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INSECT AND MITE PESTS OF THE PEACH IN COLORADO

By GEORGE M. LIST and J. H. NEWTON

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INSECT AND MITE PESTS OF THE PEACH IN COLORADO

GEORGE M. LIST and J. H. NEWTON*

The intensiveness with which peaches are grown in certain sections of Colorado, and our low annual rainfall and rather high summer temperatures, favor many of the insect and mite pests. So, even though we have not had to contend with two very serious pests that occur in many eastern sections, the Oriental fruit moth and the plum curculio, the control of pests is essential to successful commercial peach growing.

The role of insects in the spread of the virus diseases of the peach that have become established or may become established brings this more forcefully to our attention. This bulletin discusses the essential points in regard to the life habits of the pests that should be known in order for the grower to wage an intelligent control campaign, and it brings together the latest information in regard to the best methods of control.

Green Peach Aphis

Myzus persicae Sulzer

Type of Injury

This aphis attacks the blossoms, fruits, and leaves, where it feeds by piercing and sucking. The first feeding takes place on the buds, but as soon as the flowers open the lice may enter the blossom and feed upon the flower parts. The lice may appear in the blossoms in numbers sufficient to blight them. After the fruit forms they sometimes attack the young peaches in sufficient numbers to cause them to wilt and drop. The feeding upon the leaves causes them to curl and turn yellow, and if the attack is severe many of the leaves drop. In extreme cases the foliage loss may be so heavy that the growth of the tree is definitely checked. The foliage injury is the most noticeable, but the fruit loss may be as serious.

Appearance and Life Habits

The insect passes the winter in the egg stage on the peach and other stone fruits. The eggs, when deposited in the fall, are pale green in color but soon become jet-black and shining. The majority of them are deposited near the tips of the new growth behind the buds, but in the case of heavy infestations the eggs may be deposited on all parts of the tree.

Eggs have been known to hatch in February, but the young from such eggs remain more or less quiescent until the buds begin

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to swell. All the eggs, however, are hatched by the time the pink of flower buds begins to show, and most of the young stem mothers from them are full grown and giving birth to young before the peach blossoms open.

It is this first generation of young that enters the blossoms to do so much damage. The light-pink colored stem mothers continue to give birth to living young for several weeks. This second generation, and also their young, are pale yellowish-green, with 3 dark longitudinal lines on the back of the abdomen. Very few of the second generation attain wings. The third generation becomes very largely winged and begins leaving the trees about the middle of May in Mesa County.

By the middle of June the insects have almost completely left the peach for their summer hosts. Following this the peach is free from the lice until fall, when they return from the summer hosts. The list of the summer hosts is a large one. It includes many common weeds and such common crops as cabbage, cauliflower, turnip, tomato, cantaloupe, and potato. The summer part of the life cycle takes place on those summer plants. Before the occurrence of frost, winged "fall migrants" are developed that return to the peach and also to some other stone fruits such as the plum, prune, apricot, and nectarine. Until this time all individuals have been females that give birth to young; now, however, true males and females are developed, and the latter lay the eggs that carry the species over the winter.

Under greenhouse conditions, where this species is a common pest, and in the South, the egg-laying forms are not regularly developed. Breeding can apparently continue indefinitely on the summer hosts while only the fall migrants, their egg laying progeny, and the spring forms can exist on the peach.

Control

The life cycle points to the time the insect is the most exposed for control through spraying. No effective material has been found to kill the eggs. Since the lice feed by sucking, they must be destroyed by contact sprays. The only time when there are none either in the blossoms or in curled leaves, where it is impossible to strike many of them, is before the blossoms open. This means directing the fight against the stem mothers. It should be remembered that, even though these are limited in number and do no noticeable injury, they are the only source of later generations that are responsible for serious injury. The most effective time to spray then is between the time blossom buds begin to swell and the time the blossoms open.

Forty percent nicotine sulphate, 1 pint; soap, 2 to 4 pounds; and water, 100 gallons, make an effective spray. However, since

lime-sulfur should be almost universally used for the control of the twig borer, and since the time of application for the two insects is the same, the following combination is recommended: 40 percent nicotine-sulphate, ¾ pint; calcium caseinate, 1 pound; lime-sulfur spray 100 gallons. Lime sulfur alone is not effective against the aphis, so its strength is determined by that necessary to control the twig borer. For dilutions of lime-sulfur, refer to "Twig Borer-Control" and "Insecticides."

The calcium caseinate gives a better spreading and wetting effect to the spray. This is important, as the lice must be wet with the nicotine solution for it to be effective. The application should be made when the temperature is 60° F. or above, and when the wind is not blowing. The infestation of the aphis and twig borer have been serious enough during the past several seasons that the use of this combination spray should be made a standard orchard practice.

If for any reason the delayed dormant application just described has not been made, and it becomes necessary to spray after blossoming time, the nicotine-soap combination should be used, but it must be remembered that many aphids will be in blossoms or curled leaves where they cannot be reached, and only a partial control can be expected.

Black Peach Aphis

Aphis persicae-niger Smith

Type of Injury

This aphis attacks both the roots and the parts above ground. The greater part of the injury to the trees is caused by the root-feeding. Heavily-infested trees are stunted, and the foliage takes on a yellowish, sickly appearance. Trees are most susceptible to injury the first or second years after planting and occasionally are killed before they can become well established.

When the lice feed above ground it is mostly on the bark of 1-year-old wood, but some may get into blossoms and blight them or feed on leaves, causing them to curl. This type of injury is usually on the lower parts of the trees. This louse has never been general in Colorado, but an occasional heavily-infested tree is found in all the peach sections.

Appearance and Life Habits

The young lice are amber-brown in color and the mature ones black. They feed upon the roots throughout the year and breed there by giving birth to young. No males or eggs have been found. Only wingless forms are found below ground. Early in the spring, as soon as the buds begin to swell, some of the root forms crawl up the tree and establish colonies on last year's growth. They are gregarious

to the extent that a single twig or limb may be covered by masses of the lice without any being on other parts of the tree. As the season advances winged forms develop and fly to other trees. About midsummer those that have not developed wings and moved to other trees migrate to the roots.

Control

The louse is often carried from the nursery on the roots of young trees. Infested stock should be rejected or should be treated by dipping into a nicotine-sulfate solution made by using 1 part of 40 percent nicotine-sulfate to 600 parts of water, to which has been added soap at the rate of 1 pound to 25 gallons. The forms above ground are usually controlled by the sprays applied for the green aphis. There are no practical treatments for the control of the root forms on large trees. With small trees it is practical to wet the soil with the nicotine-sulfate spray as a control.

Brown Mite

Bryobia pratensis Garmen

Type of Injury

The mite feeds principally upon the foliage but to a limited extent upon the fruit. Each feeding puncture makes a small, light-colored speck where the green color of the leaf is destroyed. When these become numerous the leaf has a faded-out, pallid appearance. The mites usually attack the lower leaves first, especially the water sprouts and other new growth at the bottom of the tree. During favorable seasons the entire tree becomes involved, and much foliage turns yellow and drops prematurely. Small, black specks, the droppings or excrement of the mites, make the fruit and foliage unsightly. The fruit of a badly-infested tree is small and does not mature normally.

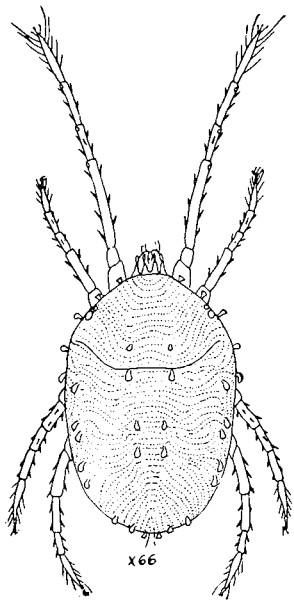

Figure 1.—Adult of the brown mite. (Original in Bul. 152, Colo. Exp. Sta.)

Host Plants

The mite has many hosts. It is commonly called the clover mite because of its prevalence upon the clovers. It attacks most of our common shade trees and shrubs. It becomes a pest upon the apple, pear, plum, prune, cherry, almond, and peach, but does not become

numerous on the apricot. The adults often collect about foundations of houses for hibernation, and on warm days of winter and spring find their way inside. They do no particular damage in the home, but their presence is very annoying.

Appearance and Life Habits

The mite passes the winter principally in the egg stage in the orchard sections of the western part of Colorado. In the eastern part of the state it appears to winter more as adults. It is here that many complaints come of its getting into houses during the winter.

The eggs are very small, round, red, glassy objects, deposited usually near the crotches of branches. Often the bark may assume a reddish color from the presence of so many eggs. When they are mashed the bark assumes a blood-red color.

The small red mites, upon hatching in the spring, have only six legs, but after the first moult they have eight. At this time the color changes to a brownish tinge or often to an olive green. The adult is brown in color. The front pair of legs is very long and constantly in motion. This characteristic and the absence of any web enable one to distinguish readily this mite in the orchard from the common red spider. During the summer eggs are deposited on the bark and leaves. Deposition of overwintering eggs may begin as early as the last of August.

Figure 2.—Overwintering eggs of the brown mite on the rough bark at the crotch of a limb. The eggs are round, red, glassy objects. (Original in Bul. 152, Colo. Exp. Sta.)

Control

An application of dormant-strength lime-sulfur to the eggs just before the buds open is the most effective control. This material does not keep the eggs from hatching, but the young mites are killed as they hatch out into it. For dilutions see "Twig Borer" and "Insecticides." Oil sprays have been used some as a dormant spray but on the whole have not been as successful as the lime-sulfur and are not as satisfactory in controlling the twig borer, which should be taken care of with the same application.

Often it is necessary to spray during the summer to protect the foliage. One pound of wettable sulfur to 10 or 12 gallons of water gives the best results. The sulfur does not kill instantly, but it does kill the young mites as they hatch into it, and it has a slow action on the adults. A week may pass before full benefits are noted. It is thought that the sulfur on the tree may be effective over a period of several weeks.

Red Spider

Tetranychus bimaculatus Harvey

Type of Injury

The injury from this species is confined to the foliage. It is quite similar to that of the brown mite; however, the yellowing of the leaves is more often in spots. This is due to the mites spinning webs over small areas and feeding within those areas. These areas may be almost blister-like in appearance. The presence of the very fine webs distinguishes the red-spider infestation from brown-mite infestation. The webbed surface collects dust during dry weather and gives the infested tree a dingy appearance. Fruit on heavily-infested trees is reduced in size.

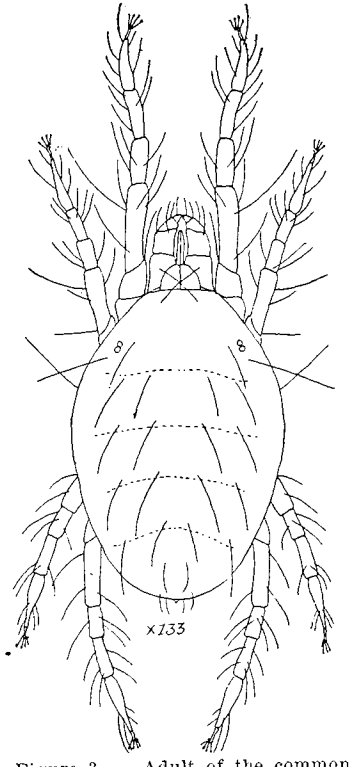

Figure 3. — Adult of the common red spider. (Original in Bul. 152, Colo. Exp. Sta.)

Host Plants

The red spider is a very general feeder. It is common on most of our shade and fruit trees, shrubs, and small fruits, and on many garden and field crops.

Appearance and Life Habits

The adults are somewhat smaller than those of the brown mite, and the fore pair of legs is much shorter. When the spider is feeding the fore legs are not extended and in motion as are those of the brown mite. This character and the presence of the webs make them easily distinguished by means of a hand lens.

When first hatched this spider is light green, with small dark-colored spots on the back. Later the color may change to light green, brown, or bright red. The color is extremely varied. The eggs, which are very small, globular, and pearly

white, appear on the under surface of the leaves. All stages of the spider can be found on the leaves through the summer.

Red spiders spend the winter as adults in the ground about the base of the trees. Movement to the soil may begin as early as August. At this time they are all red in color and may become so numerous on the trunk of the tree near the soil that they give it a reddish appearance. The mortality in the soil during the winter is undoubtedly very high. As the leaves begin to appear the overwintering adults ascend the tree and lay their first eggs.

Control

Spraying with wettable sulfur, one pound to 10 or 12 gallons of water, as recommended for the brown mite, is the most satisfactory control. Lime-sulfur summer strength and summer oil sprays are often used on other crops but cannot be safely used during the growing season on the peach.

San Jose Scale

Aspidiotus perniciosus Comst.

Type of Injury

The San Jose scale has never been as menacing on the peach as on the apple in Colorado. It is occasionally found on the trunk, limbs, and leaves, but we have no records of its being numerous enough to attack the fruit. Wherever the insect locates and feeds

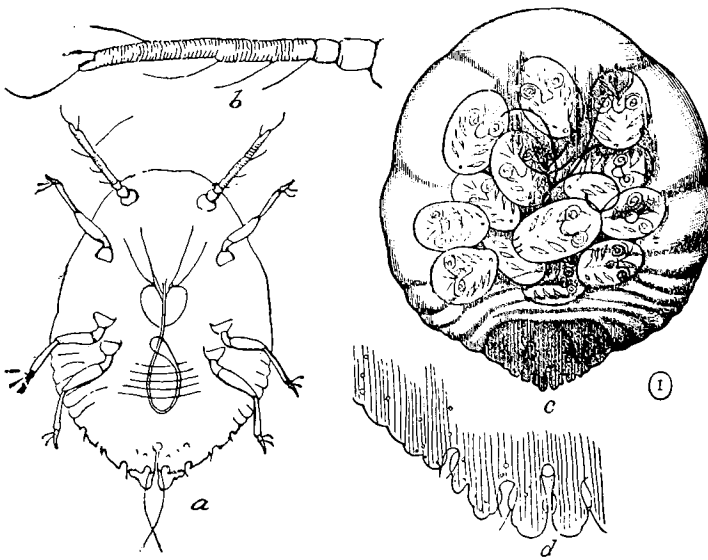

Figure 4.—San Jose scale; a, female removed from scale; b, antenna; c, gravid female, showing unborn young. The insects are yellow in color when removed from the scale. (From Bul. 47, Colo. Exp. Sta.)

on the leaves and thin bark it makes a small, reddish spot somewhat less than ¼ inch in diameter. This discoloration does not show on the old wood, but by cutting away the outer bark it will be seen on the inner bark. A heavy infestation gives the limbs a roughened and grayish appearance, and if they are scraped a yellowish liquid, coming from the crushed bodies of the insects, appears. In sections where conditions are more favorable for the scale than they seem to be in Colorado, trees may be killed by it.

Appearance and Life Habits

The scale covering of the female when full grown is less than the size of a pinhead, and it is grayish with a dark, central, nipple-like projection. The scale covering of the male is elongate. The bodies of both males and females are yellow and sac-like. All stages may be found on an infested tree in the fall, but only those that are about half grown survive the winter. The winter survivals mature in May and June, and their young come from under the old scale. They may crawl about for a few hours, but unless they are blown off or get on the feet of birds or large insects, they locate near the mother scale. As the females are incapable of moving after they locate, all natural spread must take place while in the crawler stage. There are two or more generations in a season.

Control

Control can be secured by spraying before the buds open, with a dormant-strength lime-sulfur or a 4-percent oil spray. The normal use of the lime-sulfur for twig borer control usually keeps the San Jose scale well under control.

Putnam Scale
Aspidiotus ancylus Putnam

Howard Scale
Aspidiotus howardi Cockerell

These two scale insects are so similar in appearance and habits that it is difficult to distinguish them in the orchard, and some specialists on the group consider them the same. They are closely related to the San Jose scale but as a rule do not increase as rapidly nor injure trees as severely. They are about the size of the San Jose but of a paler grayish color. The nipple-like projection, instead of being in the center and dark in color, is at one side of the center and of a dull orange color. They winter as partly-grown insects, and otherwise have about the same life habits as the San Jose. They are more often found in the peach orchards than the San Jose scale, but an occasional annual dormant spray of lime-sulfur or oil keeps them well under control.

Climbing Cutworms

Type of Injury

Early in the spring cutworms may climb the peach trees and feed upon the opening buds. The earliest injury may show the blossom buds hollowed out, but as the worms become larger the entire buds may be eaten away. At times they have been numerous enough to gnaw off the tender bark of twigs.

Description and Life History

Several species of cutworms are involved. Some of them are the same as the common ones found in gardens and climb trees to feed only because of scarcity of green food on the ground, while others are species that instinctively climb. All are sleek, plump, dull colored, obscurely-marked caterpillars. The adults are heavy-bodied, dull-colored, night-flying moths with a wing expanse of about 1½ inches. They are often attracted to lights at night during late spring and summer.

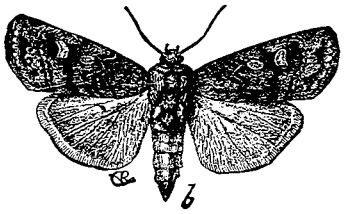

Figure 5.—The moth of one of our common species of cutworms. Such moths are common during May and June in dwellings, where they are attracted by lights. (After C. V. Riley.)

Eggs are deposited in the late summer, and the partly-grown caterpillars overwinter in the soil and begin feeding as soon as growth starts in the spring. They hide in the soil during the day and do their feeding at night. As a result trees may be stripped of their buds without the culprits being seen. Light, sandy soils are usually preferred, hence trees growing on such soils should be watched each spring. In the Palisade section the damage has been greatest along the Colorado River.

Control

Many species of cutworms are readily poisoned by broadcasting, late in the evening, poisoned bran prepared by mixing 25 pounds bran, one pound Paris green, and enough water to make a soft mash. However, the most-prevalent species in the Mesa County district, where the greatest damage has occurred, have not responded to this treatment. Efficient protection can be secured by maintaining during the blooming period a band of sticky material about the trunk of the tree to prevent the worms from climbing. Prepared materials of this type are on the market and are generally more efficient and safer to the bark of the trees than home-made materials. Peach growers in the susceptible areas should have material on hands each spring so that applications can be quickly made, as trees may be stripped of their buds in a night or two when weather conditions suddenly bring the worms out to feed.

Shot-hole Borer

Scolytus rugulosus Ratz.

Type of Injury

Trees are injured by the adults and the larvae. The adults make shot-like exit and entrance holes in the bark.

Entrance holes for egg laying are made in limbs of ½ inch or greater diameter. A tunnel is made through the inner bark then up or down the limb, rarely around it,and eggs are deposited along this tunnel. If there is an excessive flow of sap, many tunnels may be abandoned. Injuries in such trees often exude gum freely. The adults also cause much twig injury by boring short holes in the wood at the base of buds or in the angle of fruit spurs and twigs. This type of injury has been more noticeable on sweet cherries than on peaches in Colorado. A few cases have been noticed where a large percentage of the fruit spurs have been injured. Eggs have never been noted in this type of injury.

Figure 6. — Work of the shot-hole borer, sometimes called the fruit tree engraver. The upper part has the bark removed to show where the larvae have fed upon the inner bark and left their "engravings" upon the wood. The arrow points to a "shot-hole" exit made by an adult beetle.

The larvae feed between the outer bark and the wood, destroying the cambium. The injury frequently results in girdling the limb, since the larvae tend to travel at right angles from the vertical, primary egg burrow, and hence work around the limb. The borer breeds freely in the plum, prune, cherry, apricot, apple, and pear, as well as in the peach.

Appearance and Life Habits

The adult shot-hole borers are dark-brown to black in color, roughly cylindrical in shape and about 1/10 inch in length. The females cut cylindrical holes through the bark to the wood, then work up or down the length of the limb for a distance of 1 inch to 1¼ inches, and lay their round, white eggs along the sides of the burrow. After laying her eggs the female backs to the opening of the burrow and dies there in such a position that her body blocks the opening and prevents entrance of parasites and predators that might destroy the eggs or larvae.

The eggs hatch within a few days after being laid. The larvae burrow out usually at right angles to the egg tunnel. The egg tunnel is of uniform bore and remains open, while the larval tunnels become wider as the larvae grow and are packed full of sawdust-like frass. In heavy infestations the larval tunnels may intertwine, and the entire inner bark be reduced to a powder.

The full-grown larvae are white with small brown heads sunken into the enlarged anterior part of their bodies. They are legless, and their bodies usually are curved. When mature they burrow into the wood to a depth of about 1/16 inch, where they construct cells in which to pupate or transform to the adult. The adults remain in the pupal cells for a few days, then cut their way out, making the characteristic shot-hole openings.

The winter is passed largely in the mature larval stage. Some pupation takes place during the winter but most of it in the spring. The beetles emerge over a period of 3 or 4 weeks in the spring. Three generations are reported in some states, but all evidence indicates only two in Colorado.

Control

As it attacks weak or injured trees or branches chiefly, the best control of the shot-hole borer is to keep all trees in a good, thrifty condition. All weak or injured limbs and weakened or injured trees should be removed before they become centers of infestation. If infested wood is cut and piled during the winter, the beetles will emerge from it the following spring and infest nearby trees. Such wood should be burned before the first of March. Wood from healthy, non-infested trees cut during the winter may retain enough sap in the spring to be acceptable to the beetles, and it may serve as food for the spring brood. Dry wood is not acceptable to the beetles for egg laying.

After the beetles have entered the bark there is no practical way of reaching them with an insecticide. Slightly-infested trees may be saved by a severe pruning and by good care which will stimulate new growth and a normal flow of sap.

Buffalo Tree Hopper
Ceresa bubalus Fab.

Type of Injury

Roughened, longitudinal slits for egg laying are cut in the 1-year-old wood and the current season's wood by the females of the

buffalo tree hopper. The old scars may persist for several seasons. These wounds are through the bark and often into the wood. The growth of trees is often retarded, and in extreme cases limbs may be so weakened that they break easily. The injury is usually confined to the lower part of the trees, and young trees are most often attacked.

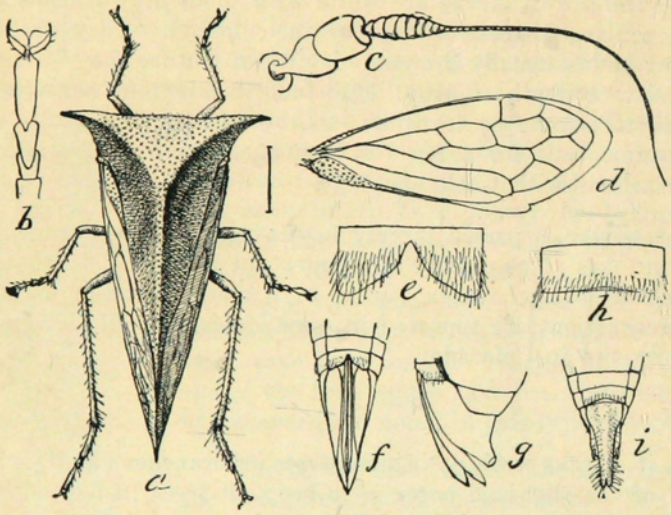

Figure 7.—Buffalo tree hopper; a, female much enlarged (note the shape that gives the insect the buffalo appearance and common name); b, foot of female; c, antennae or feeler; d, wing; f and g, last segments of the female abdomen (on g note the two knife-like parts of the ovipositor that enable the female to cut the slits into limbs for the laying of eggs). (Original Cir. 23, U. S. Dept. of Agr., Bur. Ent. and Plant Quarantine.)

Appearance and Life Habits

The adult insects are about ⅜ inch long, gray-to-green in color, triangular in shape, with two forward-growing horn-like points that suggest the appearance of a buffalo. During late summer and fall the females cut the slits into the bark with their ovipositor and deposit their whitish, cylindrical eggs side by side in the wound. From 5 to 20 are placed in each scar. The ends of the eggs often are visible, but if not their presence is readily detected by cutting away a thin layer of bark. During April and May the young hatch and drop to the ground, where they feed chiefly on alfalfa.

Control

Clean cultivation is the most practical control. It is almost essential in the case of young orchards. Usually keeping older orchards free of alfalfa will suffice. Spraying with a 4-percent oil

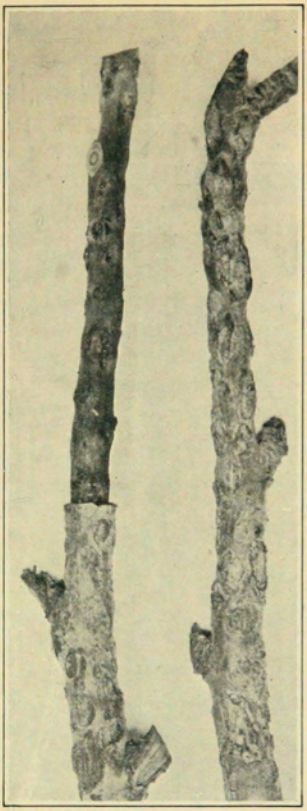

Figure 8.—Twigs showing egg scars of the buffalo tree hopper. While the eggs are placed in the bark tissue the scars often extend into the wood as shown where the bark has been removed.

will kill many eggs. Severely-attacked trees should be heavily pruned and the prunings burned to destroy the eggs.

Peach Borer

Aegeria exitiosa Say

Type of Injury

The white worms of this clear-winged moth feed within the bark of the peach and other stone fruits near or just below the surface of the soil. The external evidences of the injury are the masses of gum that exude where the injury occurs. This may be from 8 or 10 inches above the soil surface to 3 inches below. Brownish frass or sawdust is usually mixed with the gum. Trees may be partially or completely girdled. A heavy infestation may girdle a tree in one season. Successive light infestations may have about the same effect in time.

Appearance and Life Habits

The adult peach borers are black-and-yellow, clear-winged, wasp-like moths that are often seen flying about the bases of trees during the late summer and early fall. They lay their eggs mostly on the trunks of trees and within a few inches of the groundline. A few may be deposited in the soil near the trees. The small larvae immediately burrow into the soft bark, where they feed until maturity. The full-grown larva is about an inch in length and of a very light yellow color, except the head, which is dark reddish-brown.

The mature larva leaves the burrow and spins a silken cocoon in which it incorporates masses of sawdust and frass. Most of these are on the surface of the bark just at the groundline, but some are in the soil. The empty pupae skins may often be seen protruding from these masses after the moths have emerged. The moths are most active during the heat of the day, and when seen flying in the sunlight are often mistaken for wasps.

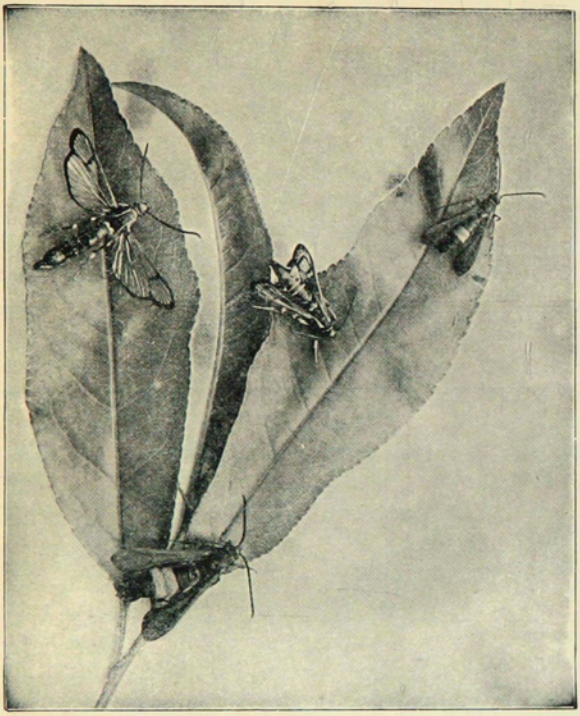

Figure 9.—Peach tree borer, adults on peach leaves. The males have clear wings with steel-blue margins. The females have steel-blue wings and a broad, orange-colored band around the abdomen. They appear more like wasps than true moths. (Courtesy U. S. Bur. Ent. and Plant Quarantine.)

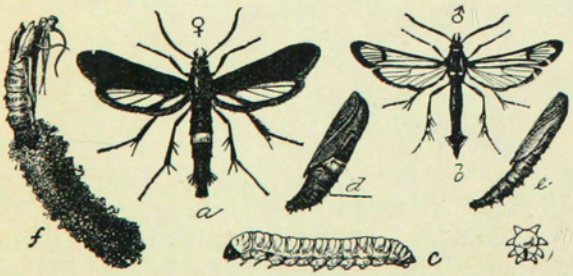

Figure 10.—Peach tree borer; a, adult female; b, adult male; c, full grown larva; d, female pupa; e, male pupa; f, cocoon with pupa skin protruding. All illustrations about natural size. (Courtesy U. S. Bur. Ent. and Plant Quarantine.)

The moths begin to appear in July, and emergence continues until September, the greater number coming out during August. Egg laying begins within a few days after the moths emerge. All eggs hatch in the fall, but this long period of egg laying gives larvae of varying sizes to go into winter.

The larger larvae, which may be as much as two-thirds grown, spend the winter in the burrow, but the smaller ones leave their burrows and spin silken hibernacula on the bark in which to winter. These are often seen on nursery stock. There is but one generation each year.

Control

Until only a few years ago no satisfactory control was known, and thousands of trees were lost in every peach sec-

tion. Now, fortunately, a method almost 100 percent effective is available, and no grower needs to lose trees or have them seriously damaged. The method consists of placing a small amount of the crystals of paradichloro-benzene, often called P.D.B., about the trunk of the tree in the fall.

The amount of P.D.B. to be used varies with the size of the tree. For trees 3 years old use ½ ounce per tree; for trees from 3 to 6 years old ¾ ounce; for most older trees from 1 to 2 ounces; and for very large and rough trees 3 ounces.

After removing grass and weeds, level the soil about the tree and apply a ring of the crystals around the tree from 1 to 3 inches distant from the bark; never have them in contact. Then cover the ring with a few shovelfuls of soil and pack it down slightly to hold the gasses against the crown of the tree.

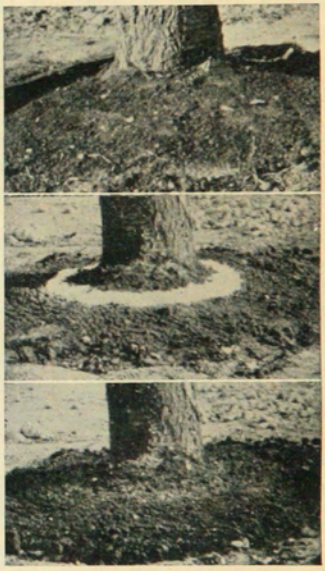

Figure 11.—Applying P. D. B. for control of the peach tree borer. Bottom, ground leveled for the placement of the crystals; middle, the ring of P. D. B. around the trunk; top, 4 or 5 inches of soil placed over the P. D. B. (Courtesy of Colo. Ext. Serv.)

Application should be made after the majority of eggs have hatched but early enough to have from 10 days to 2 weeks of soil temperature of at least 60 degrees. In the Palisade section the desirable time is just following fruit harvest and for Delta County and other sections just before fruit harvest. Some follow the practice of tearing the mounds down within 3 weeks for fear of injury, but the general practice is to allow them to remain until spring. They should be torn down then, or larvae may enter so high in the tree the next fall that it will be difficult to treat it satisfactorily. Spring treatment is sometimes used, but it is less effective than fall treatment.

The P. D. B. is sometimes applied to the trunks of the trees in oil. Mix 1 pound of P.D.B. with 2 quarts of raw cottonseed oil and apply on the injured portions with a paint brush. Soil should be banked around the tree about as with the other method. The material has been applied successfully to the trees by means of spray pumps, but there seems to be little advantage to either of these over the ring method, and there is some uncertainty with regard to the safety to the tree.

Peach Twig Borer
Anarsia lineatella Zeller

Type of Injury

The peach twig borer is probably the most destructive peach insect in Colorado when control measures are not followed. Fruits in unsprayed orchards may be as high as 25 percent wormy. The overwintering larvae eat into the tender shoots in the early spring, causing them to wilt and die. The tips of the new growth are subject to attack throughout the season. It is the later varieties that suffer the greatest injury to the fruit.

Appearance and Life Habits

The insects pass the winter as small larvae, about 1/16 inch in length, in small silken hibernacula just beneath the outer bark and usually in the crotches of both small and large limbs. Each little hibernating cell is covered by a small mound of reddish-brown bits of bark rubbed together. In the spring, about the time the blossoms open, the larvae leave the winter quarters and eat into the tips of the new growth. They may hollow out the twig for a distance of an inch, or they may eat only to the pith and move on to another twig. In this way one larva may cause several twigs to die near the tip.

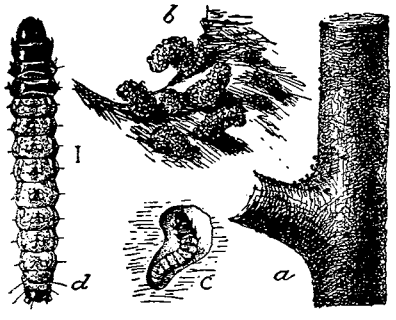

Figure 12.—Peach twig-borer; a, twig of peach showing little masses of chewed bark over the hibernating larvae; b, the same enlarged; c, larva in winter burrow; d, hibernating larva greatly enlarged. (After Marlatt, U. S. Bur. Ent. and Plant Quarantine.)

The full-grown, reddish-brown larvae, about ½ inch in length, crawl to the larger limbs and trunk, where they spin a thin, silken cocoon in the curled, loose bark. In 10 to 12 days the delicate, light-to-dark-grey moths, with a wing expanse of only about ½ inch, appear.

Three more generations follow. The eggs of the second generation are deposited largely on the new growth, and the larvae feed here, some of them to maturity; but others move to the fruit and make entrance, usually at the stem. The feeding here often causes the formation of gum. Pupation takes place in a silken cocoon often built in the hollow at the stem end of the fruit. The third brood eggs are deposited largely on the fruit. The larvae eat along the pit, or in the case of split pits they may feed upon the kernel.

They apparently give rise to a fourth generation of moths which in turn give rise to the small larvae that overwinter in the silken hibernacula built in the bark of the tree crotches.

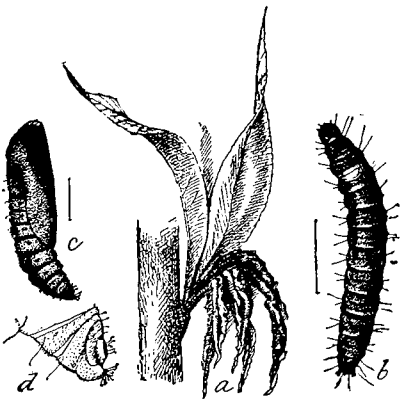

Figure 13.—Peach twig borer; a, young shoot wilting from attack of borer; b, adult larva enlarged; c, chrysalis, enlarged. (After Marlatt, U. S. Bur. Ent. and Plant Quarantine.)

Control

Lime-sulfur spray has proved very satisfactory in experimental tests and has stood the test with the better growers over a period of years. Yet despite this some growers are inclined to try less-effective materials or do not use the lime-sulfur properly or fail to make its use an annual practice, with the result that there is considerable loss from the twig borer each year. The regular dormant strength of lime-sulfur as ordinarily recommended for San Jose scale should be used. Where the standard commercial liquid concentrate is used, the dilution should be according to the table, page 30. A slightly weaker solution will give good control of the twig borer; but this strength is recommended, as the same application should control the San Jose, Howard, and Putnam scales, as well as the brown mite. Dilution of lime-sulfur is discussed further under "Insecticides."

The time of application is important. Good results are not secured when the application is made before some activity of the overwintering insect begins. The silken, cell-like, overwintering hibernacula protects the larvae rather effectively, but as warm weather comes on the larvae become somewhat active, enlarge the cells, and possibly even feed to some extent on the bark.

From this time on the silk cell is more readily penetrated by the spray due to the fact that it has been somewhat made over. The application, therefore, should not be made before the buds begin to swell nor after the first blossoms open. A later application may burn the new foliage, or it may so burn the petals that the blossoms will not open properly. The application should be thorough. Each hibernacula of the overwintering insect must be reached and thoroughly wet in order to have the spray penetrate the dry bark, frass, and web about the larva.

Miscible or soluble oils are sometimes used during this same period, but the results have not been as satisfactory as from the

lime-sulfur, nor have they controlled the brown mite. The results from them have been satisfactory for the control of the green peach aphis and the scale insects but no better than from the lime-sulfur, nicotine sulfate, and calcium caseinate combination.

Lead arsenate, 1½ pounds to 50 gallons of water, is sometimes used. An application made just before the trees are in full bloom will poison many of the larvae as they attempt to eat into buds or new growth. In the case of extremely heavy infestations, lead arsenate has been used by placing it in the lime-sulfur spray to get the contact effect of the lime-sulfur and poisoning of the arsenate of lead.

Arsenate of lead is occasionally used on young trees for the second brood. Many of the larvae can be poisoned as they enter the new shoots. The peach tree is very susceptible to burning from the use of arsenical sprays, so they should be used with caution and never during cloudy and rainy weather. The tendency to burn is greatly reduced by using a small amount of hydrated lime. The arsenate of lead should not be used on bearing trees after the fruit is well set, or the fruit may carry an objectionable amount of poison residue at harvest.

Tarnished Plant Bug

Lygus pratensis (L)

Type of Injury

The feeding of this bug on the small fruits just after the petals fall may cause many fruits to wither and fall. Those fed upon that do not fall are blemished. These blemishes may vary from slight dimples to extensive sunken or puckered areas that loose the pubescence. Peaches so disfigured are often spoken of by the growers as "cat-faced" or "monkey-faced" peaches. In extreme cases as high as 60 percent of the fruit in individual orchards has shown this injury, and 8 or 10 percent blemished fruit for an entire section is common.

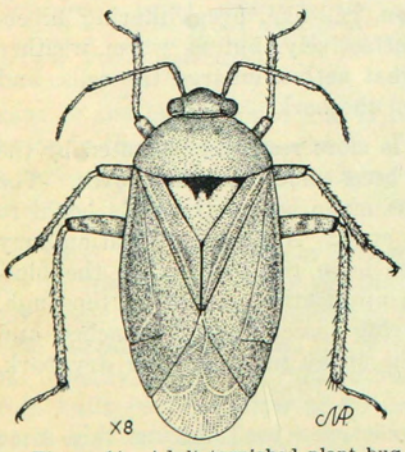

Figure 14.—Adult tarnished plant bug. Four times natural size.

The insect feeds by piercing and sucking. This injury so affects the surface tissue of the peach that the pubescence dies and comes off, and the injured area remains somewhat sunken. This injury appears to take place

just before or immediately following the shuck fall. While the fruit is still small the pubescence on injured areas shows a slight discoloration and is easily rubbed off with the edge of a knife blade.

A third type of injury known as "die back" sometimes occurs, especially on nursery stock. This is a wilting or dying back of new growth caused by a sucking of sap and a possible injection of a poisonous substance. This has never been noted in the orchards.

Description and Life Habits

The adult tarnished plant bug has coppery-brown or yellow color, is oval in shape and about ¼ inch long. Winter is spent in the rubbish along fence rows, ditch banks, alfalfa fields or other places where protection is afforded. Quite early in the spring some of the bugs fly to the trees. Our observation has been that they are on the trees for only a short time, just before and after the blossoms fall.

All the fruit injury seems to take place before the shucks fall. The size of a blemish is dependent upon the amount of feeding done on that area. The insect has been observed to remain in one place

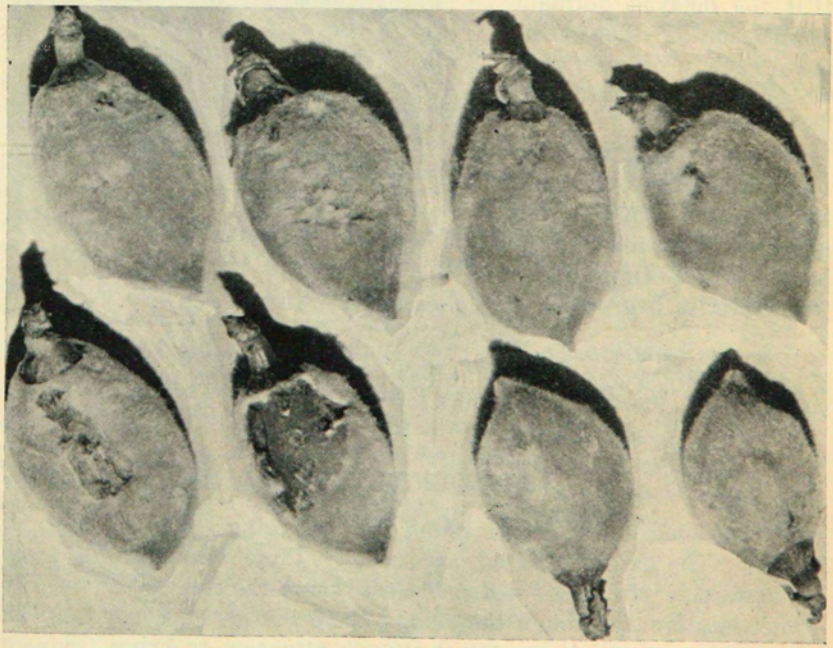

Figure 15.—Small peaches showing tarnished plant bug injuries. The two fruits in the lower left-hand corner have had the pubescence removed to show the injury to the surface. Photograph by L. G. Davis.

and to pierce the fruit several times in the one limited area. Each puncture apparently destroys some of the cells, and many small blemishes coalesce to form a large one.

Breeding takes place on a variety of plants. The young have never been observed on the peach, so the peach tree does not appear to be a breeding host. The preferred hosts are legumes and certain weeds.

Control

No satisfactory control has been developed. As it is a sucking insect it cannot be poisoned, and the adults are so active and are on so many different plants that contact sprays are not practical. Sulfur dust and wettable sulfur sprays have been reported to have some repelling effect on the insect in garden crops, but tests made by L. G. Davis in the spring of 1933 showed no beneficial results. It has been thought at times that the delayed dormant application of lime-sulfur gave some protection, but we have no data for support.

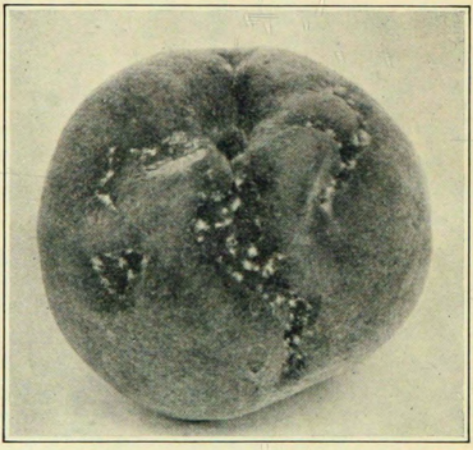

Figure 16.—A peach showing tarnished plant bug injury as it appears at harvest time.

The burning of ditch banks and fence rows, and the elimination of weeds in and about the orchard may be beneficial. Orchards in which alfalfa is growing have generally shown more injury.

As the blemishes on the fruit usually show by the time thinning is started, much can be done to reduce losses by the removal of the injured fruits.

FRUIT NOTOXUS

Occasionally peaches are found that are being fed upon by small beetles. The fruits selected are usually those that have a fresh mechanical injury or a roughened area where the insects can readily attack and break through the skin. These beetles have not been an important pest, but they attract enough attention to bring frequent inquiries.

Several species belonging to this group go under the common name of fruit notoxus. Our most common one seems to be *Notoxus monodon* Fabr. It is a dull brownish-yellow beetle slightly more than ⅛ inch long, with dark markings on the wing covers which usually take the form of a broad, cross-bar band. The thorax has a forward growth that forms a hood or horn over the head. The head is held at right angles to the body, giving the insect an awkward appearance. J. B. Gill[1] has observed it feeding upon pupae of the fruit tree leaf roller at Canon City, and W. P. Yetter[2] found it feeding on the pupae of the egg parasite, *Trichogramma minutum* Riley, that had been placed in the orchard for the liberation of the parasite.

Insects and Peach Mosaic

It behooves the peach growers of Colorado now, more than ever before, to keep insect pests well under control. Their role in spreading virus diseases such as the peach mosaic, which is rather general in one important section, is well known. Experiments are now under way with the object of determining the exact species involved. In the meantime all insects, especially those of the sucking type, should be held to as low a number as possible.

Thrips

These small insects normally live in dandelion, alfalfa, clover, sunflower, and similar blossoms, but many find their way to the peach. Several species are involved. Collections made at Palisade in 1931 by L. G. Davis and determined by J. R. Watson showed *Frankliniella helianthi* Moulton, *Frankliniella occidentalis* Pergande, *Frankliniella moultoni* Hood, *Thrips tabaci* Lindeman, and *Heliothrips fasciatus* Pergande to be present in and about the orchards. *Heliothrips fasciatus* Pergande and *Frankliniella helianthi* Moulton were taken in peach blossoms. The flower thrips, *Frankliniella tritica* Fitch, is usually a common one in fruit blossoms but was not taken in these collections.

At times from one to a dozen or more of these minute, slender, yellowish insects may be found in a single peach flower, sucking the juice from the flower parts or from the newly-set fruit. They undoubtedly prevent some flowers from setting fruit and may cause the dropping of some small fruits. Some workers have thought these insects responsible for some of the "cat-facing" of peaches, but our observations give us no proof of this.

Spraying with nicotine-sulfate 1 pint, water 100 gallons, with 1 pound of calcium caseinate or 4 or 5 pounds of soap, when the trees

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[1]Bul. 116, Pt. 5, Bur. Ent. U. S. Dept. Agr., p. 102, 1913.

[2]Accession data on specimens collected 1928., Colo. Exp. Sta. collection.

are in full bloom, will kill many. We do not have data to show this is a practical operation for the commercial producer.

Insecticides

Most of the insecticides recommended herein are standard materials and need but little discussion. However, some points in regard to dilutions, combinations, and precautions to observe should be mentioned briefly.

Lead Arsenate

This is the safest arsenical insecticide to use on peach trees. The use of hydrated lime or calcium caseinate with it helps to overcome the tendency to burn. Our experience has been that these materials stabilize the arsenate of lead more and, therefore, overcome the burning better if they are first made into a thin paste with the arsenate of lead before being added to the spray tank. From ½ to 1 pound of the calcium caseinate to 100 gallons of spray is sufficient, or if hydrated lime is used it should not exceed the amount of arsenate of lead.

Soaps should not be used with lead arsenate, as they increase the tendency to burn. Lead arsenate may be safely combined with oil sprays, nicotine solutions, and lime-sulfur. If combined with lime-sulfur the mixture should be used at once on account of chemical changes that take place upon standing. This reaction can be retarded by mixing calcium caseinate or hydrated lime with the lead arsenate as previously mentioned. Arsenate of lead should not be used after the fruit is well formed, or the poison residue may exceed the tolerance permitted by pure food regulations.

Nicotine

Nicotine is one of of our most effective contact insecticides. It is on the market as free nicotine and as nicotine sulfate. The latter is used almost exclusively in orchard work. The nicotine sprays kill by actual contact with the insect and to some extent by the fumes given off. The fumes are more effective if the wind is not blowing and the temperature is reasonably high. Sixty or 70 degrees should be the very minimum, and 80 or above is better. Calcium caseinate 1 pound, or soap 2 or 4 pounds to 100 gallons of spray increases its effectiveness by increasing the wetting and spreading power and by making the solution slightly alkaline. One of these materials should always be used unless the nicotine is used with an oil spray.

The nicotine sulfate can be safely used with lead arsenate, oil sprays, and lime-sulfur.

Oil Sprays

Oil emulsions and miscible oils are important insecticides but are not generally used in the peach-pest control program. Oil emulsions can be made at home, but this is not recommended for peach work. Only the best grades of commercial emulsions and miscible oils should be used, if any are tried.

Sulfur

The effectiveness of sulfur against the brown mite and red spider depends largely upon the fineness of the particles. Ordinary flowers of sulfur has been used at times in the past but should be used only in case more suitable material cannot be secured. Sulfurs are on the market that will pass through a 300-mesh screen. Brands of this type should be selected. Many of them have materials incorporated that cause the sulfur to go into suspension readily in the spray tank. These are known as wettable sulfur. A small amount of glue, gelatin, milk, or soap can be used to aid in wetting desirable sulfurs that do not already have a wetting material incorporated.

Calcium Caseinate

Calcium caseinate is a mixture of casein and lime that, when added to water, greatly increases its spreading and wetting qualities, thus aiding to wet waxy leaves and insects having body surfaces that naturally shed water. It is sold under several trade names. It is compatible with all the insecticides mentioned in this bulletin.

Lime-Sulfur

The insecticide known as lime-sulfur is a chemical combination of lime and sulfur. It is the material most widely used by peach growers. The active ingredients are the polysulfides of calcium. The sulfur in such combinations is spoken of as sulfide-sulfur, and the amount present determines the strength of the material.

Lime-sulfur is on the market in the liquid and dry states. It is practical to make the liquid at home, and a considerable part of that used by the peach growers of the state is so made, either by the individual growers or by communities or associations. Lime-sulfur can be combined with nicotine and lead arsenate. If the latter combination is made, observe precautions given under "Lead Arsenate."

Lime-sulfur should not be used on the peach during the summer. Best results are secured in mixing the lime-sulfur, nicotine sulfate, and calcium caseinate formula recommended for the twig borer and the green aphis by first adding the calcium caseinate to the spray tank as it is being filled. When the tank is about half filled add the required amount of lime-sulfur, then add the nicotine

sulfate last. This prevents, to a large extent, the excessive foaming that results when the materials are added in a different order or all at one time.

COMMERCIAL LIQUID LIME-SULFUR

This material has long been on the market and is well standardized. The container will show the Baume test and in some cases the sulfide sulfur content. Dilution should be according to the table.

DRY LIME-SULFUR

The dry lime-sulfur must be evaluated on the basis of the sulfide sulfur content, the same as the liquid. On this basis it takes 5 pounds to equal 1 gallon of the 33-degree Baume liquid. The dilution table calls for 11½ gallons of 33-degree Baume liquid to make 100 gallons of spray. It will, therefore, take 57½ pounds of the dry lime-sulfur to make 100 gallons of spray of the same strength. On this basis it is more expensive than the liquid unless a great saving can be made on the freight.

HOME-MADE LIQUID LIME-SULFUR

Since a large portion of the lime-sulfur used by the peach growers is made at home, and many requests come for assistance, it seems advisable to quote directions for making and diluting it from Colorado Experiment Station Bulletin 411:

Theoretically, lime and sulfur unite in the proportion of 1 part of lime to 2.28 parts of sulfur by weight. Commercial lime is never pure, so the proportions of 1 part of lime to 2 parts of sulfur have been found to give the greatest amount of pentasulfide with the least waste.

The following formula is the most generally used in home work:

Lump or stone lime	50 pounds
Commercial ground sulfur	100 pounds
Water, enough to make	50 gallons

The method of operation and addition of the materials can be varied to suit conditions. The following three methods are in use:

1. Place the required amount of water in the cooking vessel and bring almost to the boiling point. Mix the sulfur with hot water and 10 percent of the lime to form a thick cream or paste. When the

water is almost ready to boil add sufficient of the lime to bring it to the boiling point, then add lime and parts of the lime and sulfur paste alternately in such quantities that the heat for cooking and from the slaking lime keeps the solution boiling all the time.

2. Mix the lime and sulfur in dry form and then shovel this mixture into the cooking tank, after first having brought the required amount of water to the boiling point. The heat generated by slaking the lime is taken advantage of to hasten the cooking.

3. Heat about one third of the required amount of water, and to this add the lime. As soon as the lime starts slaking add the sulfur, which should have been previously mixed with enough water to make a thick paste. Then add the remainder of the water, having it hot if possible.

It usually requires 15 or 20 minutes to add the materials, then the cooking should be constant for 50 or 55 minutes after the lime has finished slaking. A slow, steady boil is to be preferred. Care should be taken to prevent overheating and foaming. The material should be constantly stirred, especially during the early part of the cooking. Any water boiled away should be replaced, as the full amount is necessary for the most complete combination of the lime and sulfur. If it is found that 5 gallons are boiled away in the cooking, it will be found best with the second batch to add this much extra in the beginning rather than to check the boiling by adding water during the cooking period.

MATERIALS

LIME.—It is essential to have a high-grade, freshly-burned stone lime (CaO), known also as lump lime or quicklime. It should be from 95 to 98 percent pure. The most objectionable impurity is magnesium, which forms insoluble compounds and greatly increases the sludge. The magnesium oxide should not exceed 5 percent, and many limes that can be purchased under a guarantee contain much less than this.

A high-grade hydrated lime can be used with fair results, but it is necessary to use one-third more by weight than is given in the formula for stone lime. This will greatly increase the amount of sludge. The hydrated lime is not recommended.

Air-slaked lime should never be used.

SULFUR.—The commercial ground sulfur is usually cheaper than the flowers of sulfur and if well ground is equally satisfactory. It should be from 98 to 99 percent pure. Many of the better sulfurs now on the market are practically 100 percent pure.

HEAT

If steam pressure is available it furnishes the best source of heat for cooking. It may be applied by means of a closed coil in the tank or by releasing the steam through a perforated coil or pipes directly into the liquid. This last has the advantage of furnishing at least a part of the necessary agitation, and usually enough steam is condensed to keep the volume of water about constant. Farm food-cooking boilers are often used satisfactorily in steam cooking.

Direct fire may be used, the cooking being done in large iron kettles or in metal bottom vats. Satisfactory vats can be made from heavy planks for the sides and heavy sheet iron for the bottom. Fuel can be conserved by building the kettles or vats into a furnace. It is advantageous to cover the cooking vessel during cooking except an opening through which the liquid can be stirred.

STRAINING THE PRODUCT

All lime-sulfur, when first made, carries some sludge or solid particles. As soon as the cooking has been completed the lime-sulfur concentrate should be drawn off, strained, and placed in storage receptacles. A 20- to 30-mesh screen (brass or tinned iron, never copper) will remove the particles that will interfere in spraying. A loosely woven burlap cloth can be used. The sludge that passes through such screens is not seriously objectionable.

The lime-sulfur concentrate may be made up and stored until needed. Metal barrels are excellent for this. If oil barrels are used and they contain much oil, they should first be steamed out or rinsed out with gasoline. The stored lime-sulfur should be protected from the air, since exposure causes crystals and a crust formation. The barrels should be completely filled and corked. In open containers a thin layer of medium-to-heavy oil can be used as a protective cover. This should be skimmed off before using the lime-sulfur.

DILUTION

It has been shown that the effective portions of lime-sulfur are the combinations of sulfur and calcium of the lime known as pentasulfides. The sulfur in these combinations is spoken of as the sulfide sulfur. The most accurate dilution is made on the basis of this sulfide sulfur content. A practical test has been developed to determine this content, but it is most too complicated to be used by individuals making only their own supply of lime-sulfur. If community plants should be established and any are interested, they will find the method described in Colo. Exp. Sta. Bul. 352.

The sulfide sulfur compound in solution in the liquid increases its density or weight. The amount of such soluble materials can be determined quite accurately by an instrument that determines this density. Such an instrument is known as a hydrometer. It works on the principle that an object will sink in any liquid until it displaces its own weight of that liquid. The stem of the hydrometer is graduated for measurement. There are two standard scales of graduation, the specific gravity scale and the Baume scale. Hydrometers with the Baume scale are used almost exclusively in testing lime-sulfur.

A hydrometer outfit consists of the hydrometer and a tall glass cylinder in which the liquid can be tested. Such an outfit is not expensive and can be ordered from dealers in chemical supplies or laboratory apparatus.

In ordering, specify an instrument with the Baume scale for lime-sulfur testing.

In testing, use only the clear liquid, which should be at a temperature of about 60 degrees F. Each batch cooked should be tested before using, as there is often a great variation. The formula given should make a material testing 26 to 28 degrees Baume, but the variation may be from 20 to 28 degrees Baume.

Under no circumstances attempt to use a home-made lime-sulfur without diluting according to test.

After the density of the concentrate is determined, the proper rate of dilution for spraying purposes is ascertained by referring to a table of dilutions.

PRECAUTIONS

Pumps used with lime-sulfur should be washed out each night after using. Pumps with brass working parts will have a scaly crust formed over the brass after continued use. The openings in the nozzle discs are eaten out rapidly so a sufficient supply should be kept on hand for replacement. Lime-sulfur will blacken lead paint. Lime-sulfur is caustic to the skin and will produce ulcers if the skin is constantly wet. A weak iodine solution placed on the skin will destroy the caustic effect of the lime-sulfur in such sores. Gloves or vaseline on the hands will protect against lime-sulfur around the nails. It is very irritating to the eyes. Goggles can be worn to advantage while spraying and while making lime-sulfur.

LIME-SULFUR DILUTION RATES FOR DORMANT SPRAYING.

Specific gravity	Baume test of concentrate in degrees	No. of gals. of water for each gal. lime-sulfur	Amount in gallons to use in		
			50 gal. tank	100 gal. tank	200 gal. tank
1.306	34	8.1	5½	11	22
1.295	33	7.7	5¾	11½	23
1.283	32	7.3	6	12	24
1.272	31	7	6¼	12½	25
1.261	30	6.7	6½	13	26
1.250	29	6.4	6¾	13½	27
1.239	28	6.14	7	14	28
1.229	27	5.9	7¼	14½	29
1.218	26	5.67	7½	15	30
1.208	25	5.25	8	16	32
1.198	24	4.9	8½	17	34
1.188	23	4.7	8¾	17½	35
1.179	22	4.4	9¼	18½	37
1.169	21	4.1	9¾	19½	39
1.160	20	3.7	10½	21	42