PEST PROBLEMS OF THE SMALL GARDEN

By

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Cover cut.—Imported cabbage worm butterflies: male, left; female, right (X 1½).
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PEST PROBLEMS OF THE SMALL GARDEN

BY CHARLES T. VORHIES AND LAWRENCE P. WEHRLE

INTRODUCTION

The prevalence of small home gardens in recent years has brought to our attention a number of insect pests other than the few most important and common forms, which are generally better known. Concerning these, a good many data on local occurrence, life history, and importance have been collected, and some simple experiments conducted in the course of our regular duties. The public has hitherto had little or no information about some of them.

Also, no suggestions have been published by this Station on the relations of birds and mammals to the garden. It, therefore, seems worth-while to now make known certain of our observations and conclusions as to control.

We shall emphasize the simplest possible controls, since this is intended primarily for the home gardener, having a relatively small garden. Such a garden may often be kept practically free of insect injury by hand methods of control, in less time than would be consumed in securing, preparing, and applying an insecticide and without the purchase or use of expensive equipment.

The senior author has grown three gardens (of small size, and in winter) in which such insects as appeared were controlled by handwork almost exclusively. The chief damage sustained was done by birds, and that was largely due to late planting. Summer gardens, on the average, probably are subject to rather more insect and less bird injury; but, even so, the remedy must fit the disease.

One point to be emphasized for the uninitiated, and that is, in so far as chemical controls (insecticides) are concerned, it is inadvisable to do much advance planning on prevention. An insecticide must be chosen and applied according to the insect present as well as according to crop. We are sometimes asked, "What can I spray my orchard with to keep off all kinds of insects?" The answer is that it cannot be done. There is no shotgun method for control of the insect army. This warfare has to be conducted by rifle fire, sharpshooting, and precision bombing.

We have recently seen a garden bulletin which gave specific instruction on the quantities and kinds of insecticides to be purchased in advance for a given size of garden. That may have been sound advice for the state in which it was published; but we feel that in our area the pests which actually become injurious are so unpredictable as to species and numbers that advance purchase of insecticides is apt to be a waste of money. A certain few pests are sure to appear; others may or may not occur.
INJURIOUS BIRDS AND MAMMALS

Fortunately, there are but few species of birds and mammals that are injurious, and most of the damage done by them is of rather sporadic occurrence. Three sparrow-size birds most common about our homes are suspect or guilty in varying degrees.

Noisiest, and best known by evil reputation, is the English sparrow, which seems to be always present, everywhere. The male English sparrow is easily recognized most of the year by his conspicuous black bib, though this is obscure for a time in the autumn. The female's breast is plain light gray, without streaks. Many people take all the sparrowlike nuisance birds for English sparrows, which are not protected by law, and hence are legitimately subject to any penalty that the irate gardener may succeed in imposing. (The others are protected by state and federal laws.)

Next is the house finch, sparrowlike in appearance, but distinctly brown-streaked, especially the female. However, it is less noisy (except an immature begging to be fed) and is a good songster. The male is readily distinguishable by his red-washed head and neck. It must be admitted that, notwithstanding its beauty of song and color, this species is an unmitigated nuisance where soft fruits are grown.

The third member of the trio is with us only as a winter visitor, arriving in October and leaving in April or May. This is the white-crowned or Gambel sparrow. Adults of both sexes are conspicuously striped with black and white on the head, while young of the year, mingled with the adults, have brown and gray head stripes instead of black and white. These birds are musical, never noisy, but they too may be nuisances in certain stages of gardening operations. They are not present during our fruit season.

In saying "unmitigated nuisance" we are not just using a hackneyed term. We mean a nuisance that is not likely to be mitigated or relieved even by direct action. Since the last two species are protected by state and federal law, direct action is prohibited. We are not allowed to slaughter them at will, which is just as well, after all, since it is not really practical to do so on an effectively large scale.

Now let us assess the damage done to our home gardens by these birds and discuss the most practical means of prevention. The chief bird damage in our winter gardens is done to the tiny seedlings as they first appear, and shortly thereafter, while the plants are very tender and so small that one or two nips of a small bird beak results either in complete destruction or in a serious setback from which recovery is difficult or impossible. If this early damage is prevented, the larger plant will usually suffer little injury from birds.

Although nothing short of continuous observation would accurately determine the relative responsibility of the birds mentioned, we are convinced from such observations as we have
made that most of this work on seedlings is done by white-
crowned sparrows; little, if any, by house finches and English
sparrows. Hence, get winter garden vegetables up beyond the
seedling stage before the white-crowns arrive, which in Tucson
is usually about the first of October. In 1943, in a late garden,
lettuce, beets, sweet peas, and even cabbage, cauliflower, and
radishes were heavily damaged or destroyed. In this garden, in
1944, the same vegetables were brought up to fairly safe size by
October 1.

No injury was done, but this garden was favored by the fact
that no white-crowned sparrows appeared in it in early October.
Whether this was due to late migration or to the presence of
greater quantities of tender plant food on the "desert" due to the
late, heavy rains, is not certain. The important fact is that, with-
out any protection whatever, the garden suffered no bird damage
the second year. This tends to confirm our belief that English
sparrows and house finches have generally little to do with
damage to garden seedlings, though in a very dry autumn the
story is different. The problem changes with weather and time
of planting.

In 1945, circumstances prevented early planting. The white-
crowned sparrows were on hand when it was started (in October)
but did little damage at first, due, apparently, to a midmonth rain
which produced a wealth of tiny seedlings everywhere. However,
as a drought of several weeks followed, and native vegetation
dried up, damage to the garden became more and more evident,
in spite of the fact that many of the plants were now 3 or 4 inches
in height. Drought continuing, English sparrows joined the at-
tack, and the garden was wrecked. Extreme measures of protec-
tion are necessary under these circumstances. A neighbor
stretched a stout string over each row at a height of several
inches, over which was laid a length of cheesecloth, forming an
elongated low tent, under which he could irrigate. This was very
successful, inexpensive, and worth while.

Winter lawns should be well along by October 1 to avoid
damage by white-crowned sparrows.

The lovely little backyard Inca dove has occasionally been
reported as a pest of garden seedlings. (It is primarily a seed-
eater.) We did not experience such damage until the drought of
October-November, 1945, above noted. In that period we saw
these birds working on good-sized radish and kale plants, damag-
ing them severely.

Damage to gardens by the Palmer thrasher has been reported.
This is a bird about robin-size, with a long down-curved beak.
Many refer to it as the "pretty-quick," from its call. This bird
can quickly knock newly planted seeds out of the ground, but
only an occasional complaint is made of it. It is less common in
the city than in outlying areas.

We have personally observed a wise old Gila woodpecker which
learns in late autumn to puncture a grape bag. It eats only a
small amount of fruit, and returns repeatedly to the same two or three punctured bags; consequently, it does not damage every bunch on the vine as finches are apt to do on unprotected grapes. While we may look on the Gila woodpecker with tolerance, they do some real damage in citrus orchards by drilling holes deep into sound fruits. We know of no repellent measures, and since they are (rightly) protected birds we cannot recommend shooting.

To save late plantings or early spring crops before these sparrows leave, the following controls are suggested:

1. Keep plantings in the open as much as possible. Damage is invariably heavier near hedges, shrubbery, or other cover, because birds prefer to feed close to shelter.

2. Cover the seedbed with the smallest mesh poultry netting, or with brush, if available. If netting is used, it must be supported a little above the ground with edges drooping to prevent entrance beneath it. Laid flat on the ground it gives practically no protection.

3. Stretch a cord or wire lengthwise of each row of seedlings a foot or two above the ground surface. Suspend from this at 1-foot intervals small pieces of bright tin cut from discarded cans, to hang only 3-4 inches above the ground. If the pieces are bent to an S-shape, so as to swing or revolve in the breeze, so much the better. Though the birds may eventually get used to this, its effectiveness will likely extend over the danger period.

4. Cover each row completely as described on page 5.

5. If you can kill an English sparrow, hang it up near the young plants or leave it lying with outspread wings and upturned toes between the rows. Though recommended, this did not prove very effective in our experience.

6. Stake out the canine or feline member of the family, just off the cultivated area. While not observed by us, this unique protective device is well vouched for. The best arrangement is to run a wire parallel to the length of the garden, on which runs a ring to which the animal's leash is attached. The guardian is thus free to run up and down the edge of the garden plot; birds do not readily become indifferent to this menace. Effectiveness will doubtless vary with the individual patrol animal, cats being more feared than dogs.

7. We have been told that a light dusting of sulphur on young plants is a fairly good bird repellent. It seemed worth trying but did not work in the severe season of 1945. It might work in other circumstances.

Since fruit enough to pay the year's water bills may be grown on an average city lot, it should be included in this discussion, though it certainly adds a vexatious problem. It is almost impossible, at least impracticable, to protect certain of our softer fruits from bird depredations. This condition exists in aggravated form in Arizona, where relatively small amounts of fruit are grown in the midst of an extensive arid region wherein juicy green foliage or wild fruit is scarce, and especially in the arid
foresummer when apricots and other early fruits are ripening. Consequently the birds, chiefly house finches, concentrate on the juicy morsels which we obligingly make so readily available to them. The white-crowned sparrows have now departed, and English sparrows are far less eager for fruit than are house finches, though they are perhaps doing some damage. Apricots, figs, grapes, dates, peaches, and doubtless any other equally soft fruits are heavily attacked by house finches before they are as ripe as we like them for human consumption.

What may be done? Were these birds unprotected by law, it would still be found impractical to protect the fruit with a gun (use illegal in city limits) except by continuous guard duty from dawn until dusk; and even then some fruit would finally be left to the birds. We are sometimes asked about the poisoned grain recommended for English sparrows. Even if its use on finches were legitimate, it is very doubtful that they would take the grain while fruit is available. Apricots, figs, and peaches may be saved in part by gathering them early each morning as they begin to ripen. Experience with your local situation will soon show at what stage they must be picked. They may be further ripened indoors; or they may be canned, preserved, or used for pies when not yet ready to eat fresh. Small trees may be covered with cheesecloth or mosquito netting, but it is not practicable to cover larger trees. Some of the finer fruits, singly or in small clusters, may be thus covered, or enclosed in paper bags, until fully ripe.

Dates, of course, are always protected with covering for each great cluster; and grapes can be saved without too much trouble. Paper bags saved from grocery purchases (or bought direct in normal times) offer a simple and practical solution of the grape problem, and will last out the season from June to autumn. A bag is required for each bunch of grapes, except where they hang very closely together, in which case two or sometimes more bunches may be enclosed in one large bag. In the latter case great care must be taken to close securely the top opening. Grapes must be thus protected in this area, regardless of birds, to save them from the fig beetle, or green June beetle, which also devours unprotected figs and peaches. (Apricots ripen before the fig beetles appear.)

We have often been asked whether grapes will ripen properly within paper bags, which of course must be put on before the fruit is ripe enough for the birds. Be assured they do. The senior author has for years used about 300 bags per year to protect his grape crop, with practically no loss except a little from mildew. Some late varieties can be kept until Thanksgiving, and sometimes later. These grapes become fully ripe, deliciously sweet, and normally colored. They are well worth the trouble of bagging, which is not a big job, once you understand how it is done. Bags can be pinned on more rapidly than they can be tied.
A further suggestion is to grow a tree of fruit just for the birds. For this purpose plant a fruiting mulberry in a location where the litter of falling fruit will be of no concern. Mulberries ripen during the season generally most difficult for the birds, and are very much liked. (They attract also many beautiful birds not otherwise noticed.)

Pomegranates, valuable for juice and jelly, are not subject to damage by birds except when they burst open on the tree, as they are prone to do.

As a final suggestion, if the above remedies seem to be too much trouble, do not grow these soft fruits. Go in for citrus, which presents practically no bird or bug problem.

The principal mammals injurious to small gardens in southern Arizona are probably the small ground squirrels, all too commonly referred to as "gophers." These rodents, the size of a small rat, are active in daylight hours from March to August or September, when most of them go into hibernation. Hence, they do their damage mostly to spring and summer plantings. The round-tailed ground squirrel, common at the lower levels of southern Arizona, below 3,500-4,000 feet, is evenly grayish tan. This is supplanted in Cochise County and other somewhat higher elevations by various other forms, especially varieties of the spotted ground squirrel, which are more brownish, speckled with small whitish spots.

These little rodents will be no problem to the dweller well within a city, but only to those living more or less in the country. They are easily killed with the common snap traps for rats. Bait with a piece of nut meat and a little sprinkle of oatmeal and place near the burrow openings. Since they live in small colonies and do not travel great distances from their home burrows, they can be readily cleared from your neighborhood.

The larger ground squirrel, or "rock squirrel," is fully capable of great damage to gardens. This species is of the size and general appearance of a tree squirrel. It occurs in suitable locations all over the state, and at various altitudes, but is nowhere abundant. The wide, flat valleys are free of them, and only the canyon or foothills gardener will be bothered. A .22-caliber rifle is the best control.

Those living on river bottom lands may find the true gophers, pocket gophers, damaging their gardens. These rodents live in underground tunnels, and throw up a system of mounds of earth in which no opening appears save while the animal is at work pushing out dirt. While these animals are not really nocturnal, they are so thoroughly subterranean in habit that they are seldom seen in the open. They eat underground parts of plants and also reach out and pull in green parts from aboveground. Special gopher traps are best for their control, but the average small garden will hardly have more than one or two, and most small gardeners will never experience their depredations. They do not occur on the caliche soils of the mesa.
For many gardeners rabbits will be no problem, since the increasing density of settlement in the urban areas has resulted in elimination of most of the jack rabbits and even the cottontails. However, they like nothing better than fresh green "garden sass," especially when the desert ranges are dry in spring and fall. At such times they will travel greater distances (a mile or more) than the small rodents to get fresh green lawn grass or garden stuff. The householder will not see the source of damage, unless by moonlight or by rising early in the morning.

One remedy is shooting.

Since these animals are usually baffled by a poultry wire barrier only 2 feet in height, a simpler and less wearing remedy is to fence them out with wire netting. We have, however, seen smart individual cottontails that had learned to climb in and out over such a barrier.

A dog of some utility breed should be an effective control on rabbits, if local conditions permit its running loose.

INJURIOUS INSECTS

We discuss in this bulletin a fairly complete list of the insects that may occur in Arizona gardens; but the extent of this list should not in itself be discouraging to the actual or prospective gardener. Many of these insects may be rated only as possible pests; relatively few of them appear with such regularity as to be of probable occurrence in any one garden.

No attempt is made to give complete accounts of life history, structure, and appearance. For the sake of brevity only the most significant features of the insect, and of the character of injury inflicted on the host plant, are included. This, we believe, will enable the novice to identify correctly his troublemaker. Misidentification may result in a wrong choice of control. Only the simplest controls believed to be effective are given.

We have attempted to make the illustrations as characteristic as possible. Use them and, in so doing, note and calculate the actual size of the insect. Symbols such as X 1, X 2, X ½ mean respectively, natural size, twice life size, and one-half life size. This means in any one linear dimension, not in area.

GENERAL CONTROL MEASURES

The best means of control is the most important problem to solve in dealing with a given insect pest. The use of poisons for control has been emphasized to such an extent that there is danger of overlooking other and often less expensive methods. There are, however, certain practices which, if properly carried out, will greatly reduce insect damage. Wild mustard growing on vacant lots furnishes breeding places for the false chinch bug. Weeds growing in fence rows furnish winter shelter for certain insects. Grass growing around the edges of gardens furnishes a
place for cutworm moths to lay their eggs; it also provides food for the young cutworms in the fall, and shelters them in winter. Badly infested plants may sometimes be removed and burned, thus protecting other near-by plants. Hand-picking of the insects is sometimes more convenient than spraying. Crop remnants should be burned or plowed under soon after harvest since such materials furnish food and shelter for certain insects. The same crop should not be grown in the same location year after year. Frequent cultivation helps to destroy certain insects such as flea beetles, which spend part of their life in the soil. Important as these control measures are, nevertheless, it is often necessary to resort to the use of poisons in the control of insects.

**HOW INSECTS FEED AND THE USE OF POISONS**

In using poisons to control insects the method of feeding must be taken into account, since insects do not all take their food in the same manner. The method of feeding very largely determines the kind of poison to use. Improper choice of insecticides wastes time and money.

Insects which feed by consuming plant tissue are called chewing insects. Examples are the Mexican bean beetle and various caterpillars. Such insects may often be destroyed by spreading a film of poison in the form of dust or spray on the foliage of the infested plant. When the treated foliage is eaten the poison takes effect internally and the insect soon dies. Such materials, called stomach poisons, are used against the chewing insects. Some common stomach poisons are arsenate of lead, Paris green, tartrar emetic, and rotenone. Arsenate of lead and other poisons containing lead, arsenic, or fluorine form a poisonous residue on the plant, and therefore should not be used on leafy vegetables and fruits near the time when such products are to be used for food.

Other insects feed by inserting their needlelike mouth parts into the plant tissue and sucking out the juices in the manner of a mosquito puncturing the skin and extracting blood from a person. These are called piercing-sucking insects. Examples are the aphids and scale insects, the false chinch bug, the harlequin bug, and many others. The punctures made in the plant are not visible to the unaided eye, and none of the tissue of the plant is devoured. Therefore, piercing-sucking insects are not affected by a stomach poison on the surface of the plant, but may only be destroyed by using a material which is caustic to the insect, or which gives off poisonous fumes which may enter the breathing system. These materials are called contact poisons and may also be applied either as sprays or as dusts. To be effective, a contact poison must be so directed as to actually hit the insect. This may be difficult to do, since some sucking insects cause the leaves to curl. Such insects are apt to be hidden in the cavities of the deformed leaves where they are difficult to reach with the insecticide. Some common contact poisons are nicotine sulphate (Black
Leaf 40), soap, pyrethrum, sulphur, various oils, sabadilla, DDT, and rotenone. Rotenone is also a stomach poison.

**GENERAL FEEDERS**

**APHIDS, OR "PLANT LICE"**

These small insects mostly range from about 1/16 to 1/6 of an inch in length. Their bodies are soft, delicate, and somewhat pear-shaped, bearing on the back, near the posterior end, a pair of more or less prominent tubular structures called cornicles. The legs are usually rather long, but the aphids move slowly. Both winged and wingless adults of a given species, as well as different kinds of aphids, may sometimes be seen on the same plant at the same time. There are green, yellow, black, brown, and red species of aphids, but also considerable color variation in the same species. Some are covered with a white powdery or woolly wax and are known as “woolly aphids.”

Aphids occur all over the world. There are many different kinds in Arizona, and considerable aphid injury to plants occurs each year. Probably every important crop, ornamental and wild plant, is attacked at some time by these pests. Some kinds are known to feed on only one kind of plant, while other species feed on a wide variety of plants. Certain aphids alternate seasonally between one kind of plant and another.

Some aphids spend the winter in the egg stage in cold climates, but may remain active where winters are mild. In either case spring is likely to bring a great increase in numbers and the pests become injurious. Several living young may be produced each day, and development is rapid. There may be as many as twenty generations per year under favorable climatic conditions.

Aphids are piercing-sucking insects. The type of injury caused depends upon the kind of plant and species of aphid concerned. Many aphids attack the tender terminal growth of plants, causing the leaves to wilt, curl, turn brown, and die. They are most often found on the undersides of leaves and at the bases of buds, but any part may be attacked, including the roots. Not only is growth checked, but the plants may be killed. The feeding activities of some aphids spread plant diseases, while others cause plant galls. Deposits of syrupy material, called honeydew, on leaves and other parts often reveal the presence of aphids; it may become conspicuous on sidewalks or on the ground beneath infested trees.

Aphids may be controlled by the use of nicotine in spray or dust. The type of equipment at hand will probably determine which will be used. A nicotine spray may be prepared as follows:

- Nicotine sulphate (40 per cent) ........ 1½ tsp.
- Household ammonia .................. 1½ tsp.

or

(1 cubic inch cake or
(6 level tsps. of

or
Soap (mild laundry type)................. (soap flakes or soap powder)
Water........................................ 1 gal.

Household ammonia, soap, or a commercial product called "Penetrol" is added to activate the nicotine and make it more effective. Household ammonia is convenient but it should not be used at temperatures above 90 degrees F. Hard soap, flakes, or powder must be dissolved in a quart of hot water and allowed to cool before being added to make a gallon of spray material. Since hard soap must be shaved into very thin slices, flakes or powder are more convenient. Soap increases the spreading and sticking power of the liquid and has insecticidal value. Use "Penetrol" according to directions of the manufacturer. Apply the spray with considerable force and hit the aphids, since only those which are actually touched by the liquid will be killed.

Aphids on low-growing vegetables and vines can usually be controlled more successfully with dust than with spray. The fumes given off kill the aphids even if they are not actually touched by the dust. A homemade nicotine dust, properly prepared, is very effective. Take:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine sulphate (40 per cent)</td>
<td>2 tsps.</td>
</tr>
<tr>
<td>Soda ash</td>
<td>3 tsps.</td>
</tr>
<tr>
<td>Hydrated lime</td>
<td>1 lb.</td>
</tr>
</tbody>
</table>

Sift the lime through a screen to remove the lumps and place in a gallon-sized tin container with tightly fitting friction lid. Add four or five smooth stones about 1 inch in diameter to aid in mixing. Pour the nicotine sulphate directly on the lime, add the soda ash, and close the lid securely. Shake for five minutes and screen out the stones. Do not allow the nicotine sulphate to come in contact with the skin, and avoid the dust as much as possible. In hot weather the soda ash may possibly not be needed to activate the nicotine. If soda ash is not available increase the nicotine sulphate to 5 teaspoonfuls. Apply the dust in the warmest and driest part of the day when there is no wind.

Nicotine dust loses strength rapidly unless kept in a tight metal container. Homemade nicotine dust, properly made, is more effective and less expensive than prepared dust sold on the market. The ingredients are stable in storage and can be mixed quickly when needed. For best results use only freshly mixed dust.

Simple soap and water mixture is very effective and convenient to use on aphids. Mild laundry soap, flakes, or powder may be used as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soap (mild laundry type)</td>
<td>2 oz. (four 1-inch cubes)</td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>Soap flakes or powder</td>
<td>8 level tsps.</td>
</tr>
<tr>
<td>Water</td>
<td>1 gal.</td>
</tr>
</tbody>
</table>
Dissolve the soap in a quart of hot water, allow to cool, and add water to make 1 gallon. Reduce the soap one half if tender plants such as young cabbage, garden peas, or beans are to be sprayed. The liquid must hit the aphids.

**BLISTER BEETLES (FAMILY MELOIDAE)**

The beetles of this family are of medium to large size, from 7/32 to 1 1/4 inches in length. They may be black, gray-green, brown, or yellow. They sometimes have longitudinal stripes, crossbands, or spots on their wings; and the broad head and narrower, necklike, prothorax may be red or brown. Their bodies are usually narrow and rather soft and the legs long and slender. Blister beetles contain a poisonous substance called cantharadin which causes a painful burn or blister when these beetles are crushed on the human skin.

Blister beetles are widely distributed. The adults feed on many plants, such as potato, tomato, beet, eggplant, cabbage, turnip, radish, bean, spinach, and many others. The larvae feed on soil-inhabiting insects and grasshopper eggs and are therefore considered to be beneficial. The life cycles are definitely known for only a few American species. Some blister beetles may require more than a year to complete a generation while others seem to complete two generations in a year. The adults feed on foliage and flowers and may completely defoliate plants. These pests usually appear suddenly in large swarms and may do serious damage in a short time.

Control measures should be taken promptly when blister beetles first appear. Sulphur and pyrethrum dusts are very effective and should be applied directly on the beetles. If a ready-made dust is used follow the manufacturer’s directions. We suggest a homemade mixture as follows:

- **Dusting sulphur** .................................................. 1 1/2 lb.
- **Pyrethrum flowers (1.3 per cent total pyrethrins content)** .................................................. 1 oz. (5 tbsps.)

Use a mixing can as for nicotine sulphate dust for aphids (page 12).

A mixture of 325-mesh dusting sulphur and 0.75 per cent of rotenone also is effective against blister beetles. Sulphur-rotenone mixtures may be had ready-made; or, some dealers will mix them in the desired proportions. This dust to be effective must also hit the insects.

Cryolite is also recommended, as follows:

- **Cryolite** .................................................. 2 parts
- **Talc, sulphur, gypsum or flour** .................................................. 1 part

Mix thoroughly, using the mixer above described.

If a spray is preferred the following may be used:

- **Cryolite** .................................................. 1 oz. (8 level tsps.)
- **Water** .................................................. 1 gal.
Mix thoroughly and apply, but do not use on leafy vegetables or parts of plants used for food unless the poisonous residue is removed by careful washing and trimming.

If preferred, blister beetles may be collected and destroyed by jarring them from the plants into shallow pans containing a little kerosene. They may also be driven with the wind into windrows of hay or straw loosely piled along the edge of the infested area and then quickly burned.

WHITE-SPOTTED BLISTER BEETLE (EPICAUTA PARDALIS)

This beetle is about 2/5 of an inch in length, with a rather narrow body and long legs. The general color is black, the wing covers white-spotted with irregular lines of white hairs. There are numerous white hairs on other parts.

This is perhaps the most injurious blister beetle in Arizona, where it is widely distributed. It feeds on potato, beets, Swiss chard, tomatoes, chili peppers, cabbage, Brussels sprouts, corn, and alfalfa.

The life history is unknown. In Arizona the beetles appear in May, June, July, and August, being most numerous in June. They breed in desert areas, and often appear suddenly in large swarms, invading and covering cultivated areas with crawling beetles. They may completely defoliate plants and cause serious injury in a very short time.

Five per cent "Pyrocide" dust proved to be a very effective control for white-spotted blister beetles on potatoes in a recent instance (Plate I, 2).

Plate I.—Beetles: 1, The soldier beetle; 2, White-spotted blister beetles; 3, Colorado potato beetles; 4, Mexican bean beetles; (all life size to slightly enlarged); 5, The spotted cucumber beetle; and 6, The western striped cucumber beetle (both X 2).

SOLDIER BEETLE (TEGRODERA EROSA)

This is another blister beetle, about 3/8 of an inch long, rather narrow, with long, slender legs. The head and prothorax are red with more or less black markings on the latter. The wings are
black with a conspicuous network of golden yellow lines. Near the middle of the wing covers, a black transverse band extends across the back. Other parts are black (Pl. I, 1).

This beetle is rather common in southern Arizona. It is said to feed on native sage brush (Artemisia). On occasion it attacks young fruit trees, alfalfa, peas, and spinach, commonly migrating from peas to spinach. It also feeds on other plants.

The life history of the soldier beetle is unknown. It breeds in desert areas and the beetles appear in May, invading cultivated areas adjacent to the breeding grounds. When numerous they seriously damage alfalfa. By eating holes in the leaves of spinach, they seriously reduce the market value of the crop.

The soldier beetle can probably be checked by the use of one of the methods of control suggested for blister beetles (page 13). The method used must be determined in part by the kind of crop infested, e.g., rotenone on spinach, where a poisonous residue is objectionable.

GRASSHOPPERS

Very few grasshoppers may sometimes do considerable damage to plants growing about the home. Sometimes one large grasshopper is attracted to a certain plant and, if the plant be small, may consume a surprisingly large proportion of the foliage before it is discovered. In such instances, capturing the grasshoppers by hand on cool mornings, using diligently a fly swatter, or other similar methods are most practical. For larger areas, involving disposal of greater numbers of grasshoppers, the use of poisoned bran mash is most effective. The mixture should be sowed broadcast among the plants and may even be tossed into the air so that some particles may lodge on the plants. It should be distributed early in the morning so that it will be available to the grasshoppers when they first become active. The mash must be fresh and moist when distributed, since dry material is not so attractive to grasshoppers. A poisoned bait for grasshoppers may be purchased on the market, or it may be home mixed as for cutworms (page 17).

CUTWORMS AND ARMYWORMS (NOCTUIDAE)

Certain moth caterpillars known as cutworms and armyworms are sometimes injurious to garden plants, field crops, and various other plants.

When full grown, these caterpillars are from 1 to 2 inches long. They are cylindrical in shape and have almost no hairs on their bodies. They are usually dull in color, being grayish, brownish, yellowish, reddish, greenish, blackish, or dirty white. The back and sides may be marked with indistinct longitudinal lines of the various dull colors. Dark areas may occur on the back. The lower side of the body may be grayish, greenish, yellowish, or reddish brown.
The heavy-bodied, somber-colored moths have a wingspread from 1 to 2 inches (Pl. II). The front wings are grayish or brownish, marked with bands and spots, while the hind wings are usually lighter in color. The moths are active only at night and their eyes glow brightly by artificial light. They have been called "owl moths" because of their glowing eyes and nocturnal habits. They occur in great variety all over the world.

Most cutworm and armyworm moths lay their eggs on grasses, weeds, or other low vegetation during midsummer and fall. Newly hatched larvae feed for a time, and spend the winter under grass or other shelter. In the spring these young caterpillars feed greedily on any suitable green, succulent vegetation. If infested grassland is plowed under and a cultivated crop is planted, the caterpillars concentrate on the crop plants. If parasitic and predatory enemies are scarce, they become very destructive to a variety of field crops, vegetables, flowers, fruit buds, and even young citrus plants in the seedbeds.

Most species of cutworms have one generation a year, though a few have two, and some may have as many as five generations annually.

Cutworms and armyworms, like the moths, are nocturnal and feed almost entirely at night, but sometimes attack plants late in the afternoon, or on cloudy days. Normally by day they hide under lumps of earth or other shelters, or in the soil. When disturbed, these caterpillars curl up and lie motionless for a time. They are called cutworms because most of them have the peculiar habit of cutting off succulent plants near the surface of the soil, or just below. Others attack the roots and underground stems and rarely come to the surface. Some consume the leaves of plants, while still others climb trees and shrubs to eat the tender parts, and these are called climbing cutworms. When exceedingly numerous cutworms may consume practically every green plant
in an infested area, and then move in vast numbers to other areas in search of food. The few species which have developed this habit to a marked degree are known as armyworms, but almost any cutworm may assume the armyworm habit under certain conditions.

Various methods of controlling cutworms and armyworms depend upon conditions. In gardens, the soil around injured plants should be carefully examined and the caterpillars destroyed if found. Pieces of board laid on the soil act as traps. The caterpillars which hide under these boards may be readily destroyed. Stiff paper collars or tin cans with bottoms removed, placed around plants and forced into the soil a short distance, give protection. Keeping the garden and its borders free of grass and weeds in the fall prevents the moths from laying their eggs there. Burning such material during the winter also aids in control. Under field conditions plowing grass and weeds under in the fall serves the same purpose.

Poisoned bran mash is probably the most effective direct control for cutworms and armyworms, when numerous. Prepare and use as follows:

<table>
<thead>
<tr>
<th>Bran (ordinary coarse wheat bran)</th>
<th>Small amount</th>
<th>Medium amount</th>
<th>Large amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 lb.</td>
<td>5 lb.</td>
<td>20 lb.</td>
</tr>
<tr>
<td>Paris green or white arsenic</td>
<td>1 oz.</td>
<td>.4 oz.</td>
<td>1 lb.</td>
</tr>
<tr>
<td>Molasses (cheap grade)</td>
<td>6 tsps.</td>
<td>1 pt.</td>
<td>2 qts.</td>
</tr>
<tr>
<td>Water</td>
<td>1½ pts.</td>
<td>7 pts.</td>
<td>3½ gals.</td>
</tr>
<tr>
<td>Orange or lemons</td>
<td>1½ fruit</td>
<td>1 fruit</td>
<td>3 fruits</td>
</tr>
<tr>
<td>or Amyl acetate</td>
<td>1/5 tsp.</td>
<td>1 tsp.</td>
<td>3¼ tsps.</td>
</tr>
</tbody>
</table>

Thoroughly mix the dry bran and poison. Squeeze the fruit juice into the water. Grind the remaining pulp and peel in a meat chopper and add this to the water. (Substitute acetate if desired.) Add the molasses to the water and fruit juice and thoroughly moisten the poisoned bran with the liquid. The bait should be moist enough so as to "form" and crumble when squeezed but should not be sloppy.

This material is then scattered thinly and evenly around the plants or along rows, or sown broadcast over the soil, late in the afternoon, so that it will still be moist when the caterpillars become active in the evening. Applied at the rate of 10 to 15 pounds to the acre, one application should be sufficient.

SMALL DARKLING GROUND BEETLES (BLAPSTINUS AND ULUS)

These beetles are only ¼ to ½ of an inch long. They are oval, or oblong-oval, convex, and blackish or brownish in color. They are widely distributed in southern Arizona where they damage young cauliflower, tomato, cotton, guayule, broccoli, and probably
other plants. The young plants are killed by girdling at or just below the soil surface when only 1 to 2 inches in height. These beetles feed on broken melons and have been reported as damaging both cantaloupe and watermelon (Pl. III, 1, 2).

Plate III.—Beetles: 1, Ulus, and 2, Blapstinus (small darkling ground beetles, X 8); 3, The spotted cucumber beetle (X 5); 4, The western striped cucumber beetle (X 5).

These pests may be controlled with the poisoned bran mash recommended for cutworms (page 17). Distribute the bait in the evening.

FALSE CHINCH BUG (NYSIUS ERICAЕ)

The adult insect is only 1/8 to 1/7 of an inch long and 1/20 of an inch wide. The wings are grayish with dark brown markings, while the body is brownish or black (Pl. IV, 4). It is very active and darts quickly from plants when disturbed. The wingless nymph is pale gray with a reddish brown abdomen.

Plate IV.—Some very small pests: 1, Desert corn flea beetle (Chaetocnema ectypa, X 12) (actually pinhead size); 2, A pale flea beetle (Systena sp., X 12); 3, The squash mirid (X 10); 4, The false chinch bug (X 10).
The false chinch bug is widely distributed in North America. It breeds primarily on wild grasses and weeds, especially wild mustard. It has been injurious to radishes, turnips, beets, parsnips, sweet corn, cabbage, cauliflower, broccoli, spinach, and potato in Arizona. It may also occur on flax, mint, pecan, lettuce, sugar beets, cantaloupe and watermelon vines, and young citrus, in this state. Still other recorded host plants are alfalfa, clover, grains, cotton, squash, grapevines, fruit trees and young fruit, berries, cherries, strawberries, native flowers, small avocado trees, peaches, and year-old apple trees.

The insect winters either in the egg, the nymph, or the adult stage. It lays its eggs in loose soil among clods of rubbish, in composite flowers, and in grass. From egg to adult is about three weeks, and there may be from four to seven generations per year.

The false chinch bug is most injurious in the irrigated semi-desert areas. With its piercing-sucking beak it saps the plant, and when numerous on potatoes or sugar beets, causes the terminal parts of the plants to wilt. Wehrle has found it damaging young pecan trees at Tucson. A mulch of wild mustard around the trees was the source of infestation which consisted mostly of nymphs. Some of the lower leaves were curled up, dead, and heavily speckled with dark fecal deposits.

Outbreaks of this pest usually originate on neglected lots and fields where wild mustard and other weeds have been allowed to grow. As this growth becomes dry in the arid foreshummer, the insects migrate in search of green food plants. These migrations mostly occur in April, May, or June (occasionally September or October), when the insects invade gardens, lawns, cultivated fields, and even houses. Migrating swarms of nymphs practically cover the soil, which they resemble in color. Adults migrate similarly, but also make short flights.

Worth-while preventive measures center around keeping down weeds, especially wild mustard in vacant lots and neglected fields. Cut early, before nymphs develop, or burn when already heavily infested with the aid of sprayed-on kerosene or scattered straw, or use a blowtorch on concentrated infestations. Migrating nymphs may be stopped by a water-filled furrow across their line of march, or greatly reduced in numbers by flooding, or repeated cultivation of the infested area.

On garden plants a dust mixture of one part ground pyrethrum flowers to nine parts of finely ground sulphur seems to be very effective. Strong nicotine dust or the nicotine sulphate spray for aphids (page 12) are moderately effective. Take care in applying nicotine spray to disturb the plants as little as possible. Hold the nozzle high enough so that the cone of spray will surround the plant. Turn on the spray and lower the nozzle gradually so as to wet the bugs in the open, and then direct the spray in among the leaves so as to wet the bugs sheltered there. This procedure is to prevent these active bugs from escaping without being hit by the liquid.
Without experimental proof we believe 2 per cent DDT may control the false chinch bug.

**FLEA BEETLES (EPITRIX, SYSTENA, CHAETOCNEMA)**

These beetles have enlarged hind legs which enable them to jump like fleas when disturbed. Flea beetles are small, only $\frac{1}{16}$ to $\frac{1}{4}$ inch long. They are various colors, such as black, green, yellow, greenish purple, greenish black, or bluish black (Pl. IV, 1, 2). In some, the head is reddish or yellowish, the necklike prothorax brownish or yellow, and the wing covers marked with black and yellowish longitudinal lines. Several kinds occur commonly in Arizona.

Some species feed upon a variety of plants. However, most of them show a decided preference for a group of closely related plants, while others are restricted to a few plants which may or may not be closely related. Flea beetles commonly feed on the leaves of potato, young corn, carrots, cabbage, cauliflower, beans, mustard, and many other plants.

The eggs are very small and are laid by some species in the soil near the host plant; others lay them on leaves or petioles, or in stem cavities made by the female. The slender, white larvae according to species, feed on roots or underground stems, exposed on the undersides of the leaves, mine in leaves, or burrow in leaf petioles. Some root-feeders bore very small, pinlike holes in potato tubers, making very small sliverlike burrows just under the skin. Such tubers are called "pimply" and "slivery" potatoes. Others cause similar injury in sweet potatoes. Flea beetle larval injury affects the market, but not the food value, of potatoes or sweet potatoes.

Pupation, usually in the soil, lasts but a few days. The number of generations varies with species, usually one or two a year, but at least one species has three or four generations.

Flea beetles eat round or irregular holes in the leaves of plants, giving them the appearance of having been riddled with fine shot. Seedlings may be killed in a day or two. When they appear, infested plants should be promptly treated with dust or spray very thoroughly applied, since the beetles will avoid the treated portions, but will soon locate any untreated portions. Use cryolite either as dust or spray as suggested for blister beetles on page 13. A pound of cryolite dust, or 3 gallons of cryolite spray, should treat about 350 linear feet of row.

Bordeaux mixture has long been recognized as an efficient and inexpensive repellent for most flea beetles, and prepared Bordeaux can be purchased on the market. Arsenical poisons are also repellent to these insects and a combination of Bordeaux with calcium or lead arsenate seems to be most satisfactory. Use 3 ounces (7½ tablespoonfuls) of calcium arsenate or lead arsenate to 3 gallons of Bordeaux.

One part of calcium arsenate to eight parts of hydrated lime also affords protection.
Since the above preparations leave poisonous residues, leafy vegetables should be treated with not less than 0.5 per cent rotenone dust, available on the market, or with the following spray:

Derris or cubé root powder (5 per cent rotenone content) ........................................... 9 level tsps.
Water ................................................................................................................................. 3 gals.

Mix the powder with a small amount of water, pour it into the sprayer, and add water to make 3 gallons.

Bordeaux mixture may be used alone where a poisonous residue is objectionable. Three per cent DDT has come into use for flea beetle control.

Since some weeds furnish breeding places for flea beetles, clean cultivation around gardens and fields is desirable.

WHITE GRUBS AND JUNE BEETLES (SCARABAEIDAE)

The term “June beetle” and “May beetle” are used interchangeably (and confusingly) for the well-known plump, brown beetles so common everywhere (Pl. V). No one can say which

Plate V.—June bugs: 1. The fig beetle or green June beetle (Cotinis texana); 2. The goldsmith beetle (Cotalpa consobrina); 3. Carrot beetles (Liguinus gibbosus); 4, 5. Smaller June beetles (Diplotaxis pacata, and Cyclocephala hirta). All X 1 1/2.)
term is "correct." To save words, we shall refer to them simply as June beetles. These insects are of world-wide distribution and common in Arizona.

The larvae of June beetles are white with brown heads, and are commonly called "white grubs." There are many species of different sizes, the commonest about $\frac{1}{2}$ to 1 inch long. Most of the body back of the head is transversely wrinkled except the enlarged rear portion which is rather smooth and shiny, with the dark body contents showing through the skin. There are three pairs of prominent legs just back of the head. White grubs lie curled on their sides when removed from the soil and are awkward and slow when they try to crawl.

The winter may be spent as a grub or as a beetle in the soil. Some species complete their development in a year, while others require two, three, or even four years.

Many so-called "true white grubs" feed almost entirely on the roots of live plants. They feed typically on the roots of grasses but they also attack almost all kinds of crop plants, especially corn, strawberries, turnips, beets, beans, and potato tubers. They may also attack the roots of privet and tree seedlings. Certain members of this group feed only on decaying organic matter and never attack live plants. These live in the soil near piles of manure or in soils rich in decaying plant material. One of these, larger than average, is the larva of the fig beetle (green June beetle), *Cotinis texana*, which does not lie curled up, but crawls on its back with its feet directed upward.

The plant-feeding white grubs are very common and important pests, which work entirely in the soil and feed on roots and underground stems. They may girdle or eat the roots, reducing the yield and quality of the crop, or even killing the plants. They also eat broad irregular holes in potato tubers. When numerous, white grubs feeding on the roots of grass cause dead, brown patches in lawns and golf links.

Certain cultural and other practices aid in the control of these grubs. Gardens and other cultivated land should be kept as free of grass and weeds as possible because such growing plants attract the egg-laying beetles. Vegetable crops or row crops should not be planted on sod land or on land which supported a good growth of grass and weeds the preceding season. Alfalfa and other legumes seem to repel the parent beetles so that fewer eggs are laid where they are present than in soils on which only grasses or weeds are growing. Gardens should be plowed or spaded deeply, and if white grubs are present extra seed should be planted. The extra plants can be thinned out later. All white grubs found should be destroyed. Poultry may be utilized to accomplish this result. The use of insecticides in garden soils is not recommended.

When white grubs become injurious to lawns and golf greens they may be controlled by the use of kerosene emulsion, long recommended for this purpose.
Kerosene emulsion is made by first preparing a stock emulsion, as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard soap or (soap flakes or powder)</td>
<td>½ lb.</td>
</tr>
<tr>
<td>Soft soap (fish-oil soap)</td>
<td>1 qt.</td>
</tr>
<tr>
<td>Soft water</td>
<td>1 gal.</td>
</tr>
<tr>
<td>Kerosene</td>
<td>2 gals.</td>
</tr>
</tbody>
</table>

If soft water is not available hard water may be used, provided that 2 heaping teaspoonfuls of washing soda (carbonate of soda) per gallon of water are first added.

Preparation of stock emulsion.—Dissolve the soap in boiling water. If hard soap is used it should first be shaved very thin. Boil until the soap is completely dissolved, taking care to keep the solution at the full required amount. Remove the hot solution from the fire, immediately add the kerosene, and vigorously churn or agitate the mixture until a creamy white emulsion is formed. This should take about ten minutes. A good method of agitation is to pump it through a spray pump with the nozzle directed back into the liquid. The stock emulsion should keep several weeks if properly prepared. If not properly made it is very apt to injure plants.

Dilution.—For use, the stock solution must be diluted at the rate of 1 gallon of stock solution to 8 ¼ gallons of soft (or softened) water. The water and the emulsion must be thoroughly mixed or injury to plants may result.

Application.—Kerosene emulsion is applied to the surface of the soil at the rate of 1 gallon to 6 or 8 square feet in area, and may be used directly on grass or other vegetation on lawns and golf greens. It should be put on in the late afternoon and may be applied with an ordinary sprinkling can. The treated area should be sprinkled copiously with water immediately after application of the emulsion, in order to wash it into the soil where it will come in contact with the grubs. Apply promptly when white grub damage first appears.

The large white grub of the fig beetle (C. texana), sometimes burrows just below the surface of the soil in gardens and causes the formation of little ridges on the surface. While this grub does not eat live plant roots, it may injure seedlings by burrowing under them, thus tearing their roots from the soil. Under such conditions it may be dug up by hand and destroyed. This grub constructs a permanent vertical tunnel in the soil, extending down to depths of 12 to 24 inches, or more. The grub lives in this tunnel, and comes to the surface to feed on decaying organic matter, mostly at night during August and September, but in winter during the warmest part of the day.

Fig beetle grubs cause very little injury to lawns, but if their presence is objectionable because of their tunnels and the unsightly castings which they produce they can usually be controlled by giving the lawn heavy irrigations for a week. Pouring ½ tea-
spoonful of carbon bisulphide into each tunnel and closing its opening is very effective.

June beetles (*Phyllophaga* spp., *et al.*) are the adults of white grubs. They constitute a large and important family, the species of which vary greatly in size, form, and color. Some of the commonest species range from % to 1 1/32 inches long. They are short, stout-bodied beetles with antennae or feelers ending in an oval-shaped portion composed of from three to seven leaflike plates. The best known are uniform brown, yellow, or brownish black in color. In some, the head and thorax are brown, while the wing covers are grayish or yellowish. Others are brown with white longitudinal lines; and the fig beetle is brilliant green marked with brown along the edges of the wing covers.

Many June beetles spend the day in the soil. At dusk they come out and fly to various plants, including garden varieties, to feed on the leaves, sometimes doing serious injury. They are attracted to lights in some numbers. Some of this family, such as the goldsmith beetle (*Cotalpa consobrina*), feed commonly on cottonwood leaves, remaining day and night (Pl. V, 2). Cottonwood trees are often completely defoliated by this species. To control build a good-sized bonfire at night near the infested tree, and disturb the beetles by shaking or beating the tree. The beetles are attracted by lights and will fly into the fire. In Arizona, June beetle adults emerge in greatest numbers during the summer rainy season.

June beetles not only commonly feed on foliage, but some burrow into the soil and girdle the roots of plants. About the middle of August the leaves of pole beans may be severely eaten by a small yellowish brown June beetle (*Phyllophaga sonora*).*

This beetle feeds at night and hides under rubbish by day. So when bean-leaf tissue has been consumed, but no insect is visible, examine the injured plants at night by flashlight, or search the vicinity of the plant. Collect and destroy the insects found feeding or in hiding.

Another species, *Phytalis pallidus,* was taken near damaged roots of eggplant in July, 1944, and was evidently the cause of the injury. The most practical method of control for these beetles is to dig them out and destroy them by hand.

**BEAN PESTS**

**MEXICAN BEAN BEETLE (EPILACHNA VARIVESTIS)**

This insect is probably a native of Mexico. The beetle is ¼ to ⅜ of an inch long, convex-oval, yellow to coppery brown, with eight black spots on each wing cover (Pl. I, 4). The orange-yellow eggs are laid in large groups on the undersides of the leaves. The larva, about ⅜ of an inch long, oval, and yellow, bears six rows

*Determinations by E. A. Chapin of the U.S. Bureau of Entomology and Plant Quarantine.*
of long, branched, black-tipped spines on the back. The yellow pupa, about \( \frac{1}{3} \) of an inch long, is fastened to the underside of a leaf, with the spiny, white, last larval skin covering the rear end.

The Mexican bean beetle feeds upon all kinds of beans including soybeans, cowpeas, and beggarweed (Meibomia sp.). The adults winter under leaves or other debris. The beetles are most common in the field from July to October, emergence being stimulated by the summer rains. The eggs hatch in eight to ten days, the larval stage lasts twenty-one to twenty-seven days, and the pupal stage eight to ten days. There are two or three generations a year.

Both adults and larvae feed on the undersides of the leaves of beans, leaving only a network of larger veins and strips of tissue. The skeletonized leaves dry up and the plant is killed by a severe infestation.

Cryolite or rotenone controls this pest. Cryolite may be used only until the pods form, after which only rotenone may be used, or rotenone may be used alone.

For cryolite spray use:
- Cryolite ........................................ 1 oz. (8 level tsps.)
- Water ............................................. 1 gal.

For cryolite dust use:
- Cryolite ........................................ 2 parts
- Talc, wheat flour, clay, or sulphur .... 1 part

Apply at the rate of 20 pounds per acre.

The first treatment should be applied when the beetles appear in the field or when one egg mass may be found on each 10 feet of row. Apply beneath the leaves thoroughly, at ten-day intervals. One to four applications may be necessary.

After pods form use only rotenone if the crop is to be used as green beans. Prepare spray as follows:

- Derris or cubé root powder
  - (5 per cent rotenone) .................. ½ oz. (3 level tsps.)
- Water ............................................. 1 gal.

First mix the powder with a small amount of water and then add to the rest of the water in the sprayer. Ready-made concentrates of derris and cubé are available and more convenient. Sprays are usually better than dusts against this pest. However, a "Pyrocide" dust containing pyrethrum ("Pyrocide" one part to gypsum five parts) is very effective. Dusts may be used only in quiet air.

**Caution.**—Do not use green beans treated with cryolite for food. Do not feed bean refuse from cryolite treated fields.

Do not apply Paris green, lead arsenate, or magnesium arsenate in any form to beans. Not only do these poisons leave residues, but on beans they are almost certain to cause serious burning and reduction in yield.
Early planting to some extent lessens injury by the Mexican bean beetle. Keep the beans free of weeds and the soil enriched to encourage rapid growth. In the small home garden beetles, eggs, and larvae may be collected by hand and destroyed. Old bean plants should be deeply plowed under or otherwise destroyed soon after harvest. Clean up, plow under, or burn grass, weeds, and other refuse in or near the garden or bean field in fall or early spring, to eliminate hibernating places.

**THE BEAN THRIPS (HERCOTHRIPS FASCIATUS)**

This tiny pest is only about 1/25 of an inch long. The front wings are marked with two light and two dark areas which give the insect a grayish black appearance, with two white bars across the middle when the wings are at rest on the back. It is of wide occurrence.

Its favorite host plants are alfalfa, beans, cantaloupes, cotton, lettuce, pears, peas, and tomatoes. It also feeds on various other vegetables and wild plants.

Eggs are inserted into practically all parts of the host plants. The eggs hatch in about seven days and the young thrips feed in clusters, mostly on the undersides of the lower leaves, moving upward as the infestation progresses. The larvae enter the soil in about ten days and transform to adults. There are usually about six generations in a season.

Feeding of the bean thrips causes silvering or bleaching of the leaves, which become papery and wilt rapidly, especially when suffering from lack of moisture. Premature defoliation may result, and annuals may be killed.

Elimination of weeds, especially prickly lettuce and sow thistle, near gardens and fields at least two weeks before the beans come up is of the greatest importance in control of this insect. Irrigation stimulates the plants and destroys many pupae in the soil. Pyrethrum dust containing about 0.25 per cent pyrethrins, used at the rate of at least 30 pounds to the acre, is said to be very effective, especially when the plants are dusted between two irrigations applied ten days apart. One per cent thiocyanate (2 per cent Lethane) commercial dust is reported to give good control.

Young bean plants are also attacked by the flower thrips (*Frankliniella* sp.). This thrips may be lemon-yellow to dusky yellowish brown to dark brown.

**CABBAGE INSECTS**

Several different kinds of caterpillars injure cabbage and related crops in Arizona. The two most commonly observed kinds of these caterpillars are the imported cabbage worm (*Pieris rapae*), and the cabbage looper (*Autographa brassicae*).*  

*A new name, *Trichoplusia ni*, is used by the U.S. Bureau of Entomology and Plant Quarantine, according to Mr. W. A. Stevenson.*
IMPORTED CABBAGE WORM

This pest is a European insect which reached North America nearly a century ago and is now common throughout the United States. The caterpillar, about 1 1/4 inches long, is velvety green with a faint yellow stripe down the middle. It has five pairs of short fleshy prolegs which support the rear two thirds of the body. (The cabbage looper has only three pairs of prolegs.) The inactive pupa, about 4/5 of an inch long, is pale green or yellowish brown. The rear end of the pupa is fastened to the plant and a silken girdle extends over the back. The parent butterflies are about 1 3/4 inches in expanse, white, with black-marked tips on the front wings. The female has two round black spots on each front wing, while the male has one such spot (cover cut). Both sexes have a round black spot at the front margin near the outer edge of each hind wing. They are frequently seen flying about cabbage plants.

The lemon-yellow egg is spindle-shaped and longitudinally ridged. It may be seen by the unaided eye as it rests on one end on the under surface of a leaf. It hatches in about a week.

Development is rapid and a generation may be completed in as little as twenty-two days, or as much as five or six weeks. There may be as many as six generations in the warmer parts of the country.

The caterpillars feed on cabbage, cauliflower, broccoli, Brussels sprouts, kale, kohlrabi, collards, radish, mustard, lettuce, other cultivated plants, and some weeds.

The young larvae first skeletonize the undersides of the leaves. Later they move about and eat irregular holes, riddling the outer leaves, and eating into the developing heads, which become stunted. They even penetrate well-developed heads. Quantities of dark green excrement accumulate in the axils of the leaves and infested plants may be made unfit for human food.

Methods of control for the cabbage worm and cabbage looper are very similar and will be discussed under the latter insect.

THE CABBAGE LOOPER

The cabbage looper moves by arching its back and extending its body forward in a looping motion. It is pale green, marked with two white stripes on the back and one white stripe on each side. It has three pairs of short fleshy prolegs near the rear end of the body.

The pupa is enclosed in a filmy silken cocoon about 1 1/4 inches long. The cocoons are usually fastened under the leaves, but may be on the soil. The moth is about 1 3/4 inches in expanse. The front wings are brown mottled with gray, and the hind wings are brown or bronze with white outer margins (Pl. II, 4). The tiny hemispherical eggs, white or pale greenish yellow, with longitudinal ridges, are laid on the leaves.

This pest is probably native to the United States, and is everywhere common. It is very active and feeds on cabbage, cauliflower,
broccoli, lettuce, mustard, turnip, radish, spinach, beet, celery, potato, tomato, watermelon, cotton, and other cultivated plants; also on tree tobacco, wild mustard, mallow, wild lettuce, and other wild plants.

The cabbage looper is active at least from March to November in the Tucson area, being most numerous and injurious during the fall months. It may be active in all stages throughout the year in the warmest parts of Arizona, but in colder areas winters in the cocoon.

The life cycle varies with the weather from three weeks to two and a half months. The larvae may completely consume small lettuce plants, or may injure the terminal buds and thus seriously hinder further development. Excrement or "droppings" of larvae feeding on the outer leaves may fall between the wrapper leaves of lettuce and make the heads unfit for human food.

On cabbage, the larvae usually feed first on the outer leaves and as they become larger, they eat holes in the leaves and often bore into the developing heads.

Control measures for the cabbage worm, cabbage looper, and other caterpillars on cabbage are similar, although there are differences in the susceptibility of these insects to different kinds of poisons. The following methods are suggested for the control of caterpillars commonly found on cabbage and related plants.

Before the heads begin to form on cabbage, undiluted calcium arsenate may be applied as a dust. A dust of one part cryolite with two parts of talc or flour is also effective; or one part of lead arsenate with four parts of flour, wettable sulphur, or talc may be used. A dust of 3 per cent DDT mixed with pyrophyllite, talc, clay, or sulphur is also effective.

When the heads begin to form or when the bud leaves begin to "cup over," insecticides containing arsenic, cryolite, and other fluorine compounds, or DDT, should not be used because these materials leave poisonous residues on the plants. For the imported cabbage worm, 1 per cent rotenone dust should be used. For the cabbage looper, prepared dusts containing not less than 0.3 per cent of pyrethrins are recommended. If pyrethrin dusts are not available for control of the cabbage looper then a prepared 1.5 to 2 per cent rotenone dust is recommended. When both the cabbage worm and cabbage looper or other cabbage caterpillars are present, a prepared combination dust with not less than 0.5 per cent rotenone and 0.15 per cent pyrethrins should be applied.

For cabbage looper on lettuce, 3 per cent DDT in pyrophyllite, talc, or clay is effective; or one part of cryolite with two parts of talc may be used if DDT is not available. DDT or cryolite should be used only on foliage which will be removed before the lettuce is used for food. Insecticides which leave a poisonous residue must not be applied to lettuce after the plants are one-third de-
developed. If control is necessary after this time use the pyrethrin-
rotenone combination dust above mentioned.

Cauliflower, broccoli, and Brussels sprouts in the seedling stage
may be dusted with undiluted calcium arsenate or cryolite as
suggested for cabbage; later only dusts containing rotenone or
pyrethrins should be used.

Cabbage and related plants should be dusted when the first
indications of the presence of caterpillars appear or when there
is an average of one caterpillar to a plant. Both sides of the leaves
should be covered with the dust. Apply at intervals of a week
or ten days and repeat until control has been established.

In small gardens the caterpillars and pupae may be collected
by hand and destroyed. Plow under or remove cabbage stumps
and other crop remnants soon after harvest. Locate new plantings
as far as possible from old. Mustard, peppergrass, and similar
weeds should be cut and burned when growing near cultivated
areas.

**HARLEQUIN BUG (MURGANTIA HISTRIONICA)**

This offensively odorous insect is about ¾ of an inch long.
It is shield-shaped, conspicuously marked with bright red and
black spots, the wingless nymphs resembling the adults (Pl. VI,
3). The egg, 1/20 of an inch long, strongly resembles a miniature
white keg with black hoops, the black spot on the side suggesting
a bunghole.

Plate VI.—Piercing-sucking bugs: 1, The squash bug; 2, Brown cotton
bug; 3, The harlequin cabbage bug. (Slightly enlarged.)

The harlequin bug, widely distributed in Arizona and Cali-
ifornia, is an especially serious enemy of Cruciferae: cabbage,
mustard, turnips, collards, rutabaga, broccoli; kale, cauliflower,
radish, horse-radish, Brussels sprouts, kohlrabi, rape, and similar
wild plants of the same family. It feeds to a lesser extent on some
other crops such as squash, corn, and beans.

The harlequin bug winters as an adult throughout most of its
range, remaining active on the host plant under mild conditions,
or seeking temporary shelter on cold days. In colder areas the adults hibernate under leaves, grass, and rubbish. The eggs are laid in twelve-egg masses, mostly on the undersides of the leaves. Development takes forty to seventy days, depending on temperature. There may be two or three generations.

This insect has piercing-sucking mouth parts in all stages, with which the host plants are punctured and sapped. Young plants are killed and larger ones seriously stunted. The crop of an entire field may be destroyed by this insect.

This pest is very difficult to control. Collect and destroy the bugs in the spring as soon as they appear, before egg-laying, and destroy eggs when found. Disk and plow under crop remnants immediately after harvest, and destroy wild plants of the mustard family growing near by. Kale, mustard, or rape, planted early, may be used as a trap crop. When the bugs are attracted to the plants in numbers, spray them with pure kerosene. Some of the regular crop left after harvest, or a new trap crop, may attract the insects for a later destruction with kerosene spray. Neglected trap crops act as breeding places. Grass- and weed-fouled crops or borders furnish shelter for the bugs and should be burned or removed.

Ordinary contact insecticides have little effect on this insect, especially the adults. Rotenone gives some control of the young bugs and is best to use. A prepared dust containing at least 0.5 per cent rotenone may be used, or the following spray will give some control of the young bugs:

- Rotenone extract .......................... 4 tbsps.
- Soap ........................................ 2 1-inch cubes
- Water ....................................... 3 gals.

Slice soap thin and dissolve in a small amount of hot water. The spray must actually hit the insects.

Laboratory tests conducted elsewhere indicate that a 10 per cent DDT dust is effective against the adults of this insect.

CORN INSECTS

CORN EARWORM (HELIOTHIS ARMIGERA)

This insect is commonly found feeding on the silks and kernels of green corn. Grown larvae are about 1¾ inches long. They vary greatly in color, being greenish, yellowish, or brownish, longitudinally striped along the sides and back, while the head is yellow.

This insect is a world-wide pest. While it feeds on a great variety of plants, it is one of the most important enemies of corn in Arizona. It is injurious to both field and sweet corn, and especially so to golden bantam sweet corn. When it bores into tomatoes it is known as the tomato fruitworm, and when it bores into cotton bolls, it is known as the bollworm.
The moths (Pl. VII, 2) are active at dusk, laying their white hemispherical eggs (which may be seen by careful examination) singly on any part of the plant above the soil. Many eggs are laid on fresh silks, the young caterpillars feeding on the silk as they make their way down to the developing kernels. Being cannibalistic, usually only a single grown caterpillar is found in an ear of corn. The full-grown caterpillar enters the soil to a depth of 2 to 7 inches, where it forms a cell with a smooth exit tunnel. Here pupation occurs, the moth later escaping through the tunnel. The number of generations varies from two in the North to as many as seven in the South. It overwinters as a pupa in the soil.

Plate VII.—Moths: 1. Corn earworm (larva) in tip of ear; (compare Pl. XII, 3); 2. Corn earworm moth; 3. Beet armyworm moth (Laphygma exigua). (All approximately life size.)

The corn earworm also bores in the heart or curl of young corn, making holes in the leaves and retarding growth. Later, as ears develop and become infested, the silks are injured and proper pollination is prevented, resulting in small, poorly formed ears. The “worms” feed on the tender kernels at the tip of the ear, this being the most characteristic work of the insect, though deeper penetration into the ear may also occur (Pl. VII, 1). This injury permits the entrance of molds and if such diseased ears are fed to livestock, serious illness or death may result.

The corn earworm may be controlled in the ears by the use of white mineral oil: (a) alone; (b) the oil with 0.2 per cent pyrethins added; or, (c) with 2 per cent dichloroethyl ether. The oil alone gives about 60 per cent control; the combinations from 75 to 85 per cent. Do not use in greater strength than recommended. Ready-mixed oil pyrethrin is more convenient to use than home mixed, and is just as efficient, and probably more economical. Use oil treatments with caution. Applied too soon, proper fertilization of the kernels is prevented; to late, the...
larvae will have penetrated and caused damage. Treat only when the external silks have begun to wither and turn brown at the tip, approximately three to seven days after the silks appear.

Apply the oil by means of an ordinary glass medicine dropper; half-full for a small ear, to three-fourths full for a large ear. Insert the dropper about ¼ inch into the silk mass and force the oil into the silks at the tip of the husk. A half pint will treat about 300 ears. Treated ears may be marked against a second treatment with a dab of paint, or by other convenient means.

Clipping off tips of ears after pollination is a simple and effective method of controlling corn earworm. As with oiling, clip only after the silks have begun to turn brown and dry at the ends. Shear off the tip of the ear near the end of the cob and collect the clipped ends in a suitable container for later destruction by fire or water. If a small brown spot on the cut surface indicates that the larva has already penetrated deeper, clip deeper until the evidence is removed.

Still another control is to dust the silks at three-day intervals with undiluted arsenate of lead. A bag containing the dust, or a tight-lidded can with small holes in the bottom may be used for applying the dust.

Two applications of 6 per cent DDT dust and one oiling of the silks are effective against the corn earworm. The first application of dust is made when the corn plants are about 24 inches tall followed by a second application ten days later. Oil- pyrethrum is applied when the silks have begun to wilt, fifteen drops being introduced into each ear silk channel.

FALL ARMYWORM (LAPHYGMA FRUGIPERDA)

The larva of this insect commonly feeds deep down in the curl of young corn. When grown it is about 1½ inches long, varying in color from light tan or green to almost black. It has three narrow, yellowish white lines on the back, and along each side a dark stripe and a wavy, red-mottled yellow stripe. The head is brown marked with cream, with a pale inverted "Y" on the front. The moth is heavy-bodied and has a wingspread of about 1 ¼ to 1¾ inches. The front wings of the male moth are dark gray, marked with irregular lighter and darker patches, and there is a light spot near the tip of the wing. The front wings of the female moth are dull gray with obscure markings. The hind wings of both sexes are pearly white with a narrow, brown border along the outer edge (Pl. II, 1, 2).

This is a semitropical insect, unable to survive the winters north of central Texas. It is an important enemy of corn in Arizona. Its favorite food plants seem to be corn, sorghum, Bermuda grass, Johnson grass, and other grasses. It also feeds on beans, potato, turnip, spinach, tomato, cucumber, and other crop plants.

The moth lays its eggs in clusters on grass or other green plants at night. The egg stage averages about five days, the larval
stage perhaps fifteen, and the pupal stage about one week, thus totaling only four or five weeks for the entire life cycle. There may be five or six generations in the Gulf states, but only one in the North.

Very young larvae eat only soft green tissue from the leaves, leaving prominent whitish areas. Later they feed along the edges or chew holes in the leaves. Larger larvae may completely consume grass and other small plants and even corn 4 to 10 inches tall, while the largest caterpillars may eat the foliage of older corn, leaving only midribs and stalk. Borings in the heart or bud indicate the presence of the fall armyworm or the corn earworm. The fall armyworm feeds on ears of green corn in precisely the same manner as does the corn earworm. The two caterpillars may be distinguished by the brown head of the fall armyworm and the yellow head of the corn earworm. Ear damage by fall armyworm is most common in the fall.

In a heavy infestation this ravenous pest may consume all of the available food plants except the toughest parts. It may then migrate over the soil in “armies” in search of more plants on which to feed.

Dusting infested corn and grass with undiluted calcium arsenate is a very effective control, especially if done while the larvae are young. A spray consisting of 4 level teaspoonfuls of arsenate of lead in a gallon of water is also effective, especially for larvae in the curl or bud of the plants. The liquid should be directed deep down into the bud. Poisoned bran mash (page 17) scattered broadcast is very effective when the caterpillars are present as armies on grass, lawns, or in similar situations.

LESSER CORNSTALK BORER (ELASMOPALPUS LIGNOSELLUS).

This borer is about ¾ of an inch long, slender, bluish green marked with brown stripes. It lashes about very actively when removed from its feeding tube. The moth, which is seldom seen, is about ¾ of an inch in expanse (Pl. II, 5, 6). In Arizona it occurs only in the southern half of the state.

This insect attacks corn, beans, cowpeas, sorghum, Johnson grass, peanuts, turnips, and several other crops. There may be as many as three generations in a season. It probably overwinters as a larva in the soil.

The larva bores into the young corn plant at or just below the soil surface, extending its burrow an inch or two into the stalk. From the entrance hole it builds a feeding tube of silk out into the soil. By carefully loosening the soil around an infested plant the attached tube and larva may be found. Burrowing in the stalk kills the bud and the terminal leaves wilt and die. Later the plant becomes dwarfed, deformed, or dies. Older corn and sorghum may be girdled near the soil surface, or may be burrowed into. Such injured stalks break off easily near the ground. Cowpeas may also be girdled or burrowed. The larvae are seldom found in the plants, but more often in their feeding tubes. Young
corn and cowpeas usually have one larva to a plant, but older corn and sorghum may have several borers.

For control, burn all infested crop remnants including weeds and grass, following in late fall or early winter by plowing. Harrow, or otherwise work, field borders to break up winter quarters of the pest.

**SOUTHWESTERN CORN BORER (DIATRAEA GRANDIOSELLA)**

The larva of this insect is a common cornstalk borer in southeastern Arizona. The grown larva is about 1 1/4 inches long, white, marked in summer with numerous conspicuous dark spots, but unmarked in winter (Pl. VIII, 1). The moth has a wingspread of 7/8 to 1 3/8 inches, white or with straw-colored front wings (Pl. VIII, 2).

Plate VIII.—Southwestern corn borer: 1. The larva, boring in cornstalk; 2. The moth. (About life size.)

The southwestern corn borer occurs in southeastern Arizona. It is most injurious to corn, particularly sweet corn; but it also attacks sorghums such as sugar cane, broom corn, Sudan grass, and Johnson grass.

This species has at least two generations in southern Arizona. It spends the winter as a creamy white larva deep in the tip of the main root of the host plant. Activity begins when moths emerge about the first of May and continues throughout the summer.

Newly hatched larvae feed upon the leaf surfaces, leaving translucent or skeletonized areas, or they bore in the curl, thus riddling the leaves before they unfold. Several larvae may feed the whorl at the same time. If the terminal bud is destroyed the severed whorl of leaves dries and is called “dead heart,” and the plant dies. Half-grown larvae abandon leaves and bore into the stalk, either upward or downward. Internal girdling in late summer just above the soil may nearly sever the stalk and cause it to fall.

Control measures for the southwestern corn borer are not very satisfactory. Corn planted in late May should escape the first generation larvae. The production of vigorous, rapidly growing plants should be encouraged by soil fertilization, adequate irriga-
tion, proper cultivation, and crop rotation. Vigorous plants can withstand attack better than weak plants. Plowing stalks and stubble under deeply, followed by disking and harrowing, is recommended where there is no danger of soil blowing. Cut corn-stalks at soil level and burn before the borers descend into the roots, burn old stalks, remove and burn corn stubble. Johnson grass in the vicinity of corn should be burned, since the borer may spend the winter in this grass.

ONION THRIPS (THRIPS TABACI)

This tiny insect, only about 1/25 of an inch long, varies from pale yellow to dark brown in color, but the wingless young are nearly white.

Occurring wherever onions are grown, this thrips is a general feeder, said to feed on several hundred kinds of plants. Both adults and young winter on wild or cultivated host plants and reproduction continues throughout the year in mild climates.

Eggs, inserted in tender plant tissues, hatch in about five days. The young develop in about five days, pupate in the soil, and emerge as adults in four days, thus completing a generation in two weeks. There may be a considerable number of generations in a year.

Thrips have rasping-sucking mouth parts, with which they puncture the surface cells of plants. Removal of the cell contents causes light colored patches on the leaves. Thus the green leaves of onions become gray or white, a condition known as “blasting” or “silvering.” Badly infested plants are stunted or killed, especially during hot weather.

Tartar emetic prepared as follows is recommended:

<table>
<thead>
<tr>
<th>Small quantity</th>
<th>Large quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tartar emetic</td>
<td>1 oz. (6 1/2 tsps.)</td>
</tr>
<tr>
<td>Sugar (brown or white)</td>
<td>2 oz. (6 tsps.)</td>
</tr>
<tr>
<td>Water</td>
<td>3 gals.</td>
</tr>
</tbody>
</table>

Dissolve the sugar in the water and then add the tartar emetic slowly while stirring the liquid. Mix a fresh lot each time, since the solution will not keep. This is poisonous and must be kept away from children, pets, and livestock. If leafy vegetables are treated, they must be washed before being used for food. Spray when injury first appears, and repeat after seven days, or as necessary.

A dust of 5 to 10 per cent DDT in pyrophyllite or 2 ounces of 20 per cent wettable DDT in 2 1/2 gallons of water is effective against the onion thrips. Certain proprietary materials known as “Lethane B-71,” a dust, and “Lethane B-72,” a spray, seem to be effective also.

Crop remnants and weeds furnish breeding places and sources of future infestation. Such materials should be cut, raked, and burned.
CUCUMBER BEETLES

The spotted cucumber beetle (*Diabrotica duodecimpunctata*) and the western striped cucumber beetle (*Diabrotica trivittata*) are commonly seen on cucumbers, melons, squash, and related plants (Pl. I, 5, 6). However, they are of rather minor importance in the small garden.

The spotted cucumber beetle is about 1/4 inch long. The head is black while the necklike prothorax is yellow. The antennae or feelers are black with yellowish bases. The wing covers are yellow or greenish yellow marked with twelve black spots arranged in three transverse lines (Pl. III, 3). It is often mistaken for a ladybird beetle.

The beetles are practically omnivorous and feed upon flowers, fruit and foliage of fruit trees, forage crops, truck crops, and ornamental plants; and on the foliage of cantaloupe, bean, beet, corn, cucumber, eggplant, grape, lettuce, parsnip, potato, squash, tomato, and watermelon. They are particularly attracted to the pollen in the flowers of cucumbers, melons, squash, and gourds. The larvae are more injurious than the beetles and feed upon the roots of cantaloupe, squash, corn, grasses, beans, and other plants.

The spotted cucumber beetle is active throughout the year in the warmer parts of Arizona, but is most common from April to November. When forced to hibernate, it spends the winter on the soil in any available shelter. The life cycle is completed in five to nine weeks and there are probably three generations in Arizona.

The direct work of this beetle is of minor importance. However, the fact that it carries bacterial wilt of cucurbits as well as bacterial wilt of corn increases its importance. Injury to the roots of cucurbits and certain other plants by the larvae is not important; but when they feed on the roots of young corn the injury is severe, and the plants may even be killed.

The western striped cucumber beetle is about 1/5 of an inch long. The head and antennae are black, and the necklike prothorax is orange-yellow. The wing covers are marked with black and yellow longitudinal stripes (Pl. III, 4).

This insect is very common in Arizona from April until fall frost. The beetles are commonly seen on the flowers and plants of cucumbers, squash, pumpkins, and cantaloupes, and the larvae feed on the roots of these plants. The beetles feed also on beans, beets, corn, peas, sunflower, almond, apple, and other plants.

The beetles feed especially on the leaves and stems of cucurbits but are not usually abundant enough to cause serious injury. However, they occasionally disfigure watermelons by eating the green outer coat, which they may remove from large areas of the fruit. They are said to attack also the rind of honeydew melons in a similar manner. The larvae feed on the roots of cucurbits, melons, pumpkins, squash, and related plants. Cucumber plants may be killed by them.
Control measures for cucumber beetles are scarcely necessary except when these insects become abundant on very small plants. One part of cryolite and four parts of talc make an effective dust. Prepared 1 per cent rotenone dust may be used, and dust of one part calcium arsenate to fourteen parts of gypsum is also effective. Treat the plants at weekly intervals or as often as necessary, but do not use cryolite or calcium arsenate on any parts of plants that are to be used for food. For control of western striped cucumber beetle larvae on the roots of cucumber a solution of 1 teaspoonful of 40 per cent nicotine sulphate to a gallon of water is recommended. Apply a small amount of this solution by means of a narrow half-pint cup so poured against the sides of the stalks that it will run down around the plant into the soil.

Dusts containing 3 per cent DDT are very effective against cucumber beetles. However, since DDT retards the growth of certain cucurbits such as acorn squash and some varieties of muskmelon and causes some varieties of cucumbers to turn yellow, it should be used only with caution on such plants. Preliminary reports indicate that the Hubbard and buttercup varieties are not injured by DDT. It can apparently be used on mature cucumbers late in the day, but its use may be followed by a rapid increase in the number of aphids.

Sabadilla dust is said to be effective against cucumber beetles. A pyrethrum dust with one part “Pyrocide” to five parts of gypsum (325 mesh) is very effective against the striped cucumber beetle.

Caution: Do not use sulphur on any cucurbits.

PEPPER WEEVIL (ANTHONOMUS EUGENII)

This is an important pest of peppers wherever it is established. The adult is a “snout beetle,” shining black, with numerous whitish hairs on the body and legs, about ½ inch long. The head is prolonged into a prominent curved snout. The larva is cylindrical, curved, about ¼ inch long, legless, with white or gray body, and yellowish brown head (Pl. IX, 3).

This insect is known to occur in the vicinity of Douglas and Phoenix. It feeds and develops on varieties of pepper (Capsicum), as well as on eggplant, and black nightshade (Solanum nigrum).

The pepper weevil makes small round punctures in the buds and pods. In each hole it places an egg so that the larva feeds in the bud, pod, or pod wall, which it destroys and discolors. Pupating within when development is completed, the beetle emerges through a hole in the wall of the pod. The adult weevil now feeds on the buds, tender pods, or even leaves, making small round holes. There may be from two to seven or eight generations per year.

The presence of the weevil is indicated by dropping of the peppers and a general unhealthy condition of plant and fruit. Small peppers drop in large numbers, and even full-grown fruits
may fall. Injured peppers are more or less blackened and decayed within, and larvae, pupae, or adult weevils may be found in them.

To control this pest, collect and destroy all fallen fruits during the growing season. Immediately after the picking season gather and burn pepper plants and dropped fruits; or under field conditions, disk immediately, and plow under deeply. This covers many weevils and destroys their chief food. Cleaning up near-by nightshade plants aids in control.

Cryolite or calcium arsenate dusts, being poisonous, are not recommended for garden use. On large commercial plantings of sweet peppers, only if adequate equipment for removing the residue is available for harvest time, cryolite may be applied. Use 6 pounds of cryolite to 4 pounds of t alc, and apply 15 to 25 pounds per acre. Four to eight applications, at weekly intervals, may be necessary. Dust must be directed downward into the young growth from 6 to 8 inches above the plants, when there is no wind. To remove poisonous residue wash the peppers for one minute in a 2 per cent solution of hydrochloric acid at a temperature of 100 degrees F. Rinse thoroughly in fresh water. Chili peppers to be dried must not be treated with cryolite or arsenate.

Plate IX.—Weevils: 1, A potato stalk borer (Trichobaris compacta retrusa, X 9); 2, The tobacco stalk borer (Trichobaris mucorea). (Notice distinguishing black blotch above front leg, X 9); 3, Pepper weevils (X 10).
PEST PROBLEMS

POTATO PESTS

COLORADO POTATO BEETLE (LEPTINOTARSA DECEMLINEATA)

This beetle is about 3/8 inch long and 1/4 inch wide and strongly convex in shape. The head and prothorax are black-spotted. The wing covers are “ten-lined” with black and white stripes (Pl. I, 3). The egg is smooth, shiny orange. The plump, strongly arched larva is red with black spots, and has black head and legs. The pupa is orange-yellow.

The Colorado potato beetle, probably native to Colorado, occurs in Arizona at Flagstaff, in Chino Valley near Prescott, at Douglas, Willcox, Tucson, and undoubtedly in other localities.

Its favorite food plant is the potato, but it is also injurious to tomato and eggplant. It thrives on its native food plant, the buffalo burr (Solanum rostratum), and also feeds on tobacco, ground cherry, and related plants.

The beetles usually hibernate deep in the soil, but sometimes under rubbish. They emerge early and egg-laying begins as early as May 1, in the warmer parts of Arizona. The eggs are attached in clusters beneath the leaves. Pupation is in earthen cells in the soil. The number of generations varies with climate from one to three.

Both adults and larvae devour the leaves and may completely defoliate the plant. Growth is retarded and development of tubers is adversely affected. These pests are very destructive to potatoes, tomatoes, and eggplants from about May 17 until frost in parts of Arizona.

Three to 5 per cent DDT dust is very effective in control, and is used at the rate of 20 pounds per acre on large plantings. One pound of cryolite to 5 pounds of hydrated lime or talc may be used if desired, but cryolite is injurious to tomatoes. One pound of arsenate of lead to 4 pounds of hydrated lime or wettable sulphur is an effective dust, but should be applied early. One per cent rotenone ready-mixed dust should be used on those plants, on which a poisonous residue is to be avoided. However, rotenone is rather expensive. Pyrethrum dust, one part “Pyrocide” to five parts of gypsum (325 mesh) is very effective and non-poisonous. Begin treatments soon after the larvae have hatched and before they have caused appreciable injury. Repeat as needed to keep the insect under control.

In small gardens the beetles and larvae can be collected by jarring them into a pan or bucket containing a little kerosene. A wooden paddle is used to jar the insects into the container where they are killed by the oil. The eggs may be crushed on the leaves by hand.

POTATO (AND TOMATO) PSYLLID (PARATRIOZA COCKERELLI)

This insect belongs to the family of jumping plant lice (Chermidae). The adult, 1/8 of an inch long, resembles a winged plant louse. Its transparent wings are held rooflike over the body. Newly emerged individuals are pale, but soon become dark brown
or black, marked with white or reddish stripes. The female has a light horseshoe-shaped spot on the back at the posterior end of the body. The hind legs are large and the insect jumps and takes flight quickly if disturbed.

The nymph is oval, flattened, and scalelike. Young nymphs are semitransparent to orange; older ones are pale with prominent orange wing pads. The full-grown nymph is only about 7/100 of an inch long. The nymphs stick closely to the surface of the plant, especially in depressions on the undersides of the leaves.

This psyllid has been reported from a dozen western states, including Arizona. It feeds on potato, tomato, eggplant, pepper (Capsicum), tobacco, petunia, numerous wild plants of the potato family (Solanaceae), and others. Specimens have been received from localities in Arizona as follows: in March at Tucson, from Lycium berlandieri parviflorum; in March and May at Yuma from potato; in May at Phoenix from potato; in September at Flagstaff from potato.

This pest winters as an adult in warm, dry, sheltered places. In early spring the psyllids congregate on wild host plants where they breed for a time. Drying up of the wild host plants may necessitate the migration of the psyllids to potato, tomato, and other crops, where they appear almost simultaneously on different plantings. The eggs are laid mostly on the young terminal leaves, on both upper and lower surfaces. The nymphs feed especially on the lower side of the leaves. There may be eight or ten generations in a year. Hot, dry weather and cold weather are unfavorable for this insect, while a temperature of 80 degrees F. seems to be best.

The psyllid has a piercing-sucking beak, through which sap is withdrawn while salivary secretions are injected into the plant through a second tube within the beak. The loss of sap injures the plant to some extent, but the most serious injury is caused by some toxic substance in the injected saliva, producing the condition in potatoes and tomatoes known as psyllid yellows. This disease is produced only by the psyllid nymph. The symptoms are quite similar in potatoes and tomatoes. The first indications are a slight yellowing of the midribs and edges, and curling up of the basal parts. Later the plant becomes yellowish green, growth is checked, the joints swell, and the leaves are small, narrow, and rigid. The upper part of the plant appears leathery and aerial tubers may develop while clusters or chains of small tubers develop in the soil. Yield may be greatly reduced. The disease is sometimes called purple top from purpling of the leaf veins.

This psyllid may be controlled with dusting sulphur, wettable sulphur, or liquid lime sulphur. The first two are preferred to lime sulphur. Either seems to be as effective as lime sulphur and is less injurious to tomato plants. Tomatoes, if treated shortly before harvest, should be washed and peeled before being eaten or canned.
Dusting sulphur is powdered sulphur to which a conditioner such as talc has been added so that it will not pack in the duster, and when blown by a blast of air will float as a dust.

Wettable sulphur is powdered sulphur to which a wetting agent has been added. When added to water it goes into suspension and is applied as a spray. Use 2 tablespoonfuls per gallon of water for control of potato psyllid.

These sulphurs should be fine enough to pass dry through a 325-mesh screen. Availability of equipment will determine which is to be used. Either dust or spray must reach the undersides of the leaves. The first application is made ten to twelve days after the psyllids first appear or when potato plants are 4 to 6 inches tall.

Second and third applications may be made at intervals of two weeks if necessary.

Liquid lime sulphur (32 Bé) diluted at the rate of 1 gallon to 40 gallons of water has long been recommended for psyllid control on potatoes; and at the rate of 1 gallon to 50 gallons of water for control on tomatoes.

STALK BORERS (TRICHOBARIS SPP.)

Potatoes and related plants are subject to damage by certain borers belonging to the group of weevils or snout beetles. These are characterized by a more or less elongated snoutlike extension of the head carrying the mouth parts on the end. The larvae are the actual borers.

Two kinds of stalk borers injure potatoes in Arizona. One of these is the tobacco stalk borer (Trichobaris mucorea);* the other, which has not yet received a common name, is known to science as Trichobaris compacta retrusa.*A third related species is Trichobaris cylindrica. This has been collected from horse nettle (Solanum) in Arizona. It is potentially a pest of potato. (The potato stalk borer (Trichobaris trinotata) an important enemy of potato from Nebraska, Colorado, and Texas eastward is not known to occur in Arizona.)

The tobacco stalk borer (Trichobaris mucorea), widely distributed in Arizona, is barely ¼ inch in length. The body and legs are black, overlaid with fine gray or white hairs, giving the beetle a general gray color. On the back are three black spots, one in the middle and one on each side in front of a shoulderlike elevation. On the side, above the front and middle pair of legs, there is a prominent black area (Pl. IX, 2). Just back of the head is a more or less distinct orange-yellow collar.

Tobacco, potato, tomato, eggplant, and belladonna are attacked by the tobacco stalk borer. Wild host plants are ground cherry (Physalis), horse nettle and nightshade (Solanum), and various species of jimsonweed (Datura spp.). We have records from Mesa, Casa Grande, and Tucson.

*Identifications by L. L. Buchanan of the U.S. Bureau of Entomology and Plant Quarantine.
The second species, *Trichobaris compacta retrusa*, also widely distributed in Arizona, closely resembles the tobacco stalk borer, but it lacks the black area on the side of the body above the first and second pairs of legs and the orange-yellow collar just back of the head (Pl. IX, 1). It has been found on potatoes at Tucson. Reported hosts of this borer are potato, ground cherry (*Physalis*), and jimsonweed (*Datura* spp.).

The larvae or grub stages of the stalk borer of potato in Arizona are uniformly white, with yellowish brown heads. The fully grown legless larva is about 7/16 of an inch long. The body is cylindrical and somewhat wrinkled. When removed from its burrow the larva lies on its side in a curved position.

Studies by the U.S. Bureau of Entomology and Plant Quarantine indicate that there are three overlapping generations of the tobacco stalk borer on tobacco in Arizona and that the adult beetle hibernates in the stalks of tobacco and jimsonweed in Texas. It undoubtedly winters in the adult stage in stalks of potato and other host plants in Arizona, becoming active in the spring as its food plants begin to grow. *T. compacta retrusa* undoubtedly has a similar life cycle.

In Arizona the borers are found in potato stems in May and June, and are sometimes especially destructive in June. They bore in the stems both above and below the soil surface. Plants injured in this manner wilt and may die, and the entire crop may be destroyed.

The most practical control measure is to collect and burn all potato stalks in infested fields as soon as the crop has been harvested. Stalks and stubs of tomato, eggplant, and tobacco when infested should be burned immediately after harvest. The wild host plants, mentioned above, when growing near potatoes should be cut and burned. If this practice be continued year after year, the stalk borers may be almost entirely eliminated.

**SQUASH INSECTS**

**SQUASH BORER** (*MELITTIA SATYRINIFORMIS*)

The adult is a beautiful wasp-like moth 1 to 1 3/8 inches in wing expanse, the front wings greenish, the hind wings transparent with dark veins (Pl. X, 2). The body is conspicuously marked with orange-red, green, and black. The hind legs are prominent, "feathered" conspicuously in orange-red, black, and white. The eggs are inconspicuous. The full-grown larva, white with a brown head, is about 1 to 1 3/16 inches long.

This pest is very common and destructive in southern Arizona, attacking squashes, pumpkins, gourds, cucumbers, muskmelons, and watermelons in about the order named. It also attacks wild cucumber. The moths, which fly swiftly with a humming sound in daytime, are easily confused with wasps. Eggs are laid on leaves and stems, mostly toward the base of the plant. The
Plates X.—The squash vine borer: 1, Larvae burrowing in squash vine; 2, The moth. (Approximately life size.)

young larvae bore into the vines soon after hatching (Pl. X, 1), and after four to six weeks' growth enter the soil and construct cocoons for pupation, the new moths emerging later.

The moths may be seen on squash leaves in the morning or evening, or at midday in cloudy weather. At Tucson they become active about May 21. The first larvae are numerous in the vines about June 12, apparently completing their growth by about July 6. The remainder of the seasonal history in southern Arizona is uncertain. There appears to be a generation of moths in the last half of August and another later in September.

The caterpillars bore into the vines and main stalk of the plant, and may also bore into the fruit at the stem end or from beneath. Coarse, yellow borings are pushed out through holes in the infested parts and the vine may suddenly wilt and die.

The simplest method of controlling this pest in a small garden consists in slitting the infested places in the vine lengthwise with a sharp knife and destroying the borers. Draw soil over the injured place so the vine will heal and develop roots at that point; also cover the vines with soil at points 2 to 3 feet from the base to develop supplementary roots in case the vine is cut off from the main stalk. Keep plants in a vigorous growing condition by fertilization and irrigation. Destroy moths morning and evening when they can be easily seen and readily collected. Destroy old vines as soon as the crop is harvested. Community action on this would greatly reduce the number of moths. Deep plowing in the spring prevents moths from emerging. Locate new plantings away from infested soil, if possible.

Rotenone seems to be the most effective insecticidal control. A commercial dust containing 3/4 to 1 per cent rotenone will be more satisfactory than a homemade mixture. However, a derris dust containing rotenone may be prepared as follows:
Derris or cubé root powder
   (5 per cent rotenone content).......................... 1 part
   Talc..................................................... 3 parts

Derris may also be used as a spray as suggested for the Mexican bean beetle on page 25. Rotenone extract, 2 teaspoonfuls to a gallon of water, is also effective.

Apply dust or spray when the first moths or eggs appear and repeat each week for four to five weeks. The dust or spray must thoroughly cover the main stalk as well as the vines and leaf stalks, so as to destroy the eggs.

Preliminary tests indicate that a 3 per cent DDT dust is very effective against the squash borer, but note caution on page 37.

**SQUASH BUG (ANASA TRISTIS)**

This is a flat-backed bug about 3/4 of an inch long, dirty blackish brown above the mottled yellowish beneath (Pl. VI, 1). The wings fold diagonally across the back, leaving a triangular space between their bases. The beak extends rearward from beneath the head. The nymphs are gray with black head, legs, and antennae. Both adults and young give off a strong, disagreeable odor.

The squash bug seems to occur at all elevations in Arizona. It is particularly injurious to squash and pumpkin, but also feeds on cucumber, cantaloupe, watermelon, and gourd.

Adults winter under dead vines, leaves, clods, stones, boards, brush, weed piles, outbuildings, or similar shelter. Emerging from winter quarters in late spring, they feed only on plants of the squash family. They are present throughout the warm season in the Tucson area. Eggs, laid on the leaves, usually beneath, hatch in seven to seventeen days, depending on season. The nymphs from one egg-cluster feed together on the underside of a leaf, becoming adult in from thirty to fifty days. More than one generation may be expected in this area.

Both adults and nymphs sap the plants, the nymphs being particularly injurious. A toxic substance is injected into the plant by the insects, causing the formation of large grayish discolored areas on the leaves. The leaves wilt, curl up, turn brown, and die, and the whole plant may die if heavily infested. While seedlings are killed quickly, the greatest damage comes late in the hot weather season when nymphs are numerous. After the vines have been killed, the bugs cluster on and damage the fruits of squash and pumpkin.

The squash bug is very resistant to contact sprays. In the home garden, the adults and their egg-clusters should be collected and destroyed in early summer before the first eggs hatch. The over-wintering adults will crawl under pieces of board or burlap placed near the plant. The bugs which thus assemble during the night should be destroyed early the next morning. New plantings should be located at some distance from old plantings. Stimulate growth by heavy fertilization to produce a good yield in spite of
some injury. Immediately after harvest, destroy or feed to livestock all cull fruits; clean up or plow under all old vines; burn marginal brush, weeds, and similar debris, thus eliminating winter shelter for the insects.

A pyrethrum dust ("Pyrocide" one part to gypsum five parts) is said to be very effective, if applied often. It keeps the plants free of the insect for only about two days, and twelve to eighteen applications may be necessary. About 5 pounds of dust are required to treat an acre of seedlings and about 20 pounds are required when the plants cover the soil. Strong rotenone sprays seem to be most effective against this insect. The following formula is suggested:

\[
\begin{align*}
\text{Rotenone extract} & \quad 4 \text{ tps.} \\
\text{Water} & \quad 1 \text{ gal.}
\end{align*}
\]

The dust or spray must actually hit the insects.

Preliminary tests with sabadilla dusts and sprays and DDT dusts seem promising, but further experiments with these materials are needed. Note caution on page 37. Use no sulphur.

**SQUASH MIRID (PYCNODERES QUADRIMACULATUS)**

The adult is about \(\frac{3}{8}\) inch long, black, mottled with gray and white, with dull white wing tips, and pale yellow legs (Pl. IV, 3). Adults are very active and fly readily. The nymphs are green, dark mottled.

The squash mirid is numerous in late summer in southern Arizona, feeding on squash, watermelon, casaba, cucumber, cantaloupe, beans, okra, lettuce, and weeds. At Tucson leaf lettuce has been injured in March. All stages puncture the leaves and sap them from the lower surface, causing the upper surfaces to become greenish gray. Plants may be seriously injured, and whole fields of squash and beans have been destroyed in Arizona.

Since these pests probably hibernate under grass and weeds, cleaning up such materials is indicated. Old plantings of squash may be sources of infestation for other susceptible crops. Clean up and burn abandoned crops and infested weeds.

The following spray has been found quite effective for control of this insect:

\[
\begin{align*}
\text{Nicotine sulphate (40 per cent)} & \quad 2 \text{ tps.} \\
\text{Household ammonia} & \quad 2 \text{ tps.} \\
\text{Water} & \quad 1 \text{ gal.}
\end{align*}
\]

Apply early, when the bugs first appear, and repeat as necessary. Direct the spray at the underside of the leaves where the young bugs, which must be hit, are located. This mixture has caused slight burning of tender young bean leaves, but did not seem to be serious.

Ten parts of sabadilla to ninety parts of hydrated lime, talc, or pyrophyllite (pyrax) would be worth trying against this insect,
especially on lettuce, or other crops where the residue must be considered. Sabadilla does not leave a poisonous residue.

DDT is liable to injure squash, pumpkins, melons, and other cucurbits and should not be used on such plants. Five per cent DDT in pyrophyllite dust should be effective against this insect on beans, but green beans to be used for human food should not be treated with DDT after the pods have formed. Use no sulphur.

**TOMATO PESTS**

**BROWN COTTON BUG (EUCHISTUS IMPICIVENTRIS)**

This insect is about $\frac{1}{2}$ inch long and $\frac{3}{4}$ inch wide, broadly oval or shield-shaped, and somewhat flattened. Each “shoulder” or forward angle of the shield bears a sharp spine which is usually tinged with red (Pl. VI, 2). The general color of the upper surfaces of the head and body is grayish brown. The membranous terminal portion of the wings is darker grayish brown with a blackish tinge. When closely examined with a lens the grayish brown surface is found to be marked with numerous densely placed small black circular pits scattered irregularly over a general background of light tan. Two small slightly darker areas formed by a more dense grouping of these pits are visible on the middle of the back. The antennae and portions of the legs are tinged with red to a variable degree. The entire underside of the insect is yellowish or greenish yellow.

The brown cotton bug seems to be rather widely distributed in Arizona. It has attracted special attention here because it is probably the most important cotton insect in Arizona. It punctures the bolls of cotton with its piercing-sucking beak, which results in severe staining of the lint. At Tucson in August, 1944, Dr. R. B. Streets took this insect on tomato fruits which it had injured. This is the first instance to come to our attention of the brown cotton bug being injurious to tomatoes.

The insect feeds on both green and ripe tomatoes, the feeding punctures showing as tiny brown or black specks. In unripe fruit the tissue around these punctures may turn a faint yellowish green. The general whitish green ground color of unripe fruit, when badly punctured, is mottled with darker green and yellowish green areas surrounding the dark feeding punctures. In ripe fruits the tissue around the feeding punctures may be green, yellow, or greenish yellow. Decayed spots may develop in either green or ripe fruits. The insect also feeds on the leaves and stems. The eggs are barrel-shaped, standing on end in clusters, and may be laid on either upper or lower leaf surfaces.

Under ordinary conditions in the small garden, hand-picking the insects will probably be adequate. Dusting the plants with ready-made pyrethrum powder containing 0.3 per cent pyrethrins should be effective.
HORNWORMS

These are the large green caterpillars with a prominent “horn” on the end of the body. Two kinds of hornworms injure tomatoes in Arizona. One is the tomato hornworm (Protoparce quinque-maculata), the other, the tobacco hornworm (Protoparce sexta).

The principal food plants of both hornworms are tomatoes and tobacco, with potato and eggplant frequently, and other plants occasionally, attacked.

The fully-grown tomato hornworm is from 2 1/2 to 3 1/4 inches in length. Its general color varies from vivid green to brown, marked on each side with eight conspicuous V-shaped stripes pointing toward the head (Pl. XI, 2). Each “V” embraces an elliptical black spiracle with a bluish edge. The body, except the head and last two segments, is speckled with numerous round or elliptical bluish white spots, more conspicuous in the dark than in the green forms. The “horn” is black in this species. This horn is not a sting and is harmless.

Plate XI.—Sphinx moths: 1, Tomato hornworm moth; 2, Tomato hornworm (the “horn” is harmless); 3, Tobacco hornworm moth. (About one-half life size.)

The moth is 4 to 5 1/4 inches in expanse. The front wings are narrow, pointed, ashy gray, marked with irregular black and brown lines. The hind wings are lighter in color with a broad, gray band along the margin, and four dark brown bands, the middle pair sharply zigzagged. The large gray abdomen tapers to a point and has five orange-yellow spots along each side (Pl. XI, 1).

Hornworms may cause serious injury by defoliation. The most practical control in small gardens is to collect and kill them by hand. If excessively numerous in gardens or more extensive plantings, dust with undiluted calcium arsenate at the rate of 20 to 30 pounds to the acre. Do not dust within ten days before the fruit begins to ripen. Even so, the fruit should be washed or wiped with a cloth before using. Fall or winter plowing aids in controlling hornworms.

The tobacco hornworm closely resembles the tomato hornworm, but there are certain distinguishing characters. The tobacco hornworm has seven oblique white lines extending up and back on each side of the body instead of the V-shaped lines of the tomato hornworm. In this species the horn is red.
This moth has a wingspread of 4 3/4 to 5 inches and its general color is sooty brown. Near the central portion of each front wing there is a distinct small white oblong spot. Each hind wing has two obscure ashy gray bands along the border while the remainder of the wing is marked with three or four black and three white, more or less complete, crossbands. There are six orange-yellow spots along each side of the pointed abdomen (Pl. XI, 3).

**TOMATO FRUITWORM (HELIOTHIS ARMIGERA)**

This is the *corn earworm*, called by a different name on tomato. It is an important enemy of tomatoes in Arizona. The full-grown larva, about 1 3/4 inches long, varies greatly in color from green to almost black, marked with pink, yellow, and brown stripes, or without stripes (Pl. XII, 3).

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Plate XII.—Some tomato pest damage: 1. Tomato vine, and 2. Tomato fruit severely injured by tomato russet mites; 3. Tomato fruitworm (corn earworm) on tomato.

The moth is active at dusk and into the night, laying eggs singly on the leaves. The larvae start feeding on the foliage, but soon make their way to the fruits into which they burrow. Since the larvae migrate from fruit to fruit, attacking in various places, a single one may damage many tomatoes. In fact, damage to fruits is the principal injury done to tomato by this pest.
Control of fruitworm is feasible only while the larvae are feeding on the foliage. Begin control when 2 to 4 per cent of the developing fruits are infested. Two pounds of cryolite mixed with 1 pound of talc is a very effective dust. Undiluted calcium arsenate dust applied at 15 to 25 pounds per acre is also effective. A dust consisting of 4 pounds of cryolite or calcium arsenate mixed with 1 pound of sulphur should control both the tomato fruitworm and the tomato russet mite. Half-and-half arsenate of lead and hydrated lime, applied at 10 to 20 pounds per acre has been recommended. A spray of 3½ teaspoonsfuls of arsenate of lead to 1 gallon of Bordeaux or water should also be effective. Dust or spray must be applied evenly and thoroughly over the vines. One to three applications may be necessary. Since cryolite and arsenicals form poisonous residues on the fruit, such materials should not be used after the fruit is half grown. If it is necessary to dust or spray the plants later, the fruit must be thoroughly washed or wiped before it is used for food.

A poisoned bait, prepared by mixing 1 pound of cryolite with 10 pounds of dry corn meal, and scattered over the plants is a simple and effective control.

Plowing the vines under as soon as the crop has been harvested will prevent further development of the insect on the plants. Plowing also exposes the pupae, which are in the soil, to weather conditions and natural enemies, and destroys weeds which may furnish food for the larvae.

THE TOMATO RUSSET MITE (PHYLLOCOPTES DESTRUCTOR)

This is a microscopic mite, yellowish white in color, and wedge-shaped. The body tapers toward the rear end and is slightly humped. Its eight legs are on the front broader portion of the body. This mite is a newly introduced pest, first found in California in 1940, and in Arizona and Colorado in 1943. It occurs on tomato, petunia, potato, and a few other nightshades. So far as known, tomato is the only plant killed by it. In Arizona this mite has been very destructive in June, and continues active on tomato through the hot season.

The russet mite feeds on both surfaces of the leaves of tomato, on the stems, and to a less extent on the fruit, causing a brown or russeted condition (Pl. XII, 2). The base of the stem is first injured and becomes bronzed, and this injury spreads upward, the stalk becoming brown and dusty in appearance (Pl. XII, 1). Growth is not arrested, the terminal parts of the plant remaining green until the plant dies. The stems are not hollow as in curly top, but the main stalk cracks in three or four weeks. The leaves become bronzed, brown, and dry, paperlike, and have the appearance of having been exposed to extreme heat. The under surfaces of infested leaves have a glazed or pale appearance. Gradual defoliation takes place, beginning at the base of the plant, and the fruit becomes sunburned. Purple veins are not present as in curly top.
Infested tomato plants should be dusted with fine dusting sulphur (325 mesh). Probably very little burning of the leaves will result, except possibly in the case of very tender, young leaves. If infested plants are not sulphured, they will almost certainly be killed by the tomato russet mite. Directing a strong stream of water against the infested plant, giving them a thorough drenching at frequent intervals, seems to help control this mite.

A FEW USEFUL REFERENCE WORKS

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