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Oregon Agricultural College

EXTENSION DIVISION

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INSECT PESTS OF TRUCK AND GARDEN CROPS 1913

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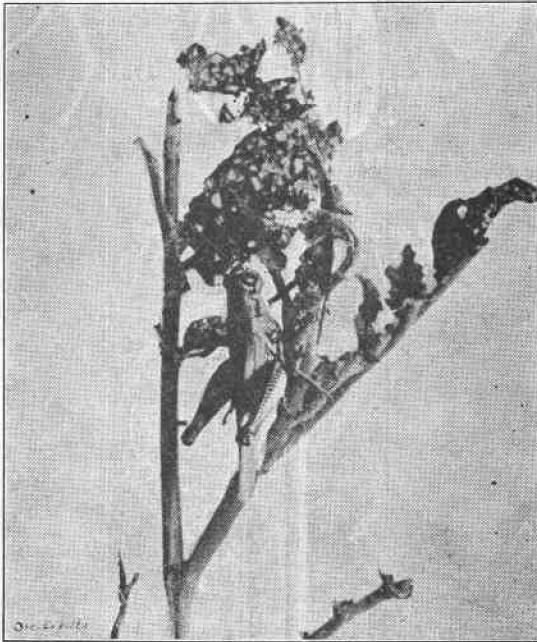


Fig. 1. Grasshopper Feeding on Potato Foliage.

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all residents of Oregon who request them.

CROP PEST CIRCULAR.

The Insect Pests of Truck and Garden Crops.

Insect Pests constitute an appreciable factor in the business of truck growing and gardening. Truck growing is followed on a commercial scale in limited areas of Oregon, and gardening is practiced to a greater or less extent by nearly every class of people, from the large fruit and grain raisers of the rural districts to the suburbanite in our towns and cities. 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 per cent of the crop, or the astounding total of \$60,000,000.

Considering it inexpedient to elaborate on any particular phase of the subject of truck and garden pests, or to discuss in detail any pest or plant, it has been our sincere endeavor to treat in simple, terse language the facts, so far as known, that vitally affect this important branch of the trucking and gardening business. Many minor insects have necessarily been omitted. No effort has been made to make this a complete treatise, but most of the common insects have received brief consideration.

Good Farming Methods a Great Insecticide. That "an ounce of prevention is worth a pound of cure" applies to the successful control of insects as truly as to the control of any other evil; it becomes apparent as we observe the habits of insects and note the marked difference in the losses sustained by the careful, up-to-date grower and his less progressive neighbor. The ultimate success following the use of insecticides will, almost without exception, follow this same rule. To be of most value, sprays should be applied before the injury is apparent. A knowledge of the insect's life history and habits becomes, therefore, an essential part of the education of the successful grower who would reap the highest net returns for the time and capital invested. With this knowledge, growers may look ahead and so manage their land and crops as to avoid many serious losses. The careful rotation of crops; fall, winter and early spring plowing; clean cultivation; the general cleaning up of roadways, fence corners, and trash about the field; care as to time of planting; the proper use of fertilizers; the use of trap crops; and the frequent examination of young plants for insect pests; each 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. Having the crop in a clean, thrifty, growing condition is the initial step.

When spraying, be sure to have the right proportions in mixing the materials, and mix thoroughly. The thorough mixture 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. 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.

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.

GENERAL PESTS.

Cutworms. (Noctuidae):—The sleek, well fed, greasy, sparsely haired cutworm caterpillars, (see Fig. 2); varying in size when mature

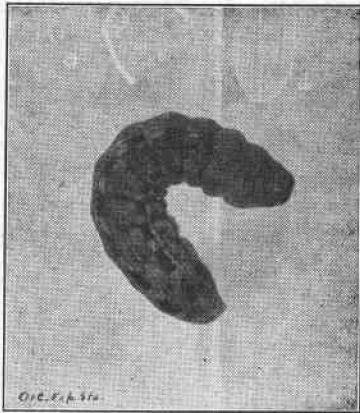


Fig. 2. Cutworm Caterpillar (slightly enlarged).

from 1 to 2 inches; and 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 brown moths attracted to lights, are the adults of the cutworm caterpillars, (See Fig. 3). Varying with the species, cutworms pass the winter as eggs; pupae and adult moths; or as half grown cutworms in the soil. The last named type is the most injurious in Oregon.

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.

Natural Enemies. Because of their frequent occurrence and numbers, the cutworms have invited the attack of a host of natural enemies. Poultry, and several types of birds, including the robin, catbird, blackbird, and quail, feed on the cutworm. Toads feed on these worms, and should therefore be protected rather than destroyed. Spiders, certain ground beetles, wasps, and the spined soldier bug, all prey on the cutworms. Certain small insects deposit their eggs in or on the caterpillar, and their larvae feed on its internal organs.

Control Measures. Late summer, fall, or early spring plowing, followed by frequent stirrings with the harrow, is, where practicable, very effective in controlling cutworms. By thus keeping down all vegetation, the worms are starved out.

The poison bran mash (See p. 31) is the standard remedy for cutworms. The material should be spread broadcast over the field several

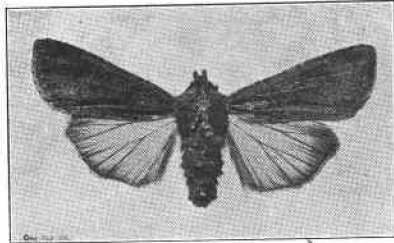


Fig. 8. Cutworm Moth, Adult (slightly enlarged).

days before the new crop is to appear. Small heaps of the mash may be placed about the young plants, such as tomatoes, cabbage and melons. Where the cutworms are working in from one side of the field, the mash may be scattered or drilled at right angles to their line of attack. Make the mash crumbly—a sloppy mash may do injury to plants. Scatter the material in the evening so it will be moist for a longer time. Do not allow chickens free range on a treated field.

Frequent stirrings of the surface soil will expose many of the worms.

Cylinders of stiff paper or tin, pressed down into the soil about the plants and allowed to project about 2 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 severe. Several species occur, but their habits and injury are similar.

The winter is passed in the egg stage. The eggs are placed in the soil in a capsule-like sac. Rather compact soil, such as grass lands, clover, and alfalfa fields and roadways, seems most acceptable for egg laying. The young hoppers appear in late spring. They are very much like the adult grasshopper in appearance, except for size and the absence of wings. They are mature in midsummer.

The Injury. While grasshoppers feed to a slight extent almost every season on our cultivated crops, the years of excessive injury are infrequent and are more liable to occur in the vast grain and hay tracts than in the truck fields. Where conditions are right, the grasshoppers swarm into the fields in hordes and devour all green vegetation in their path.

Control Measures. The use of a disc harrow or a renovator during late summer and fall on grass and hay lands adjacent to the truck fields would destroy many egg capsules. Burning grass lands in the spring, when an abundance of young hoppers is observed, will kill them off and eliminate the possibility of a later attack in the cultivated fields. Arsenical sprays are often used on plants to protect them against grasshoppers. The poison sometimes acts rather slowly.

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.

The Tarnished Plant Bug (*Lygus pratensis* Linn.). As an injurious insect pest, the tarnished plant bug (Fig. 4) has seldom been ac-

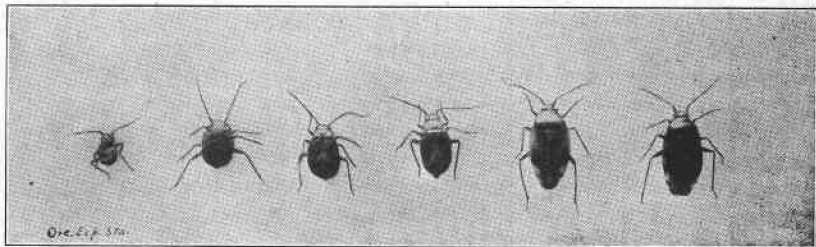


Fig. 4. The Tarnished Plant Bug (*Lygus pratensis* Linn.)
Adults and nymphs enlarged 2x.

corded the position it rightly deserves. The very nature of its attack; its innocent appearance, and shy, retiring disposition, have often absolved it from suspicion of an injury where conviction was really due. This insect is characterized by its wide distribution, its general abundance and great variety of food plants.

The adult insect is one-fifth inch long, and nearly half as broad. As viewed from above it appears rather flattened. The general color is yellowish or greenish yellow, varying to a tawny brown with just a hint of green. There is a hint of red on the thorax and the entire

insect has a slightly brassy lustre. The young are smaller, green and bug like.

The insect passes the winter as an adult and, possibly, as nearly mature nymphs, hibernating under leaves and trash in and about the field. Feeding and egg laying begin in the early spring. The eggs are placed in the stems, leaf petioles and even in the leaves. They hatch in from 12 to 20 days, and from this time on throughout the season, the insect may be present in all stages. The adults, when approached, will drop or fly quickly. The nymphs are also shy and active, slipping around to the opposite side of the plant and concealing themselves, when possible.

The Injury. Both the adults and the nymphs feed on the leaves, buds, tips and developing fruits of growing plants. They pierce the tender tissue with their long beak and suck the plant juices. A dwarfing, blighting and malforming of the foliage and fruit is the result. The injury varies with the plant attacked.

Control Measures. The tarnished plant bug is an exceedingly difficult insect to control. Many may be captured by sweeping over the plants frequently with a regular insect net. Practice will give one proficiency.

A 7 per cent kerosene emulsion is very effective against the nymphal forms. Any treatment is best practised in the early morning when the insect is rather sluggish.

Cleaning up fence corners, etc., during the winter, and keeping down the weeds about the field, are measures of especial value for the control of this pest.

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. There are several species present. 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 fields 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 beetles 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 drive them at night into a small fire of straw arranged in a windrow along the windward side of the

field. 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 more satisfactory where the blister beetles occur in swarms.

Wireworms (Elatceridae). The wireworms occur in the soil as long, cylindrical, worm-like larvae; with a hard, smooth, waxy, reddish brown surface; the body segments well defined. The head is flattened and wedge-shaped and fitted with powerful jaws. The worms vary in length from one-half inch to an inch. The adults of the wireworms are brownish beetles known as jumping jacks or click beetles (See Fig.

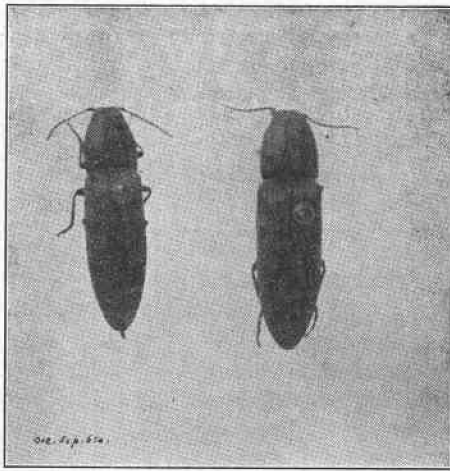


Fig. 5. Adult Wireworms or Click Beetles.

5), because of their habit of throwing themselves with a snapping or clicking sound.

The normal habitat of the wireworms is the grass lands. The eggs are deposited here and the young worms feed on the grass roots. From 2 to 5 years are required for them to mature. Where sod land is brought into cultivation the worms present in the soil often attack the cultivated crop. The worms mature in July, form cells in the soil, and transform to adult click beetles. They may emerge in the late fall, but usually remain in the cell until the following spring.

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. 6). Other seeds, bulbs, and root crops often suffer in a similar manner from the attack of this pest.

Control Measures. Plow in late summer and harrow the ground frequently for a month or more. Rotate the crops, working the in-

fested soil into one of the legumes a season or two. On restricted areas poisoned baits of bran mash may be placed under stones or boards about the field.

Coarse rock salt used in the winter at the rate of 300 pounds to the acre is recommended by some of the onion growers for the control of

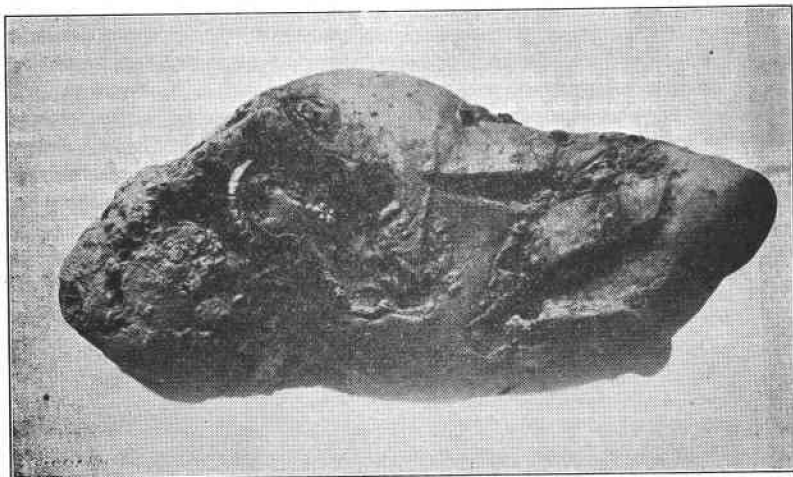


Fig. 6. Potato Tuber showing wireworm larvae and their tunnels (reduced one-half).

wireworms. This treatment has not been given a thorough test, and at best it should be employed with caution.

White Grubs. (*Lachnosterna* sp.). White grubs or grub worms are a very common root pest. They lie in the soil curled in a semi-circle; are white in color; the tip of the abdomen dark and distended, the head brown. They measure about 1 inch in length. The adults of the white grubs are the robust green and brown beetles known as "June bugs" or "May beetles."

The eggs are deposited during June, usually in sod lands, though cultivated fields are also appropriated. The eggs hatch in early July and the grubs feed and thrive in the soil for a period of 2 years. In July of the second year they transform to adult beetles, but remain in the soil until the following spring, when they emerge to deposit eggs.

The Injury. The grubs girdle large roots and eat off completely the smaller ones, often killing the plants attacked. Dead areas here and there through the field, will, when the soil is examined carefully, often reveal this pest as the offender. The adult beetles feed on the foliage of shade trees.

Control Measures. Plow the soil to a good depth during the fall. Ordinarily from October 1 to 15 will prove the best time. For land

infested in 1913, this fall plowing should be done in 1914, that is, the fall of the year following that of the heavy attack.

Crop rotation is of some value. Chickens trained to follow the plow will pick up many worms.

The Garden Slug. (*Limax* sp.). The garden slug is a very annoying and destructive garden pest. The protracted wet season of the Willamette Valley seems particularly favorable to its multiplication. This repulsive, slimy, slow moving creature is often termed a snail, but is properly termed a slug.

The adult garden slug is about 2 inches in length. It is a deep mottled grey or greenish grey in color. The head and body are contractile; the former bears 2 pairs of contractile feelers near the front. Just back of the head is a broad plate or mantle with a small opening on the side. The body is covered with a mucous slime which forms a slimy trail on any object over which the slug crawls.

The eggs are about one-half the size of a garden pea, almost colorless and with a glistening transparency. They occur in the surface soil, usually in small masses. The young slugs are about one-twelfth inch in length. They are lighter in color than the mature slug. They mature in from 4 months to a year.

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 attack the foliage of our bush fruits. The ugly feeding punctures they make afford a ready entrance for decay and often whole plantings are ruined.

Birds aid materially in the control of slugs. The thrush is especially valuable. Domestic fowls will feed on slugs and may sometimes be used to an advantage in checking them.

Control Measures. Remove all refuse tops and stumps after the crop is gathered. Clean up all weeds and trash about the field.

Traps consisting of bits of sacking, boards and damp straw placed about the field will attract the slugs. These may be visited in the early morning and the slugs destroyed.

The arsenical sprays on cabbage and other growthy plants are very good. Use a sticker for slick foliage. An under spray nozzle is very essential to direct the solution to the under surface of the foliage.

The poison bran mash as employed for cutworms, a small heap about each plant, is also of value for slugs.

Drippings prove an attractive bait for slugs. To 1 quart of grease add 1 level teaspoonful of lead arsenate. Dip large cabbage leaves in this material and place them about the field.

Salt; hot water; air slaked lime, 10 parts and white hellebore, 1 part; air slaked lime, 96 parts and caustic soda, 4 parts; and tobacco dust, are among the materials recommended as giving good results when employed against the slug.

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. Reports of slight injury due to millepedes are common, but during recent years the worms have become a really serious pest in Oregon. 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 closely allied to the centipeds. They differ in that they have two pairs of legs to the segment instead of a single pair. They are elongate, rather flattened, the segments well defined, hard and shining. They measure when mature from one-half inch to an inch in length.

Eggs are deposited during the winter and early spring. The immature worm may vary considerably from the adult. About 2 years are required for the worms to reach maturity.

The Injury. But few garden, truck or field crops are free from possible attack. Ornamental shrubs, both field grown and in pots, are also subject to injury. Reports are on file of the complete destruction of successive plantings of garden crops on soil infested by them. In infested districts, a considerable portion of the fruit which does mature is rendered unfit for market because of the tunnels of these worms and the subsequent decay. Greenhouses have experienced heavy losses due to their work.

Control Measures. From a glance at the life history of the millepedes and a study of their habits, it becomes evident that the pest is one not easy to control. The following recommendations are suggested as being of some value in checking the pest.

The treatment recommended for wireworms (See p. 7) should be of value in the control of millepedes. A dressing of a nitrate fertilizer, or of salt, promises much for their control. A heavy dressing of rock lime on land which tends to be heavy or sour should kill or repel many of the worms. 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 them.

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.

Leafhoppers (Jassidae). Leafhoppers, as a garden pest, are of minor importance. Injury due to their attack is characteristic. The leaves at a distance present a whitish or yellowish color, and on closer examination show a distinct speckling of white dots due to the puncture of the insect's beak.

The adult leafhopper is very small, whitish or pale green in color. It is winged and can hop or fly very quickly. The nymphs resemble the adult, except that they are smaller and wingless.

Control Measures. Spray as soon as the nymphs are noticed, with a contact spray. Repeat the application in 5 days and give a third application 10 days later. The solution to be effective must actually wet the insect.

The Red Spider (*Tetranychus telarius*). Beans, cucumbers and melons are sometimes attacked by a minute reddish or greenish mite about one-fiftieth of an inch long. These mites spin a web over the surface on which they feed and travel over these fine threads.

Control Measures. Spray with a solution of water, 1 gallon; soap, 1 ounce; and flower of sulfur, 1 ounce. To be effective the spray must wet the pest.

Nematodes. Elongate, thread-like, waxy yellow worms which burrow into the roots and tubers of various plants. The exterior of an infested root or tuber shows small pin holes, and the interior crumbles to a whitish powder in the hand.

Control Measures. Wood ashes, lime or salt applied to the soil will materially reduce the amount of injury.

POTATO AND TOMATO INSECTS.

The Western Potato Flea Beetle (*Epitrix subscrita*, Lec.). The western potato flea beetle (Fig 7) is probably the most serious insect

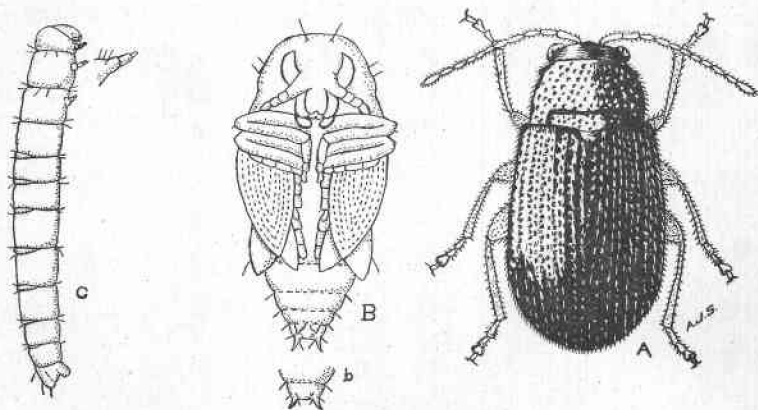


Fig. 7. Western Potato Flea Beetle. a Adult; b pupa; c larva.

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. 8). The total injury is sufficient materially to cut down the food supply of the plant, and to decrease the eventual size of the tubers below ground. Early blight attacks injured leaves more readily than healthy ones. It is reasonable to suppose also that the beetles may carry the spores of the disease from plant to plant on their bodies and mouth parts.

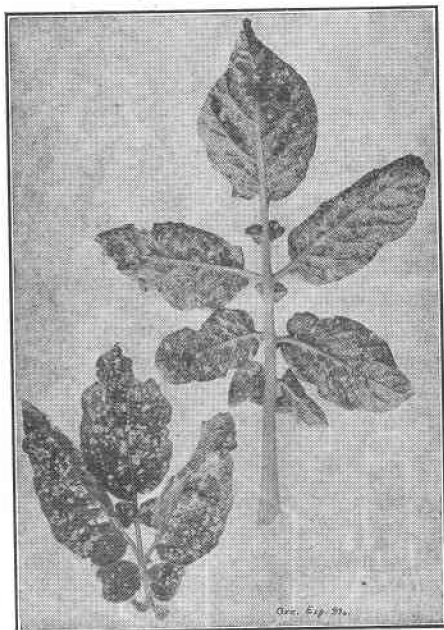


Fig. 8. Potato foliage showing injury due to flea beetles.

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 its market value. Here also a fungus usually gains entrance and spreads along the sides of the tunnels.

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.

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.

The larva is slender, elongate, white in color and with a small, light brown head. It measures, when mature, about one-eighth inch

in length. The mature larva forms a small earthen cell in the soil, contracts and transforms to a naked 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 of the first generation 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. They later transfer their attack to cultivated plants where they feed and deposit eggs. The larvae soon hatch, and during June and early July are present in the soil in all stages of development. The adult beetles continue to feed on the foliage during this time. Pupae occur in early July and the beetles of the second 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. Pupae occur about Sept. 12 to 15. They transform to adults more slowly than the early generation, the first adult beetles appearing about Oct. 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. 33), 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. Where Bordeaux is used consistently and thoroughly, using an underspray nozzle and wetting the under surface of the leaves, flea beetle injury is slight. Repeated applications are necessary for best results.

Arsenate of lead, 3 pounds to 50 gallons, with the addition of 2 ½ quarts of a good cane syrup, is suggested as a spray with possibilities. Thoroughness of application and the necessity of getting the solution on the under surface of the leaves, cannot be too strongly emphasized.

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 bristle board works very well) about the dimensions of a tomato can, placed about the plant, have given satisfactory results.

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

The Potato Tuber Moth (*Phthorimaea operculella*, Zell). This insect is by far the most serious of the potato pests in California. We have no reports of its presense in Oregon, but that this condition can long exist seems doubtful. The enormous financial losses this insect may occasion, and the fact that it is a pest very difficult to control,

warrants a short discussion of it. Suspected material should be sent to the Experiment Station.

Description. The mature moth is very small, with narrow fringed wings and quick darting habits of flight. The larva is a smoky white, loosely built worm with a dark brown head, the brownish color extending back to the first two segments of the thorax. The pupa is formed within a silken cocoon, spun by the mature larva. It is brown, and very like the pupa of similar moths.

The Injury. This pest attacks the potato, both in the field and in storage. The worms burrow into and through the potato, filling the tunnels with excrement. A decay sets in and the tuber is rendered worthless for human consumption. The plants in the field are also attacked, and as a result are often weakened or killed.

Control Measures include crop rotation; the destruction of weeds, and of the potato tops as soon as the crop is removed; care in the practice of cultivation and at digging time not to expose the tubers; and the removal of culls from the field after digging, cooking them and feeding to stock. In stored potatoes, fumigation is practiced.

The Stalk Borer (*Papaipemanitcla* 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 1 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, it is thought. The worms hatch in the spring and migrate to the cultivated plants.

Control Measures. Cut out infested stalks and burn.

The Tomato Worm (*Heliothis obsoleta* Fab.), which burrows into the fruit, also attacks sweet corn and is discussed on page 28 as the Corn Ear Worm.

The large, green, naked caterpillar, with various brilliant colors, and a prominent spine near the anal end, works on the foliage, but is seldom a serious pest.

Control Measures. The larva is so conspicuous and usually occurs in so few numbers that direct hand methods are employed for its control. The arsenical sprays would control it eventually, but act slowly on these large forms.

The Tomato Aphis (*Marcrosiphum lycopersici* Clark). This small, dark green plant louse occasionally attacks the tomato and more rarely the potato. It seldom occurs in injurious numbers. The contact sprays as employed for similar aphids would prove equally effective in the control of this one.

BEAN AND PEA.

Stored beans and peas possibly suffer more from insect attack than do the crops in the field. Two weevils are particularly bad in Oregon and will be given brief consideration.

The Bean Weevil (*Acanthoscelides obtectus*, Say) attacks the pods in the field and is also able to breed in the stored seed. 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 hind femur has one large spine and two small ones.

The adult weevil deposits eggs in or on the pods in the field. The grubs hatch and burrow into the 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 to feed and develop. Where infested seed is planted, the grubs will continue development, and proceed to infest the new crop.

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

A temperature of 145 degree 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 seed in a suitable receptacle in an oven and raise to required temperature; hold here for 6 hours.

Fumigation with carbon-bisulfide (See p. 33) is the standard treatment for stored grain pests. Beans placed in a tight receptacle of some sort may be treated very effectively.

Seed may be poured into boiling water at planting time to kill the grubs. The seed should be cooled 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 that of the bean weevil. The beetle is larger and does not breed in the stored seed. Nevertheless, in the Northwest this pest is the more serious of the two, and the losses due to it are much heavier. Dr. Fletcher estimates that the loss in Ontario alone is now over \$1,000,000 annually.

The adult beetle is one-fifth inch long, black with a brown pubescence variegated with black and white. The sides of the thorax are notched, and the point of the abdomen beyond the wing covers is marked with two black spots. The hind femur is thickened and bears two large spines.

The adult weevils appear in the field at blossoming time and deposit eggs on the forming pods. Thus the peas of an eating size are

often grubby. The grubs are mature at gathering time. They pupate in the stored pea and later emerge as adult beetles. Ordinarily, only one weevil occurs in a pea, and, as statd before, there is a single generation during the year, the insect being unable to breed in the stored seed.

Control Measures. Care should be taken to distinguish between this pest and the previous one, as the variation in habits makes a difference in the control measures adopted.

Hold over seed. 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.

Peas should be securely bagged immediately after threshing.

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, compared with most of the garden forms. It has prominent reddish brown eyes, fairly long antennae, and long legs. Both winged and wingless forms occur.

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 only fairly satisfactory for this insect. Kerosene emulsion is possibly the best of the contact sprays for the pea aphid.

The brush and cultivator method is used extensively on the large commercial plantings of the south. The rows are planted sufficiently far apart to allow a single horse and cultivator to pass between. The aphid are brushed from the vines during the heat of the day, and the cultivator stirs them into the hot soil where they die. A similar arrangement is a long shallow galvanized pan, built as wide as the rows. This is dragged between the rows and the plant lice brushed into it. The pan should be filled with water and a thin covering of oil added.

The Diabroticas. The Striped Cucumber Beetle, (*Diabrotica trivittata*), and its near ally, the Spotted Cucumber Beetle, (*D. soror*), are often serious pests on beans. The former is a small beetle about two-fifths inch long. It is a bright greenish yellow in color, with three black stripes on the wing covers. The spotted cucumber beetle is slightly larger and has twelve black spots on the wing covers, instead of the stripes. These two pests are discussed under cantaloupe, cucumber, and squash insects. (See p. 23).

CABBAGE AND RADISH.

The Cabbage and Radish Maggot (*Phorbia brassicae*, Bouche).
The cabbage and radish maggot (Fig. 9) is the most serious pest of these crops in Oregon. Besides attacking the cabbage and radish, this insect feeds on the turnip, cauliflower, celery, rape and kale.

The larva is a footless grub or 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.

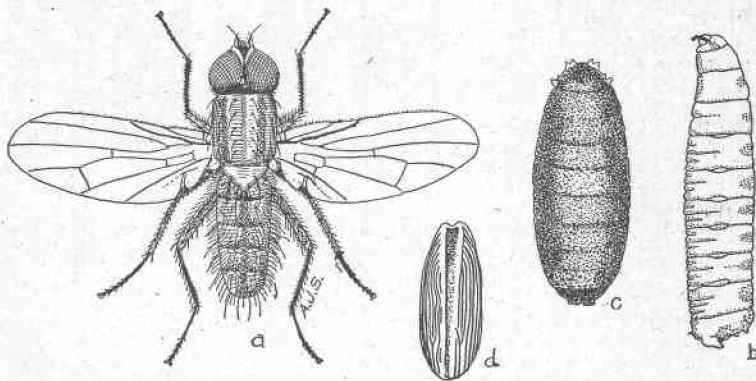


Fig. 9. Cabbage and Radish Maggot. a Adult fly; b larva; c pupa; d egg (enlarged).

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.

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 winter is passed as maggots and pupae in and about the roots of the food plants. The adults emerge in the early spring and seek their favorite food plants for egg laying. The eggs hatch in from 4 to 10 days and the young maggots burrow at once into the tender plant. The maggots reach maturity in from a month to 6 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. Infested radishes are unfit for table use.

Control Measures. Gather and destroy all waste roots and refuse tops as soon as the crop is removed. Plow the land to a depth of 4 inches or more. Destroy, so far as possible, 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 decidedly beneficial.

Screening of the cabbage seed beds is highly recommended by one authority. 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 12-inch boards, with wires across the top to prevent the cover from sagging, and the whole then covered with coarse cheese cloth, (20 threads to the inch), making the frame fly proof, serves very well. This frame should be removed a few days before the plants are transferred, to enable them to become hardy.

Hand picking is often employed on small fields of cabbage. The plants are simply pulled up, the roots examined carefully for maggots or eggs and the plant reset.

The tarred felt discs are used for cabbage and cauliflower and give excellent results. The purpose of the discs is to prevent the

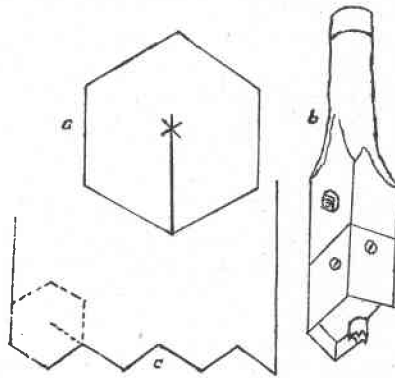


Fig. A. *a* Tarred felt card in outline, one-third size; *b* tool for cutting cards, about one-sixth size; *c* showing how discs are cut, dotted lines show position of tool. (After Goff.)

female fly from depositing eggs against the plant stem. No better description of the discs or their use can be given than is found in the original description by Mr. W. H. Goff. The description is transcribed from Circular 63 of the Bureau of Entomology.

"The cards are cut in a hexagonal form in order to better economize the material, and a thinner grade of tarred paper than the ordinary roofing felt is used, as it is not only cheaper, but being more flexible, the cards made from it are more readily placed about the plant without being torn.

"The blade of the tool, (Fig A) which should be made by an expert blacksmith, is formed from a band of steel, bent in the form of a half hexagon, and then taking an acute angle, reaches nearly to the center. The part making the star-shaped cut is formed from a separate piece of steel, so attached to the handle as to make a close joint with the blade. The latter is beveled from the outside all around, so that by removing the part making the star-shaped cut, the edge may be ground on a grindstone. It is important that the angles in the blade be made perfect, and that its outline represents an exact half-hexagon.

"To use the tool, place the tarred paper on the end of a section of a log or piece of timber and first cut the lower edge into notches, using only one angle of the tool. Then commence at the left side, and place the blade as indicated by the dotted lines; strike the end of the handle with a light mallet and a complete card is made. Continue in this manner across the paper. The first cut of every alternate course will make an imperfect card, and the last cut in any course may be imperfect, but the other cuts will make perfect cards if the tool is correctly made and properly used.

"The cards should be placed about the plants at the time of transplanting. To place the card bend it slightly to open the slit, then slip it on the center, the stem entering the slit, after which spread the card out flat and press the points formed by the star-shaped cut snugly around the stem.

"A Wisconsin grower protected 7,000 plants and secured a splendid crop, while unprotected plants near by would have been a complete failure if the maggots had not been picked off by hand. Others have reported similar success. One reported having lost only 25 plants out of 10,000 to 15,000 that he protected with the cards, where ordinarily he should have lost from 75 to 90 per cent of the crop."

The discs should be cut about $2\frac{1}{4}$ inches in diameter. The success of this treatment depends on the timely and proper application of the cards. They should be applied as soon after transplanting as convenient. They must be pressed down firmly about the plant, leaving no open spaces. Soil should not be allowed to collect on top of the discs.

Sulfur applied in the drill rows with the seed of radish and turnips is claimed by several growers to give a reasonable degree of freedom from attack. Five parts of sulfur to one part of tobacco dust was used in a small experimental plot with very good results.

Lime and carbolic acid applied to the surface soil, so as to form a slight crust about the plants, acts as a repellent for this pest. Slake the lime and dilute to a thin cream. To 1 gallon of water add 3 pints of the milk of lime and 1 tablespoonful of crude carbolic acid. Mix well and apply with a garden sprinkler.

Kerosene and sand. 1 pint of kerosene to 3 gallons of sand is also recommended as a repellent. Mix well and apply a small handful to soil about each plant.

Bran and Glue. This mixture consists of 2 pounds of glue dissolved in 1 gallon of water. Add sufficient bran or sawdust to make a thin slop. Small handfuls of this material placed about the newly set plants has in certain instances given very satisfactory results.

Powdered tobacco placed about the plants at the time of planting, and the treatment renewed every week, is recommended.

White hellebore, 1 part, and air slaked lime, 10 parts, applied as a dust to the surface soil gives very good results as a preventive.

The materials so far considered are used as preventives. The application should be renewed whenever the effect of the previous treatment ceases.

Crude Carbolic Acid Emulsion.

Crude carbolic acid	1 pint
Soap	1 pound
Water	1 gallon

Dissolve the soap in the boiling water; remove from the fire and add the carbolic acid. Agitate briskly for some time to form a perfect emulsion. For application, use 1 part of the emulsion to 50 parts of water. In using this solution draw back the soil from about the plant, exposing as much root surface as practicable. Apply about one-half pint of the material to each plant. If a pump is used and the solution applied with considerable force, it will require less material and do more good than when simply poured about the plant. This solution should be applied to the plants as soon as they are well established in the field, and the application repeated about every 8 or 10 days.

Hellebore Decoction. This solution is prepared by steeping 2 ounces of powdered hellebore in 1 quart of water for one-half hour. Dilute to make one gallon of solution. Apply in the same manner as the carbolic acid emulsion solution.

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. The mass becomes putrid, offensive in odor and disgusting to the eye. Small cabbage and rape plants are often weakened by the attack of this aphid so that they do no good. While these plant lice are supposedly held in check by their natural enemies, this condition is not generally apparent in portions of Oregon during the early summer. Most of the natural enemies seemingly prefer other species of aphids and attack the cabbage aphid in numbers only in the late summer, when other plant lice are scarce.

This aphid is a soft bodied, greenish plant louse, showing greyish generally, because of a sort of waxy or powdered covering. It has a sucking beak, and is made up of both winged and wingless forms.

The insect passes the winter in the mild climate of the Willamette Valley as adults and nymphs, and probably also as eggs. Winged forms occur in the spring and migrate to new food plants. The mature aphids give birth to living young. The rate of increase is enormous, several generations occurring during the season.

Control Measures. Plant lice are not easy to control. Since the insects suck their food the arsenicals are worthless. Contact sprays to be effective must actually wet the insect, therefore several applications are often necessary to reach all of them in the curled leaf.

Destroy all old stumps and leaves in the field; it is here that the aphids pass the winter.

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 ef

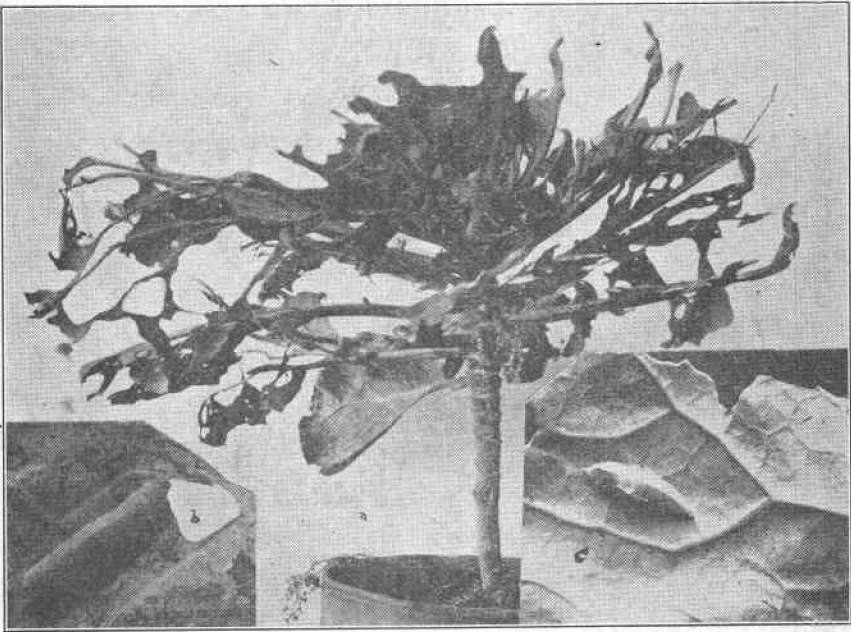


Fig. 10. The Imported Cabbage Worm.
a Cabbage plant showing injury; b larva or cabbage worm; c the chrysalis or pupa.

fective dip. The home made fish-oil soap, (See p. 32), at the same dilution, is equally good.

From a series of tests with warm water as a dip, we submit the following summary:

1. Water heated to 122° F., or 50° C., will kill cabbage aphids where the insects are submerged.
2. Cabbage plants entirely submerged in water at this temperature for even a short period wilted badly and revived only under the most favorable circumstances.

3. Plants where only the tops were dipped for 5 seconds or more wilted badly.

4. Plants where only the tops were dipped for from 2 to 3 seconds were uninjured and 100 per cent of the aphids were killed.

Spraying in the field. Whale oil soap or naphthalene soap, 1 pound to 12 gallons of water, gives very good results when applied as a contact spray in the field.

Kerosene Emulsion as a 7 per cent solution (See p. 32) is possibly the best of aphis sprays, considering both cheapness and efficiency. The time and care taken in its proper preparation serve to make the commercial sprays more popular.

"Black Leaf-40," 1 part to 1600 parts of water, with the addition of 1 pound of whale oil soap to 20 gallons of the solution, gave excellent results in all of our tests.

It is almost necessary in spraying cabbage to have the addition

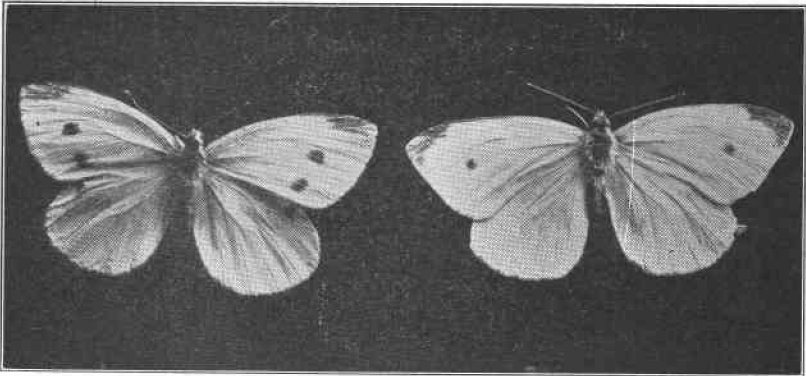


Fig. 11. The Imported Cabbage Worm (*Pontia rapae* Sch.).
Adult Butterflies, female and male.

of some oil, soap, or emulsion to make the spray solution spread properly on the slick foliage of the cabbage.

It is always desirable to spray in the field before the infestation becomes so severe as to cause the leaves to curl badly. Where the curled condition is present, more pressure and time are required in the application of the spray. Frequent examinations of the under surface of the leaves for isolated colonies is strongly advised. The destruction of these initial colonies will often mean practical freedom from serious injury.

The Imported Cabbage Worm (*Pontia rapae* sch.) is a heavy feeder on the leaves of cabbage, (Fig. 10), and closely allied plants. The worm is a velvety green in color, with a faint yellow strip down the back and a row of yellow dots down each side. The adult is a white butterfly, (Fig. 11), 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 eggs are small, yellowish, oval and marked with longitudinal ridges. They hatch in from 4 to 10 days. The young worms feed greedily and are mature in 10 to 15 days. The chrysalis is green with a sort of bonnet effect, (Fig. 10), and is attached to the leaf or other support by means of a silken band about the center. There are at least 3 generations per 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. Remove and destroy old cabbage stumps and other rubbish from the field as soon as the crop is removed. Plow where at all practicable. Spray or dust the young plants with one of the arsenicals. The dust (See p. 30) is usually better for small plants. It is well to add soap to the 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.), as a larva is comparatively small, measuring when mature about three-tenths 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. The moth is small, fringe winged, bronze brown in color, with a row of diamond shaped figures of a clay yellow color showing down the center of the back when the moth is at rest.

Control Measures. Same as for Imported Cabbage Worm.

CUCUMBER, CANTALOUPE, AND SQUASH INSECTS.

The Western Twelve-Spotted Cucumber Beetle (*Diabrotica soror*, Lec.) 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, giving them a roughened, pimply appearance. This work on the roots, stems and fruit, seems to invite the attack of fungus, and the total injury may be considerable. Often the

wilting of plants, already growing well, is attributed to some other cause, where really the work of the worms on the roots and stems is the primary trouble.

The most noticeable injury of this pest is, however, the work of the beetles on the foliage of the above plants. They will collect on their food plant 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 also attack the fruit, pitting and disfiguring it.

The beetle is about one-fourth inch long, yellowish green in color, the wing covers marked with twelve black spots. The two median spots in front are usually united and the middle pair on each wing may also be joined.

The egg is of a dirty lemon yellow color, about one-thirty-fifth inch long.

The mature worm is a little less than one-half inch in length. The body is cylindrical, waxy white or yellowish in color, the segments not clearly defined. 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 at this time, attacking with apparently equal gusto, dirty or clean, tough or tender, sprayed or unsprayed foliage. Pairs commence mating after a few days. From careful dissections and observations it seems doubtful if eggs are deposited before a lapse of 18 to 24 days. After about 10 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 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.

Egg deposition begins in late April or early May. The eggs are probably placed about anywhere the insect happens to be, but the majority of them are deposited in the surface soil in the cracks about the stem of the food plant. They may be deposited singly or in small

groups. The egg period is from 9 to 26 days, with an average of about 14. The period of egg deposition is probably 20 days or even more, and mating is frequent, so the total egg deposition of a virile female is likely quite high. One female in confinement, without a male, deposited 165 eggs, and then escaped.

The larval stage is from 5 weeks to 2 months' duration, the earlier forms developing more slowly. When mature the larva constructs an earthen cell near the surface of the soil and transforms to a pupa. The length of the pupal stage has not been fully determined. One individual in the laboratory transformed to the adult in 5 days.

The new generation appears in numbers about June 30 to July 12. For a short period of time 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. There is very probably at least a partial second generation.

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. This practice should be supplemented, however, where practical. 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 hemispheres, the straight edge then drawn together and sewed with wire. Obtain wire gauze 34 inches wide; cut it in squares 34 by 34 inches. With a piece of chalk describe the hypotenuse from opposite corners. Their intersection marks the center. 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 protections are fitted down snugly about the young plants, and the earth drawn up about the base. The cones may be used for a period of years. In our tests a special wire having 20 strands to the inch was employed. We found this very difficult to obtain and more expensive. If ordinary screen is employed, it should be dipped in paint or painted 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 alternated where either is desired as a main crop; or either of them 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 10 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.

Where no trap is left, the beetles will either work below the treated portion, girdling the stem of the plant, or they will "sit with folded hands," and await the growth of new tender unsprayed portions. It is only for a comparatively short time, in the early season and again in late July, when the new generation appears, that the beetles can be effectively poisoned.

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 as a dust (See p. 30), and for the older plants spray with zinc arsenite, one pound to 60 gallons of water. Lead arsenate paste, 3 pounds to 50 gallons, is also good.

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

The Western Striped Cucumber Beetle (*Diabrothica trivittata* Mann.) is very similar to the spotted beetle in the general food habits, life history and injury. It emerges slightly later in the spring, and seeks hibernation earlier in the fall. Generally speaking, the injury is not so wide spread as with the preceeding species; while to the individual crops under discussion it may prove the worse offender.

The beetle is quite well known, about two-fifths 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) is another of the numerous soft-bodied plant lice attacking garden crops. Soon after the melon vines commence to run, the leaves here and there will be observed galled, curled or wilted. An examination will reveal the small, green sucking aphids busily feeding on the plant juices.

Control Measures. Spray with the contact sprays (See p. 32). Remember the value of the contact spray lies in thoroughly wetting the insect.

Tobacco fumes under cover (See p. 33), will also control this and similar plant lice.

ONION INSECTS.

The Onion Thrips (*Thrips tabaci*, Lind.) is becoming 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 one twenty-fifth 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 per cent 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 (*Pegomyia ceparum*, Bouche) 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. 17) will serve for this pest also.

Control Measures. See Cabbage Maggot (p. 18). Fertilizers are of value. Pull infested plants as soon as observed and destroy, taking care to get the maggot with the plant.

CORN INSECTS.

The Corn Ear Worm (*Heliothis obsoleta*, Fab.). The tips of the ears of our corn are often found eaten away, the silks cut off and the



Fig. 12. Corn ear showing worm and injury, reduced.

whole tip 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 when mature, rather slender and with varying shades of color and markings. This pest is known as the corn ear worm (Fig. 12).

Sweet corn, pop corn, and field corn are favorite food plants in about the order named. This pest has an amazing number of other food plants; it is the famous cotton boll worm of the South; the bud worm of the tobacco districts; the tomato worm of the trucking districts, it feeds on peppers, peas, cow-peas, beans and many other vegetables and fruits.

The adult of this corn ear worm is a moth, measuring, with wings expanded, about one and three-quarters inches. The moths are variable in color, some being a dark olive brown, others lighter and with markings on the wings. These moths are night fliers and may be seen in the fields at sundown, flying here and there with their characteristic zig-zag flight. They 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, reaching maturity in about three weeks. They then crawl down into the surface soil to a depth of about 2 to 4 inches, where they construct a cell with a tunnel leading up to near the surface of the ground. In this cell the worm will contract and pupate. The pupa appears as a shining, reddish brown capsule-like case about four-fifths inch long. About two weeks later 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. This generation of worms, when mature, also enters the soil to repeat the cycle. It is as pupae in the soil that the winter is passed by this pest.

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.

A trap crop of the white field bean planted adjacent to the corn at such a time that the plants will be in bloom at the time the corn is in the silk will also be of value. The bloom of the bean is attractive to the moth and the vine will be utilized for egg deposition. No experiments have been conducted here, nor have we any definite data at hand as to just the time this bean crop should be planted.

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 plow-

ing breaks up the pupal cells and exposes the pupae to unfavorable weather conditions and to the attack of their natural enemies. The surface cultivation breaks up the emergence tunnels.

Sprays. Arsenical sprays are sometimes employed for the first generation of corn ear worms. The corn is knee high or less at this time, and permits of such a practice.

For valuable plots of sweet and pop corn, where only clean ears are salable, it has been suggested that an arsenical spray at silking time would be of value. Without experimental data on the subject, it is impossible to determine just how efficient this practice would prove. Undoubtedly the young worms feed on silks while working their way into the tip of the ear. It will be necessary for the individual grower to determine for himself the practicability of such a course.

INSECTICIDES.

Insecticides are divided roughly into four groups:

Poisons, consisting principally of substances with arsenic as the active ingredient. These are used as stomach poisons against insects which chew their food.

Contact Insecticides, are more particularly for soft bodied forms. Insects such as plant lice feed by means of a jointed beak which they insert into the tissue of their food plant. These contact materials either suffocate, corrode or clog the breathing pores of such insects.

Repellents, while a loose term, really means certain substances which tend to repel insects from the food plant which is treated.

Gas Fumigation is used for inaccessible insects, stored grain pests, etc., which cannot be readily reached by other treatments.

POISONS.

Paris Green, except as a dust, is used but little in recent years. The amount of total arsenic is not uniform. The material is more expensive than some of the newer insecticides and is more liable to burn foliage. The spray formula is given in case one desires to use it:

Spray.

Paris Green 1 heaping teaspoonful.
Lump lime 3 ounces.
Water 3 gallons.

Dust.

Paris Green 4 ounces.
Cheap flour, sulfur, or road dust 5 pounds.

Mix well and place in coarse sacks. A very convenient method is to place one sack on each end of a stick, cut the length of the width of the rows, and walk between the rows with the sacks suspended. Two

rows may thus be treated simultaneously. Dusts are best applied in the early morning while the dew is on the foliage.

Arsenate of Lead paste should be fresh. Material which has dried out badly or has been allowed to freeze is not reliable. The material is prepared now as a powder by some manufacturers.

Arsenate of Lead Paste1 to 1½ pounds.
Water20 gallons.

or

Arsenate of Lead Powder4 to 8 ounces.
Water20 gallons.

One pound of whale oil soap, dissolved and added to either of these solutions, will aid materially in keeping the arsenate in suspension, and will help the solution to spread uniformly. In preparing either solution, the lead arsenate should be first mixed in a little water and then added to the whole.

Arsenite of Zinc powder is comparatively cheap, easy to handle, and stays in suspension well. It shows up but little on the foliage, and insects which are repelled by sprays which leave a heavy coating will sometimes eat zinc arsenite unawares and be poisoned. For the cucumber beetles on beans, squash and melons, it seems very satisfactory. Reports of burning from its use are not uncommon; and while we have used the material in some very fair tests in our experiments with bean foliage, with no indication of burning, caution should be exercised in its use.

Zinc Arsenite3 to 8 ounces.
Water20 gallons.

Hellebore is used mostly for ornamentals where a minimum of discoloration is desired, and on nearly mature fruit and vegetables where the possible danger of arsenical poison prohibits the use of an arsenate. Only fresh white hellebore powder should be used.

Hellebore1 to 3 ounces.
Water3 gallons.

Pyrethrum is similar to hellebore and may be used at the same dilutions.

Poison Bran Mash. Especially good for cutworms, grasshoppers and garden slugs.

Coarse Bran16 pounds.
Paris Green½ pound.
Salt¼ pound.
Cheap Syrup1 quart.
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.

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 $\frac{1}{2}$ 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 per cent 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 per cent solution, add $15\frac{3}{4}$ gallons of water.

To obtain 7 per cent solution, add $8\frac{1}{2}$ gallons of water.

To obtain 12 per cent solution, add $4\frac{1}{2}$ gallons of water.

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

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 $\frac{1}{2}$ pound.

Water $12\frac{1}{2}$ gallons.

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

Whale Oil Soap is sometimes used in solution for certain soft bodied insects.

Whale oil soap 1 pound.

Water 4 gallons.

White Hellebore power may be used as a contact insecticide for garden slugs, etc.

Hellebore 1 part

Air-slaked lime, sulfur or cheap flour 5 parts

Tobacco dust acts in much the same way and may be used at the same dilution.

Fish Oil Soap. Especially good as a dip for young plants, to free them from plant lice, etc.

Caustic soda $1\frac{1}{2}$ pounds

Water $1\frac{1}{2}$ quarts.

Fish oil $5\frac{1}{2}$ pounds.

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

Repellents.

These materials, as such, have but a limited use. A variety of substances may serve as a repellent under certain conditions.

Lime, wood ashes, sulfur, tobacco dust or hellebore dusted over plants will sometimes protect them.

Bordeaux Mixture is used as a repellent for flea beetles. The material should be made fresh each time it is used.

Copper sulfate	1	pound.
Quick lime	1	pound.
Water	12 ½	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 8 ½ gallons of water.

GASES.

Fumigation is of interest to us in this connection mainly for the control of insects or stored products, including grain, peas and beans, and potatoes.

Carbon Bisulfide is the most common fumigant. It is a liquid which on exposure to air passes off as a gas. This gas has a pungent, disagreeable odor and is heavier than air. The dosage is from 5 to 8 pounds to 100 bushels of seed, or 1 pound to 100 cubic feet of space. The seed should be placed in an air-tight bin or box, or the receptacle made as nearly gas proof as possible. The liquid may be poured over the surface of the seed, or better still, placed in trays or dishes on top of the seed. Close the bin securely and leave for 24 hours. Open at the end of this period and ventilate thoroughly.

Caution. Carbon bisulfide is very inflammable. It should never be opened near a fire, and one should dispense with smoking while applying it.

Sulfur. The fumes of burning sulfur will kill most insect pests. The objections to its use are its bleaching effects on colors and its injurious action on plant life. The germinating power of seeds is destroyed by the fumes, but their value for food is not impaired. Stick sulfur, 2 to 5 pounds to 1000 cubic feet of space will suffice.

Tobacco Fumes. Various tobacco or nicotine preparations are on

the market for fumigation purposes. Some of them are liquids and are volatilized over a slow flame, and others come in prepared sheets ready for use. This material is used extensively under cover for plant lice. Movable frames, covered with heavy canvas, may be constructed so that outdoor plants, such as melons, cabbage and bush fruits, may be quickly rid of aphids by treatment with tobacco fumes. Directions for use usually accompany the material.

SPRAY CALENDAR

Crop At- tacked.	The Pest.	The Spray.	Time of Application.	Remarks.
All or a Va- riety of Crops.	Cutworms.	Poison Bran Mash	In Spring. A few days before plants are to appear. About base of plants when set.	Sow broad cast over the field, or place in small heaps at base of plant.
	Grass- hoppers.	Ditto Above	When pest appears.	Ditto Above.
	Tarnished Plant Bug.	Kerosene Emulsion or Black Leaf-40 and Soap.	In spring and during summer.	Careful watch should be kept up for the appearance of the nymphs. See text.
	Blister Beetles.	Lead Arsenate.	When present.	Beating over plants with brush, driving them with the wind. will often rid a field
	Wireworms.			Poison baits are of some avail. Farm methods. See text
	White Grubs			See text.
	Slugs.	Arsenate sprays, dusts and traps.	Throughout season.	
	Millepedes.	Traps and repellents.	When troublesome.	See text.
	Leaf Hoppers. Red Spiders.	Kerosene emulsion, or any con- tact spray.	In spring when nymphs appear.	Examine under sur- face of foliage for insect. Use under- spray nozzle.
	Nematodes.	Lime or salt.	When troublesome.	Soil treatment.
Potatoes and Tomatoes.	Flea Beetles.	Bordeaux.	In spring when beet- les become numerous. Again about July 20. Repeat if necessary.	For very small plants use cylinders, or Paris Green dust. Use underspray noz- zle.

SPRAY CALENDAR (*Continued*)

Crop At tacked.	The Pest.	The Spray.	Time of Application	Remarks.
Potatoes and Tomatoes (Continued)	Stalk Borer.			Out out infested stalks and burn.
	Tomato Worms.	Arsenical sprays.	When present.	Hand pick the large forms.
	Tomato Aphis.	Contact sprays.	When present.	
Bean and Pea.	Bean Weevil Pea Weevil.	Carbon bisulfide.	In storage.	See text.
	Cucumber Beetles.			See cantaloupe and squash.
Cabbage and Radish.	Cabbage Maggot.	Tarred felt discs, crude carbolic emulsion.	When plants are set or appear. Repeat every 10-12 days	See text.
	Cabbage Aphis.	Contact sprays.	When pest appears.	Dip plants when transferring to field See text.
	Cabbage Worms.	Arsenical dusts and sprays.	When plants are well established. Repeat in 10 days. Again in 2 weeks.	
Cantaloupe Cucumber, Squash, Etc.	The Cucumber Beetles.	The Arsenical sprays.	In early May and again in July and August if pest is present.	Trap crops at time of planting main crop. See text.
	Melon Aphis.	Contact sprays or tobacco fumes.	When pest appears.	
Onion.	Thrips.	"Black Leaf-40" and whale oil soap.	When pest appears.	The sheaths should be pulled down and frequent examinations given.
	Maggot.			See cabbage maggot. Pull and burn infested plants.
Sweet Corn.	Ear Worm.			Cultural methods. See text.

All authorities available have been freely consulted in compiling this information, and their remarks and recommendations incorporated where consistent.

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