
Oregon Agricultural College Extension Service

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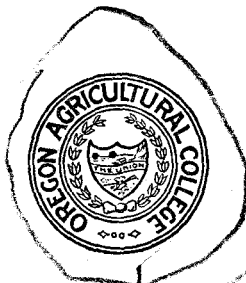
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Insect Pests of Truck and Garden Crops

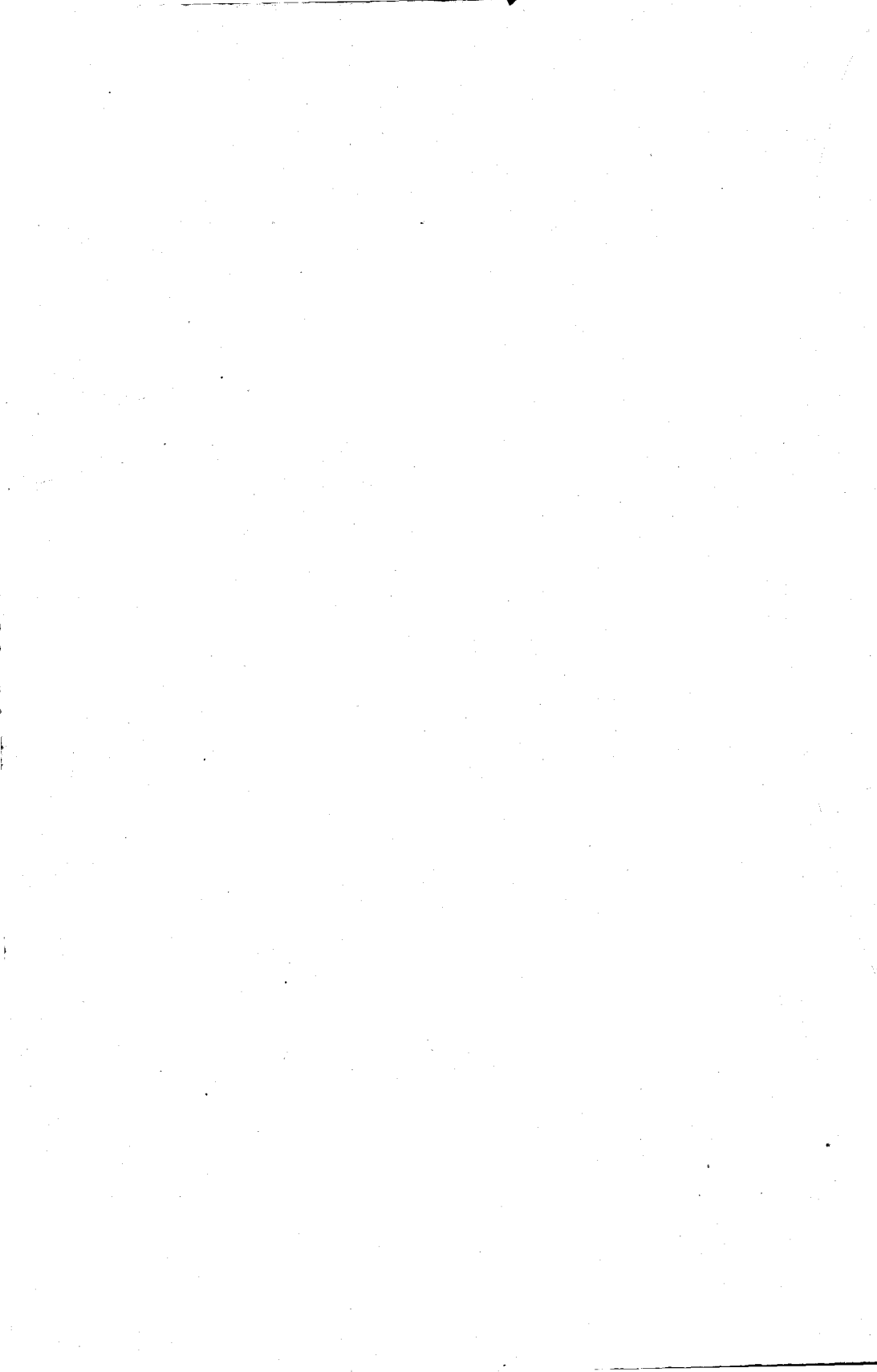
By

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CORVALLIS, OREGON

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Insect Pests of Truck and Garden Crops

Insect pests constitute an appreciable factor in the business of truck growing and gardening. The total amount of injury due to insect pests is enormous. It is estimated that the value of truck crops in the United States annually is \$300,000,000 and that insect pests cause a loss of 20 percent of the crop, or the astounding total of \$60,000,000.

Good Farming Methods a Great Insecticide. "An ounce of prevention is worth a pound of cure" as truly in the control of insects as of any other evil. To be of most value, sprays should be applied before the injury is apparent. The careful rotation of crops; fall, winter and early spring plowing; frequent cultivation; general cleaning up of roadways, fence corners, and trash about the field; care as to time of planting; proper use of fertilizers; use of trap crops; and frequent examination of young plants for possible insect pests—each of these practices is in itself a big step in the right direction for the control of our insect pests.

Spraying is Not a Cure-all. The use of insecticides is essential to the highest production of first-class truck and garden crops. Spraying will not remedy all the troubles arising from neglect and abuse. Sound seed, a well-prepared seed bed, and having the crop in a clean, thrifty, growing condition constitute the initial step.

When spraying, be sure to have the right proportions in mixing the materials, and mix thoroughly. The thorough mixture of a liquid spray is best obtained by pumping the solution through the hose and back into the container. Keep the solution thoroughly agitated while spraying. Do not continue to spray until the material runs from the plant. Cover the plant with the solution and then stop. An angle nozzle aids materially in the ease of application of the spray. For practically all truck and garden crops, the spray is best applied as a fine mist, and, for best results, a considerable pressure should be maintained.

For the small plants of all vegetables and at all stages in the growth of particularly tender plants, the dust sprays are advisable. There is apparently less danger of burning in the application of an equal amount of poison in the powdered form as compared with a liquid spray.

The best type of sprayer will depend on the work to be done. For the larger commercial truck growers, the power sprayers are most acceptable. For the smaller growers, the barrel type of spray pump will recommend itself. Then we have the knapsack and small compressed air pumps fitted up for a variety of purposes and very efficient in a small way. The general-purpose spray pump should have the working parts of brass. Always wash out the hose and working parts of the pump with water after using.

A dust spray gun for the application of powdered arsenate of lead should be obtained. There are small hand-bellows types that are very good for small areas, and large powder guns fitted with a fan wheel and extensions suitable for almost any purpose.

GENERAL PESTS

Cutworms (*Noctuidae*)

The sleek, well-fed, greasy, sparsely haired cutworm caterpillars (see Fig. 1), varying in size when mature from 1 to 2 inches, streaked and mottled with varying shades of yellow, grey and brown, are very well known. The caterpillars, as well as the adult moths, are most active during the night. The majority of the medium-sized, mottled grey and

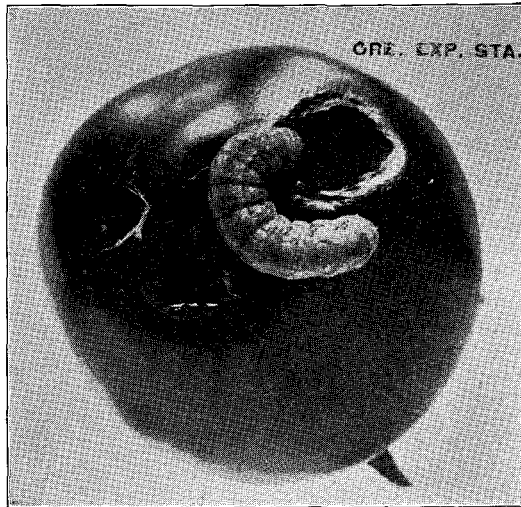


Fig. 1. Cutworm caterpillar (slightly enlarged).

brown moths attracted to lights, are the adults of the cutworm caterpillars (see Fig. 2). Varying with the species, cutworms pass the winter as eggs, pupae, and adult moths, or as half-grown cutworms in the soil.

Our most commonly injurious cutworms in Oregon pass the winter as half-grown caterpillars in the soil. They are present in the early spring when the soil is prepared for planting and await with voracious appetites to attack the newly set plants or the seeded crop as soon as it appears above ground.

Nature of Injury. Young plants just pushing through the ground are found cut off just below, just at, or just above, the surface of the soil, the wilted top lying near. The fruit of tomatoes, the heads of cabbage, and the ears of corn are tunneled into and ruined.

Poison Bran Mash. This is the standard remedy for cutworms. This material, when properly prepared and applied, is preferred to the vegetation by both cutworms and grasshoppers. The expense is not prohibitive and the results are quick and sure. The poison mash is prepared as follows:

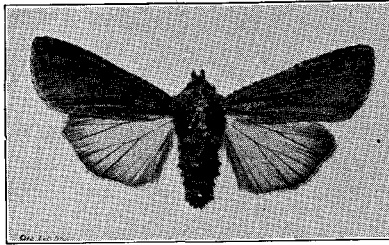


Fig. 2. Cutworm moth, adult (slightly enlarged)

Coarse bran.....	16 pounds
Calcium arsenate, lead arsenate or white arsenic.....	$\frac{1}{4}$ pound
Salt	$\frac{1}{4}$ pound
Sirup	1 pint

Warm water to make a coarse, crumbly mash.

The dry ingredients should first be thoroughly mixed and the water and sirup added. Do not get the material sloppy; have it so it will fall apart readily in the hand after pressing together. A large galvanized tub or a half barrel is an excellent receptacle in which to mix the material. Calcium arsenate, where obtainable, is especially efficacious in the bait. Lead arsenate, white arsenic, or paris green, are good poison materials where calcium arsenate is not at hand. The amount per acre indicated above is sufficient for the most serious cutworm outbreak. The material is simply spread broadcast over the infested area. It should break into small flakes, a few of which fall near each plant. Scatter the material in the evening. As our most injurious cutworms are present in the soil at planting time a very excellent method is to treat the area with the bran mash following the preparation of the soil and previous to the setting of the plants in the field. This preventive treatment has frequently given practically perfect results in cutworm control.

Do not allow chickens in a treated field.

Late summer, fall, or early spring plowing, followed by frequent harrowing is, where practical, very effective in diminishing the numbers of cutworms. Frequent summer surface cultivation is likewise of value.

Cylinders of stiff paper or tin, pressed down into the soil about the plants and allowed to project about two inches above the ground, give some protection.

Grasshoppers (*Acrididae*)

Grasshoppers, or locusts, have become a scourge at different times since our earliest history. As the land is brought under cultivation and more intensive farming is practiced, the attacks from these insects become constantly less frequent and less severe. Several species occur, but their habits and injury to crops are similar.

The winter is passed in the egg stage. The eggs are placed in the surface soil in a capsule-like sac or egg pod. Rather dry, bare, compact soil, such as is found in ditch banks, roadways, fence rows, and run-

down alfalfa fields, seems most acceptable for egg laying. The young hoppers appear in late April and May. They are very similar to the adult grasshopper in appearance, except in size and the absence of wings. They are mature in from three to seven weeks.

The **poison bran mash** is as effective in the control of the grasshoppers as in the control of cutworms. Be sure to add the salt, as grasshoppers appear especially fond of this material. A little more water may be added to the mash for the hoppers, and it may be more thinly scattered (five pounds to the acre), placing it in small heaps, as the hoppers will crawl to it.

For small orchard trees and bushes, jar the hoppers out of the trees after dark; scatter bran mash about the base of the trees.

Blister Beetles (*Meloidae*)

The blister beetles are elongate, cylindrical insects with soft bodies, long legs, and flexible wing covers. They have a broad, round head, attached to a narrow thorax by a distinct, slender neck. They are sometimes termed old-fashioned potato bugs. The average length is a little more than one-half inch. They vary in color from dull shades of black, grey, and brown to bright metallic hues, variously striped and shaded. Where they occur in numbers, an offensive odor is quite perceptible.

The Injury. The adult beetles feed on the foliage of almost any of the truck crops. Usually they appear in the field in a great swarm, attacking some particular crop to the exclusion of all others, until this food plant is thoroughly riddled. The immature forms of the blister beetle are beneficial, the young of some species feeding on the egg sacs of the grasshopper.

Control Measures. The beetles may often be driven from the field by simply sweeping over the plants with a brush, driving them with the wind. Another method is to prepare a windrow of straw along the windward side of the field. Fire this straw, after dusk, and sweep over the field driving the beetles into the burning straw. In potato fields, a paddle and bucket of suds will serve very well, simply knocking the beetles off into the bucket.

The arsenical sprays will check them in time, but as the poison acts rather slowly, some mechanical means is usually

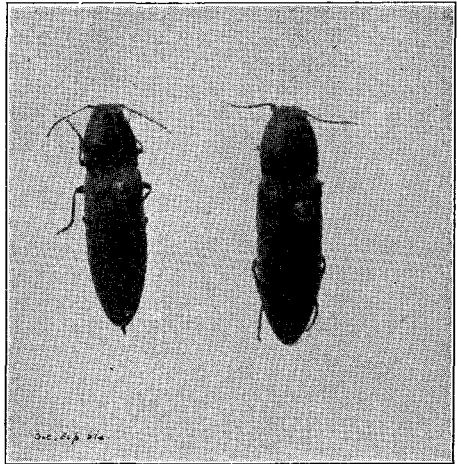


Fig. 3. Adult wireworms or click beetles.

more satisfactory where the blister beetles occur in swarms.

Wireworms (*Elateridae*)

Wireworms occur in the soil as elongate, cylindrical, active, worm-like larvae; with a hard, smooth, waxy, reddish brown surface; and with the body segments well defined. The worms vary from one-half inch to an inch in length. The adults of the wireworms are brownish beetles known as jumping jacks or click beetles because of their habit of throwing themselves with a snapping or clicking sound (see Fig. 3).

The normal habitat of the wireworms is the grass lands. The eggs are deposited here and the young worms feed on the grass roots. They spend from two to five years in the soil as wireworms before they become mature. Where sod land is brought into cultivation the worms present in the soil often attack the cultivated crop.

The Injury. Grain and potatoes suffer most. The worms bore into the seed and eat the germ of the grain and excavate tunnels in the potato tuber (see Fig. 4). Other seeds, bulbs, and root crops often suffer from a similar attack by wireworms.

Control Measures. Soil-infesting insects present a difficult problem in effective control. Wireworms are especially difficult to handle. Baits for the larvae and traps for the adults, while involving a considerable amount of labor and patience, are effective and practical for gardeners and truck growers.

Bait for Wireworms. The most successful bait appears to be rice bran balls as employed by the Japanese gardeners. Roast the rice bran in shallow pans in the oven, stirring frequently, until well browned. Moisten the bran and mould into compact balls, about the size of a golf ball, and let dry. If possible bait the soil in early spring before cropping. In the first treatment place the bait in rows ten feet apart and eight feet apart in the row. After locating the centers of infestation, as indicated by the abundance of the wireworms attracted to the baits, increase the number of baits on the heavily infested areas. Where a crop is present, place the bait between the rows, ten feet apart in the row.

The process of setting the bait consists in gouging out a shallow hole with a hoe, dropping in the bran ball, and kicking the soil in place. Place sticks or indicators of some sort near the planted bait. At weekly intervals visit the baits, break them open carefully, and remove the wireworms; reset the baits, increasing the number where necessary.

Traps consisting of piles of coarse straw, about three piles to the acre, may be used to attract the adult beetles. The successful use of traps depends upon one's ability to recognize the beetles, upon having the field free of all other trash and debris, keeping the piles of straw loose and fairly dry by frequent turning, getting these piles on the field in early spring, and frequently examining the traps. When beetles are found in the piles burn them at once.

Plowing in late summer, rotation of crops, and growing of mustard on the land are measures of possible value.

The Garden Slug¹ (*Agriolimax agrestis*)

The garden slug is a very annoying and destructive garden pest. This repulsive, slimy, slow-moving creature is often incorrectly termed a snail. The adult is about two inches in length. It is a deep mottled grey or greenish grey in color. The body is covered with a mucous slime which forms a slimy trail on any object over which the slug crawls.

The Injury. Nearly all garden and truck crops are attacked. The slugs attack the plants mainly at the surface of the soil. They may feed down some distance below ground and also injure the heads of cabbage, lettuce, etc. The ugly feeding punctures they make afford a ready entrance for decay and often whole plantings are ruined.

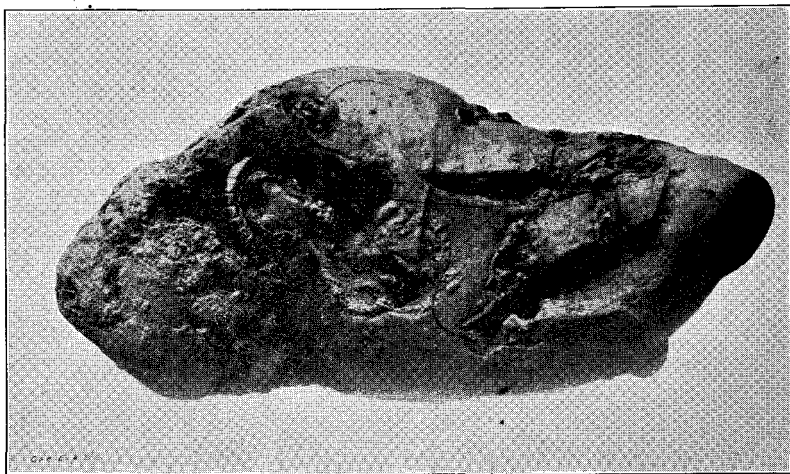


Fig. 4. Potato tuber showing wireworm larvæ and their tunnels (reduced one-half).

Control Measures. In planning a campaign for the control of slugs it is advisable first of all to clean up all trash, crop remnants, and debris about the garden. For use in the garden a combination of a repellent spray applied to the plants and an attractive poison bait scattered on the soil will give excellent results.

The Repellent Spray. Bordeaux mixture 4-4-50 sprayed on the foliage of the plant proves an excellent repellent. The slugs will eat the sprayed foliage only under stress from lack of other food. Commercial dry bordeaux may be applied as a dust. Liquid bordeaux probably is a little more effective, but the powdered form sticks better to smooth waxy foliage such as cabbage.

The poison bait for use in combination with the spray consists of:

Calcium arsenate.....	1 ounce
Chopped-up lettuce leaves.....	1 pound

Mix well and scatter in small heaps about the area to be protected. In case lettuce is not available, the tender foliage of cabbage, kale, clover or other succulent leaves may be used. Of nearly equal value is

¹For a detailed discussion of this pest and its control see Ore. Exp. Sta. Bulletin 170.

the poison bran mash as recommended for cutworms. The essential factor is that the poison be calcium arsenate. Lead arsenate or the other poisons will not give an equal degree of efficiency in the poison bait for slugs.

Aphids or Plant Lice (*Aphididae*)

Aphids, which attack most garden and truck crops, occur as small, greenish, soft-bodied, pear-shaped insects clustered on the foliage and stems of plants. Their mouth parts are fitted for sucking and they pierce the surface tissues of the plant and suck out the plant juices from within. Poison sprays applied to the surface of the foliage are therefore of no value in the control of plant lice.

Plant lice have a unique method of reproduction enabling them to increase in numbers at a tremendous rate. During the growing period of the plant, all the aphids present are asexual females capable of giving birth to living young at the rate of from one to six a day. These progeny are mature in twelve days and in turn begin giving birth to living young. Both winged and wingless forms occur. One winged adult settling on a plant may in a comparatively brief time produce a colony of sufficient magnitude to devitalize the infested plant. The winged forms are continually flying to new hosts, so reinfestation often occurs soon after control sprays have been applied to the crop.

Control. Plant lice are controlled by contact sprays (see pages 23-24). To be effective the solution must actually wet the insect. The use of "all in one" dusts at frequent intervals on plants such as cabbage and peas will do much to keep down serious infestation.

Millepedes (*Chilognatha*)

Millepedes feed on both plant and animal life. The slight good they may do by preying on other pests is overshadowed by their injury to cultivated plants. They destroy whole plantings of garden and truck crops, and do considerable injury to the fruit of tomatoes, cucumbers and similar plants where they come in contact with the soil.

The millepedes are not insects. They are elongate worms with two pairs of legs to the segment, rather flattened, the segments well defined, hard and shining.

Control Measures. The poison bait, as recommended for slugs, is of some value against millepedes. Use of bits of poison potato worked into the surface soil is recommended by one authority and might be practical on small areas.

A dressing of 10 parts of sulfur and 1 part of tobacco dust worked into the surface soil will repel millepedes.

Traps of sacking, boards, etc., as employed for slugs, would be equally effective for this pest.

Hot water will kill them where they are near the surface of the soil, but does not act to any great depth.

Symphilids

Injury by symphilids is of so obscure a nature as frequently to escape detection. Planted seeds fail to appear above ground and newly sprouted plants wither and die. Where this pest is the offender, the

attack is ordinarily so general as to destroy the stand. In extreme cases three successive plantings of garden seed have been destroyed and even weeds killed out on the infested soil.



Fig. 5. View of Symphylids as they appear in the soil. Enlarged 10x.

Symphylids occur in the soil as minute, elongate, white creatures hardly visible to the naked eye. Superficially they resemble newly hatched centipeds. They attack the sprouts, stems, and roots of plants, excavating channels along the surface or tunneling minute pinholes through the plant.

Control. Frequent stirring of the soil by cultivation and the hoe is of value. Sulfur planted with the seed serves as a repellent. Beans appear particularly attractive to the worms and may be planted as a trap to lure them. Dig out the infested beans in a few days and expose to the sun.

POTATO AND TOMATO INSECTS

The Western Potato Flea

Beetle (*Epitrix subcrinita* Lec.)

The Western potato flea beetle (Fig. 7) is probably the most serious insect pest of the potato and tomato in Oregon. The beetles eat small irregular holes in the leaf. This in itself might often prove of lesser importance, but these feeding punctures seemingly invite the attack of a fungus, which spreads out from the puncture and eventually affects a considerable portion of the leaf's surface (Fig. 6).

The larvae tunnel into the developing tubers underground. These feeding tunnels extend but a short distance into the potato. They give the surface of the potato a roughened, pimply appearance which may seriously affect the market value.

This insect feeds on a variety of plants, but apparently confines its serious attack to a small group of cultivated plants, of which the potato, tomato, peppers, and egg-plant are most important.

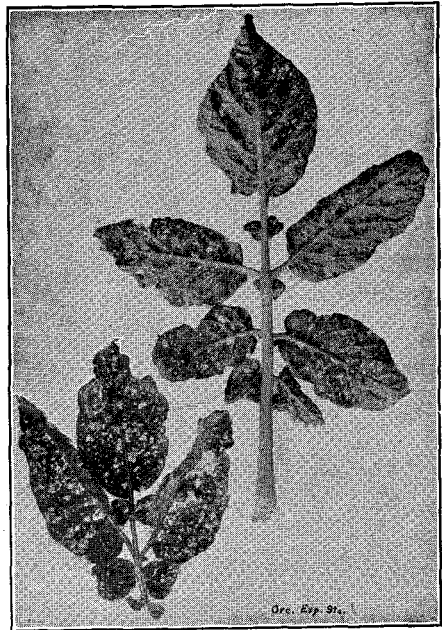


Fig. 6. Potato foliage showing injury due to flea beetles.

The adult flea beetle is nearly one-twelfth inch long, slightly oblong in form, and a dark metallic brown in color. The femur of the hind leg is much enlarged, giving the insect its ability to jump quickly like a flea when disturbed.

When mature the larva forms a small earthen cell in the soil and transforms to a pupa. The pupa is white in color and about the size of the adult beetle.

Life-history. There are two generations during the year. The beetles pass the winter in sheltered nooks about the field. They appear in late March and early April and feed on available weeds or plants of the potato group, later transferring their attack to cultivated plants.

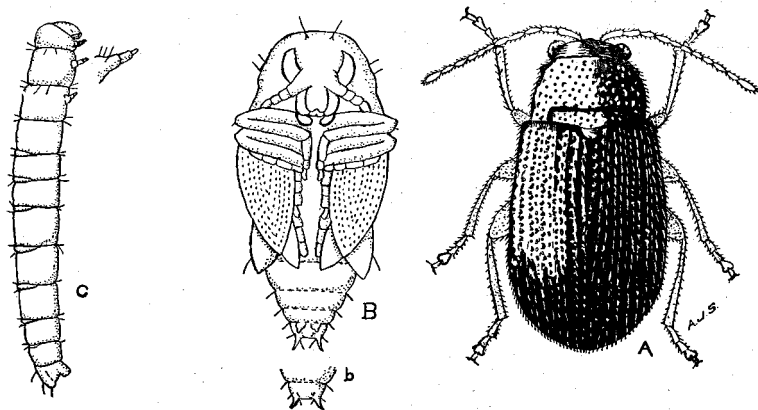


Fig. 7. Western potato flea beetle. a, Adult; b, pupa; c, larva

The larvae are present in the soil during June and early July. The adult beetles continue to feed on the foliage during this time. The beetles of the new generation commence emerging about July 20. These beetles in turn attack the foliage and deposit eggs in the soil. They fly readily and thus migrate to the new fields of late potatoes. The larvae of the second generation feed and grow through August and early September. The first adult beetles of the fall generation appear about October 10. These beetles feed for a time on the foliage of various plants and then seek suitable places for hibernation.

Control Measures. The Western potato flea beetle avoids sprayed foliage. This makes it an insect difficult to control with the ordinary arsenicals as applied for most leaf-eating pests. Bordeaux mixture

(see p. 24), applied for the potato fungous troubles acts as a very effective repellent for the flea beetle. By far the majority of the flea beetles feed on the under surface of the foliage, therefore a spray, to control them, must be directed as an underspray. Repeated applications are necessary for best results.

Arsenate of lead, 3 pounds to 50 gallons, with the addition of 2½ quarts of a good cane sirup, is suggested as a spray with possibilities.

For newly set tomato, pepper, and similar plants, two different treatments are recommended by some of the successful growers.

Cylinders of tin or paper (false bristol board works very well) about the dimensions of a tomato can, placed about the plant, have given satisfactory results.

Use of strips of paper suspended over the plants on a string stretched the length of the row is highly recommended by one grower.

The Colorado Potato Beetle (*Leptinotarsa decemlineata* Say)

This very injurious potato insect was but recently introduced into Eastern Oregon. As yet it is confined to a comparatively small area of the eastern portion of the State and does not occur in Western Oregon so far as known.

The insects pass the winter in the soil as adult beetles. They appear in the fields in the spring just as early potatoes are sprouting. They feed on the tender tips of the young plants and after a few days begin egg deposition. Eggs are deposited in compact masses on the under surface of the leaves. The larvae are slug-like, deep reddish in color, and they too attack the foliage of the potato. When mature they drop to the soil and tunnel in to change again to adult beetles. There is a second generation of the beetles and grubs in midsummer through most of the Middle West.

Control. Poison sprays are the standard treatment for the potato beetle. Two applications of spray should be made, the first as soon as the beetles appear on the young plants in the spring and a second about two weeks later. The dust spray (see page 23) is excellent for the earlier application. Calcium arsenate is the preferable poison. Lead arsenate will control effectively. Use the poison at the rate of 3 pounds to 100 gallons of liquid. When spraying with bordeaux for potato diseases the arsenate may be added to the bordeaux spray.

The Stalk Borer (*Papaipema nitella* Guen)

This borer tunnels into the stalk of the potato and tomato, eating out the heart and thus killing the stem attacked. The mature larva measures one inch in length. The color is purplish brown, marked with five longitudinal white stripes. All but the median stripe are absent on the four segments near the middle of the body, giving the worm a characteristic divided appearance. The mature larva eats a hole in the stalk and then pupates in the burrow. From this pupa there emerges a fawn-grey moth. This moth emerges in late August and deposits eggs in the wild grasses. The worms hatch in the spring and migrate to the cultivated plants.

Control Measures. Cut out infested stalks and burn. Keeping down weeds about the field will help.

The Tomato Worm

This worm, which burrows into the fruit, also attacks sweet corn and is discussed as the Corn-ear Worm.

BEAN AND PEA INSECTS

Stored beans and peas possibly suffer more from insect attack than do the crops in the field. Two weevils are particularly bad in the stored seed.

The Bean Weevil (*Acanthoscelides obtectus* Say)

The first evidence of infestation is usually in the stored seed. Many beans will show the round hole where the adult weevil has emerged, and an examination of the interior of others will disclose the grubs still at work inside. Several grubs may feed on the interior of a single bean.

The adult bean weevil is one-eighth inch in length. It is covered with a coat of brown-grey and olive pubescence, giving the body a mottled effect. The wing covers are shorter than the body.

The adult weevil deposits eggs on the pods in the field. The grubs hatch and burrow into the green beans, and are carried into storage with the seed. The beetles emerge in the bins and deposit eggs on the dried beans. The grubs soon hatch and burrow into the beans.

Control Measures. Weevily beans should not be planted. The vitality of an injured seed is low and many will not germinate.

A temperature of 145° Fahrenheit will kill the weevil in all its stages and will not injure the germination of the seed. To treat the seed with heat, place in a suitable receptacle in a moderate oven and hold there for six hours.

Fumigation with carbon bisulfide² is the standard treatment for stored grain pests.

If infected seed is to be planted, just previous to planting pour in boiling water to kill the grubs; cool at once by the addition of cold water.

The Pea Weevil (*Larid pisorum* Lec.)

The evidences of injury due to the pea weevil are practically the same as in the case of the bean weevil. The beetle is larger and does not breed in the stored seed.

Control Measures. Peas should be securely bagged immediately after threshing. If the seed is held over a season in a tight bin or receptacle, the weevil will emerge and die, as it cannot breed in dried seed.

Kerosene at the rate of one-half gallon to 5 bushels of seed is recommended. Simply pour the liquid over the peas, stir thoroughly, then spread the peas out so the oil may pass off.

The treatments as recommended for the bean weevil are equally efficacious for this pest, fumigation being the standard treatment for the stored seed.

The Pea Aphis (*Macrosiphum pisi* Kalt.)

This plant louse is of a uniform pea-green color, rather large as compared with most of the garden forms.

²For discussion on fumigation of stored grain insect pests send for Extension Bul. 228, Oreg. Agri. College, Corvallis.

These plant lice, when abundant, are able to sap the life out of a plant in a few days; they multiply rapidly and are very hardy. In addition to the peas, they feed on sweet peas, vetch, and clover.

Control Measures. The contact sprays as applied for other plant lice are fairly satisfactory for this insect. Kerosene emulsion is possibly the best of the contact sprays for the pea aphid.

The Striped Cucumber Beetle, and its near ally, the **Spotted Cucumber Beetle**, are often serious pests on beans. These two pests are discussed under cantaloupe, cucumber, and squash insects.

CABBAGE AND RADISH INSECTS

The Cabbage and Radish Maggot (*Phorbia brassicae* Bouche)

The cabbage and radish maggot (Fig. 8) is a most serious pest of cabbage, turnip, cauliflower, celery, rape, and kale.

The larva is a typical maggot, waxy white or yellowish in color. The body is cylindrical, ending bluntly behind and tapering to a point toward the head. When mature it measures about .32 inch in length.

The pupa consists of a small brown case or puparium some .2 inch in length. It occurs in the soil about the infested plants.

The adult insect is a two-winged fly, not unlike the common house fly. It is smaller in size and brown, with a distinct hump. When at rest, the wings extend some distance beyond the abdomen and overlap.

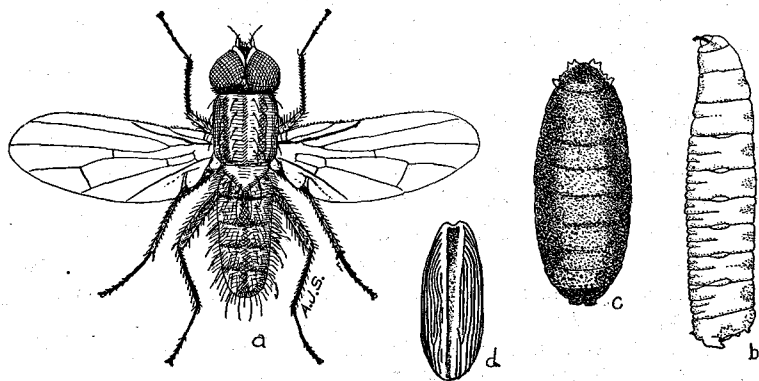


Fig. 8. Cabbage and radish maggot. a, Adult fly; b, larva; c, pupa; d, egg (enlarged)

The egg is small, measuring only .04 inch. It is white, and by the keen observer may be seen lying on the soil close to the stem of the food plant.

The adult flies appear in the early spring and seek their favorite food plants for egg laying. The eggs hatch in from four to ten days, and the young maggots burrow at once into the stem or root of the tender plant. The maggots reach maturity in from a month to six weeks, pupate, and emerge again as adult flies. From this time on until late fall, the insect is usually present in all stages of development.

The Injury. A few days after the cabbage plants are set in the field, they show a sickly bluish cast. Upon pulling up the affected

plant, the tunnel and the repulsive maggot are discovered. Radishes, turnips, etc., show the tunnels; the interior is often decayed and filthy.

Control Measures. Of a great variety of control measures recommended and practiced, the screening of the cabbage seed beds and of the radish plantings and the use of corrosive sublimate on the cabbages and similar plants in the field are the most practical and effective treatments.

Screening of the cabbage seed beds and of early radish beds has proved a very satisfactory and paying method of control. Cabbage plants are often infested while yet in the seed beds and the maggots carried with the plants when they are transferred to the field. A frame of twelve-inch boards, with wires across the top to prevent the cover from sagging, and the whole then covered with coarse cheese-cloth (twenty threads to the inch), making the frame fly-proof, serves very well.

By keeping out the adult female fly and thus preventing egg deposition, the plants are kept free from maggots. This frame should be removed, in the case of cabbages, a few days before the plants are transferred to the field to enable them to become hardy. A bed which is to be protected in this way should be located on well-drained and well-prepared soil, as cultivation under the cover is impracticable.

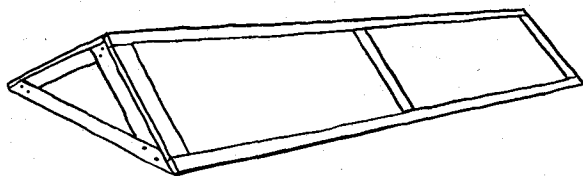


Fig. 9. Radish maggot screen frame illustrating type of construction suggested for protection of radish beds.

A light frame constructed as an inverted trough (see Fig. 9) and covered with wire screen or coarse cheese-cloth proves a most handy and satisfactory protection for radish beds. The approximate dimensions of the radish screen frame are 10 feet long, 2½ feet wide, and 1 foot high. These frames are light enough to move with reasonable ease, and where given some care will last for several seasons. The slight shade afforded assists the growth of the radishes. With three such frames to be used over successive plantings one is assured of detectable radishes free from maggots, at all seasons.

Corrosive sublimate at the rate of one ounce to twelve gallons of water is a most efficient material for use on permanent plantings of cabbage, cauliflower and similar plants. In tests carried out by Canadian entomologists in British Columbia 2500 plants were treated for the season at an average cost of one-third of a cent per plant. One hundred-percent maggot-free plants were obtained and the tonnage doubled as a result of the treatment.

About two liquid ounces to the plant should be used, the material being simply poured on the surface soil about the plant. Four treatments should be given, the first treatment three days after transplanting and succeeding treatments at ten-day intervals until four have been made.

A barrel in the back end of a wagon, fitted with two leads of hose and stop cocks, affords a fairly rapid method of application.

Reasonable precaution should be observed because of the poisonous nature of the corrosive sublimate. The treatment is not recommended for use on radishes and turnips.

Destroy all waste roots and refuse tops as soon as the crop is removed. Plow the land to a depth of four inches or more. As far as possible destroy all wild mustard and similar weeds about the field.

Rotate the crops so that plants of the Cruciferae group occupy the soil but a single season. The flies are weak fliers and do not usually travel far.

The use of a quick-acting fertilizer and frequent surface cultivation are of value.

The Cabbage Aphis (*Aphis brassicae* Linn)

This aphid is a very serious cabbage pest. It attacks all members of the group to some extent. Patches of rape and kale are often observed with many of the leaves absolutely covered with aphids and the depressions formed at the base of the leaves filled with the cast skins, parasitized plant lice, and the honey dew excreted by them. Small cabbage and rape plants are often weakened by the attack of this aphid so that they amount to nothing.

Control Measures. Contact sprays as for other plant lice are effective but several applications are often necessary to reach all of the aphids in the curled leaf.

Seed Beds. Plants are often infested in the seed bed. They should either be dipped at transplanting time or fumigated with tobacco paper. Whale-oil soap, 1 pound to 8 gallons of water, makes a very effective dip.

The Imported Cabbage Worm (*Pontia rapae* Sch.)

The imported cabbage worm is a heavy feeder on the leaves of cabbage and closely allied plants. The worm is a velvety green in color,

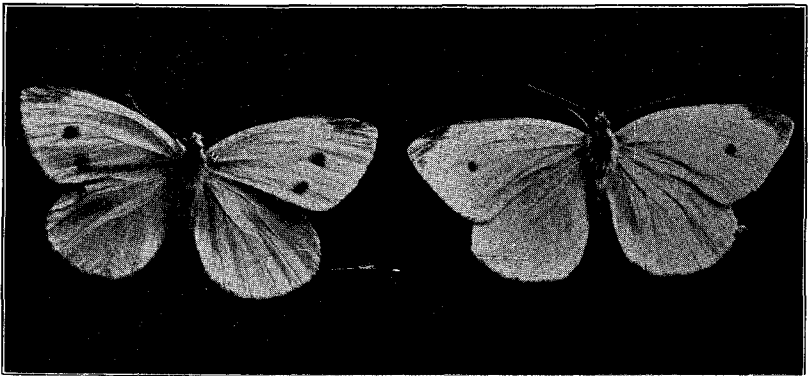


Fig. 10. The imported cabbage worm (*Pontia rapae* Sch.); adult butterflies,

with a faint yellow stripe down the back and a row of yellow dots down each side. The adult is a white butterfly (Fig. 10), a very familiar figure about the garden, though not always recognized as an enemy. These butterflies are among the first to emerge in the spring and they soon commence to lay eggs on the leaves of any available food-plant. The young worms feed greedily and are mature in ten to fifteen days. The chrysalis is green with a sort of bonnet effect and is attached to the leaf or other support by means of a silken band about the center. There are at least three generations during a season.

There are a number of parasites which prey on this worm very effectively and may even prevent its becoming a serious pest.

Control Measures. Spray or dust the young plants with one of the arsenicals. The dust is usually better for small plants. In fact if an arsenical dust is used on the plants at intervals of two weeks during growth until the plants begin to head, injury by cabbage worms will be extremely slight. It is well to add soap to the liquid sprays as a sticker for the slick foliage. The treatment should be repeated frequently until the heads are well formed.

Hot water, 150° F., or a salt solution, will kill the worms if they are wet with it.

The Diamond-back Moth (*Plutella maculipennis* Curt.)

The diamond-back moth as a larva is comparatively small, measuring when mature about .3 inch. It is of a pale green color, very active and easily disturbed. It is sometimes termed the cabbage shot-hole worm, because of the nature of its feeding punctures. These worms attack especially the central heart of the cabbage and cauliflower head.

Control Measures. Same as for Imported Cabbage Worm.

CUCUMBER, CANTALOUPE, AND SQUASH INSECTS

Western Twelve-Spotted Cucumber Beetle (*Diabrotica soror* Lec.)

This is probably the most serious of the insect pests attacking this group. It is a very general feeder, and its attack is by no means confined to these plants. Beans, potatoes, turnips, and similar truck crops suffer in much the same way. It is a serious pest of ornamental shrubs, devouring the buds and blighting the growing tips. Similar injury occurs to orchard trees; blossoms are eaten, forming buds are blighted or devoured, and the forming fruit is scarred and malformed by this active beetle. The silks, tassels, and even the green corn prove an inviting food at times.

The larvae feed on the sprouting seed of grain and may also girdle or burrow into the roots of other food plants. They also mine into the stems and rinds of the melon, cucumber, and squash, where these fruits are in contact with the soil.

The most noticeable injury of this pest, however, is the work of the beetles on the foliage of the above plants. They will collect in numbers, beginning their work when the young plants first appear above ground. Whole plantings are often killed out or the stand so depleted as to necessitate replanting. On the older plants they skeletonize the leaves, leaving only a gauze-like vein structure.

The beetle is about one-fourth inch long, yellowish green in color, the wing covers marked with twelve black spots.

The mature worm is a little less than one-half inch in length. The body is cylindrical, waxy white or yellowish in color. The head, prothorax, and anal segment are dark brown.

The winter is passed in the adult stage. These beetles become active during March. The wild gourd or "man-in-the-ground" is a favorite food plant at this time. They may also be found feeding on the bloom of the false dandelion. Whatever the food plant, they feed ravenously, attacking with apparently equal gusto, dirty or clean, tough or tender, sprayed or unsprayed foliage. After about ten days of feeding, many of the beetles become restless and rise high in the air and fly to new fields. These migratory forms constitute the early generation which attacks the young cultivated plants just pushing through the ground. A very common practice at this time is for the beetles to collect just at or just below the surface of the soil, feeding on the stems and sprouts. The plants are often girdled or cut off, the work much resembling that of a cutworm.

About this same time the beetles become more choice in their food habits, avoiding anything but the more tender and clean growth. Any dust or spray acts more or less as a repellent, though where carelessly applied may but serve to increase the injury by driving the beetles down to the untreated stems, where the practice of girdling will become more pronounced.

The new generation of beetles appears in numbers about June 30 to July 12. For a short period these beetles feed voraciously, devouring both sprayed and unsprayed foliage. After a few days, as with their predecessors, they refuse all but the very choice, tender portions of the plant.

Control Measures. It is seldom that any one treatment will prove entirely effective for this pest. The "trap crop" method gave excellent results in some of the tests at the Station. A number of suggestions are given and from the whole the grower may select such as best fit his conditions.

Protective coverings, consisting of boxes, hoops, or bent wires covered with cheese-cloth, serve very well for the protection of small plants. Wire screen cones are also recommended and were used in our tests here. These cones consist of the regular screen wire cut in half-circles, the straight edge then drawn together and sewed with wire. Obtain wire gauze 34 inches wide; cut it in squares 34 by 34 inches. Measure with a piece of string the distance from the center to the side, and, with a piece of chalk, describe a circle. Now cut with a pair of tinner's shears and bisect the circle. This will form two cones.

These protectors are fitted down snugly about the young plants, and the earth drawn up about the base. The cones may be used for a number of years. They should be dipped in paint or painted over both to prolong the life and to decrease the size of the openings.

Planting an excess of seed will be of some value where a stand is desired at all hazards.

Clean Culture. All of the old vines and trash in the field should be destroyed after the crop is removed. The destruction of the wild gourd will remove one very inviting breeding place.

Fertilization with some quick-acting agent has been suggested to aid young plants to make a quick growth and thus outgrow the injury.

Trap Crop. Taking advantage of the apparent preference of the beetles for squash and beans, these crops may be used in conjunction with other crops as the trap crop. The squash is probably more inviting under most conditions. The trap should be planted about the border of the fields, and on large plantings a few rows should be placed through the field. The number of plants in the trap must be left largely to the judgment of the grower.

Proceed as follows: Some ten days before the planting of the main crop, plant a few hills of the trap crop; at the time of planting the main crop plant more of the trap crop; some two weeks later make a third planting of the trap crop. When the first beetles appear, spray or dust the main crop with an arsenical. Repeat this treatment as often as the effect of the previous application is lost. This treatment of the main crop must be thorough, care being taken to treat every portion of the plant above and below. The treated vines will prove distasteful to the beetles and they will collect on the trap crop, where they may be destroyed by mechanical means.

Various substances have been recommended for treating the main field, such as wood ashes, air-slaked lime, tobacco dust, and bug-death. Lime water and bordeaux are two other substances which have been used. All of these materials are fairly effective, but some of them may stunt the young plants. For very small plants use the arsenical dust, and for the older plants dust or spray with lead arsenate.

Repellents, such as kerosene, tar, tobacco, etc., used alone, are of no practical worth against this pest.

Western Striped Cucumber Beetle (*Diabrotica trivittata* Mann)

This is very similar to the spotted beetle in the general food habits, life-history, and injury. The beetle is about .4 inch long, of a rather whitish-green color, and with two black stripes down each wing cover, which, when the beetle is at rest, appear as three black stripes; hence the name.

Control Measures. Same as for the Western Spotted Cucumber Beetle.

The Melon Aphis (*Aphis gossypii* Glover)

The melon aphis is another of the numerous soft-bodied plant lice attacking garden crops. Spray with the contact sprays (see pp. 23-24). Remember the value of the contact spray lies in thoroughly wetting the insect.

ONION INSECTS

The Onion-thrips (*Thrips tabaci* Lind)

The onion-thrips is a serious pest of this valuable crop in the onion districts; and where, for any reason, the growth of the onion is checked for even a short time, the injury may prove severe.

The adult thrips is very small, measuring about .04 inch. It is of a pale lemon-yellow color, with a blackish tinge. The thrips are very agile, moving with a gliding motion, the body twisting and turning as they travel. The females deposit very minute eggs in the surface of the leaf. The young nymphs resemble the adults, but are smaller and lighter in color. The various stages are of short duration, and there are several generations during the season. Winter is passed as nymphs, pupae, and probably also as adults. They occur in trash and refuse tops about the field. While onions suffer most, cabbage and kale, cucumbers, tomatoes, and several of the ornamentals are also subject to attack.

The injury is due to a rasping of the surface of the plant, the mouth parts of this pest being peculiarly constructed. Injured onions appear whitish or blighted. They wilt down and the bulb itself does not grow. An examination of the inner tender surface of an infested plant reveals groups of these minute insects hurrying about.

Control Measures. Black Leaf 40, 1 part to 1600 parts of water, with the addition of whale-oil soap, 4 pounds to 100 gallons of the solution, will control the thrips. Kerosene emulsion as a 7-percent solution is equally good. Whale-oil soap, 1 pound to 6 gallons of water, is also recommended. Any of these solutions, to be effective, must wet the insect. Spray thoroughly, driving the spray into the sheaths and also wetting the soil about the stem.

The Onion Maggot (*Hylemyia antiqua*)

The onion maggot attacks the onion much the same as the cabbage maggot attacks the radish. Infested plants, where small, may be killed outright. Older plants, where infested, may decay in storage.

The various stages and life-history and habits of this pest are so similar to those of the cabbage maggot, that the previous discussion (see p. 14) will serve for this pest also.

Control Measures. An effective, simple, and thoroughly practical method of control for this very serious pest has recently been developed by entomological investigators in British Columbia. This treatment consists in the use of volunteer onions in the field as a lure for the flies at egg-laying time. Field observations indicate that over eighty percent of the eggs are deposited on or adjacent to these volunteer plants. The most logical practice in commercial onion districts would be to leave an occasional volunteer onion in the field. In the absence of such onions, plant cull onions in the field as a lure. Plants of a rather low, bushy growth are most attractive. Leave about two or three volunteer onions every one hundred feet in the row.

Delay thinning about ten days, removing the volunteer onions about one week before thinning. In thinning take particular care to remove infested onions. All trap onions and all maggot-infested onions should be removed from the field and destroyed.

CORN INSECTS

The Corn-ear Worm (*Chloridea obsoleta* Fab.)

The tips of the ears of corn are often found eaten away, the silks cut off, and the whole ear presenting a most uninviting combination of injured kernels, decaying material, and frass. Usually a further search reveals the offender, a smooth, greasy, cutworm-like larva, about one

and one-half inches in length, rather slender and with varying shades of color and markings. This pest is known as the corn-ear worm (Fig. 11).

Sweet corn, pop corn, and field corn are favorite food plants in about the order named; it feeds also on peppers, peas, cow-peas, beans, and many other vegetables and fruits.



Fig. 11—Corn ear showing worm and injury (reduced).

The adult of this corn-ear worm is a moth, measuring, with wings expanded, about one and three-quarters inches. These moths are night fliers and are often attracted to the lights at night.

The moths appear in the spring about the time corn is knee high. At this time the eggs are deposited on a variety of plants. The young worms which hatch from these eggs feed and grow to maturity. The new generation of moths appears just in time to deposit eggs on the silks of the developing ears of corn. From these eggs hatch the worms which play havoc with the tips of the ears.

Control Measures. The numerous plants fed upon in the early spring and the fact that the moths can fly for some distance to deposit their eggs, are factors that make the control of this pest especially difficult.

Rotation. Planting the corn some little distance from land occupied by corn the past season will prove of some value. Early planting is recommended. In this way the corn will be in the silk before the moths are out in numbers to infest it.

Sprays. For valuable plots of sweet and pop corn, where only clean ears are salable, and in corn grown for seed, powdered arsenate of lead dusted on the silks of the ears gives good control. This material must be dusted on the silks every eight days, from the time the silks shoot until they become dry. The dust is applied by hand, using a can with a perforated top, "peppering" the silks. The silk and tip of each ear must be lightly dusted.

DUST FOR CORN-EAR WORM

Sifted wood ashes or sulfur.....	30 parts
Powdered arsenate of lead.....	60 parts
Mix thoroughly and apply as recommended.	

Fall, winter, or early spring plowing, followed up with frequent summer surface cultivation, is the practice followed in the great field-corn districts of the Middle West. Where practiced consistently, these cultural methods generally suffice for the conditions there.

The Asparagus Beetle (*Crioceris asparagi* Linn)

This beetle has recently appeared in Oregon. The beetle is about .25 inch in length. The general color is bluish black; just back of the head the body is reddish and there are three orange blotches on each wing cover. The grubs are slug-like in form, grey in color, with the head and legs black.

The beetles appear in the field as the new asparagus shoots are coming up. They feed on the tender tips, scarring and discoloring the tissues. Eggs are attached to the stems; they are stood on end in rows. The young grubs soon hatch and they too feed on the tender growing tips. There are probably two generations in the season.

Control. Where the crop is being cut for market, the injury may largely be prevented by cutting the crop clean every three to five days. All volunteer plants should be destroyed. If a few plants here and there are left uncut the beetles will congregate here and poison sprays may be applied for control. After the cutting season is over spray thoroughly with lead arsenate, $\frac{1}{2}$ pound to 20 gallons, giving two or three applications at ten-day intervals.

INSECTICIDES

Broadly speaking we must use poisons for those insects which chew their food or devour foliage and contact sprays for those which suck their food through a beak. Gas fumigation is used against inaccessible insects such as stored-grain pests which cannot readily be reached by other treatments.

Poisons

Most of our poison insecticides have arsenic as the active ingredient. They include white arsenic, London purple, paris green, zinc arsenate, calcium arsenate, and lead arsenate.

Any of these materials are effective and, in the absence of the more approved forms, may be used. The insecticides recommended for general use, because they are so uniformly standard and high grade, giving maximum efficiency in insect control and minimum injury to plants, are lead arsenate and calcium arsenate.

Lead Arsenate. This is our standard high-grade poison insecticide. The powdered form of lead arsenate is preferable for general use. Where the paste form is employed double the amounts given in the spray formulae.

Calcium Arsenate. This poison is possibly not so uniformly high grade as lead arsenate. For general use in truck and garden spraying, however, except on the younger and more tender foliage, it is considered the preferable form. It has a higher killing efficiency than the lead arsenate and for garden slugs is the only satisfactory poison material for use in the bait. Dealers in general, because of the previous small demand for calcium arsenate, have failed to stock up on this insecticide. Its value is so apparent in the control of garden insects, that growers would do well to see to it that local dealers have calcium arsenate available for use.

Applying the Spray. The more general method of applying insecticides is as a liquid spray. This method is still the preferable one in the application of contact insecticides. In the application of poison insecticides in general to garden and truck crops, however, the dusting method is equal to and in some ways superior to the liquid spray. Dusts stick better to the slick foliage of plants such as cabbage. It is generally possible to get an even and more complete covering, and poisons applied as a dust apparently do not burn tender foliage so readily. While one of the various types of dusters is preferable in applying dust materials, dust may be applied very satisfactorily through a coarse sack or cheese-cloth bag.

Formula for Dust Spray. It is inadvisable to apply the poison at full strength. Dilute with some inexpensive carrier.

Arsenate of lead or calcium arsenate (by weight).....	1 part
Sifted wood ashes, air-slaked lime or sulfur (by weight).....	9 parts

Be sure the materials are thoroughly mixed, apply lightly. Best results are obtained when there is no wind blowing.

Formula for Liquid Spray. The following is a satisfactory formula:

Lead arsenate or calcium arsenate (powder).....	½ pound
Water	20 gallons

Where attempting to apply liquid sprays to slick foliage such as cabbage, dissolve ½ pound of soap in hot water and add to the water.

Contact Insecticides

Kerosene emulsion is usually prepared as a stock solution and then diluted to the required strength for spraying, as used.

Whale-oil soap.....	½ pound
Water	1 gallon
Kerosene	2 gallons

Dissolve the soap in the boiling water. Remove from the fire and add the kerosene, stirring vigorously. The solution must now be agitated until it assumes a thick, creamy consistency that does not separate on cooling. This condition is most readily brought about by the use of a small bucket pump, forcing the solution through the hose and back into the container.

About a 7-percent solution will serve for most of our truck and garden pests. Some crops will permit a heavier dosage, and in a few cases a weaker dilution is advisable. The following dilutions will probably serve all ordinary purposes. The figures are given on the basis of 1 gallon of the stock solution.

To obtain 4-percent solution, add 15 2-3 gallons of water.
 To obtain 7-percent solution, add 8½ gallons of water.
 To obtain 12-percent solution, add 4½ gallons of water.

Oil sprays are best applied on bright days and when there is a slight breeze blowing.

Commercial nicotine sprays have the advantage of being easily prepared, reasonable in price, and reasonably sure not to burn foliage. A standard spray is as follows:

Black Leaf 40.....1 oz. (2 tablespoonfuls)
 Whale-oil soap.....½ pound
 Water.....12½ gallons

Black Leaf 40 may be obtained from any dealer in standard spray materials.

White hellebore powder may be used as a contact insecticide on crops nearly ready to harvest where other materials might prove objectionable.

Hellebore.....1 part
 Air-slaked lime, sulfur or cheap flour...5 parts

Fish-oil Soap. Especially good as a dip for young plants, to free them from plant lice, etc., is the following:

Caustic soda.....1½ pounds
 Water.....1½ quarts
 Fish oil.....5½ pounds

Dissolve the caustic soda in the water. Add the fish oil slowly with constant vigorous stirring. To use, take 1 pound of soap to 8 gallons of water. Do not submerge the plants. Dip only the infested portion; i. e., the root or top.

Bordeaux mixture should be made fresh each time it is used.

Copper sulfate.....1 pound
 Quicklime.....1 pound
 Water.....12½ gallons

Use only wooden or earthenware vessels in preparing bordeaux. Dissolve the copper sulfate in 2 gallons of water, in one vessel. Slake the lime and make up to 2 gallons in another vessel. Pour the two solutions simultaneously through a strainer into a container holding 8½ gallons of water.

Poison Bran Mash. Especially good for cutworms and grasshoppers.

Coarse bran.....16 pounds
 Calcium arsenate or lead arsenate.....¼ pound
 Salt.....¼ pound
 Cheap sirup.....2 quarts
 Warm water to make a coarse, crumbly mash.

Do not get the material sloppy; it should fall apart readily in the hand after pressing together.

"All in One" or "Three in One" is a commercial powdered insecticide containing arsenate, nicotine, and sulfur. For small gardeners particularly, who hesitate to take the trouble to prepare their own insecticides, this dust is very convenient. It serves better as a preventive than a cure. Dust young plants with the material at twelve-day intervals.

Gases for stored products pests like the bean weevil are discussed in Oregon Agricultural College Extension Bulletin 228. This is sent free to residents of the State who request it.