associated with, or is a manifestation of, the early stages of dieback.

The tree appears stunted; and if the disease is not checked, a large part of the tree may later become affected.

HOW RECOGNIZED ON THE FRUIT. What is known as anthracnose of the fruit is usually recognized by brown or dark-colored patches, or spots, from an inch in diameter to one-fourth the size of the fruit. These spots usually give rise to decay. The anthracnose spreads rapidly on mature or nearly mature fruit, especially in moist weather. Another even more widespread indication of the work of the fungus is the occurrence on the fruit of red specks, which may later develop into large, shallow depressions. This stage may develop during the packing or shipping period, even though the individual fruits seem unaffected when picked.

TEAR STAINING is less serious than anthracnose and is recognized by reddish-brown markings on the surface of the fruit, extending from the stem to or toward the blossom end. It was formerly attributed to the same fungus as withertip, and was supposed to be caused by spore-laden water from diseased twigs dropping on the fruit and running down from the stem to the blossom end. More recent observations, however, seem to show that much or in some cases all of the tear staining is caused by rust mites, since it is prevented by spraying with lime-sulphur solution, diluted 1 to 40. Furthermore, copper sprays are without effect. It has also been attributed in some cases to *Diplodia*, another fungus disease of citrus fruits.

BLOOM BLIGHT, caused by the withertip fungus, results in the blighting or shedding of the bloom and especially of unopened buds, which often show small red markings. This is most common where true withertip of the twigs and branches occurs. If not checked, much fruit is likely to drop.

CAUSE. The cause of these various manifestations of disease, except most or possibly all cases of tear staining, is a fungus (*Colletotrichum gloeosporioides*, Penz), which is apparently capable of causing material injury only to weakened trees. The spores of the fungus are supposed to be very generally present in citrus groves.

HOW TRANSMITTED. The disease is transmitted by means of small spores, or "seeds", which appear as dark-colored pustules on the dead wood and as spots on leaves and fruit. In moist weather innumerable spores may be exuded from the pustules, as pink masses. These spores are so small as to be invisible without the use of a powerful microscope, and they may be distributed by wind, rain, birds, or insects. If the air is sufficiently moist, they germinate wherever they find a suitable lodging-place; as, for example, on a weak leaf or shoot.

TREATMENT. Since the spores are carried over in the dead wood, all such wood as well as sickly branches should be cut out and burned, cutting back a foot or more behind the affected area. Proper fertilization, not too late in the season, and careful spraying are the most effective preventive measures. Overbearing and injury by extreme cold are favorable to withertip development. The appearance of sickly yellow shoots shows about how far the fungus has progressed. Pruning from December to the middle of January is preferable to summer pruning because the trees are more nearly dormant. Spraying with 3-3-50 Bordeaux-oil mixture, immediately after the winter pruning, may be of some use.

If anthracnose appears suddenly and abundantly, spray at once with ammoniacal solution of copper carbonate, and repeat every week or ten days until the progress of the disease is stopped.

For bloom blight a 3-3-50 Bordeaux-oil mixture sprayed into the bloom is very effective, but may of itself cause some loss of bloom. One or two applications may be needed. The dropping of fruit due to other causes than withertip cannot be prevented in this way. Use only ½ per cent of oil.

FRENCHING

FRENCHING may appear alone or in conjunction with withertip or dieback. The cause is not definitely known, although it has been asserted that it occurs most frequently where the soil has a low humus content.

HOW RECOGNIZED. The recognizable point of attack is the leaves. They become yellow on either side of the midrib between the main veins, and are usually undersized. Some trees will recover without treatment, if the attack is light. Otherwise conditions must be studied to ascertain the probable cause.

CAUSES. Disturbed moisture conditions, malnutrition due to an excess or lack of essential plant foods, the presence of injurious soil ingredients, or too deep cultivation. There may be several additional causes.

TREATMENT. The cause of frenching must be diagnosed and remedied, if possible, in each instance, and a remedy applied which fits the case in hand. Experienced citrus experts can frequently detect the trouble at an early stage and suggest remedies with considerable success.

CITRUS SCAB

This disease, which in Florida is next in importance to melanose and stem-end rot, is widely distributed, and is the most serious of all fungus diseases in Florida citrus nurseries. It affects young leaves, young twigs, and young fruit. It is especially injurious to young grapefruit, the sour orange, and rough lemon. The satsuma, lime, and tangerine are also subject to attack, whereas sweet oranges are generally more or less resistant. Formerly, grapefruit was considered fairly immune to scab, but this is no longer the case; and the seriousness of the injury to fruit under three-fourths of an inch in diameter is often great, provided the moisture conditions are favorable to its development at this stage.

HOW RECOGNIZED. Scab is recognized on leaves, twigs, and fruit by the appearance on their surfaces of "irregular, elevated scabby masses and wart-like projections." Its first appearance is as "minute light-brown points" on unfolding leaves. Later these spots become elevated on one side of the leaf and depressed on the other. The spots may be small and scattered, or may often coalesce. They finally become light brown, pinkish, or dark brown. The leaves become crinkled,

Frenching, a form of chlorosis of citrus leaves sometimes occurring in Florida.

may fall, and the shoots die. The fruits lose their shape and become warty. Much shedding of fruit follows. More commonly on mature fruit, there are "irregular, scabby spots or caked masses, light brown to purplish in color, covering the greater portion of the surface." These do not extend to the interior of the fruit, but, like melanose, make it unsightly; and loss by culling follows.

CAUSE. Citrus scab is caused by a fungus commonly, but probably erroneously, referred to as *Cladosporium citri*, Massee, the spores of which are formed under favorable moisture conditions. These spores attack only young and tender shoots, and young fruit in the presence of a suitable amount of moisture. The chief period of infection of the leaves and twigs is up to three to four weeks after new growth begins; and in the case of the fruit, from the time the blossom drops until four to six weeks later. If the weather is dry during these periods, infection is not likely to take place, even though the disease spores are present in abundance. Cool, wet weather provides the best conditions for the development of scab, although serious infections sometimes occur in hot, rainy, summer months if the other conditions are favorable. The spores of the fungus live over from one growth period to another in the scab spots on the old leaves. Winston, contrary to earlier views, says that he finds no evidence that the fungus lives over winter on matured fruit. It is thought that parts of the fungus as well as spores may survive for several months on the surface of twigs or leaves and still retain enough vitality to cause reinfection.

TREATMENT. Since infection with scab spores takes place only within relatively short intervals of time, spraying with a 3-3-50 Bordeaux-oil mixture is an effective preventive of the disease. Burgundy mixture, which is more likely to cause injury to the trees, is less effective; and an ammoniacal solution of copper carbonate is still less so. Lime-sulphur sprays are much less effective against this disease than Bordeaux mixture, and other sulphur sprays have no advantage over lime-sulphur. Spray just before new growth begins, covering thoroughly all of the interior branches. Follow with a second spraying of like character and strength in the middle of the blossoming period,

and with a third after the fruit has set. When the smallest fruit has reached a diameter greater than three-fourths of an inch, spraying for scab is of no use. If in consequence of this spraying, the scale insects show much increase, a suitable contact insecticide must be used to hold them in check.

It is possible to practically eliminate scab by cutting off and burning all affected foliage and outer twigs which were produced the preceding year. This should be done in December and January, and the trunk and remaining branches should be sprayed with a 3-3-50 Bordeaux-oil mixture before new growth starts. Some authorities formerly recommended for this purpose a stronger Bordeaux mixture. Following such treatment, suitable fertilizer should be applied so as to avoid withertip, and all scale insects must be destroyed. It was formerly advised, when young trees were quite generally attacked by scab, to remove all of the leaves during the dormant period and spray the wood thoroughly with a strong Bordeaux mixture; but this treatment is now held by good authorities to be too drastic. When this course was followed, the new growth was sprayed at once and again two or three weeks later. In young grapefruit groves, where scab has attacked only occasional trees, cut out all infected foliage and twigs and follow with successive sprayings the same as for other citrus fruits, beginning a week to ten days before new growth starts, and repeat the application two or three times at two-week intervals. Remove and bury or destroy all culls in the grove and around packing-houses. If any sprouts from sour-orange or rough-lemon stock appear, these should be removed so that they will not serve as propagating media for the scab fungus.

The sprays which are most effective in controlling scab also prove destructive to the beneficial entomogenous fungi. Furthermore, these sprays are rather persistent and hence may have this destructive effect for some time after their application; so that even in the case of grapefruit, which should be sprayed for scab a considerable time before the entomogenous fungi become very active, there is still a possibility of destroying some of these fungi with the scab spray.

Directions given by J. R. Winston, February 15, 1922 (United States Department of Agriculture, Circular No. 215) for spraying for citrus scab where the disease is *always* serious, where it is *moderate to serious*, and where it is of *minor* importance.

SPRAY SCHEDULE No. 1.[1]

[For orchards where citrus scab is always serious.]

Application.	Date.	Materials used.	Object.
First application...	Just before growth sets in.	3-3-50 Bordeaux mixture plus 1 per cent oil.[2]	To cover old scab lesions. Direct spray especially toward under-surface of leaves. Reduces very early citrus-scab infections.
Second application	In height of bloom....	3-3-50 Bordeaux mixture plus ½ per cent oil.	For protection of expanding leaves and small fruit against citrus scab.
Third application..	Two weeks later.....	....do	For protection of small fruit against scab.
Fourth application.	Two weeks after third application.	3-3-50 Bordeaux mixture plus 1 per cent oil.	Advisable if season is rainy for protection against scab. Will also reduce early melanose infection.

[1]Insecticidal applications must follow, to prevent serious scale injury.
[2]Prepare 3-3-50 Bordeaux mixture in the usual way. Three quarts of oil emulsion, Government formula, in 50 gallons of Bordeaux mixture gives 1 per cent oil. *Add the oil emulsion to the Bordeaux mixture while the latter is being thoroughly agitated in the spray tank.* Keep up the agitation while spraying. For preparing Oil Emulsion see p. 77.

To insure bright, clean fruit at harvest time follow this schedule with the regular scale, white-fly, and rust-mite spray applications (see Farmers' Bulletin 933) and one or two additional applications to check the heavy increase of insect pests following copper sprays.

SPRAY SCHEDULE No. 2.

[For orchards where citrus scab varies from moderate to serious.]

Application.	Date.	Materials used.	Object.
First application...	Just before growth sets in.	3-3-50 Bordeaux mixture plus 1 per cent oil.	To cover old scab lesions; direct spray especially toward under-surface of leaves; reduces very early citrus-scab infections.
Second application	In height of bloom....	Lime-sulphur, 1 to 40, or 3-3-50 Bordeaux mixture plus ½ per cent oil.	If season is normal use lime-sulphur; if season is rainy use Bordeaux mixture, to protect expanding leaves and small fruit from citrus scab.
Third application..	Two weeks later.....	....do	If season is normal use lime-sulphur; if season is rainy use Bordeaux mixture, to protect small fruit from citrus scab.
Fourth application.	....do	3-3-50 Bordeaux mixture plus 1 per cent oil.	If season is rainy probably advisable for protection of smallest fruits against citrus scab; will also reduce early melanose infection.

A fine young grove where A. A. Quality Citrus Fertilizers are used.

To insure clean, bright fruit at harvest time follow this schedule by the regular scale, white-fly, and rust-mite spray application. When Bordeaux mixture is used additional applications of oil emulsion most likely will be necessary.

SPRAY SCHEDULE NO. 3.

[For orchards where citrus scab is of minor importance.]

Application.	Date.	Materials used.	Object.
First application...	Just before growth sets in.	Lime-sulphur, 1 to 30.	To cover old scab lesions, direct spray especially toward under-surface of leaves; prevents early scab infections.
Second application	In height of bloom....	Lime-sulphur, 1 to 40.	To prevent infections on expanding leaves and small fruit.
Third application..	Two weeks later.....	....do	To prevent infections on expanding leaves and small fruit. (Advisable only if season is especially favorable for scab development)

To insure clean, bright fruit at harvest time follow this schedule by the regular scale, white-fly, and rust-mite spray applications.

Nurseries can be kept commercially free from citrus scab by occasional applications of Bordeaux-oil emulsion. As a rule, monthly applications probably will afford adequate protection. In many instances a smaller number of applications will suffice; however, the frequency of application is dependent upon local and seasonal conditions. Care must be taken to keep new flushes protected during periods of wet weather.

The use of Bordeaux-oil emulsion has been followed by a considerable increase in the growth of grapefruit seedlings even when citrus scab did not occur in the planting. Where citrus scab has occurred in sour-orange and rough-lemon seedlings the increase of growth following applications of Bordeaux-oil emulsion has been greater than the probable retardation due to scab. These two observations seem to indicate that this spray mixture may act as a growth stimulus in citrus nurseries.

Preparation of boiled oil emulsion, Government formula.

[See U. S. Dept. of Agr. Farmers' Bulletin 933.]

Paraffin oil.....gallons.. 2
Water.....gallon.. 1
Fish-oil soap.....pounds.. 2

Put oil, water, and soap into a kettle or other vessel that will stand fire, and heat to the boiling point. While still very hot but after removal from the fire, pump the material into another vessel with a bucket pump and then pump back again.

CITRUS CANKER, *Pseudomonas citri,* Hasse

This has been called "the worst disease of citrus that has ever been introduced into Florida." It attacks any part of the tree that is above ground and any variety of citrus that is of commercial value, except the kumquat. Grapefruit is the most susceptible; then follow in order *Citrus trifoliata,* Key lime, navel orange, satsuma, tangerine, mandarin, King orange, and lemon. Great progress has been made in the eradication of the disease, and the work was announced in 1920 as practically com plete; but a recent limited outbreak in a rather isolated citrus section shows that eternal vigilance will have to be exercised to make sure of its permanent eradication.

HOW RECOGNIZED. Citrus canker is distinguished by small, light-brown spots, usually round, that occur on fruit or leaves. Sometimes they appear singly or, as in the case of fruit, run together, making an irregular outline. The spots are raised and consist of a quantity of spongy, dead cells. In an advanced state, they pierce the leaf tissue.

CAUSE. The disease is bacterial, and a compound micro- scope is required to see the small organisms that cause it.

HOW TRANSMITTED. The spots are infested with bacteria and, if wet with rain or dew, exude them in masses. Water, wind, or rain may spread the bacteria, which are capable of penetrating the unbroken surfaces of leaves, fruit, and tender twigs. A wound or crack may be necessary for infection in the more mature bark.

TREATMENT. The only effective treatment is to destroy promptly all trees that may be infected.

BLIGHT

Excepting, possibly, citrus canker, this, as has been said, is "the most dreaded of all citrus diseases." It is, however, con- sidered less serious at present than formerly.

HOW RECOGNIZED. Appearance as of injury by drought, especially after transplanting; first showing possibly in a single

limb, or even extending to the entire tree. The attack may occur at any stage of growth; the leaves wilt and drop; new shoots appear on the trunk and crown, the leaves of which become yellow or frenched, contracted, and finally die.

CAUSE. The cause of blight is not yet definitely known; it is most common in old trees. The disease is supposedly due to functional disturbances rather than to specific parasitic organisms. Enzymes and poisonous substances in the soil have been suggested as causes of blight, due to its frequent occurrence only in circumscribed areas.

TREATMENT. The only effective plan is to remove the tree with its roots and burn it. Pruning out diseased parts is of no avail.

PRECAUTION. Roots of affected trees left in the ground may perpetuate the disease. Blight seems to spread to surrounding trees, but how is not known. Underground waters have been thought to carry the infection, but proof of this is lacking.

MELANOSE

Melanose was first noticed in Florida after the freeze of 1895, and an increase of it is usually expected after severe frosts.

HOW RECOGNIZED. Melanose may occur on leaves, twigs, or fruit. It attacks tender, succulent growth but is most prominent on mature fruit and leaves, on which appear "small circular, hard, brown specks or spots with smooth glazed surfaces which are raised above the healthy tissue." The spots may "run together, forming irregular masses, circles, streaks or bands." The markings may be in streaks, somewhat resembling tear stain; or the whole fruit may be covered, giving a russeted effect. Fortunately, the attack injures only the appearance, but not the quality of the fruit. In severe cases, much young fruit drops, and twigs may shed their leaves and die.

CAUSE AND TRANSMISSION. Melanose is the result of an attack of a fungus (*Phomopsis citri*, Fawcett), which is propagated on dead citrus twigs and branches. The spores

Melanose as it often appears on citrus fruit.

which give rise to the disease are formed in moist weather, and are washed from the dead limbs upon the tender leaves and young fruit. The browning effect is caused by the destruction and elevation of some of the surface cells. Several generations of spores may be produced in a single season, if there is dead citrus wood in the grove. This fungus also causes stem-end rot, by contact of the spores with the stems of mature fruit which have been injured by scale insects or other agencies. If the fungus is well established, rapid decay of the fruit follows. Control of the scale insects is, therefore, of great importance. The fungus may also propagate and produce spores on fallen diseased fruit.

TREATMENT. Repeated, thorough pruning-out of all weakened branches, dead wood, and twigs is the first essential, and while it will not wholly prevent the occurrence of the disease, it will greatly reduce it. Control of the whitefly and scale insects, and adequate, judicious fertilizing are all important. Winter pruning, when the trees are most nearly dormant, is preferable, although pruning may be done in late June or July if vigorous growth is not taking place. Immediately following winter pruning, several authorities recommend spraying thoroughly with a Bordeaux-oil mixture; and O. F. Burger of the Florida Agricultural Experiment Station says that he has "shown beyond the shadow of a doubt, that the spraying of citrus trees with 3-3-50 Bordeaux plus one gallon of oil is sufficient to control melanose. This spraying should be done about ten days after the blossoms have dropped." When pruning, cut an inch or two back into the sound wood and cover all large, exposed cuts with an antiseptic. Burn or bury all trimmings, rubbish, and dropped fruit.

SCALY BARK, or NAIL-HEAD RUST

This disease is confined chiefly to sweet oranges even when oranges, grapefruit, and tangerines are equally exposed to it.

It has, nevertheless, been found on rough-lemon stock in neglected nurseries and even on the sour orange. It is present

in several parts of Florida, but chiefly on the Pinellas Peninsula, where much damage has been caused by it.

HOW RECOGNIZED. This disease appears on the bark and fruit and sometimes on the leaves. The early stages on the younger twigs and branches are characterized by the appearance of "oval-shaped spots, one-fourth to one-half an inch or more in diameter, raised above the surface with well marked edges and rusty color." At first, "the young spots appear as greenish yellow blotches on the surface of the green bark, somewhat watery or oily in appearance. As the spots grow older, the surfaces become glazed, brittle, and usually break into cracks." Later, "zonated" effects occur and the surface breaks "into small flakes". The spots may be separate or may merge into patches of bark of a scabby reddish-brown color, finally giving to the large limbs and trunks a shaggy appearance. In this latter stage, the spots are not distinct and their flakes and scales cover the surface. At this stage, the disease might be mistaken for gummosis. Twigs less than six months old are rarely affected and the spots occur most commonly on wood from nine to eighteen months old. The disease appears to the greatest extent from the first of June to December.

On the leaves, the spots occur but rarely and do little damage. "They appear as brown blotches, showing thru on both sides of the leaf. The edges are usually marked by a pale-yellow color and sometimes a white area is observed at the center".

On the rind of the fruit, the disease is commonly referred to as nail-head rust. Here it appears at first on the green fruit as yellowish to reddish spots, which finally become dark, sunken rings with a temporarily elevated center, which later drops to the level of the remainder of the spot. The fruit spots are "usually round and vary in breadth from one-fifth to one-half an inch." They occur from July to August and may continue until the fruit matures, becoming more noticeable as the coloring progresses.

CAUSE. The disease is caused by a fungus, *Cladosporium herbarum*, var. *citricolum*, Fawcett. The spores by which the

disease is propagated are produced in the diseased patches of bark and in the spots on the fruit. In the late stages of this disease, entrance is afforded to the withertip fungus, which further increases the injury.

TREATMENT OR CONTROL. Several preventive and curative procedures have been proposed.

(a) TOP-WORKING. Since the grapefruit, tangerine, and mandarin are highly resistant to scaly bark, they may be used for top-working in December and January in groves which are already badly affected, working first alternate rows. This may be done by sawing off and grafting the larger limbs, or the tree may be cut off at the ground and crown grafted. If the former course is pursued, the trunk and limbs should be sprayed with 3-3-50 Bordeaux-oil mixture, though earlier some authorities recommended 5-5-50 Bordeaux mixture. This spraying should be repeated four or five times during the year, once just before grafting. Otherwise, treat immediately with Avenarius carbolineum diluted with half as much water, in which soap has been dissolved at the rate of one pound to four gallons of water. One thorough application of this just before grafting may be sufficient.

(b) HEADING-BACK. If it is not desired to top-work to other varieties, head back during the dormant period, leaving only the trunks and stubs of the largest branches, and spray with one of the materials mentioned under (a).

(c) PRUNING. The disease, if not too serious, may be checked by pruning. In this case, cut out all dead or diseased wood and apply an antiseptic covering to all large cuts; also scrape any diseased trunks and apply Avenarius carbolineum.

(d) SPRAYING. Bordeaux-oil mixture temporarily reduces the amount of the disease on branches and will quite effectively protect the fruit from nail-head rust, if applied four times in the course of the season, at the same time serving as a contact insecticide. Spray first in December or January, being particularly careful to cover the center twigs and branches thoroughly. Spray again just before the tree blooms, again after the setting

Winter Haven warehouse of The American Agricultural Chemical Company.

of the fruit, and finally in late July or early August, using each time a 3-3-50 Bordeaux-oil mixture. It is advisable to employ ½ per cent oil emulsion in the spray, following the setting of the fruit; and for the later spraying it should be twice as strong, or 1 per cent. Even though the oil emulsion is used in the Bordeaux mixture for controlling this disease, one should not fail to watch most carefully for scale and spray for it at the proper time.

FOOT ROT (Gum Disease, Mal di Gomma)

OCCURRENCE. Foot rot of citrus trees was first recognized in the Azores, where it wrought havoc before 1845. The extent of foot rot is now world wide, and it exists in all parts of Florida where stock or trees are grown which are susceptible to it.

HOW RECOGNIZED. The disease occurs on the crown and main roots, at points extending from one to two feet above ground to an equal distance below. The appearance of a spot of decayed, apparently water-soaked bark, usually just below the level of the soil, is the first positive evidence of the disease. This is likely to be followed by a yellowing of the leaves, especially along the midribs, and is accompanied by the oozing out from the diseased area of small drops of gum, and also the occurrence of watery gum under the diseased bark.

The inner surface of the affected bark begins to decay and emit a disagreeable odor. As new tissue is formed around the diseased area, the old bark begins to dry up and fall away. One or many spots may be involved; and if not discovered until the crown has been girdled and all of the main roots are attacked, it is too late to apply any remedial measures. Affected trees may die within a year or may linger for several years, according to the rapidity with which the disease progresses. Sometimes the affected spots fail to enlarge during the season and the drying of the diseased bark produces a slight depression. If the progress of the disease is stayed for a time, healing may begin around the edges of the spots, whereupon

the dead bark may crack, leaving a fissure around the injured area. Unless properly treated, the disease may spread again from these patches whenever conditions become especially favorable to its progress.

CAUSE. For a long time, the disease has been supposed to be caused by a fungus or bacterium. Many investigators have considered the fungus *Fusisporium limonii* responsible for the disease; but H. E. Stevens concludes that in Florida, at least, the causative or chief causative organism is *Phytophthora terrestria*, Sherb., which also gives rise to the "buckeye" rot of tomatoes. Unfortunately, this fungus is widely distributed in Florida and it can multiply in the soil without association with either citrus or tomato plants, although it probably occurs on some wild host plants. It has been said to be especially abundant in moist and shaded locations, although according to Stevens this may be questioned. Some of the spores are of the "resting" type, which may remain alive but inactive for a long time, or until conditions become favorable to their growth.

AVOIDANCE. The best plan is to avoid foot rot in so far as possible by using the sour, or most resistant, stock, whenever the soil conditions are such that it is suitable.

Old sweet seedling groves and those on lemon stock are most susceptible to foot rot. Grapefruit stock, though somewhat resistant, is not equal in this respect to sour stock.

Drainage of wet soils is especially important, and all trees should be inspected carefully and frequently from early spring to late fall.

TREATMENT. Where disease is suspected on old trees, remove all top soil from the main roots out to three or four feet from the butt. In doing this, be careful not to injure the roots. If water pressure is available, a stream of water will be of great aid in both excavating and avoiding root injury. Cut out all diseased areas down to healthy wood, and burn everything which is removed. Paint the cut surfaces with a 1 to 1000 corrosive-sublimate (bichloride of mercury) solution, with half

to full strength Avenarius carbolineum;* or with crude carbolic acid, to which one-half as much water, containing some dissolved soap, has been added. Such applications, made directly upon diseased areas without removing them, will not accomplish the purpose. It is well, likewise, to paint the trunk and all of the exposed roots with a mixture of equal parts of air-slaked lime and powdered sulphur, to which enough water has been added so that it can be readily spread. A concentrated lime-sulphur solution may be used for the same purpose. This may aid for some time in preventing future attacks. The use of Bordeaux paste on freshly-cut citrus bark is often followed by an exudation of gum, and therefore is not recommended for treating trees for foot rot.

In California, cyanide of mercury is used, employing 1 part to 750 parts of a mixture consisting of half water and half denatured alcohol; but whether it will work equally well in the moist climate of Florida remains to be ascertained. Great care should be used in handling either this material or corrosive sublimate on account of their highly poisonous action when taken internally by human beings or animals.

After treatment, leave the crown and roots exposed for several weeks provided severe cold weather is not expected. In the interval, the soil should be stirred and exposed to the sun during dry, hot periods, for the purpose of destroying as many fungus spores as possible before it is replaced over the roots. Watch all trees most carefully for some time after the treatment, so that any fresh outbreak may be detected as soon as possible.

SOOTY MOLD

SOOTY MOLD is widely distributed in the different citrus sections of Florida.

*Stevens has observed no injurious effects following the use of this particular kind of carbolineum; but he mentions injuries resulting from material sold under the general name of "Carbolineum." He emphasizes especially the importance of the use of soap in preparing the mixture.

Early, or curable, stage of gummosis on an old grapefruit tree.

HOW RECOGNIZED. The mold forms a sooty, black covering on leaves, fruits, and twigs of citrus as well as on other trees, shrubs, and herbaceous plants, when attacked by scales and related insects which exude much honeydew. Its greatest damage to citrus fruits is usually following attacks of the common citrus whitefly, *Dialeurodes citri*, and several other related species The fly lives chiefly on the under side of the leaves, and the honeydew to which it gives rise falls on the upper side of the lower leaves as well as upon twigs and stems, where it serves as a culture medium for the fungus. As the fungus grows, it produces a black, sooty covering, which when seen in the distance much resembles stove polish. This black screen keeps light from the leaves, and the tree remains in an unhealthy condition which greatly lessens the yield of fruit. The mold is sometimes removed by polishing with cross-cut sawdust, by washing, or simply brushing; but on rough-skinned oranges, it is difficult to remove all of it. Such rather severe cleansing is not good for the fruit, and the combined cost of harvesting and marketing is necessarily greater than in the case of fruit which is clean.

CAUSE. The cause of sooty mold is the fungus *Meliola camelliae* (Catt.) Sacc., which grows in honeydew.

TREATMENT. The only practical treatment is to control the whitefly or other insects responsible for the formation of the honeydew. According to Stevens, a thorough spraying with the oil sprays or soap solutions for the destruction of the whitefly readily loosens this fungus covering, and it is removed by wind or rain.

GUMMOSIS

This is a disease of the bark, which usually appears as spots on the trunks and larger branches of bearing trees. All forms of citrus may be attacked, but chiefly grapefruit and sweet oranges. Some practical growers believe it to be contagious. This disease may repeatedly appear and disappear.

HOW RECOGNIZED. The bark looks scaly and there is a flow of gum. The dead tissue hardens, is pushed up, breaks;

and a brownish, resinous, roughened scar is visible. Spots are small at first, but may enlarge until finally the limb or trunk is girdled.

TREATMENT OF GUMMOSIS. From all affected trees remove the diseased bark and cut away all diseased or dead wood. Apply to wounds an antiseptic, such as Avenarius carbolineum, pine tar, or white-lead paint, to prevent reinfection. When there is much of the disease, wash the trunks of all the trees with an antiseptic once or twice a year, and repeat until the disease disappears. The wash may consist of air-slaked lime and powdered sulphur in equal parts mixed with water. Apply with a brush from the ground up to a height of two to three feet. Instead of this paste, a commercial lime-sulphur or home-mixed, concentrated lime-sulphur may be employed, testing 32° Baumé. This should be used 1 part to 10 to 15 parts of water. Stevens reports that Bordeaux paste, if applied to the cut surfaces of citrus bark, tends to promote gumming, and therefore he does not recommend it.

PSOROSIS. Another less common but more severe type of gummosis is known as psorosis, occurring on trunks, large limbs, and even on twigs, forming zones or bands ranging from only a few inches to three feet wide. Stevens states from his observations that "when psorosis once appears, it is permanent."

HOW RECOGNIZED. Affected surfaces show small, thin scales and moderate gum flow, often in individual drops. Later the new bark has a thick, rough, brown, swollen appearance. The cause of psorosis and gummosis has not yet been determined, though in many ways it is similar to a parasitic disease. Fungi are present later in affected areas and add to the injury.

TREATMENT OF PSOROSIS. No remedy has yet been found. If a tree is badly affected, it should preferably be removed; but if not, the affected parts should be treated occasionally with an antiseptic.

BLUE MOLD

This is the most widespread of the citrus-fruit rots. It may

begin wherever the fruit has received the slightest injury. The skin softens and a white mold appears, which is followed by a "blue-green or olive-green powdery layer of spores, giving off a smoky dust when disturbed." The decay is due to two fungi, which may or may not act together. These are *Penicillium italicum* (Blue-Green mold) and *Penicillium digitatum* (Olive-Green mold).

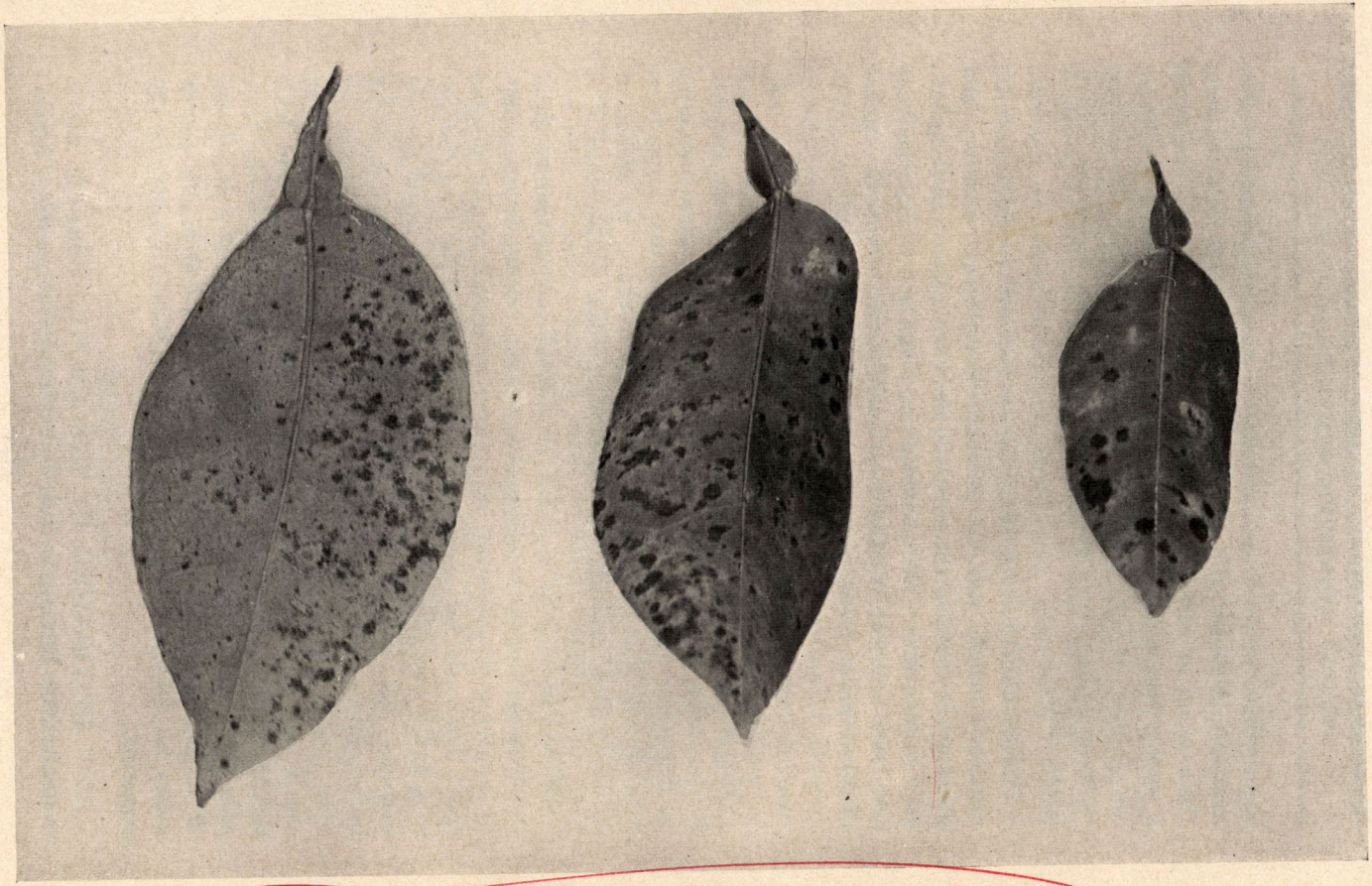
PREVENTION. The best preventive is the exercise of the greatest possible care in picking, transporting, washing, and packing the fruit, so that bruises, and even finger-nail scratches, may be avoided. The packing-house and grove must be kept free from decaying fruit so as to avoid to the utmost the spread of these spores, from which the mold propagates.

STEM-END ROT

This disease causes citrus fruits to drop prematurely and rot. It also causes mature fruit to soften and rot during or soon after its shipment. The loss of fruit from this disease may range from 2 to 40 per cent or more within three weeks of its arrival at its destination, especially if not kept at a low temperature.

HOW RECOGNIZED ON THE FRUIT. A circular patch at the stem end begins to soften, but usually can be detected only by applying the pressure of a finger or thumb to the affected spot. Later, the soft area increases in size and the rind changes to a dull-brown, drab, or coffee color; and the decayed portion becomes soft and often sticky, sometimes exuding a sticky brown juice. The peel is less brittle than when attacked by blue mold. The fungus progresses most rapidly along the center and along the inner white part of the rind and least rapidly in the juice sacks. It can be distinguished in the later stages from the blue-mold decay by the absence of a blue-green or olive-green spore formation; and unlike *Diplodia* rot, it shows no dark bands corresponding with the divisions of the segments.

HOW RECOGNIZED IN THE GROVE. Stem-end rot is recognized on immature fruit by a dark-brown, reddish-brown,



Black, or greasy-leaf, melanose on citrus leaves.

or nearly black color about the stem end; and is often noticed on fruit still clinging to the tree, although sweet oranges and grapefruit frequently drop before this stage is reached. This rot may be expected to begin in August or early September. Sometimes affected oranges show a wrinkling of the skin at the stem end, accompanied by a depression of the stem.

CAUSE. The cause of stem-end rot is the fungus *Phomopsis citri*, Fawcett, which also causes the disease known as melanose. Another rot which appears identical with stem-end rot in the early stages is that caused by *Diplodia natalensis*, but later the difference is easily distinguishable.

HOW TRANSMITTED. The disease may be transmitted through the stem, and also directly to bruised or injured fruit by the entrance of some of the disease spores. Scale insects on the stems are frequently responsible for causing infection.

PREVENTIVE TREATMENT. The most important preventive measure is the removal of all dead twigs and wood from the trees, since the fungus lives on these; and if this material is not removed, the spores will be present in great numbers during the entire season. Dropped fruit should be removed and fed or destroyed, since the fungus propagates on decaying or mummified fruit.

The drawback to the use of fungicides for combating stem-end rot is that after their employment, there is usually a severe infestation of scale insects. The use of fungicides in the wash waters has not proved effective in preventing the rot.

The pruning should preferably be done during the dormant season, December and January. If not done then, it should be done in summer after the first flush of growth has hardened or, usually, late in June or in July. Take care to make smooth cuts and be sure to paint them with Avenarius carbolineum, diluted by adding to it one-half its volume of water. Pine tar may also be used instead of Avenarius carbolineum.

DIPLODIA ROT, *Diplodia natalensis*

This rot in its early stages resembles stem-end rot; but as

decay progresses, the discoloration, at the stem end, becomes darker, showing dark bands along the divisions between the segments. Later, the fruit becomes black and light in weight. The rot often passes through to the blossom end, where it shows a discoloration even before all of the peel is affected. Punctures, worm holes, and other injuries afford entrance to the germs. Usually, a small quantity of thin gum or much sticky amber-colored juice exudes.

TREATMENT. The treatment is the same as for stem-end rot and for black rot, described below.

BLACK ROT, *Alternaria citri*

This rot starts at the blossom end, especially of defective fruit. It works its way upward in the center where the segments meet. The fruit ripens prematurely with a deep color. The decay, dark in color, is confined more nearly to the interior than in some of the other rots, and softening is less rapid.

LEAF SPOTS

Certain forms of leaf spotting may be caused by either insect or fungus attacks. In most cases, they are not of a serious character. The following have been described:

(1) A small, round, hard, brown, glazed spot on the upper surface of citrus leaves, sometimes penetrating the tissue, possibly caused by the pumpkin bug.

(2) A larger, less common spot, brown, slightly thickened, glazed, and showing on both sides of the leaf, three-eighths to an inch or more in diameter, bordered by a brownish band, and having a round sunken pit in the center. The cause, according to Stevens, is unknown.

(3) Dark-brown to black, round to oval spots, showing on both sides of the leaf, often dark, fuzzy, and indistinct when older. These accompany frenching. They are supposed to be due to a fungus.

(4) Round, hard, compact light-brown spots of unknown origin, somewhat resembling citrus canker, except for the absence of a spongy interior. They appear on the upper side of the leaves, are slightly sunken, brown, and have a thin, white, membranous covering.

(5) Large, circular, yellowish spots containing dark dots carrying the spores of the causative fungus. They attack the lime and lemon, and can be controlled by spraying with Bordeaux mixture or with an ammoniacal solution of copper carbonate.

CITRUS KNOT

Citrus knot, caused by a fungus, *Sphaeropsis tumefaciens*, Hedges, has its beginning in a slight swelling of a branch, at first rather smooth and light colored. It later darkens and cracks, and still later, after losing the bark, appears black, rough, and badly furrowed. Frequently, large knots may develop, showing only the first stages. Often, many shoots are thrown out at the knots, and soon die. Knots may completely girdle and kill a limb. The disease-producing spores are formed in the knots and are often present in any nearly dead wood.

TREATMENT. Remove and burn infected trees. If cut off even down to the ground, any new shoots may also develop knots. Do not replant in the same spot for several months. The disease has sometimes been controlled by severe and repeated pruning. In Florida, where it is now seldom found, no chance should be taken of its becoming established. It is possible that certain galls and knots may occur, due to other causes, but the grove owner should take no chances.

FLYSPECK, OR SOOTY FUNGUS

This is a disease not caused by or arising from insects or insect association, and hence should not be mistaken for sooty mold.

HOW RECOGNIZED. This disease is recognized by a superficial sooty covering of the rind of citrus fruits present over

A young grove in the "Ridge" district where A. A. Quality Citrus Fertilizers are used.

considerable areas or occurring in irregular patches. These sooty patches give a blotched appearance to the fruit. On these sooty areas, small black specks appear, often more or less grouped; or the sooty effect may have entirely disappeared, leaving only the black dots.

CAUSE. This disease is caused by the fungus *Leptothyrium pomi* (Mont. et Fr.) Sacc., the threads of which give rise to the spots and dots. As thus far observed, it does not propagate by spores, but possibly directly from threads of the fungus which become detached. The only effect of this fungus is to render the fruit unsightly and hence to lower its selling value.

TREATMENT. Washing the fruit removes most of the traces of the disease. While formerly it was recommended to spray with a strong Bordeaux mixture for the removal of the sooty fungus, this is no longer necessary where oil sprays are used for destroying the whitefly, purple scale, and other insects, since this spray loosens the sooty mold.

BLACK MELANOSE (Greasy Leaf, or Greasy Spot, Stevens)

These are various names used in referring to a certain type of spots occurring very commonly on citrus leaves in Florida, Cuba, and the Isle of Pines. Heretofore, it has not been considered serious, but it seems to be increasing. Only the leaf appears to be affected and then only when well matured.

HOW RECOGNIZED. The spots may occur on either side of the leaf, and while most common on grapefruit, other citrus varieties are not immune. The spots are dark, elevated, and have a somewhat circular or blotched appearance. When a spot is prominent above the leaf, it is less so below, where it is lighter colored and resembles a greasy stain. The spots range from one-eighth to one-quarter of an inch in diameter and may be few and scattering, or closely grouped. They often coalesce into black, irregular, strikingly greasy masses.

CAUSE. No definite fungus or bacterium has yet been found to cause this disease. It is, therefore, *in no way related to the*

real melanose, and appears to be neither infectious nor contagious.

REMEDIES. Because of the relatively small amount of damage caused by the disease, no remedies have as yet been proposed.

LICHENS

Various lichens occur on citrus trees, especially if growing in moist, shaded locations. They are to a certain extent injurious to the tree, as they hinder "a free interchange of gases through the bark" and furnish shelter for insects and their eggs and for fungi. They are more plentiful on trees that are in poor condition.

One of the most common lichens on citrus-tree trunks and branches has a grayish-green, papery appearance and is an inch or more across. The lobed edges tend to curve upward. A second kind appears as a round pinkish spot attached to the bark; another, as a cluster of white ridges; and still others, as black spots on a whitish background. Lichens are much fewer on the leaves.

LICHEN DESTROYERS. The psocids, large-headed insects, which promptly march off in single file when disturbed, are beneficial, since they feed on lichens growing on the bark. Two species are common on citrus trees in Florida.

Another lichen remover is the Cistelid beetle, which sometimes collects in groups of hundreds, feeding in the early morning and late afternoon.

TREATMENT. Practically all fungicides, including Bordeaux mixture, will destroy lichens. Commercial lime-sulphur diluted to 1 to 15 may be applied with a brush, so as not to get any of it on the foliage. If no other growths, diseases, or insect pests can be controlled by the treatment at the same time, the cost of it may not be justified.

ALGAE

Algae belong to a low order of plants closely related to fungi, which injure only a few of the higher plants. Those most commonly known are not parasitic, and produce the green scum seen especially on fresh waters which are stagnant. Citrus leaves and bark are both attacked. Usually little damage is done, yet in some cases the injury is serious on old grapefruit trees.

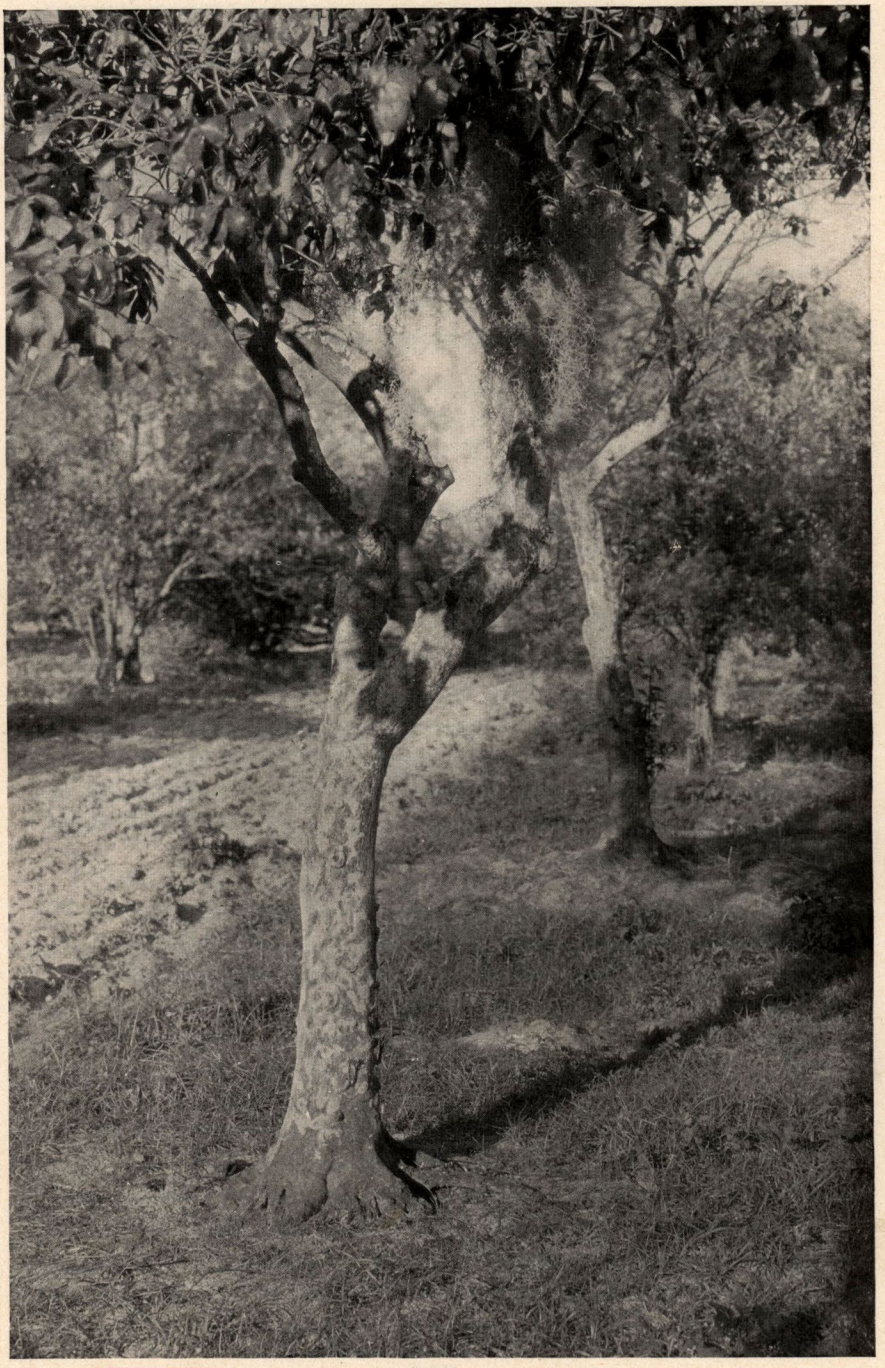
HOW RECOGNIZED. Algae cause irregular, slightly raised patches an inch or more in diameter to appear on the bark, especially in warm, damp locations. A short, reddish-brown, hair-like growth appears on the attacked surfaces. Later, this color is replaced by a greenish-gray, velvety appearance. If a twig becomes girdled, it will appear at that point as if the bark were swollen or the twig enlarged. The algae do not penetrate deeply into the bark.

On the leaves, small, round, raised spots appear, from one-eighth to one-fourth of an inch in diameter, which may be formed on either side of the leaves. The usual brownish, raised spots do not, however, break through the tissue of the leaf. At an early stage, the spots may show short, stubby, reddish-brown, hair-like fruiting bodies; but soon these disappear, giving place to a greenish, followed by a brown, appearance.

TREATMENT. Cut out and burn all affected growth as soon as noticed, and spray at once with 3-3-50 Bordeaux-oil mixture. This work should preferably be done when the trees are dormant and, if necessary, the spraying may be repeated.

SUNSCALD, OR SUNBURN

Sunscald is supposed to be due to the intense heat caused by drops of water focusing the sun's rays upon single spots. The spots appear on both the upper and lower surface of the leaves, but more commonly on the latter. They are yellow to reddish brown, are hard, glossy, and sometimes raised. The affected fruit becomes pitted and then is easily attacked by fungi. No means of its avoidance is known.



Lichens on trunk and Spanish moss on branches of neglected grapefruit tree.

SPLITTING AND CREASING

SPLITTING is a term applied to fruit when the skin and rind, because of not expanding naturally, give way under growing pressure from within, leaving the pulp exposed. It has been noted that splits are most numerous in the fall when a drought is followed by heavy rains. Irrigation and subsequent cultivation are the usual preventive measures recommended.

CREASING. This is only the preparation for a break, as the skin remains intact. It may or may not occur on trees where splits are found. It is reported that creasing has been known to disappear after a generous application of fertilizer rich in potash.

CHEMICAL INJURIES

Chemical injury to citrus trees may result from the use of too much copper sulphate in the Bordeaux mixture used in spraying for dieback or other diseases. In fact, injury may result even from oil sprays if too strong or improperly mixed. When chemical injury occurs, spots appear near the blossom end of the fruit similar to those of anthracnose; and these upon infection may cause decay. All sprays should therefore be most carefully mixed, and should not be applied when the sun is high or the temperature much above 90° Fahrenheit.

MECHANICAL INJURIES

These are due to wounds; and if received when the fruit is immature, they show later on the surface. Often wounds enable mold fungi to enter and cause rotting. As the fruit increases in size, a scar grows which seriously affects its commercial value. On this account gloves should be used in picking and handling the fruit. In fact it has been said that "the fruit must be handled with as much care as a high explosive."

LIGHTNING INJURY

A single lightning stroke may cause serious injury to only

one or two citrus trees, or may more or less affect a few branches on several trees. Those unfamiliar with such injury often attribute it to some disease. The bark at the base of the stem may be reduced to a pulpy covering, which either sloughs off or can easily be removed with the fingers; and often only one branch in the tree is seen to be burnt and defoliated, having acted as the conductor. Trees that are badly injured should be replaced, whereas the injured branches in others should be cut out.

INJURY BY COLD

Spring or fall frosts may injure the citrus foliage without doing any serious damage to the trees; but when the trees are growing rapidly, severe frosts or freezes may kill even hardened growth and split the bark of branches or trunks. Even when trees are nearly dormant, especially if they lack vigor because of disease or malnutrition, some injury may be caused by freezing temperatures. Dead patches of bark, due to extreme cold, may sometimes be mistaken for gummosis, especially if some gum has begun to exude.

TREATMENT. First apply an antiseptic on all split places and bind them up to prevent extreme drying; then bank the trees, remove any dead bark, and apply an antiseptic to all exposed surfaces. Any dead twigs or branches found later should be taken out and an antiseptic or suitable covering should be applied to the cut surfaces. Provide fertilization and cultivation calculated to develop normal growth.

In the case of young trees frozen to the tops of the earth mounds, cut off and remove the dead tops at once, so that they cannot become breeding-places for melanose or other fungi, and be careful to cut down into the live wood.

CASSYTHA

This is a vine-like growth on citrus trees sometimes mistaken for dodder. It is especially abundant on the lower East Coast of Florida, south of Melbourne.

HOW RECOGNIZED. This plant is a perennial, having green tendril-like branches. It bears no leaves and the flowers are so inconspicuous as to be hardly noticeable. It is often found climbing over underbrush in the woods. It grows more vigorously than dodder and has a looser, or more open, appearance. The seed germinates in the ground; but after the plant attaches itself to a tree, the ground connection may cease and is no longer necessary to its existence. This plant is not considered a serious enemy to citrus fruits.

TREATMENT. Remove as much of the vine as possible, just as in the case of any ordinary vine.

DODDER, *Cuscuta* sp.

Dodder, which has many host plants in Florida, is sometimes found on grapefruit trees.

HOW RECOGNIZED. This parasite is recognized as a small, yellow vine, twining tightly around the twigs. It penetrates the bark, and draws its nourishment from the sap of the tree. Practically all of the tree may soon be covered with its yellow, thread-like tendrils, which bear an abundance of yellowish, bud-like clusters of flowers. The attack causes a weak, stunted growth, and frequently the death of the tree.

TREATMENT. The dodder and all affected twigs and branches, as well as any dodder growing near the grove, should be removed and burned as promptly as possible. If it reappears, repeat the treatment. Burning over infected areas of land is likely to kill any dodder seeds lying on or near the surface of the ground.

SEPTOBASIDIUM

This is an occasional but not serious disease of citrus fruits, caused by the fungus *Septobasidium pedicillatum*, Schev. Pat. It is frequently found on the pear and plum. On citrus trees it appears as a soft, light-brown, leathery covering along the petiole and base of the leaf, and completely encircling the

A young orange tree showing the effect of severe cold.

twig; or it may appear as a raised band an inch or two wide. It is a strictly surface growth, appearing smooth, compact, or membranous above, with a soft, spongy mass below.

TREATMENT. This disease can be controlled by cutting out all affected growth. So little damage is caused by it that this is usually all that is required.

INSECTS INJURIOUS TO CITRUS FRUITS

These insects are usually divided into two classes, the biting and the sucking. The former eat the part attacked and are large enough to be easily seen. They may be controlled by poisonous substances applied to the surface upon which they feed. Such insects are the grasshopper, katydid, and orange dog.

The sucking insects extract the juices of the plant and in many cases can be distinguished only by the use of a magnifying glass. They must either be suffocated by a poisonous gas or fine powder; or be sprayed with some substance that will penetrate their bodies, or cover them so completely as to shut out the air. This group may be still further divided into scale insects, which may be armored or unarmored; and other insects, like the whitefly and citrus mites.

GRASSHOPPERS AND KATYDIDS

HOW RECOGNIZED. There are three species of grasshoppers that may attack citrus trees:

(a) The Bird Grasshopper, *Schistocerca americana*, Drury, strong-winged, light brown in color, with stripes and dots of black.

(b) The Yellow-Lined, *Schistocerca alutacea*, Harris, dark brown, with a yellow stripe down the center of the back.

(c) The Lubberly Locust, *Dictyophorus reticulatus*, Thunb., short-winged and no flier, yellow, with markings of black and red on the wings.

INJURY. Grasshoppers feed on the newer leaves and growth, especially of the outer trees of a grove, sometimes spreading into the interior of it as they increase in numbers, but fortunately seldom cause serious injury. Young stock is more likely to need protection than older trees. If they bite the fruit, it is permanently injured and loses in market value; for each injured area increases in size with the growth of the fruit and acquires a rough, scurfy, or sunken appearance.

HOW CONTROLLED. The Criddle mixture is usually recommended. The ingredients are Paris green, 1 part; salt, 2 parts; horse manure, 40 parts; with water sufficient to soften the mixture. This should be well sprinkled through the grove.

An arsenical spray is also effective; likewise the so-called "Kansas Bait," which consists of bran, 20 lbs.; Paris green, 1 lb.; water, 2½ gals.; lemons, 3 or 4; syrup, 2 qts. The Paris green and bran must be carefully mixed. The lemons reduced to a pulp should be added to the water. The bran should then be sufficiently moistened with the water to bring it into a flaky condition, after which the syrup is thoroughly kneaded into the bran. This mixture is scattered on the ground in the early morning.

THE KATYDIDS are about as injurious as grasshoppers, but are fewer in numbers. They are bright green and sometimes difficult to detect, as the veining of their wings resembles that of the leaves. The common species are the broad-winged, *Crytophyllus concavus,* and the angular-winged, *Microcentrum retinerve.* The former deposits a row of overlapping eggs on the border of the leaf; while the latter deposits its eggs upright in two or three rows on a dead twig.

The same methods of control should be used for katydids as for grasshoppers.

ORANGE DOG, *Papilio cresphontes,* Cramer

HOW RECOGNIZED. This is an ugly-looking caterpillar in its first stage, about 2½ inches long, which in full view eats the

leaves of citrus trees, especially if young. It is brownish black with patches of "dirty-white" or light yellow on the rear, sixth and seventh segments, and sides of the head. It has bright red feelers; and if disturbed, emits a liquid having a most disagreeable odor. The caterpillar is a voracious feeder and two or three in a few days may strip a young tree of its leaves. It eats and rests alternately. After about a month it enters the chrysalis state, resembling a suspended twig, in which it stays from 12 to 17 days in warm weather, or in cold weather all winter, and from which it emerges as a beautiful black and yellow butterfly about 6 inches across. Each female may lay from 400 to 500 eggs, which are deposited on the tender growth, and there are usually four broods each season, the last of which appearing during the interval from August to October, does the most damage.

HOW CONTROLLED. The grove treatment suggested is "hand-picking" of the eggs and caterpillars. In the nursery, however, one should spray the foliage, when the caterpillars appear, with Paris green, at the rate of 4 oz. to 50 gals. of water, or with arsenate of lead 1 lb. to 50 gals. of water. If used on young foliage, Watson suggests "slaking 2 or 3 lbs. of quicklime in a little warm water," and after straining it, adding it to the solution to prevent burning the foliage.

KINDS AND CHARACTERISTICS OF SCALE INSECTS, *Coccidae*

There are said to be eighty-seven different scale insects in Florida. In destructiveness they rank next to the common whitefly. The name was given them because they cling so closely to the surface of the host plant. They exude honeydew, like the whiteflies, but most of them not so abundantly. Scale insects injure trees chiefly by extracting such large amounts of juice, or sap, that the vitality of the trees becomes weakened. These insects are usually classified in three groups: armored scales; unarmored, or soft, scales; and mealy bugs.

The armored scales have two hard plates, secreted by the

Katydids, leaves injured by them, and a leaf partly fringed with their eggs.

larva, and between them is the insect. After its beak has been inserted in the plant tissues, the insect cannot withdraw it. The insects of the second group are the soft scales. In this case there is no separate scale formation, but the surface of the body hardens and has a waxy covering. In the third, or mealy-bug, group, the insect has a waxy coating which gives it a mealy appearance. These retain their legs and can move about freely during their existence. They are very injurious; and if not checked by parasites or spraying, quickly kill citrus trees. Fortunately these bugs have numerous natural enemies. They secrete much honeydew, in which sooty mold flourishes, covering the bugs and all near-by foliage. Because of their great destructiveness the individual members of the first and last group will be discussed later in detail.

PURPLE SCALE (ARMORED), *Lepidosophes beckii*, Newm.

This is the most injurious of the scale insects. The name is due to the color of the male, which is reddish or purplish brown.

HOW RECOGNIZED. In shape it somewhat resembles an oyster shell and it is sometimes popularly called "Oyster-Shell Bark Louse." There are several broods a year, and any stage of development may usually be seen at any time on an infested tree. The female is sometimes 0.12 of an inch long, twice the size of the male. Purple scale is likely to be found with the whitefly, since the young scales, or crawlers, liking darkness, seek the shelter of the sooty-mold fungus, which grows in the honeydew from the whitefly.

INJURY. The purple scale attacks leaves, twigs, and fruit. The leaf grows yellow in spots, which may turn brown or even develop into holes. These leaf spots may also become infested with fungi, and often the leaves eventually fall. Damage to the twigs is not so readily noted. On the fruit, however, the work of the scale, if abundant, is evident. Infested fruit is undeveloped, ripens slowly, and the coloring is not uniform. It must be cleaned before packing. Where scales pierce the rind, fungi may enter and cause decay.

HOW CONTROLLED. The purple scale has fortunately several natural enemies. These consist of fungi, predaceous insects, and even internal parasites. Some of these are the red-headed and gray-headed scale fungi and the black fungus; the twice-stabbed and blood-red lady beetles, the downy-darkling beetle; lace-winged flies; the trash bug; predaceous mites; and internal parasites, such as the larvae of the ichneumon fly and the chalcids.

Spray with the miscible oil emulsions used for the whitefly, ordinarily, shortly after the greatest number of crawlers is seen. This is likely to be about the middle of April and of July, late October, and the middle of February, the exact time depending greatly upon the temperature during the preceding weeks. It is important to delay the first spring spraying until even later than the middle of April, provided the fruit is not at least an inch in diameter; for otherwise it may be injured. Sometimes the spraying done for the whitefly may be all that is required, but often more spraying is needed.

When spraying with the whitefly fungi, as many as possible of the scale-destroying fungi—including the red-headed, white-headed, pink, and black—should also be introduced.

LONG SCALE (ARMORED), *Lepidosophes gloverii*, Pack.

This scale in length and color closely resembles the purple scale, though it is less curved and is narrower. The young are waxy-white and become reddish or purple with age. It has been known in Florida since 1835. By 1860 it was so prevalent that it seemed about to destroy the citrus industry. Later it came under better control, as hostile insects and fungi were introduced or became accustomed to prey on it. It attacks the leaves and fruit rather less than does the purple scale, but in most other respects it is similar to it.

FLORIDA-RED, NAIL-HEAD (ROUND) SCALE (ARMORED), *Chrysomphalus aonidum*, L.

This scale is nearly round or top-shaped, dark reddish-brown

approaching black, and is marked by a light-brown to a reddish-yellow center. It is thicker and heavier than the purple scale. The mature female, beneath the scale, is bright yellow, as are the eggs and young crawlers. Leaves, branches, and fruit may be infested with the scale, though it is less abundant and therefore less injurious than the purple and long scales.

Fortunately for the citrus grower, it is fairly well controlled by its various insect enemies and by two fungi, the red-headed and the pink, of which the latter is the more efficient.

HOW CONTROLLED. The treatment is the same as for the other scales, although sometimes a second spraying may be necessary since the adult females and eggs are unusually resistant.

CHAFF SCALE (ARMORED), *Parlatoria pergandii*, Comst.

This is a "thin, gray or brownish-gray scale. It often completely covers the branches of a tree and one may overlap another, giving the tree the appearance of being covered with chaff." It establishes itself on the smaller branches and trunks; but when very abundant, it is found on the leaves, on the larger branches and trunks, and especially on the fruit. This scale also attacks camphor, palms, japonica, mango, and oleander. It is a little smaller than the Florida red scale. The young female is white; the adult under the scale is dark purple, tinged on the posterior margin with yellow. The adult male is also purplish.

HOW CONTROLLED. In addition to the lady beetle and other usual enemies of scale insects, the chaff scale has a special foe in a parasite that resembles a wasp. The red-headed and black scale fungi also help to control it, the latter being especially efficient. Oil emulsions may be used or whale-oil soap when the crawlers are most abundant, as in March or April and in late September or October, but the generations are likely to overlap one another. The branches as well as the leaves and fruit should be sprayed with the insecticide.

Purple scale on citrus fruit and leaves.

ORANGE SNOW SCALE (ARMORED), *Chionaspis citri,* Comst.

This is rarely seen in Florida, though it is common in Louisiana, Bermuda, and Cuba. The white males are very noticeable, when found in clusters on twigs or leaves. Their three longitudinal ridges distinguish them from the chaff scale. The females are dark brown and in shape somewhat resemble the purple scale; but are broader, and are distinguishable from the latter by having a longitudinal ridge, as well as by their color.

HOW CONTROLLED. Use the same remedies as for chaff scale.

CAMPHOR SCALE (ARMORED), *Pseudaonidia duplex,* Ckll.

This new citrus pest, which was introduced into the United States from Japan and has been in Louisiana for several years, has now reached Grand Bay, Alabama, where it is causing great injury to the satsuma and other citrus varieties. It also lives on camphor trees. There should be the fullest coöperation with our State Plant Board, in order to keep this highly destructive scale out of Florida.

CALIFORNIA RED SCALE (ARMORED), *Chrysomphalus aurantii,* Mask.

This scale does much damage in California. It has been observed in a few localities in Florida for a long time, but is not considered especially injurious because it is so well controlled by the red-headed scale fungus and its other enemies. This scale is round, but flatter and lighter in color than the Florida red scale. It is most easily identified by means of the adult female, which shows red through the scale and is heart-shaped.

CALIFORNIA YELLOW SCALE (ARMORED), *Chrysomphalus citrinus,* Coq.

This is a rather rare scale, yellowish in color but nearly related to the California red scale.

DICTYOSPERMUM SCALE (ARMORED), *Chrysomphalus dictyospermum,* **Morg.**

This scale resembles somewhat both the California Red and the Florida Red. It seems to have a wide distribution north and south and has been seen in several localities in the state. In addition to the citrus family, it is said to attack about forty other kinds of plants. It has not yet become a dangerous enemy of citrus trees.

WEST INDIAN RED (ARMORED), OR RUFOUS, SCALE, *Selanaspidus articulatus,* **Morg.**

As its name indicates, this scale is common in the West Indies and is present in Florida only at Key West, where it attacks the lime. It is also found on oleander, *Ficus,* and some palms. Its spread northward should be prevented, if possible. In appearance it is flat, nearly round, and of a pale-brown color.

SAN JOSÉ SCALE (ARMORED), *Aspidiotus perniciosus,* **Comst.**

This scale, highly injurious to deciduous fruits, is also found on *Citrus trifoliata* in Florida. Where the peach is grown with citrus, young orange trees are sometimes attacked. It is a small, hard, gray scale not easily detected. It is generally recognized at first by each scale becoming the center of a reddish or pinkish area. If present in large numbers, these scales give to the whole bark a grayish color.

This scale is readily controlled by spraying with the red-headed and the black scale-fungus in summer; and in the winter, when the branches are dormant and almost leafless, Stevens and Watson recommend the use of lime-sulphur solution, 1 part to 9 of water.

UNARMORED, OR SOFT, SCALES

These insects, unlike armored scales, are not covered with a scale separate from the body; instead, a waxy secretion enters in-

to or forms a layer on the skin, which toughens with age. The female does not attach herself to the bark and can move about until the eggs begin to form, at which time the swelling of the body covers them. The eggs are laid under the female or may remain in her until hatched. The six-legged crawlers are oval and active. The scales produce much honeydew, which attracts ants, and an abundance of sooty mold soon develops in it. The chief injury caused by the soft scales is to nursery stock and newly-set trees. Their natural enemies generally hold them well in check; and, if not, spraying with oil emulsions will readily destroy them. Fortunately, also, these scales drop from the trees after their death so that light and air are not permanently excluded, as in the case of the armored scales. Since the customary spraying for the whitefly and other scales usually controls the soft scales, the means of identifying each is of only minor or individual interest; hence the reader is referred for a detailed description of them to Bulletin No. 148, by J. R. Watson, of the Agricultural Experiment Station of the University of Florida, who describes the following: turtle-back, or soft brown; hemispherical; black; pyriform; mealy-shield; and three wax scales—Florida wax, Japanese or Mexican, and barnacle. It should be added that the wax scales are soft and secrete and cover themselves with a white wax, which is easily removable. This is to protect the delicate skin below. Because of exuding large amounts of honeydew, the infested plants become greatly blackened by the growth of sooty mold. Fortunately, the following fungi are destructive to the soft scales and to the Florida wax scale: the Cuban aschersonia, the turbinata, and the cephalosporium.

CITRUS MEALY BUG, *Pseudococcus citri*, Risso.

This insect occurs throughout the state and is especially prevalent in the spring and fall. While it may be found on any part of a tree, it prefers a sheltered spot, like the angle between a leaf-stalk and the stem, the stem end of a fruit, crevices in bark, or the point of contact of two fruits. Grapefruit trees, therefore, afford a favorite resort for the mealy bug, and hence

Florida red scale on Valencia oranges.

the sooty fungus has to be carefully washed from the fruit before it is packed.

HOW RECOGNIZED. The female is from one-tenth to one-fourth of an inch long. In color it is white or light brown, with brown antennae and legs. The male is smaller and has two long, white, wax-like posterior projections. The female deposits from 350 to 400 eggs in the cottony mass that she gives off. The larvae are oval and yellowish, and when crushed yield a yellow liquid.

HOW CONTROLLED. The mealy bug is eaten by various larvae, notably those of the ladybug and the lace-winged fly, also by the scale-eating caterpillar, the moth of which is grayish brown, one-third of an inch long. The caterpillar may be seen in March and April; the moth, in June. In the autumn there is another brood.

Heavy summer rains often help the citrus grower to get rid of the mealy bugs; for when washed to the ground, they seldom return to the tree. Since the honeydew secreted by the mealy bugs is much liked by ants, the latter are active in distributing them. Controlling the ants, therefore, often controls the bugs, and this may be done by pouring scalding water or carbon disulphide into the nests of the ants. Since the fumes of carbon disulphide mixed with air are highly explosive when ignited, one should not smoke when using it. Mealy bugs may often be washed off trees by spraying at high pressure with water only. It is generally preferable, however, to use a miscible oil such as is used for the whitefly; or to employ whale-oil soap or a kerosene emulsion. A spray is used in California that consists of 2⅓ pints of crude carbolic acid and 2⅓ pounds of whale-oil soap dissolved in hot water and diluted to form 50 gallons of spraying mixture.

According to A. T. Speare of the United States Department of Agriculture, there is a fungus, *Entomophthera fumosa* n. sp., which is destructive to the mealy bug; but this fungus is itself destroyed by spraying with Bordeaux mixture. Therefore, if care is not taken, the mealy bug may become as serious

a pest as it is in California. If not kept in check it causes much loss of foliage, much dropping of fruit, and makes the fruit unmarketable.

It should be borne in mind that such ornamentals as the coleus, croton, oleander, royal-palm roots, and lantana, are favorite resorts of the mealy bugs and so should not be grown near citrus trees.

LONG-TAILED MEALY BUG,
Pseudococcus longispinus, Targ.

This is far less common than the citrus mealy bug. It is smaller and of a light-yellow or gray color. Instead of two there are four wax-like posterior projections, of which the two inner ones are especially noticeable. It is controlled by the same means as the citrus mealy bug.

COTTONY CUSHION SCALE, OR FLUTED SCALE,
Icerya purchasi, Mask.

"This notorious pest of citrus," belonging to the mealy-bug group, is a native of Australia. It reached California in 1868, and its attack upon the citrus groves threatened to destroy the industry. Fortunately, its old Australian enemy, the ladybug, was brought to California and has since held it in check. In 1897 this scale reached Florida and the ladybug was enlisted to destroy it. While found at first only in the Pinellas Peninsula, it has now spread to most of the citrus-growing regions of the state.

APPEARANCE. The name "Cottony" scale was suggested by the fact that the female lays her eggs, from 500 to 800 in number, in a large cottony mass. This being ridged gave rise to its other name, "Fluted" scale. The adults resort to the bark of trunk, limbs, or twigs, whereas the young are found on the leaves close to the midrib. Both seek sheltered hiding-places. When crushed, the young show red. This scale is also found on roses, wormwood, and many other hosts. Dry weather favors the scale, and it is more resistant than the mealy bug to heavy

rain. Three or four months are required to develop a generation and there are three of these a year, but no distinct broods. Ants do much harm by distributing the scale.

HOW CONTROLLED. The use of lime-sulphur and of the usual oil sprays, prepared preferably with the lighter oil, is effective. The Australian ladybug affords, however, the most satisfactory means of control. This is a small cardinal-red, black-fringed beetle; with four black spots on the back, two either side of a central band of black. The female lays between 150 and 200 eggs, usually in the cottony egg cushion of the scale. The young of the beetle, hatching in five or six days, consume the eggs of the scale and later also both old and young scales. The life cycle of the beetle is complete in a month, while that of the scale requires three months. So the beetle has the advantage. If at any time the number of ladybugs becomes depleted because of lack of food, they multiply so rapidly when the mealy bugs increase that they soon regain control.

The twice-stabbed lady beetle is active against the scale, and trash bugs and the scale-eating caterpillar are also known to feed upon it.

WHITEFLIES INJURIOUS TO CITRUS TREES IN FLORIDA

Eight of the thirteen species of whiteflies attack citrus trees in Florida. These are:

(1) Common citrus whitefly, *Dialeurodes citri,* R. and H.

(2) Cloudy-winged whitefly, *Dialeurodes citrifolii,* Morgan.

(3) Woolly whitefly, *Aleurothrixus howardii,* Quaint.

(4) Flocculent whitefly, *Aleurothrixus floccosus,* Maskell.

(5) Bay whitefly, *Paraleurodes perseae,* Quaint.

(6) Inconspicuous, or sweet-potato, whitefly, *Bemesia inconspicua,* Quaint.

(7) Mulberry whitefly, *Tetraleurodes mori.*

(8) Guava whitefly, *Trialeurodes floridensis,* Quaint.

Cottony cushion scale on stem and branches.

In order of destructiveness, the common citrus whitefly leads all the citrus insects of Florida. This is followed by the cloudy-winged whitefly, whereas the woolly whitefly has not as yet done serious damage except in a few groves. The others cause only minor injury.

LIFE HISTORY OF WHITEFLIES. The life history of the various species differs only in minor details. The eggs are small, nearly oval, barely visible without using a magnifying glass, and give a dusty, mealy appearance to the leaf. The eggs are fastened to the lower leaf surface. From the eggs, there emerge in a few days the so-called "crawlers," each having six very short legs. In order to avoid light, they insert their sucking mouth parts, or beaks, into the lower surface of the leaves and suck the sap, remaining thereafter anchored closely to the leaf. They grow so rapidly that in a few days they molt, casting their skins, legs, and feelers. Then their appearance is entirely changed. This process is repeated twice. During the fourth stage, less sap is used, they become thicker, and the organs of the fly begin to develop. Later, the time depending upon the temperature, the pupal case splits across the back, and the orange or yellow-bodied, two-winged fly emerges, the male being slightly smaller than the female. They live only a few days. All but the common citrus and cloudy-winged whiteflies are rather inactive, whereas both of these are very active. The female may lay more than a hundred eggs.

COMMON CITRUS WHITEFLY

This fly sucks the sap, weakening the trees, lessening the crop and injuring its quality. The honeydew from its alimentary tract is soon filled with the jet-black fungus, "sooty mold," which blackens both tree and fruit, necessitating washing, with its attendant danger of scratching, bruising, and inoculation with fungi that cause decay. Sooty mold indicates the probable presence of the fly. The sooty mold keeps light from the leaves and thus interferes with the important chemical changes upon which the vigor and life of the tree are dependent. The mold, by affording shade to the purple and long scales, causes a great increase in their numbers.

SPECIAL CHARACTERISTICS. The eggs are pale yellow, and are distributed singly, especially on young leaves. The females live 7 to 10 days, and each lays about 100 eggs, which hatch in 10 to 12 days. The summer brood passes about three weeks in the larval stage; the others a longer time, up to five weeks. Spring and summer broods spend about two weeks in the fifth, or pupal, stage, and the autumn brood from four to ten months. In southern Florida, there may be a partial brood in January or February. The spring brood is especially abundant in March. The summer brood flies in June and the largest one of all, in August or early September.

ENEMIES. The twice-stabbed lady beetle destroys some crawlers and a few old larvae. A small, dark-brown lady beetle eats some eggs. Another species of lady beetle that feeds abundantly on the eggs has been introduced into Florida in the hope that it will multiply and become an effective enemy. In addition, there are several destructive entomogenous fungi, including the brown fungus, the red aschersonia, yellow aschersonia, the white-fringed fungus (*Microcera*, sp.), and cinnamon fungus. A new strain of red aschersonia has recently been reported by Berger (No. 5805) which fruits satisfactorily during the hot weather of June and July, as the other strains will not do.

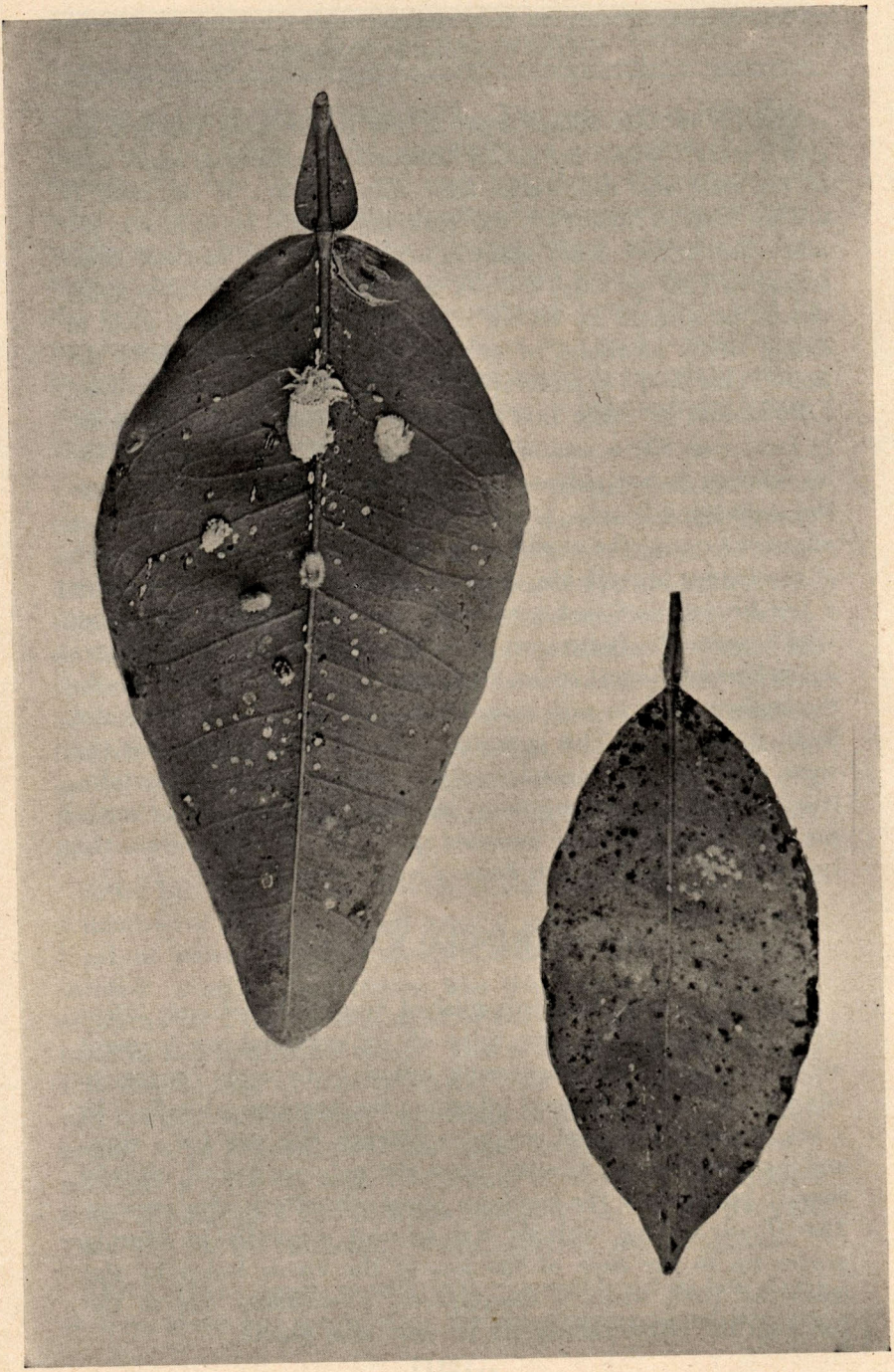
SPRAYS. The original treatment consisted of spraying with a mixture of 8 lbs. whale-oil soap, 2 gals. of paraffin oil, and 1 gal. of water. If much cheaper, ordinary soap may be substituted. Another preparation like that above, except that it requires only 2 lbs. of soap, must be boiled if used. Hard water must be softened before using. This is accomplished by adding 1 lb. caustic soda to 1 qt. of water; then stir for a minute and add 100 gals. of the water. A method of softening water, which is said to be simpler, safer and more satisfactory, is to add 2 packages of SOF for each 100 gallons of water. Next dissolve 2 lbs. of soap in 1 gal. of water and add this to the 100 gals. Then add the oil emulsion. When spraying, use no agitator.

SPRAYING. Spray usually with a miscible oil in late April or May, about two weeks after the chief spring brood has dis-

appeared, or just before most of the larvae have reached the pupal stage. When the adults become less numerous, make note of the date and two weeks later spray again. If the fruit is not an inch in diameter, the spraying should be delayed; for otherwise it may cause some injury. When the summer rains begin, in June or July, the red and brown entomogenous fungi should be secured by taking leaves bearing them from trees in damp, shady locations, or cultures can be purchased from the State Plant Board at Gainesville. The latter is the safer method. Care should be taken that no leaves are used which bear scab. In fact, even citrus canker might be spread in this way. If the inoculation is not successful, try again in August to introduce the destroying fungi. At this time, the brown fungus, which is effective later in the season, is preferable to the red. If enough of the fungus is available, spray all of the trees; but if not, spray a few branches of each tree high up on the shaded side, from which point the fungus can readily spread. Use the oil spray again late in August or in September; or in the north, late in September; and in any case, about two weeks after the chief flight disappears. This spraying must be thorough so that the trees may remain in good condition over winter; incidentally, it will tend to loosen any sooty mold on the fruit so that washing will be easier. The summer spray should also contain the spores of the fungi which destroy scale insects.

CLOUDY-WINGED WHITEFLY

This can hardly be distinguished from the common citrus whitefly excepting by the color of its eggs and its frequent attack by the very characteristic yellow aschersonia fungus, in addition to the other fungi attacking the common whitefly. In a few isolated groves of southern Florida, this was for a time, and perhaps still is, in some cases the only species of whitefly found; but usually the common citrus whitefly is also present. The cloudy-winged whitefly was present generally in Florida groves up to the time of the loss of the citrus leaves by the freeze of 1895, when it disappeared, presumably due to the fact that the citrus family are its only host plants.



Cottony cushion scale in various stages of development on a citrus leaf.

Larvæ of the woolly whitefly, showing the woolly protective covering responsible for its name.

HOW RECOGNIZED. The eggs of the cloudy-winged whitefly are black, and may be laid separately or may be so abundant, especially on leaves of water sprouts, as to give a general blackening effect. The yellow fungus mentioned above is another ready means of recognition. The larvae are distinguished from those of the common citrus whitefly by having a skin so much thinner that the pupal case collapses after the fly emerges. The adult fly also shows more of its abdomen; the wings are carried lower; and in the middle of each wing is a darkened area having a cloudy effect, which suggested the name.

LIFE HISTORY. The cloudy-winged whitefly requires two weeks longer than the common citrus whitefly for completing its summer life cycle; but, unlike the latter, has no partial winter brood. The spring brood emerges in greatest numbers in early April, about three weeks behind the common species; whereas the summer brood comes forth a month behind it, or in the first half of July. The last brood emerges in late October, or seven weeks after the common citrus whitefly appears.

HOW CONTROLLED. Spray the same as for the common citrus whitefly; but if both are present, time the spraying to control the common whitefly, and most of the others will be destroyed. If only the cloudy-winged fly is present, the time of spraying should be adapted to it, which would be about early May and the first of August and November. Remove and destroy all egg-laden water sprouts before more than a few adults have emerged, or usually about the middle of May and August, and in December, January, or February. Add the yellow aschersonia to the fungi commonly used in spraying for the common citrus whitefly; and if the further work of the State Plant Board indicates their effectiveness, possibly cultures of the goldiana fungus should be added.

WOOLLY WHITEFLY

This whitefly, first found attacking citrus plants in the West Indies, has been supposed to be identical with a Florida pest of the sea grape (*Coccolobus*). It is supposed, nevertheless, to have been brought into Tampa, Florida, from the West Indies

in 1908, and from there it has become rather widely distributed, excepting in a few northern and lower east-coast groves. With but few exceptions, it has proved only slightly injurious for the reason that it is kept in check by its insect enemies. The injury caused by this species is in many cases due chiefly to the fact that the persistent woolly mat which it leaves on the tree serves as a shelter and hiding-place for the purple scale, which is generally abundant following great numbers of these whiteflies.

HOW RECOGNIZED. This whitefly is readily distinguished by the woolly-like, waxy filaments covering the pupa, and by the long adherence of the pupa cases to the trees. The eggs are brown and slightly curved; and are laid usually in circles, because of the fact that the female inserts its beak in the leaf tissue and rotates around that center. The eggs are generally laid on nearly mature leaves, or even on those on which the adult has been reared. The larvae in the first stage are light green and have both legs and antennae. In later stages, they are brown, or black if already parasitized, with "a corona of shining, white, waxy plates." The flies produce much honeydew, which is generally seen adhering to them. The woolly covering is formed in the third stage. The adults carry their wings lower than either of the preceding species. They are more yellow, sluggish, fly but little, and readily attach themselves to one's clothing.

HOW CONTROLLED. This whitefly is controlled to a large extent by fungi, of which the red aschersonia and brown fungus are the least important. These whiteflies are kept in check by a wasp-like insect, *Eretmocerus haldemani*, which deposits its eggs in the larvae. The grubs from these eggs feed upon and destroy the larvae and pupates within them, causing them to become enlarged. The adults of these wasp-like insects emerge through a round hole made in the top of the whitefly pupal case at about the time the adult whitefly would normally have appeared. As a rule, these natural methods of control are sufficient; but if not, the same oil sprays should be used as for the other species, but should be applied before the third, or

woolly, stage has been reached. Spray late in February or early in March and in June; also again about August 15 and November 1.

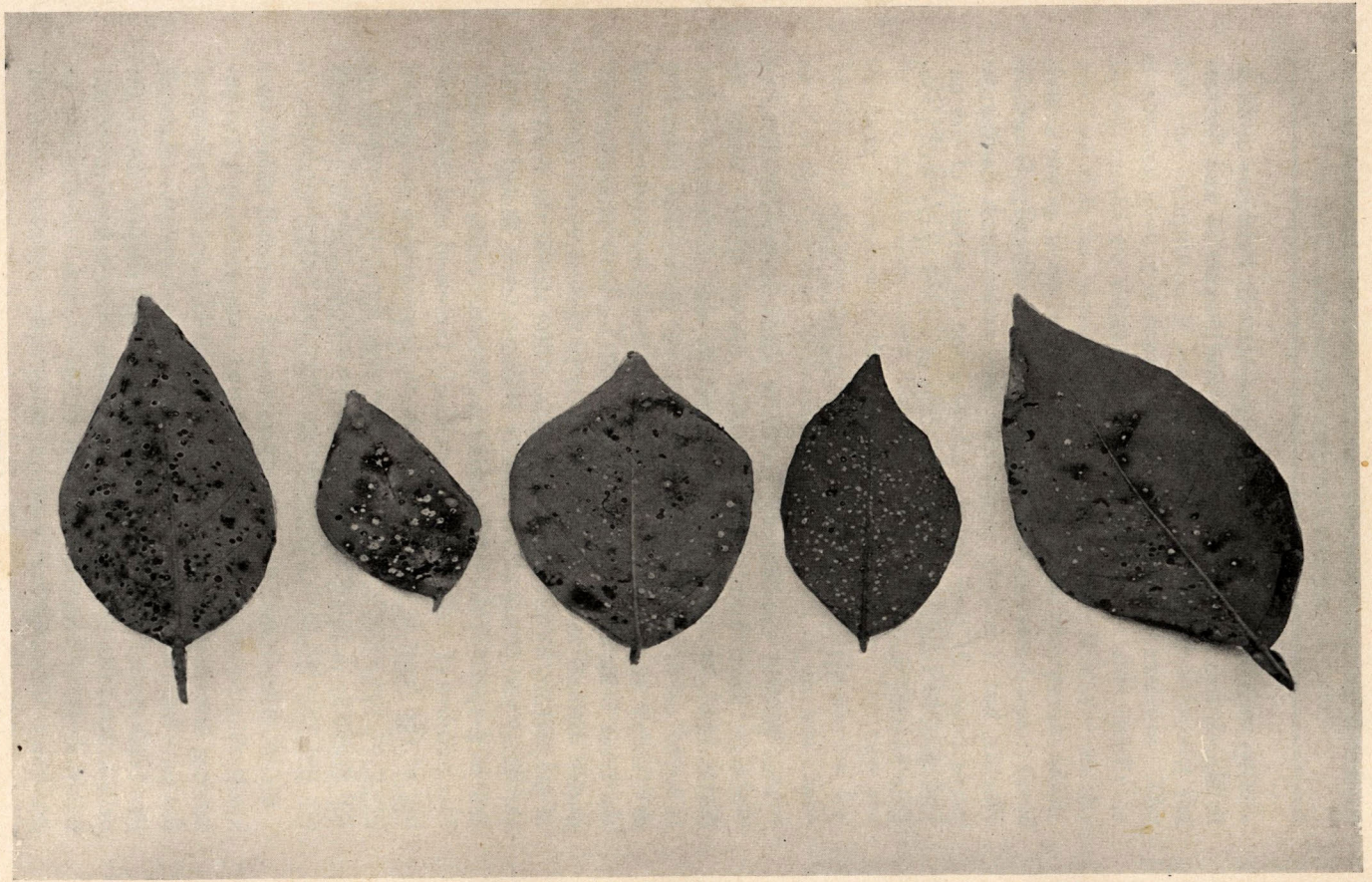
OTHER WHITEFLIES

The flocculent; bay; inconspicuous, or sweet potato; mulberry; and guava whiteflies, are all occasionally found in Florida, but it is only rarely that they cause much damage to citrus trees. If they do, the introduction of certain of the entomogenous fungi or the application of an oil spray will probably control them.

RUST MITE, *Eriophes oleivorus*, Ash.

This pest of citrus trees, formerly sometimes referred to as "Orange Rust Mite" and "Lemon Silver Mite," ranks in destructiveness only below the citrus fly and the purple scale. It sucks oil from both leaves and peel, giving the former a dry, shiny appearance; but its effects are more noticeable on the fruit because of the russeting and leathery character imparted directly and possibly indirectly to the exterior, especially of grapefruit, by the aid of a fungus. The size of the fruit and the final yields are often greatly reduced, even though in the case of grapefruit the peel sometimes becomes relatively thicker. The number of culls is correspondingly increased and the coloring of the fruit is delayed. While the appearance and selling price of the russeted fruit are lowered, the eating quality is not injured. Contrary to some earlier notions, russeted oranges are not sweeter than others, unless they are harvested later.

HOW RECOGNIZED. The rust mite is so small that it can hardly be detected without the aid of a magnifying glass enlarging fifteen to twenty times. When abundant, the effects of the mite are recognized by the "dusty or powdery appearance of the fruit and leaves." The mite is wedge shaped and light yellow, broad in front and tapering to the rear, where two small lobes, or false feet, may be seen which are used in clinging or crawling. Toward the front on either side are also two weak



Red and brown aschersonia, two friendly, or entomogenous, fungi, destroying the pupæ of the whitefly.

legs for use in creeping. The young are relatively shorter and also paler than the adults.

HOW PROPAGATED. The few eggs hatch in four or five days in summer and may require two weeks or more in winter. A week to ten days after hatching molting occurs, and the white discarded skins impart the characteristic dusty or mealy appearance to the leaf. Egg-laying then begins, and in a few days the second generation appears, followed by others in equally rapid succession.

The mites, though often carried by other agencies, can move on smooth citrus leaves at the rate of ten to twelve feet per hour; and upon sucking the sap from one cell, can move quickly to another. Spiders and various insects are probably frequent carriers of the mite. It seeks a certain amount of shade; hence the protected side of an orange may be russeted and the other not. Very heavy shade is, however, avoided by the mites, which explains the frequently observed freedom of oranges from russeting in some heavily-shaded hammock groves.

WHEN MOST ABUNDANT. Since heavy downpours of rain wash off some of the mites, the greatest infestation generally occurs during or following dry periods, or usually in June and November; yet damage may be caused by them during any month in the year. They have few parasites and are only partially checked by syrphus flies and other enemies; hence spraying must usually be depended upon to check them, although sudden severe cold may destroy both the mites and their eggs.

CAREFUL OBSERVATION. With the aid of a magnifying glass one should examine the fruit every few days, especially that from a June bloom, and all trees that have a dusty or powdery appearance. Spraying must be done before any russeting occurs, or the fruit cannot be graded as "bright." As coloring progresses, russeting becomes less noticeable yet it will not disappear. If russeting has developed and mites are still present, one should spray immediately. The spraying machines and supplies should always be ready for instant use.

Some growers spray for the mite monthly, but a part of this expense can be saved by making frequent careful examinations for mites and by spraying only when needed.

SPRAYING WITH SULPHUR COMPOUNDS. Lime-sulphur is one of the best sprays for the rust mite, and it should be used at the rate of 1 gal. for each 70 to 75 gals. of water. The carefully made commercial preparations are generally considered superior to that which is home-boiled. The lime-sulphur should be tested with a hydrometer; and if of standard 32° Baumé strength, 1 gal. to 70 gals. of water will be enough. The following table from Watson shows the number of gallons of water to use with one gallon of lime-sulphur for rust mites, with any of the usual hydrometer (Baumé) readings likely to be encountered. Included is also the amount for a winter wash to kill San José scale on *Citrus trifoliata*, peaches, or plums, and the amount to be used as a fungicide on citrus trees in the summer.

Dilution Table for Lime-Sulphur Sprays
for Rust Mites and other Purposes

Baumé reading	Number of gallons of water to one gallon of lime-sulphur		
	For a winter wash	As a fungicide	For rust mites
36	9½	34	82
35	9	33¼	79
34	8¾	32	76
33	8¼	31	73
32	8	30	70
31	7½	29	67
30	7¼	28	64
29	7	27	61½
28	6½	26	57¾
27	6¼	24½	54¾
26	6	23½	51½
25	5½	22¼	48½
24	5¼	21	45½
23	5	19	42½

22	4¾	18¼	39⅔
21	4½	17½	36¾
20	4	17	34
19	3¾	16½	31¾
18	3½	15¼	29¾
17	3¼	14½	27¾
16	3	13½	25¾
15	2¾	12¾	24

It is claimed for these sprays that they stimulate fruit development and cause earlier ripening.

The oil emulsions kill only such rust mites as are actually hit by the spray and have no effect on near-by scales, which are destroyed by sulphur and the lime-sulphur sprays when deposited near them.

For mites special "soluble-sulphur," or soda-sulphur, is sometimes added to the oil emulsion used for other purposes, and this combination spray is employed as a substitute for lime-sulphur or dusting with sulphur. This soda-sulphur stock solution is made from the following:

Flowers of sulphur	30 lbs.
Caustic soda	20 lbs.
Water	20 gals.

This should be made to test 16 degrees Baumé and one part should be added to 40 parts of water. This solution, if used alone, is less efficient than lime-sulphur.

FLOWERS-OF-SULPHUR DUST FOR MITES. The rust mites, red and other spiders, are easily killed by sulphur; and even though their eggs are not destroyed, sulphur particles remaining on the trees or fruit will kill all of the young that happen to be hatched within "a radius of a small fraction of an inch" of them. This killing is presumably due to the acid formed by the slow oxidation of the sulphur. The sulphur requires two or three days to accomplish the degree of destruction wrought immediately by the lime-sulphur, but its effects endure for some time.

A typical six-year old orange tree which has always received
A. A. Quality Citrus Fertilizers.

In applying flowers of sulphur, it should preferably be mixed thoroughly with hydrated lime, at the rate of three parts of sulphur to one part of lime. The hydrated lime can be prepared by carefully and slowly sprinkling four gals., 32 lbs., of water over 100 lbs. of quick, or builder's, lime. The mixture of sulphur and lime is applied by means of the usual dusting machines. The dust should be applied preferably when the air is still, and by all means when the trees are moist with dew or rain. The best results are secured when the days are bright and the nights damp. In California, where the moisture conditions are less satisfactory, the sulphur combinations are only 50 per cent effective, and oil emulsions must be substituted.

If only spraying machines are available, 1 to 5 gals. of the dry sulphur-lime mixture may be added to 50 gals. of water. The spreading power and adhesiveness of the spray can be greatly increased by adding to each 50 gals. 3 to 4 lbs. of soap.

RED SPIDERS

The name, "Red Spider," is often applied solely to the six-spotted mite, whereas others apply it also to the purple mite. Both, like the rust mites, are more abundant and destructive in dry than in wet weather. They have many insect enemies and are the prey of larger spiders, ladybugs, and lace-winged flies. They are controlled by the same means as the rust mite.

SIX-SPOTTED MITES, *Tetranychus sexmaculatus*, Riley

These mites, for their protection, spin tent-like webs below themselves on the under side of the leaf. The adults, unlike the usual larvae, are recognized by small dusky spots arranged in two rows of three spots each, on each side of the back of the abdomen. The mites have two eyes on each side, the forward one of each being red but both having that appearance. The eggs are deposited along the under surface of the leaves and the larvae, which suck the plant juices under protection of the tent, cause the leaves to become yellow. The attacked yellow spots grow in size with the appetite of the mites and

later the leaves curl and fall. If much foliage dies, the tree loses its vitality and the fruit also falls. More than half of a crop may be lost in this way.

During the rains of June and July these mites usually disappear. If the water supply is such that the trees can be drenched, when necessary, with water at high pressure, the results are usually satisfactory, although the same lime-sulphur or soda-sulphur solution employed for the rust mite may be used for their destruction.

PURPLE MITES, *Tetranychus citri*, McGregor

These are less injurious than the six-spotted mites. They attack both the upper and under side of the leaf and also the fruit. The attacked surfaces look gray and dry. The eggs are reddish yellow and stick fast to the leaves, mostly on the under side close to the midrib. Each egg is also attached to the leaf by means of fourteen silky threads, all meeting at the end of a perpendicular support extending upward or downward from the exposed side of the egg, depending upon the side of the leaf upon which the egg is deposited. The young are hatched in from one to two weeks and attain their growth in about twelve days. At first they have six legs but later add two. The female has a month of adult life and lays from thirty to seventy-five eggs. They are controlled by the same means as the other mites.

FLORIDA FLOWER THRIPS, *Frankliniella bispinosus projectus*, Watson

This tiny insect frequents many other kinds of flowers besides citrus blossoms.

HOW RECOGNIZED. It is about one twenty-fifth of an inch long, and ranges in color from yellow to orange, the abdomen being lighter colored than the thorax. It has brownish-red eyes and eight-jointed antennae, which can be recognized by the aid of a magnifying glass. There are four thin wings fringed with long hairs. Upon disturbing the insect, it curls its ab-

domen up over its back as if preparing to sting, but in fact it only bites. In warm weather the eggs hatch in from two to four days. They then exist as larvae for ten to twenty days and for the last two days as pupae. The adult begins to lay eggs when five days old.

DAMAGE. Thrips may cause an excessive amount of blossoms and young fruit to fall, in addition to scarring fruit and materially lessening its value. The insects feed in the blossom just inside the cylindrical column of stamens and on the petals; and if they are very numerous, the tissues at the base of the ovary and the ovary itself may be attacked. It is in the receptacle at the base of the ovary that most of the eggs are laid. Here the larvae feed and the receptacle, if seriously injured, turns yellow and the blossom drops. Some argue, in case of a very full bloom, that a moderate or even heavy infestation of thrips may be of benefit by preventing the setting of more fruit than would ripen. On the other hand, if the bloom is light and the crop promises to be small, thrips may further greatly reduce it, and spraying becomes most necessary.

Smooth, shining, brownish, sunken areas in circles, streaks, or blotches, deeper than spots due to scab and shallower than those caused by grasshoppers and katydids, mark the previous work of thrips on the blossoms or young fruit. These areas are much more subject than the normal peel to attacks by the pumpkin bug and other insects and by fungi. A loss of from five to ten per cent in the grading of the fruit due to scarring and a small increase in culls may sometimes be expected where young thrips of the second generation have been numerous.

HOW CONTROLLED. Thrips have few or no natural enemies. A driving rain is most effective for their destruction, for it dislodges and beats them to death. One spraying will frequently increase the set of fruit from three to eight per cent. The spray should be directed into the blossom at high pressure when the trees are in full bloom. After a week to ten days, and a day or two ahead of the best time to spray rather than a day or two late, if many thrips are seen on the later bloom or on the young fruit, one may spray again if necessary.

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A soap solution containing tobacco extracts will kill thrips effectively; but when trees are in bloom, the red spiders, rust mites, and scab are so abundant that the following formula, according to Watson, is likely to give much better results:

Commercial lime-sulphur solution, 32° Baumé,	2⅔ qts.
Blackleaf 40	3½ oz.
Water	50 gals.

He also suggests that if lime-sulphur is used to control scab, at the rate of 1 lb. to 40 lbs. of water, 3½ oz. of Blackleaf 40 may also be added to control thrips. He adds, however, that some growers have observed injury from lime-sulphur spray of that strength; yet more recently in The Florida Grower he states that in combination with lime-sulphur of rust-mite strength, 1 to 65 or 70, as much as 13 oz. of nicotine sulphate are necessary to effect satisfactory killing; but by using lime-sulphur 1 to 40 only 10 oz. of nicotine sulphate are necessary. Therefore on the basis of economy he recommends the latter. A spray gun is also recommended rather than the use of the rod and nozzle, since it forces the spray more deeply into the blossoms, where the thrips are most abundant.

LARGE PLANT BUGS

Several of these bugs attack citrus trees, sucking the sap from leaves and small twigs, which causes them to wilt and die. Sometimes half of the ripening fruit may be similarly attacked and then it falls; or the peel may be punctured so that rot-producing fungi enter. The thin-skinned tangerines and satsumas are more subject to such attacks than the orange, whereas the grapefruit because of its thicker peel is least likely to be injured.

GREEN SOLDIER BUG, OR PUMPKIN BUG, *Nezara viridula*, L.

HOW RECOGNIZED. This bug breeds especially on cowpeas, also on beggar-weed or velvet-bean cover crops which are allowed to stand too long or which are left in patches between

the trees. The bugs vary from dark green or pinkish while hibernating, to bright green. The female is slightly more than one-half an inch in length and is only about half as wide; whereas the males are usually shorter and narrower. The young are more nearly circular, are bluish, and have red markings. Like other stink bugs, they have a disagreeable odor. About two months are required for them to hatch, and to complete their fifth and final molt. They are most abundant in the autumn and in March and April, at which time the young appear.

HOW CONTROLLED. Because of their large size, spraying is not effective against the adults; but the young can be killed by oil emulsions, various tobacco extracts, and soap solutions.

The adults are collected by the use of a short-handled muslin or canvas net three feet or more in diameter and equally deep, the handle of the net reaching across so as to support the further side of the rim. Larger nets, 6 by 12 feet, may be used for very large trees. The net, after the bottom has been dipped in kerosene for the purpose of killing the bugs, is placed or held under the limbs, which are given a vigorous shaking, whereupon the bugs fall into it. After making the collection from each tree, the net is again dipped in kerosene, which keeps it continually moistened. If the temperature is not below 70° F., the bugs are likely to fly away before reaching the large nets, unless these are used in the early morning, on moonlight nights, or when it is cold. The use of some cotton waste in the nets is often helpful in wetting the bugs with kerosene.

The cover crops should be cut by September 15, and the trimming under the trees should precede the mower in order that wingless young may migrate to the middles.

Other Plant Bugs controlled by the same means are the northern green soldier bug, the brownish-gray stink bug, the leaf-footed plant bug, and the big-thighed plant bug.

Thistles, which attract such bugs, should be kept out of citrus groves.

A thrifty young grove in the Lake Wales district, grown with A. A. Quality Citrus Fertilizers.

COTTON STAINER, ***Dysdercus suturellus,*** **Herrich—Sch.**

This dark-red bug, which feeds in cotton bolls and imparts a reddish stain to the lint, sometimes attacks a grove in hordes much as the pumpkin bug does. Again for several years it may be absent or scarcely noticeable, just as in cotton fields. The matured, oblong-oval bug is less than ½ x $\frac{3}{16}$ of an inch in size. The thorax, head, and base of the legs are red; the wings, dark brown with yellow edges. When the wings are crossed over the back, they look like two crossed, diagonal lines.

HOW CONTROLLED. The bugs may be collected in nets, as pumpkin bugs are; or piles of cotton seed, which attract them, may be placed under the trees. When the bugs accumulate on it, destroy them, preferably with a gasolene torch; for a spray of kerosene, though effective, makes the seed unattractive to the pests.

MINOR CITRUS-FRUIT PESTS

ORANGE TORTRICIDS are small moths which resemble the moth that destroys woolen fabrics. Their larvae tunnel citrus fruits, but especially grapefruit on low hammocks. They are flesh colored, hairless, and when fully grown about half an inch long. Sometimes in nurseries they may require spraying.

THE BAG WORM, so called because of its bag-like protecting covering, which it constructs for itself out of pieces of sticks and straws bound by silk, feeds on and injures young citrus fruit.

THE CITRUS ROOT-WEEVIL, *Pachnaeus opalus,* Oliv., a greenish-blue beetle, one-third to one-half an inch long, with short, thick snout, feeds on citrus leaves and blossoms. The larvae attack the roots. A poison spray such as lead-arsenate will destroy the adults of all three of these pests.

INSECTS INJURIOUS TO TRUNKS AND LIMBS

The Orange Sawyer, *Elaphidion inerne,* Newm., a long-horned beetle more than half an inch in length, lays its eggs

ANTS

Small black ants destroy tender buds that are just starting and especially those that have been used for budding. The leaf-cutting ants of Southern Florida cut off and carry away parts of leaves.

These ants do the greatest damage by acting as protectors of mealy bugs, scales, aphids (plant lice), and other destructive insects that exude honeydew. These insects are to the ant what the family cow is to the household; and they are distributed, cared for, or protected accordingly. Wherever ants are seen in abundance, the presence of one or more of these kinds of insects may be suspected.

The Argentine ant, already present in California, Louisiana, and Mississippi citrus sections, is especially bad, because of the highly efficient protection which it affords these citrus enemies and because its nests are so large and so widely extended that it is difficult to destroy them.

TREE PROTECTORS. Trees are sometimes protected from the ants by banding them with tow, into which has been worked a mixture of corrosive sublimate and lard or other oily substance. If too much of the mixture is introduced into the tow, it may kill the bark. So long as the band remains moist and close to the tree, it is effective unless the ants bridge it with earth.

For the same purpose Watson mentions the following formulas as more durable; Numbers (1) and (2) remaining effective for 3 to 5 months:

(1) Tree Sticky.....6 parts
Powdered corrosive sublimate..... 1 part
(2) Flowers of sulphur by weight..... 1 part
Tree Sticky by weight.....6 parts
(3) Black axle grease..... 1 part
Tree Sticky.....2 to 3 parts

If no ant nests are near the trunk, a circle of slaked lime on the ground around the tree is protective as long as it remains dry and is not blown away.

in rotten citrus wood, and the white cylindrical larvae may even eat down into the live wood. These insects should be avoided by cutting off all dead branches close to the trunks or big limbs and painting the cut surfaces.

THE SHOT-HOLE, OR PIN-HEAD, BORERS and their larvae make pin-size holes in the bark and sapwood. The trunk may look as if struck by a charge of small shot. Coating with whitewash containing a handful of salt has been recommended, but removal and burning of the tree is considered preferable.

THE TINEID MINER sometimes mines young twigs, in which case they should be cut out and burned.

SLUG CATERPILLARS

These embrace the Puss moth, *Megalopyge opercularis*, S. and A., with a pupa resembling a twig bearing a dormant bud; the caterpillars of the Saddle-Back moth, *Sibene stimylea*, Clemens; and Hag moths, *Phobetron pithecium*, S. and A., which bear among their hairs some that have a stinging, nettling effect. They seldom do enough injury to warrant special treatment, but spraying with lead arsenate is the usual remedy suggested in case of necessity.

THE SHARPSHOOTER, OR ORANGE JASSID, *Oncometopia undata*, Fab.

These oblong or triangular bluish-orange insects are about one-half an inch long and the relatively wide head is about one-eighth of an inch across. "The thorax and fore wings are steel blue, marked with grayish lines." They are found on citrus and other twigs from which they suck the sap, causing the small ones to wilt and the bark of the older ones to crack.

HOW CONTROLLED. Unless whiteflies or scales are present, which should be destroyed, they may be knocked off into a pan of kerosene; but otherwise an oil emulsion may be used, or a spray made by mixing 6 lbs. of soap and 1/3 pt. of Blackleaf 40 with 50 gals. of water.

HOW CONTROLLED. This is best accomplished by pouring into the nests a solution of potassium cyanide or of the cheaper sodium cyanide. An ounce of the cyanide is dissolved in a quart of water, and a few ounces of the solution are poured into a hole punched in the center of the nest to a depth of a foot or more. After the liquid has settled, tramp the surface hard so that the gas which will later be given off will penetrate the galleries and kill both ants and pupae. This should be done at night or in the early morning, when the ants are in the nest. Do not make such applications near young trees or they may be killed. The fumes given off by these cyanides are deadly and must be avoided; furthermore, in using cyanide not a trace of it or of the solution should be allowed to get into any wound or into the mouth.

Carbon bisulphide (disulphide), the fumes of which are heavier than air, can be used to destroy ants; but it costs more, is inflammable, and mixed with air in certain proportions is terribly explosive. Kerosene does not penetrate the nests well; and gasolene, though better in this respect, is inferior to the other treatments. Boiling water kills the ants but cools off too quickly to destroy all of those in distant galleries.

WHITE ANTS, TERMITES, OR "WOOD LICE,"
Termes flavipes, Kollar

These pests inhabit rotting wood, whether on the tree, in the banking around it, or piled in the grove for possible protection against a freeze. They are soft-bodied, pale insects, yet they may attack the bark and even completely girdle young trees.

HOW CONTROLLED. Cut out all rotting wood from the trees and paint the cut surfaces; also keep all rotting wood from the banks and remove it from around the trees. Do not set trees much deeper than they stood in the nursery. Piles of wood, if used for heating, should be as far from the trees as possible. Remove the earth from attacked areas, for the insects cannot endure full exposure. Plant land containing much de-

A typical tree grown with A. A. Quality Citrus Fertilizers.

caying wood, preferably for a year or two, to some general crop.

Following the abundant flight of the black, winged males and females, which usually occurs after a rain, will disclose their nest, which should then receive the same treatment as ant nests.

PRICKLY-ASH BEETLE, *Trirhabda brevicollis*, Lec.

Only the adult of this insect feeds on and defoliates citrus trees, and then only when the near-by prickly ash on which it breeds (*Xanthoxylon clava-herculis*, L.) has been defoliated. This ash should not be mistaken for the so-called "prickly ash," or "Hercules Club," on which the beetles do not feed.

HOW CONTROLLED. All prickly-ash shrubs near the grove should be cut out. If necessary, spray the citrus trees with lead arsenate.

OTHER HOST PLANTS OF INSECTS INJURIOUS TO CITRUS FRUITS

The wild olive, and wild chinaberry trees, as well as the prickly-ash, should be cut out from lands adjoining citrus groves. These and the privet are host plants of the whitefly.

If subtropical fruits, including mangoes, figs, and avocados, and such ornamentals as privet, japonica, camphor, croton, oleander, and roses, are growing near a grove, they should be sprayed at the same time as the citrus trees for the destruction of insect pests common to both.

MELON APHIS, *Aphis gossypii*, Glover.

This serious pest of melons and cucumbers, which produces honeydew for the ant, attacks young citrus leaves, especially on water sprouts. The damage in nurseries and in newly planted groves is accompanied by a dwarfing and curling of the leaves. This aphis is dark green and has red eyes. The winged forms are nearly black, and the young are light or yellowish

green. Where melons or cucumbers are to be grown in or near a citrus grove, it is especially important to eliminate the aphis from the grove in the spring, before the winged females can depart for these or other of their food crops. Since weekly broods of aphids are produced, prompt destruction is necessary.

HOW CONTROLLED. Cut out all water sprouts; and if aphids are present, either burn the sprouts or dip them into an oil or tobacco solution. The trees in young groves should be sprayed with a soap and tobacco decoction. The latter may be made by covering tobacco stems or other tobacco refuse with water and holding it for an hour just below the boiling-point, or allowing it to soak over night. The liquid should have the color of dark tea, and before using should be diluted by adding ten times its volume of water. If not used promptly, add 1 oz. of salicylic acid to each 4 gals. of the undiluted extract to prevent its decomposition. If preferred, a ready-made nicotine preparation, such as Blackleaf 40, may be employed. The latter should be used at the rate of 1 part in 1000 parts of water, and others should be diluted according to their strength. If soft water is used, add to 5 gals. of water 2 to 3 lbs. of whale-oil soap or other caustic soap. If the water is hard, the amount of soap should be increased. Add to this 1 pint of Blackleaf 40 and warm it for 5 minutes; finally, just before using, dilute it with 50 gals. of water. This is applied as a fine spray, so as actually to hit as many of the aphids as possible.

NATURAL DESTROYERS. There are many natural enemies of the aphids, which usually keep them in check in citrus groves, but not in melon fields. These embrace among others certain birds, wasp-like insects, the syrphus fly, lace-winged fly, and several kinds of ladybugs.

STRIPED CUCUMBER-BEETLE, *Diabrotica vittata*

The adult of this beetle is yellow, striped with black, and is about two-fifths of an inch in length. It attacks young citrus trees and especially satsumas, injuring both leaves and fruit.

HOW CONTROLLED. Spray with the following mixture: 1 lb. of lead arsenate; 2 lbs. of lime; and 50 gals. of water. Every part of the leaves and fruit should be covered.

RATS, SQUIRRELS, AND GOPHERS

Rats and flying squirrels gnaw oranges in order to get the seeds, and rats girdle limbs or trunks of citrus trees if near their hiding-places. Gophers, burrowing under ground, will entirely girdle or eat off the tap root and cause the trees to die. These are less likely to be troublesome in groves where heavy tractors are used.

HOW CONTROLLED. For getting rid of rats, mix barium carbonate with three times its bulk of corn meal and place it in some dark, obscure corner which is frequented by them. Upon eating it, rats generally leave the buildings in search of water and die outside. Special cultures are also often used to advantage which impart a destructive disease to rats.

ANIMAL FRIENDS OF THE CITRUS GROWER

Citrus trees have their enemies, but also numerous friends. The Australian ladybug, which controls the cottony-cushion scale, is at home in a citrus grove. Its coloring of dark orange or red and black makes it noticeable, and it should always be protected.

The wheel bug and others destroy the orange dogs, tortricids and other caterpillars, as well as the pumpkin bug and various other bugs.

Wasps and parasitic flies also perform most useful functions.

Another friendly and frequent visitor to the citrus grove is the golden-eyed, lace-winged fly. Because of throwing on its back the scales of its insect victims, it often appears like a bit of bark or lichen. It lays its white eggs on "hair-like stalks" to protect them from its enemies. When full grown, it is a delicate fly with deep-green iridescent wings of lace. This fly, like the ladybug, should be looked upon as a public benefactor.

An orange tree with tap root eaten off by the subterranean gopher.

While a few of the sap-sucking birds may do injury and others feed on some of the beneficial insects, the creepers and other small birds destroy many scale insects. Furthermore, all young birds are usually raised on animal food, consisting chiefly of various stages of insect life.

Since skunks (polecats) feed on mice, white grubs, and grasshoppers, they are generally beneficial.

Snakes, toads, frogs, and lizards destroy both insects and mice.

In the preparation of this manuscript the writer has been greatly aided by Hume's "Citrus Fruits and Their Culture"; by the Bulletins of the Florida Agricultural Experiment Station of the University of Florida, prepared by Professors Rolfs, Stevens, Watson, and others; also by Publications of the United States Department of Agriculture by J. R. Winston, W. W. Yothers, and H. S. Fawcett; likewise by various articles on citrus culture published in the Proceedings of the Florida Horticultural Society and in The Florida Grower. Thanks are also due for advice and suggestions to Dr. E. P. Felt, Professors F. V. Coville, C. R. Crosby, O. F. Burger, Dr. Longfield Smith, Dr. M. D. Leonard, Messrs. D. F. F. Christiance, T. J. Harris, T. Ralph Robinson, and J. Lee Swan, and to many practical citrus growers and experts in Florida who have kindly aided in various ways.

A Spray Schedule for Citrus

The following spray schedule represents the combined judgment of W. W. Yothers, entomologist, and J. R. Winston, pathologist, U. S. Department of Agriculture; O. F. Burger, pathologist, H. E. Stevens, former pathologist, and J. R. Watson, entomologist, Florida Experiment Station; and E. W. Berger, entomologist, Florida State Plant Board.

This combined schedule is based on the work to date of state and federal investigators and represents their composite judgment regarding the control of certain citrus insects and diseases by spraying. **The five applications in bold face type (Nos. 3, 4, 7, 8, and 9) are recommended as sufficient for the control of the enemies usually destructive on grapefruit in an average season, provided the spraying is done thoroly. Oranges will ordinarily require only four applications (Nos. 4, 7, 8, and 9.)** Under conditions especially favorable for disease or insect increase some of the remaining applications may be required also.

No.	Citrus Fruit.	Enemy.	Material.	Time of Application.	Remarks.
1	*Grapefruit.	Scab.	Bordeaux-oil mixture, (3-3-50)	Just before first flush of growth.	Bordeaux mixture plus 1% of oil in the form of an oil emulsion stock solution. (See remarks under No. 7.)
2	*Grapefruit.	Scab. Rust mites. Red spiders.	Lime-sulphur solution, 32° Baumé, 2½ gals. in 100 gals. water.	Just before the petals open.	To be applied if scab infections appear on new growth, or, if rainy weather favorable for scab follows No. 1.
3	**Grapefruit and †Oranges.**	**Scab. Thrips. Rust mites. Red spiders.**	**Lime-sulphur solution, 2½ gals., and 13 oz. nicotine sulphate to 100 gals. of the spray solution.**	**When ⅛ to ½ the petals are off.**	**Add the nicotine if 25 or more thrips to the bloom are present. If thrips are abundant but no scab, use 1½ gals. lime-sulphur and 2 pounds nicotine sulphate solution to 100 gallons.**
4	***Grapefruit.**	**Scab.**	**Lime-sulphur solution, 2½ gals., in 100 gals. water.**	**7 to 10 days after ⅓ to ½ the petals are off.**	**Lime-sulphur will also kill rust mite and red spiders, and for thrips 12 ounces nicotine sulphate are added. Bordeaux-oil is not as effective as lime-sulphur for above insects.**
		Scab and Melanose.	**Bordeaux-oil.**		

5	Grapefruit and Oranges.	Scab, Scale-Crawlers. Rust mite. Scab & melanose.	Lime-sulphur solution, 2½ gallons in 100 gals. water. Bordeaux-oil.	14 to 20 days after ⅓ to ½ the petals are off.	To be given if rainy weather favorable for scab or melanose follows No. 4.
6	Grapefruit and Oranges.	Rust mites. Tearstain.	Lime-sulphur solution, 1½ to 2 gallons in 100 gals. water.	April 5 to 15.	If any two lime-sulphur sprays out of Nos. 3, 4, and 5 have been given, this can be omitted; otherwise, this is the critical spraying for rust mite on grapefruit.
7	**Grapefruit and Oranges.**	**White fly. Scale insects. Rust mites.**	**Oil emulsion, 1% plus 2½ lbs. dry soda-sulphur in 100 gals. water.**	**In May when fruit is at least 1 in. in diameter.**	**The oil emulsion should be used so that the diluted spray material will contain 1% oil; that is, if the emulsion contains 66% of oil, 1½ gallons would be required for 100 gallons water.**
8	**Grapefruit and Oranges.**	**Rust mites. Tearstain.**	**Lime-sulphur solution, 1½ to 2 gals. in 100 gals. water.**	**In June.**	**On oranges this is the critical rust mite spray, if the fruit has not received any previous lime-sulphur application.**
9	**Grapefruit and Oranges.**	**White fly. Scale insects.**	**Oil emulsion 1%.**	**Preferably in September or October but certainly before Feb. 1.**	**To be given, if scale insects or white-flies are noticeable.**
10	Grapefruit and Oranges.	Rust mites.	Lime-sulphur solution, 1½ to 2 gallons in 100 gallons water.	November to January.	To be given only if rust mites are noticeable.

* The scab applications indicated for grapefruit also may be required on highly susceptible varieties of oranges, especially of the kid-glove type.

† Application No. 3 will be required on oranges only when thrips are abundant.

Be cautious about using lime-sulphur solution when the temperature is above 90°F. If applied under this condition, use the weaker strength and be sure of the accuracy of the Baumé test and of the diluting.

Bordeaux mixture requires 3 pounds of bluestone and 3 pounds lime in 50 gallons water. Get the best grade of fresh stone-lime obtainable. Never use air-slaked lime. If hydrated lime or an inferior grade of quicklime must be used, make it 4 pounds.

A harvesting scene in a citrus grove. The fruit is hauled to the packing house to be washed, graded, and packed for shipment.

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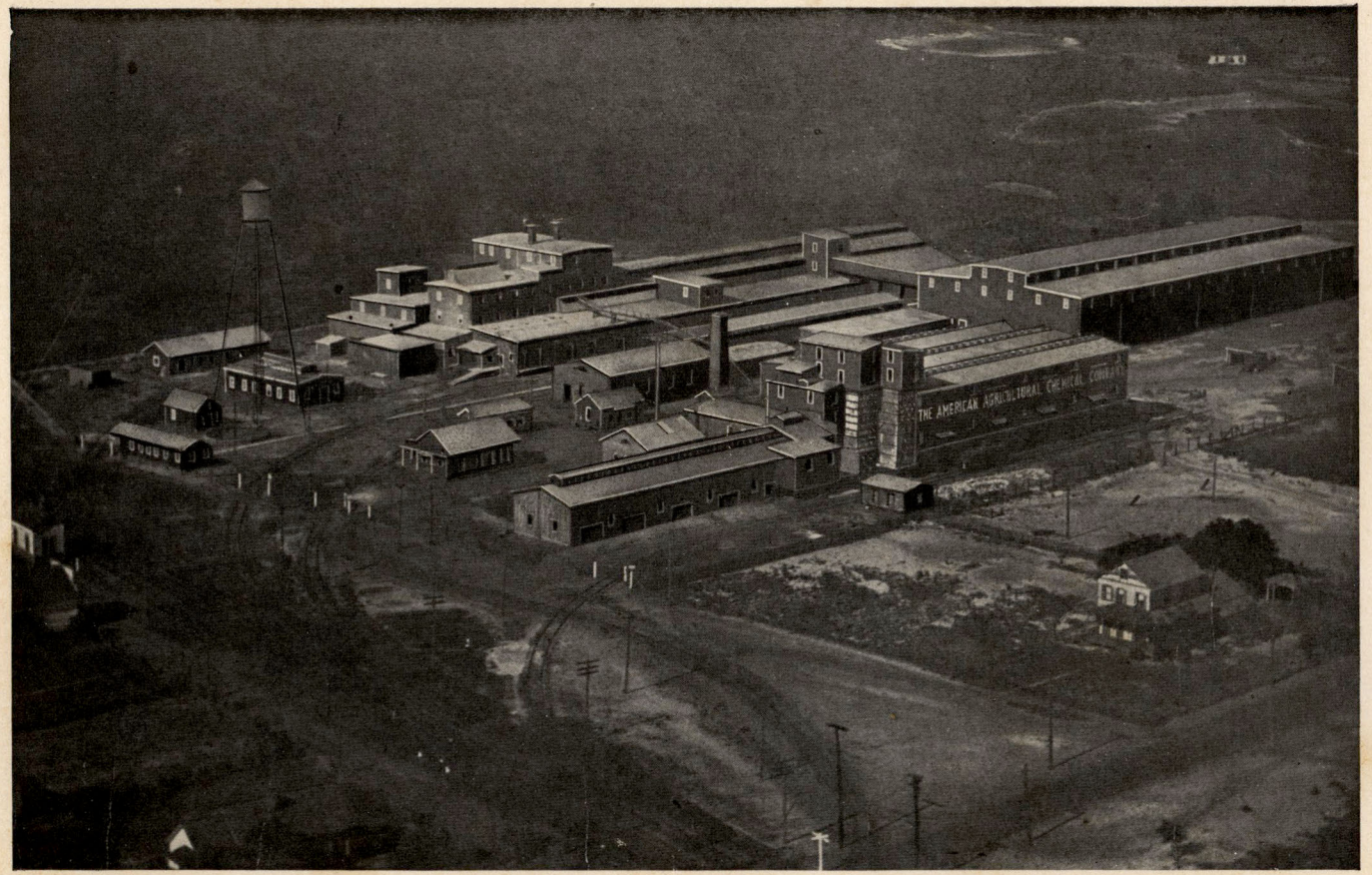

An aeroplane view of The American Agricultural Chemical Company factory at Pensacola, Florida.

14
2 1/4
3 58
28
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15.70

225
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3150

12 / 175.00
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