INSECTS AFFECTING SUGARBEETS GROWN FOR SEED

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INSECTS AFFECTING SUGARBEETS GROWN FOR SEED

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Sugarbeets grown for seed are subject to attack by various insects from the time the crop is planted in the late summer until the seed is harvested the following June or July. These pests include (1) foliage feeders, chewing insects, and sucking insects; (2) insects that feed directly on the developing seed; and (3) vectors of various virus diseases. Without control, chewing insects often ruin stands soon after emergence of the plants, and sucking insects may so lower the vitality of the plants that little or no seed is produced.

Studies were undertaken by the Bureau of Entomology and Plant Quarantine [1] in 1938 at its Phoenix, Ariz., laboratory to determine what insects were occurring in the beetfields and what effect they were having on the plants and on the seed produced. Surveys were conducted in the beetfields from the time the plants first emerged in the fall until the seeds were harvested the following spring. The seasonal occurrence of all insects as well as their relative abundance was recorded.

The damage of chewing insects was obvious, but the effect of sucking insects on the beet seed crop required special study. In these studies the various species were confined separately on seed spikes in field cages. Lygus bugs were soon identified as a major pest, and their abundance in various fields was correlated with losses in seed yield and viability. The effect on the beet seed crop of virus vectors such as the beet leafhopper, which transmits curly top, and aphids, which transmit the yellow virus, was determined. The effectiveness of insecticides against the various insects as well as the most effective time of application was studied in small plots and later in large-scale farmer-cooperative plots.

The purpose of this publication is primarily to assist growers and others to identify the more economically important insects that occur in fields of sugarbeets grown for seed and to become familiar with the relationship of these insects to the production of sugarbeet seed. Some of the insects found in the fields are of little or no economic importance; others feed on pest insects and are beneficial.

The nature and amount of damage done by the various insects and the need for control remain relatively constant. However, because of the development of resistance in insects to insecticides and the continual improvement of insecticides, recommendations are subject to change. Therefore, the mention of insecticides in this handbook should not be interpreted as a recommendation for their use. The latest insectide recommendations are given in the current issue of Agriculture Handbook 120, Insecticide Recom-

[1] Now Entomology Research Division, Agricultural Research Service.

mendations of the Entomology Research Division for the Control of Insects Attacking Crops and Livestock.

The production of sugarbeet seed in the United States is a comparatively new industry. Prior to World War I practically all sugarbeet seed used in the United States was imported from Europe, where it was grown by the biennial method. By this method the seed was planted in the spring and the roots were harvested in the fall and held over the winter in clamps, or pit silos. In the spring the roots were removed from the clamp and planted in the field. With the resumption of growth, seed stalks developed and produced seed for harvest the following fall.

In an attempt to establish a beet sugar industry in New Mexico, trial plantings of sugarbeets were made by the New Mexico Agricultural Experiment Station at State College, N. Mex., in the early 1900's. These trials were unsuccessful. In the 1920's through a cooperative agreement with the U.S. Department of Agriculture, trial plantings of sugarbeets for sugar were again made. These were primarily time-of-planting experiments. Beets were planted on the 1st and 15th of every month throughout the year. From these trial plantings it was discovered that sugarbeets planted in the early fall not only successfully overwintered but produced a crop of seed the following spring or early summer.

Further tests were conducted to develop an adequate fertilizer program as well as to determine the proper planting dates, the best seeding rates, row width, and spacing of plants in the row. Results of these experiments placed the annual method of beet seed production on a sound footing and were basic to an industry in the United States that now supplies all the sugarbeet seed used in this country.

The first commercial plantings of sugarbeets for seed by the annual method were made near Las Cruces, N. Mex., in 1927. Other areas proved to be better suited for the crop than New Mexico, and by 1962 beet seed was produced in Arizona, California, Nevada, Utah, and Oregon.

The insects attacking the beet seed crop are described in this handbook under the following headings: Foliage Feeders, Seed Feeders, and Virus Vectors.

FOLIAGE FEEDERS

Lepidopterous Larvae

The most severe damage caused by lepidopterous larvae is to the young beet plants as they emerge in the fall. Unless the fields are watched closely, the stands may be ruined in the early stage of development and replanting will be necessary (fig. 1).

The three most important species attacking the sugarbeet crop are the beet armyworm (*Spodoptera exigua* (Hübner)), the yellow-striped armyworm (*Prodenia ornithogalli* Guenée), and the garden webworm (*Loxostege similalis* (Guenée)). Also several of the cutworms are sometimes of economic importance. Both the eggs and larvae of all these species are attacked by small parasitic wasps, but usually they are inadequate and chemical control is often necessary.

Beet Armyworm and Yellow-Striped Armyworm

Moths of the beet armyworm are grayish brown with light-gray markings on the forewings (fig. 2).

TC-7453

FIGURE 1.—Sugarbeet seedlings damaged by lepidopterous larvae. (× 1.)

There is a characteristic light-gray spot about halfway back and toward the outer margin of each forewing. They have a wingspread of about 1 inch, and when at rest they are five-eighths to three-fourths inch long. Moths of the yellow-striped armyworm are somewhat darker and have distinctive light-gray markings on the forewings (fig. 3). They are a little larger than the beet armyworm, with a wingspread of about 1¼ to 1½ inches, and when at rest they are three-fourths to seven-eighths inch long.

The hindwings of both species are white with a dark band near the outer edge. Both of these armyworm moths are nocturnal but readily fly in daylight if disturbed. They deposit large masses of eggs on small plants almost as soon as they emerge. The egg masses are covered with scales from the body of the moth (fig. 4). This distinguishes them from other eggs. The individual eggs are approximately 0.50 mm. in diameter. They hatch in a few days into light-green larvae with dark heads.

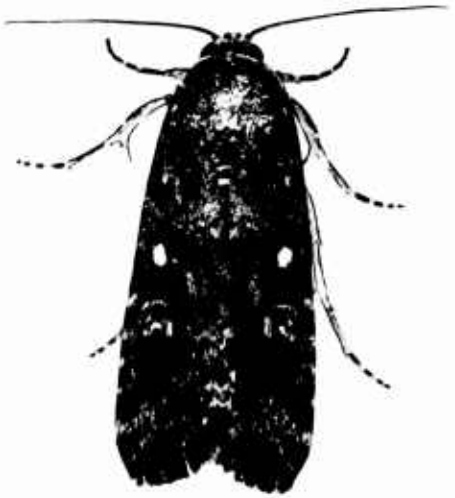

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FIGURE 2.—Moth of the beet armyworm (*Spodoptera exigua*). (× 3.)

In the early stages of development these two species of armyworms are very similar in appearance. Their feeding habits and damage to the plants are also similar. The larvae, or small worms, remain in groups, spinning protective webs. Often they will tie leaves together with webbing to form a protective cell for the group. At this stage the worms feed only on the surface of the leaves causing skeletonizing. When about three-eighths inch long, they spread out over the plants and consume entire leaves.

The full-grown beet armyworms are a little over 1 inch long (fig. 5). They are pale olive to dark green above and yellowish green beneath.

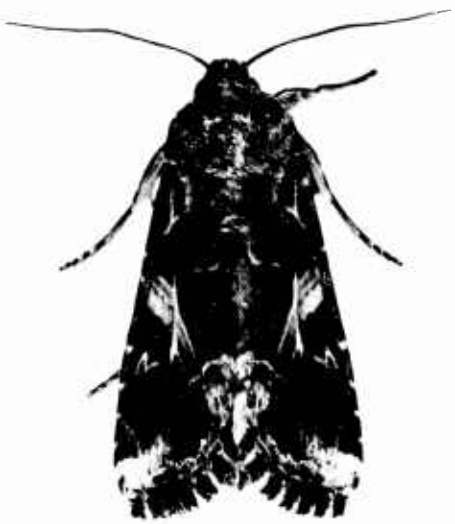

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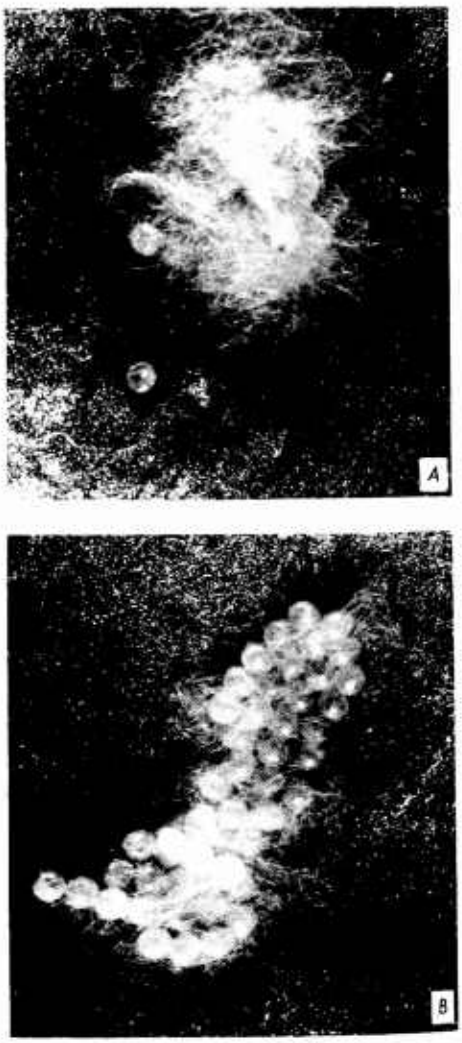
FIGURE 3.—Moth of the yellow-striped armyworm (*Prodenia ornithogalli*). (× 2½.)



TC-7455

FIGURE 4.—Armyworm egg mass: *A*, Eggs covered with moth scales as they normally occur; *B*, scales removed to show eggs. (× 8.)

TC–7456

FIGURE 5.—Full-grown beet armyworm (*Spodoptera exigua*). (× 2.)

These two colors meet at a narrow pale-yellow line along each side. In the more highly colored specimens there is sometimes a second narrow pale-yellow line above this stripe. There may also be a pale line or stripe along the sides below the dividing line of the two colors. There is a distinctive black spot on each side of the second thoracic segment, which has the second pair of legs. This is sometimes difficult to see in the darker specimens, but it is characteristic of the beet armyworm.

The full-grown yellow-striped armyworms are about 1½ inches long with a conspicuous yellow stripe along each side of the back and a white or light-yellow stripe on each side (fig. 6). Several narrow light-colored lines between these stripes give the appearance of a broad multicolored stripe along the sides. A broad dark stripe below this stripe in some specimens with a broad pinkish stripe below that gives the appearance of three broad stripes along the sides. The colors vary considerably.

In some individuals the back between the yellow stripes is velvety black; on others it is gray and may take on a pink cast. In some specimens there is a pair of black spots on the back of each body segment just inside the yellow stripes. These are sometimes in the shape of a triangle. Usually there is a conspicuous velvety black spot on each side of the first abdominal segment. In the lighter colored specimens a pink median stripe often occurs on the back, and they may also be pink below the stripe on the sides. All are olive green on the underside.

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FIGURE 6.—Full-grown yellow-striped armyworms (*Prodenia ornithogalli*). (× 1⅓.)

The half-grown larvae are usually not so highly colored. Most of them are light to dark olive green on the back with a dark shadowlike median stripe. They have the same yellow stripes along each side as the full-grown larvae.

Garden Webworm

Moths of the garden webworm have a wingspread of about seven-eighths inch, and when at rest they are about one-half inch long (fig. 7). They are light brown with shadings and irregular markings of light and dark gray on the forewings.

The flattened cream-colored eggs are usually placed on the underside of the leaves of young plants in small masses overlapping like fish scales or shingles (fig. 8). They are covered with a transparent plasticlike coating.

TC-7458
FIGURE 7.—Moth of the garden webworm (*Loxostege similalis*). (× 4½.)

The larvae are more damaging than the larvae of either of the armyworms because they feed in the terminal bud; thus, a comparatively small amount of feeding will kill the plants. Newly hatched garden webworm larvae are pale yellowish green with small black spots over the entire body. As the larvae grow, the spots become more conspicuous (fig. 9).

The full-grown larvae are about three-fourths inch long and pale green with two white lines down the back. There are six black spots on each body segment. Three are located on each side of the dorsal white lines and are arranged in a triangle. When the larvae are disturbed, they have a characteristic backward wiggle. The larger larvae often spin a silken tunnel from the feeding site to the base of the plant. This tunnel may lead to a silk-lined cell beneath a clod. The larvae feed mostly at night and spend much of the time within this tube. This habit makes them more

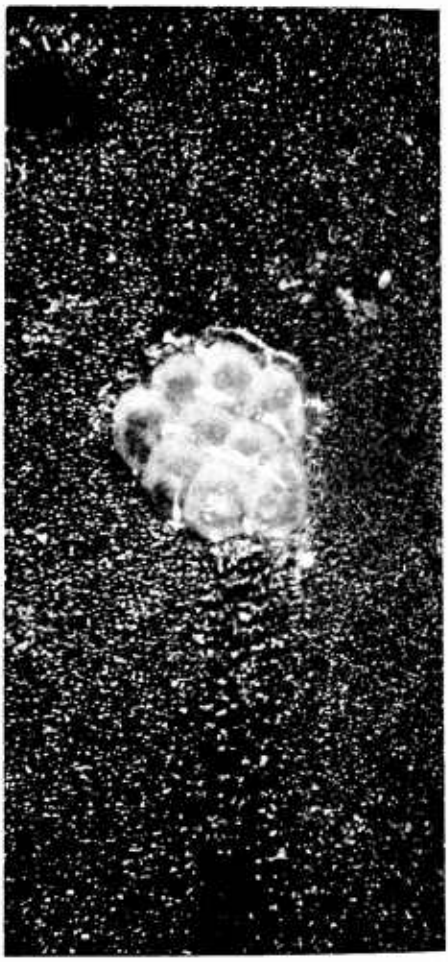

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FIGURE 8.—Eggs of the garden webworm (*Loxostege similalis*) on the underside of a beet cotyledon. (× 16.)

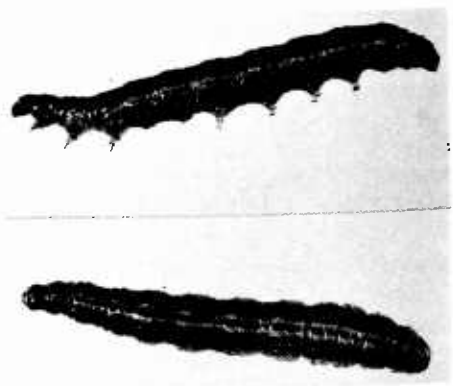

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FIGURE 9.—Full-grown garden webworms (*Loxostege similalis*). (× 3.)

TC–7461

FIGURE 10.—Moth of the granulate cutworm (*Feltia subterranea*). (× 2.)

difficult to kill with insecticides than other species that feed in the open.

Cutworms

Cutworms are also a problem at times during the fall. Several species may attack sugarbeets. All cutworm moths are nocturnal. They have dusty-gray heavy bodies. They have a wingspread of 1¼ to 2 inches and are ¾ to 1 inch long when at rest.

The most common species infesting the seed beetfields in the Southwest is the granulate cutworm (*Feltia subterranea* (Fabricius)) (fig. 10). Moths of this species lay their eggs in groups of usually not more than 6 to 18 eggs (fig. 11). They are off white, about 0.67 mm. in diameter, and ribbed, with a purple spot on the top and an irregular purple band around this spot. As the young larva matures within the egg, it becomes darker. Most of the eggs are laid on the underside of the leaves. Often the moths are attracted to small weeds in the beetfield, and more eggs may be laid on these than on the beets.

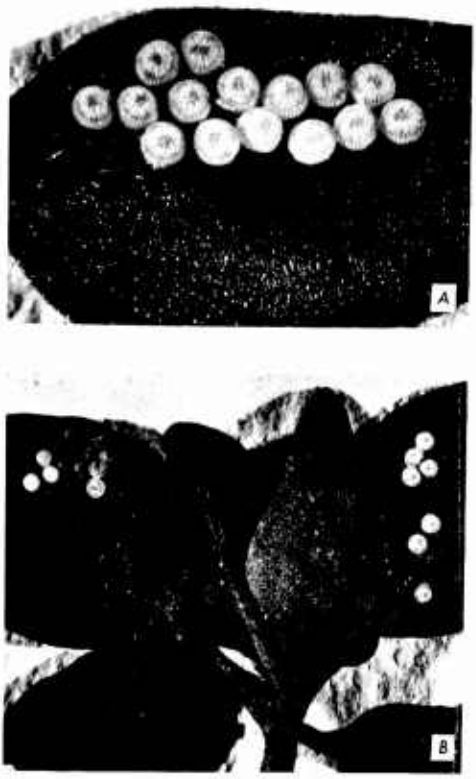

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FIGURE 11.—Eggs of the granulate cutworm (*Feltia subterranea*) on the underside of a sugarbeet cotyledon (*A*) and of a small careless weed (*B*). (× 9 and × 4.)

Damage to the young plants by the small cutworms is similar to that by the small armyworms. Larger cutworms often cut off the plants at the soil surface, as the name implies. They feed mostly at night and hide under clods in the daytime. Full-grown cutworms are about 1½ inches long, varying from light gray to dark brownish gray, sometimes with darker markings. If disturbed, the worms curl up tightly and may remain inactive for several minutes (fig. 12).

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TC–7464

FIGURE 12.—Full-grown granulate cutworm (*Feltia subterranea*). (× 3.)

Salt-Marsh Caterpillar

The salt-marsh caterpillar (*Estigmene acrea* (Drury)) is often a problem in the fall, especially where seed beets are grown near cotton. The eggs are deposited in large numbers on cotton leaves. The larvae feed in cotton until they are nearly full grown and then move out in hordes, feeding on almost anything as they move. Aluminum-foil barriers around the beetfields will prevent injury from the migrating caterpillars. A foil strip about 7 inches wide is set upright in the ground so that about 5 inches protrudes above the soil surface. Post holes dug against the barrier about every 20 feet will trap the caterpillars as they travel along the foil.

At rest, the moths of the salt-marsh caterpillar appear white, with small black spots scattered over the wings (fig. 13). In this position they are about 1 inch long. If the wings are spread, they reveal an orange body with black bands. The hindwings of the female are white, whereas those of the male are orange. The wingspread is usually a little over 2 inches. The eggs are spherical, pearly white, and about 0.80 mm. in diameter. They are laid in large masses (fig. 14).

Newly hatched caterpillars are dark and covered with long black hairs. They feed for a time close to the old egg mass and then disperse. The full-grown caterpillars are about 2 inches long and are cov

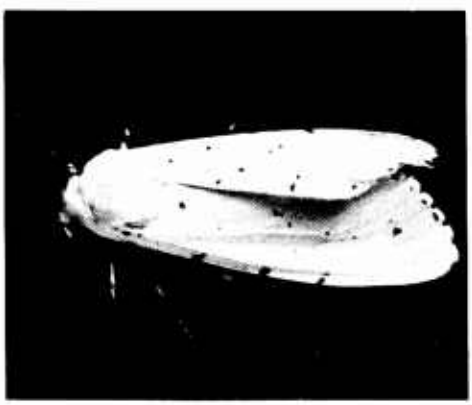

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FIGURE 13.—Moth of the salt-marsh caterpillar (*Estigmene acrea*). (× 2.)

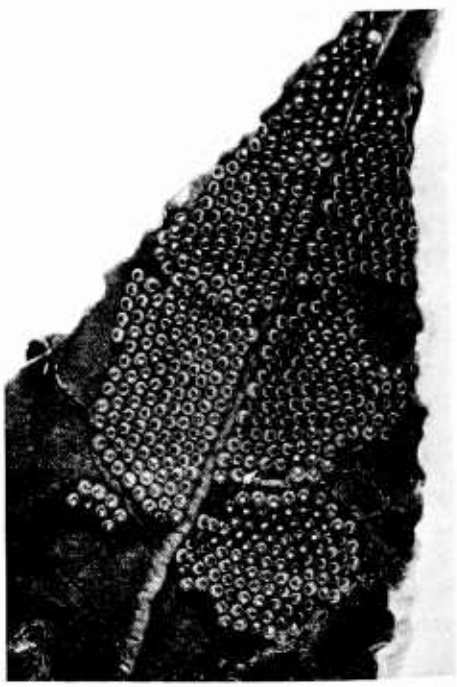

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FIGURE 14.—Egg mass of the salt-marsh caterpillar (*Estigmene acrea*) on a small leaf of a beet seed stalk. (× 2¼.)

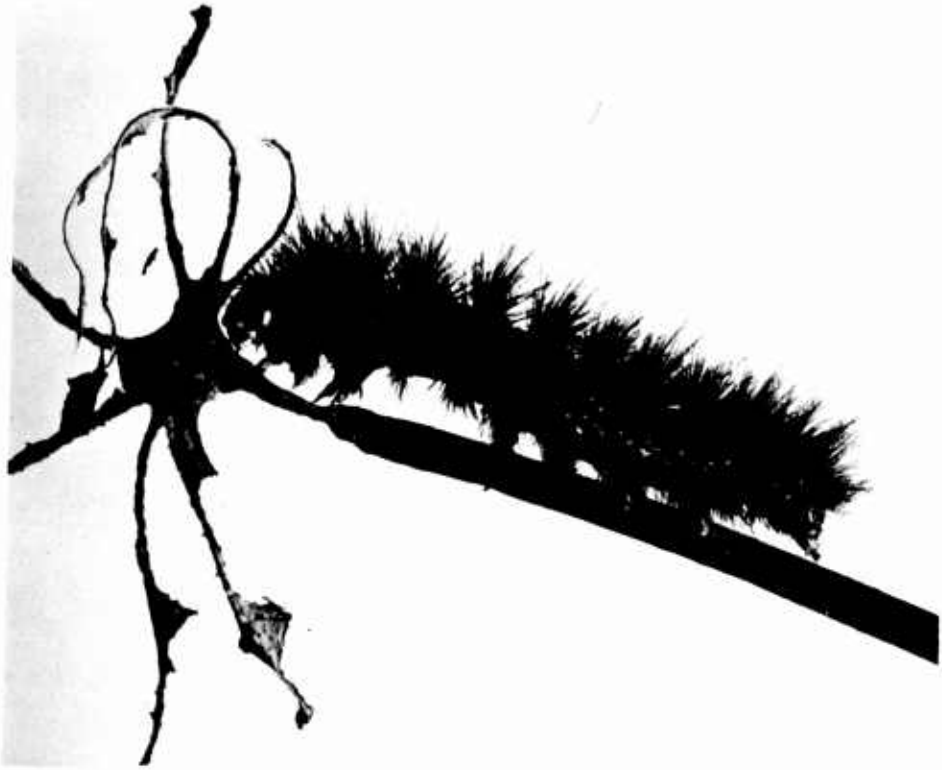

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FIGURE 15.—Salt-marsh caterpillar (*Estigmene acrea*) on the remains of a cotton leaf. (× 1½.)

ered with black and rust-colored hairs from which they get the name woolly bear (fig. 15). Partially grown larvae are sometimes more gray.

Occasionally the eggs will be laid on the leaves of larger beet plants late in the fall or in the spring on small leaves on the seed stalks, but the young caterpillars soon disperse and little damage is caused. Usually the only control necessary is the aluminum-foil barrier to prevent the larger caterpillars from entering the beetfield as they migrate from cotton.

Celery Leaf Tier

Larvae of the celery leaf tier (*Udea rubigalis* (*Guenée*)) sometimes become numerous in seed beetfields in the spring and may do some damage by defoliating the plants. The moths are difficult to distinguish from those of the garden webworm. They are light brown with darker markings on the forewings (fig. 16). They have a wingspread of about seven-eighths inch and when at rest are approximately one-half inch long. They have a distinct snout, and in the resting position they appear triangular in outline. The eggs and egg masses are similar to those of the garden webworm (fig. 8).

The full-grown larvae are about three-fourths inch long and pale green or yellow green with a dark median line down the back and a white line on either side of the dark line (fig. 17). The body is sparsely covered with very fine hairs, barely visible to the unaided eye. When

TC–7466

FIGURE 16.—Moth of the celery leaf tier (*Udea rubigalis*). (× 5.)

the larvae are disturbed, they have a rapid backward wiggle similar to that of the garden webworm. They are web spinners and form protective cells by tying leaves together.

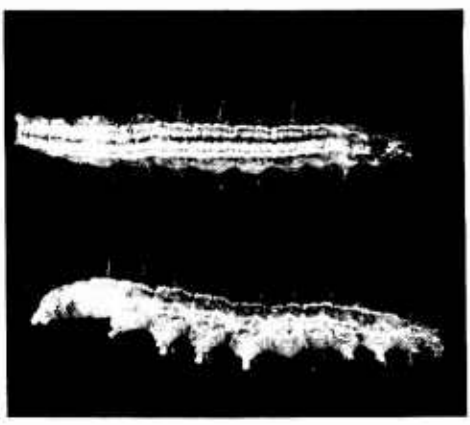

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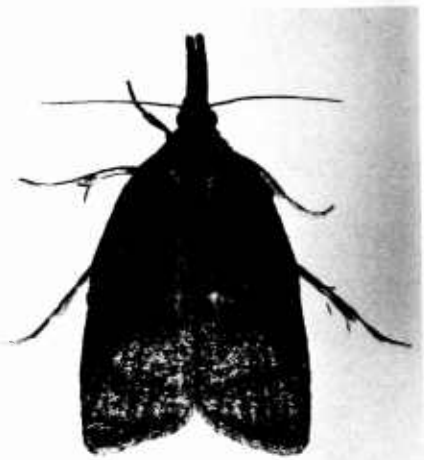
FIGURE 17.—Larvae of the celery leaf tier (*Udea rubigalis*). (× 2½.)

The mature larvae pupate on the leaves within these silken cells and the moths emerge in a few days.

Platynota stultana

Another species of moth, *Platynota stultana* Walsingham, sometimes infests seed beets both in the fall and in the spring. The moth is slightly smaller than the celery leaf tier and is darker brown (fig. 18).



TC–7468

FIGURE 18.—Moth of *Platynota stultana*. (× 5.)

It has a distinct snout similar to that of the moths of the garden webworm and celery leaf tier, but it does not have the same triangular outline when at rest. In this position the outer edges of the forewings are nearly parallel for about two-thirds the length of the body and the anterior one-third slopes sharply toward the head.

The eggs of *Platynota* are similar to those of the garden webworm and the celery leaf tier in that they are flat and laid in masses overlapping like fish scales or shingles (fig. 19). They are covered with a transparent plastic coating as are the eggs of the other two species,

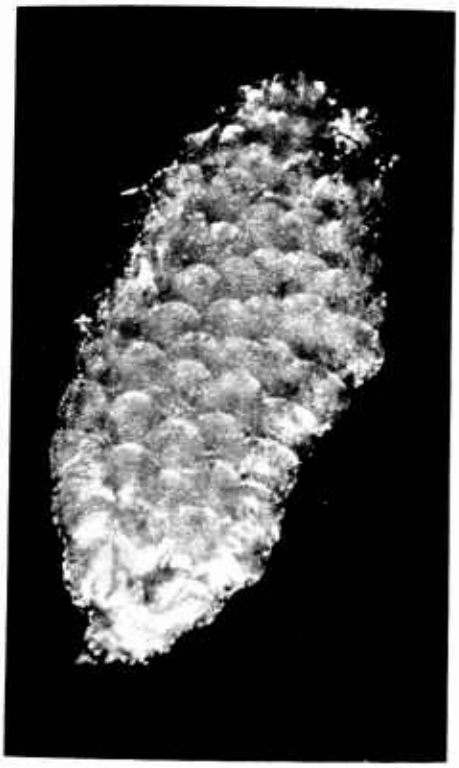


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FIGURE 19.—Egg mass of *Platynota stultana*. (× 16.)

but they are green. Usually the masses are larger and flatter than those of the garden webworm or celery leaf tier. The mass is usually about one-eighth inch across and one-fourth inch long and contains 30 to 40 eggs. However, it may sometimes be longer and contain over 200 eggs. The individual eggs are approximately 0.50 mm. across. The extreme flatness and green color make them very hard to see. They may be laid on either surface of the beet leaf or on nearby weeds.

The habits of the larvae are similar to those of the celery leaf tier and garden webworm. The *Platynota* larvae are about three-fourths inch long when full grown and vary from light green to olive green (fig. 20). There is a dark line down the middle of the back. A row of white dorsal spots on each body segment forms a dotted line on each side of the dark median line.

Usually control is not required, but occasionally *Platynota* may become numerous enough to require insecticide treatment. However, large numbers of moths are sometimes produced that move to other crops, particularly cotton. The larvae of *Platynota* have also caused considerable damage to cantaloup by tunneling into the rind.

Grasshoppers and Crickets

Grasshoppers and crickets are not often a problem in sugarbeets grown for seed, but they do occasionally occur in newly planted fields and can under these conditions do considerable damage to the young plants.

Grasshoppers sometimes become numerous in weedy fence rows and ditchbanks adjacent to newly planted beetfields. Johnsongrass is especially attractive to these insects. Such areas should be cleaned up before planting.

Blapstinus Beetles

Small darkling ground beetles (*Blapstinus* spp.) sometimes attack beet seedlings soon after the plants emerge. Ordinarily they feed on decaying organic matter, and therefore fields most susceptible to attack are those planted to beets before residues of the previous crop are completely decomposed. These beetles are dark brown or nearly black and about one-fourth inch long (fig. 21). They occur not only around bits of decaying organic matter but also under nearby clods. Control is not often necessary, but occasionally it may be desirable.

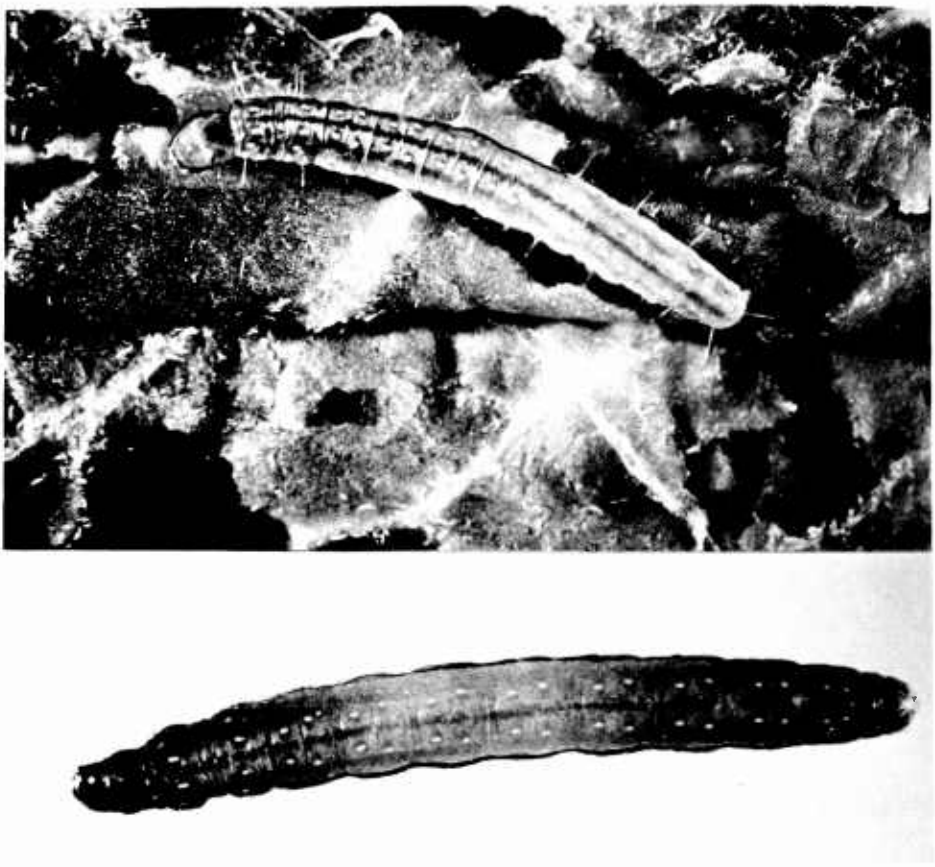

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FIGURE 20.—Larvae of *Platynota stultana*. (× 5½.)

Spider Mites

Two species of mites of the genus *Tetranychus* occur in the seed beets in southern Arizona—*T. desertorum* Banks and *telarius* (L.). Other species may occur in the seed beet growing areas of California, Utah, and Oregon. These species are not easily distinguished, but this is not important, since they cause the same damage and are controlled in the same manner. These mites, sometimes called red spiders, feed on the foliage or seed spikes of sugarbeets at any time of the year, but they do not ordinarily become numerous enough to damage the crop until warm weather in the spring. They may be anywhere in the field, but they are often more numerous near the edge and especially along a dusty road.

They are ovoid, vary from pale green to red, and usually have large dark spots on each side, which can be seen with a hand lens (fig. 22). The adult females are about one-half mm. long; the males are slightly smaller. The eggs are spherical, about 0.14 mm. in diameter, and almost transparent when first deposited. They become reddish before they hatch into six-legged larvae, which are only a little larger than the egg itself. After the first molt, eight-legged nymphs appear. Both larvae and nymphs resemble the adult, except they are smaller and pale green. All species

TC-7471
FIGURE 21.—Darkling ground beetle (*Blapstinus* spp.). (× 10.)

TC-7472
FIGURE 23.—Minute pirate bug (*Orius tristicolor*). (× 25.)

spin webs. As populations increase, webbing becomes more noticeable.

Often spider mites are held in check by predators, primarily the minute pirate bug (*Orius tristicolor* (White)). Before chemical control is started, these predators and mite populations should be watched. If *Orius* is sufficiently numerous, mite populations will gradually decline.

The *Orius* adults are about three thirty-seconds inch long (fig. 23). The forewings are black and white and are held flat over the back. The nymphs are orange and ovoid (fig. 24). Both adults and nymphs feed on adults, nymphs, and eggs of spider mites and are also predaceous on thrips and eggs of other insects.

Mites feed by sucking plant juices and thereby devitalize the plants

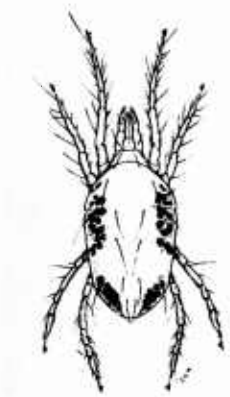

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FIGURE 22.—Spider mite (*Tetranychus* sp.). (× 40.)

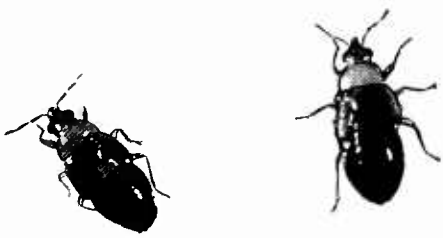

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FIGURE 24.—Nymphs of the minute pirate bug (*Orius tristicolor*). (× 15.)

TC-7475

FIGURE 25.—Adult of the southern garden leafhopper (*Empoasca solana*). (× 18.)

and reduce the seed yield. If they are present in the field, reproduction begins with warm spring weather. If they are not held in check by predators, they may become so numerous as to completely web over the seed stalks. Such an infestation will greatly reduce the seed yield, but there is no evidence that mites affect the viability of the seed. Timing of insecticide applications is important in mite control. Populations should be watched. If noticeable increases occur in the absence of predators, miticide treatment is indicated.

Southern Garden Leafhopper

The southern garden leafhopper (*Empoasca solana* DeLong) is often the most numerous insect in seed beetfields in the winter and early spring, particularly in the Southwest. The adults are light green, slender, and approximately one-eighth inch long (fig. 25). The nymphs resemble the adults in general form and color. The nymphs are usually found on the underside of leaves and have a habit of moving across the leaf with a "crablike" motion when disturbed. When the adults are disturbed, they fly readily.

This insect has sucking mouth parts and ordinarily is of little economic importance. However, experiments by Hills et al. (*15*) [2] showed that when excessively large numbers were allowed to breed during the winter in field cages, seed yield was reduced, but the germination of the seed was unaffected.

False Chinch Bug

The false chinch bug (*Nysius ericae* (Schilling)) is a true bug and therefore has sucking mouth parts. It is dark gray and a little over one-eighth inch long (fig. 26).

[2] Italic numbers in parentheses refer to Literature Cited, p. 28.

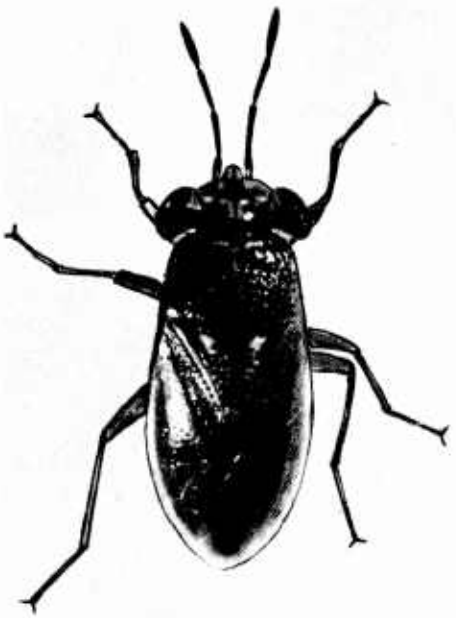
TC-7476

FIGURE 26.—False chinch bug (*Nysius ericae*). (× 16.)

The wings are plaited over the back when at rest. These bugs normally breed on weeds, either within the cultivated area or in adjacent uncultivated lands. Mustards are among the favored host plants.

Only occasionally are these insects of economic importance to the beet seed grower. Results of field-cage tests (*8*) showed that 500 false chinch bug adults per plant from bloom to harvest did not reduce the yield or viability of the seed. However, from field observations it is shown that these insects are highly gregarious and may occur in large numbers in comparatively small areas. Under these conditions plants on which they congregate may become so desiccated that they appear burned. If this occurs on the seed stalks when the seeds are maturing, little or no seed will be set.

The big-eyed bug (*Geocoris* sp.) commonly occurs in seed beetfields and is sometimes confused with the false chinch bug. It is about the same size and color as the false chinch bug, but it can easily be distinguished by its stubby antennae and large prominent eyes from which it gets its name (fig. 27). *Geocoris* is predatory on other insects and is therefore beneficial.



TC-7477

FIGURE 27.—Big-eyed bug (*Geocoris* sp.). (× 14.)

Aphids

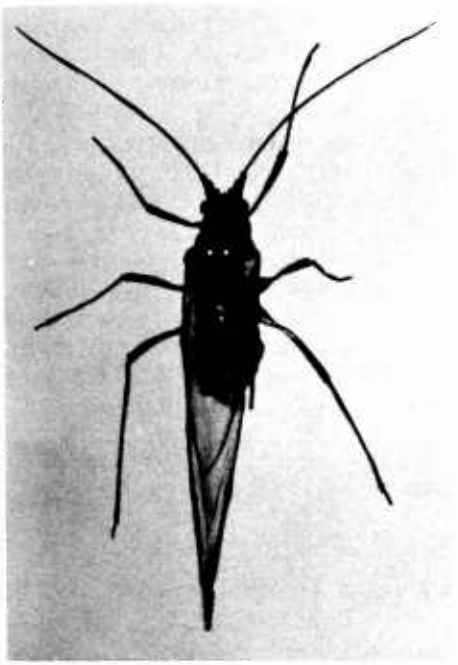
The green peach aphid (*Myzus persicae* (Sulzer)) (figs. 28 and 29) is the most numerous aphid attacking sugarbeets grown for seed, although in some of the southern California areas the bean aphid (*Aphis fabae* Scopoli) also occurs in considerable numbers. The principal damage caused by aphids is the transmission of harmful viruses. The direct effect of their feeding is devitalization of the plants. They do not reduce seed viability, but if sufficiently numerous they will reduce seed yield (*8*).

Aphids have many natural enemies, which will often hold populations at a low level or sometimes almost eliminate them from the field. However, the buildup of parasitic and predaceous insects is sometimes slow. Since the aphids are vectors of harmful viruses, the grower cannot usually afford to wait. However, he can take advantage of assistance from these insects by choosing an insecticide effective against the aphid, but less harmful to the beneficial insects.

Lady beetles are among the most effective natural enemies of aphids. The convergent lady beetle (*Hippodamia convergens* Guérin-Méneville) is one of the most numerous species occurring in the seed beetfields. The beetles move into aphid-infested fields, feed on aphids, and deposit eggs on the plants (fig. 30). The eggs are spindle shaped, about

TC-7478

FIGURE 28.—A colony of green peach aphids (*Myzus persicae*) on the back of a sugar-beet leaf. (× 5.)



TC-7478

FIGURE 29.—Winged green peach aphid (*Myzus persicae*). (× 10.)

one-sixteenth inch long, and pale yellow. They are laid on the leaves or stems in clusters. These hatch into alligatorlike larvae. Larvae of the more common species are black or bluish gray with orange markings (fig. 31).

Both adults and larvae feed voraciously on aphids. In the absence of aphids, the adults will maintain themselves in the fields on pollen. The full-grown larvae reach a length of nearly one-half inch and then attach themselves to stems or leaves, where they pupate (fig. 32).

Lacewings (*Chrysopa* spp.) are also important predators of aphids. The adults of the more common species are very delicate. They are about five-eighths inch long with four membranous light-green wings (fig. 33). The eggs may be laid singly or in groups on slender stalks (fig. 34). They are elongate-ovoid, approximately 1.0 mm. long, 0.40 mm. wide, and pale green. The stalk is hairlike and approximately 5 mm. long. The eggs hatch into larvae similar in form to those of the lady beetle, but they are slightly more slender and less highly colored. They are about three-eighths inch long when fully grown and brownish gray; they are covered with short, spiny hairs. They have mandibles resembling ice tongs with which they seize their prey (fig. 35).

Unlike the lady beetle larvae, these insects do not completely consume the aphids. The mandibles are hollow tubes through which they extract the body fluids of their prey. For this reason they destroy more aphids in a given length of time than do larvae of the lady beetles.

TC-7480

FIGURE 30.—Adult of the convergent lady beetle (*Hippodamia convergens*) and eggs on a beet seed spikelet. (× 5.)

TC–7481

FIGURE 31.—Larva of the convergent lady beetle (*Hippodamia convergens*). (× 7.)

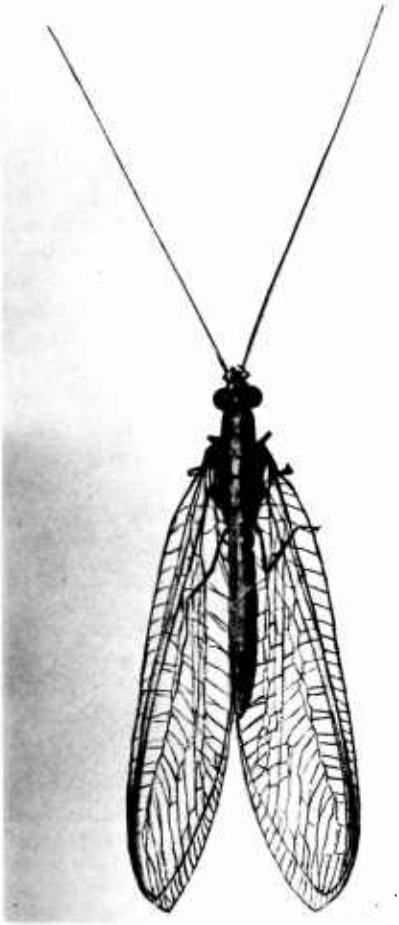
Larvae of syrphid flies are also predaceous on aphids. The adult flies resemble wild bees, except that they have only one pair of wings. The eggs are deposited on aphid-infested foliage, and the maggots feed on the aphids.

There are also several very small wasplike insects that are true parasites, depositing eggs directly within the bodies of the aphids. The larvae then feed on the aphid internally and finally pupate within the body and emerge through a circular opening in the abdomen. These parasitized aphid bodies can easily be distinguished by their swollen appearance, brown color, and the emergence hole of the wasp (fig. 36).

Fungus diseases may also attack aphids and under certain conditions may completely eliminate an infestation. First, dead aphid bodies appear among the colonies, and soon the whole colony may become infected. Sometimes the dead bodies may be covered with a typical fungus growth, or they may simply appear as mummies.

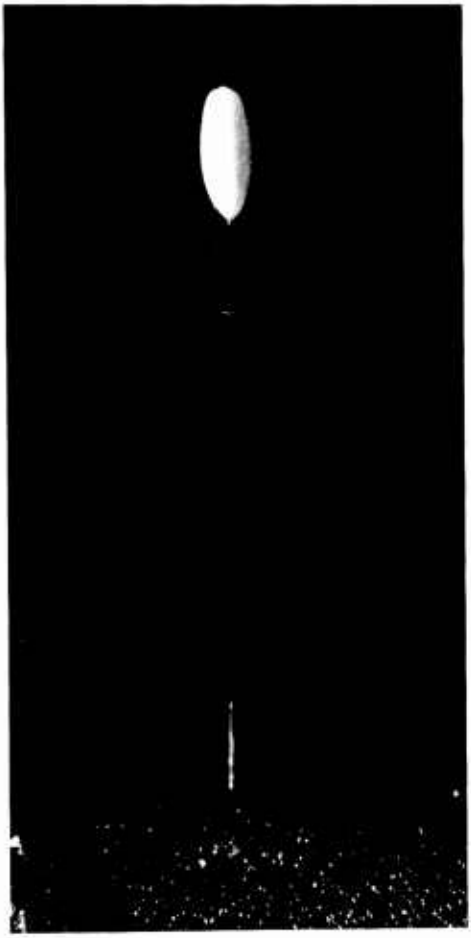
TC–7482

FIGURE 32.—Pupae of the convergent lady beetle (*Hippodamia convergens*) on a beet leaf. (× 3.)



TC–7483

FIGURE 33.—Green lacewing (*Chrysopa* spp.). (× 4.)

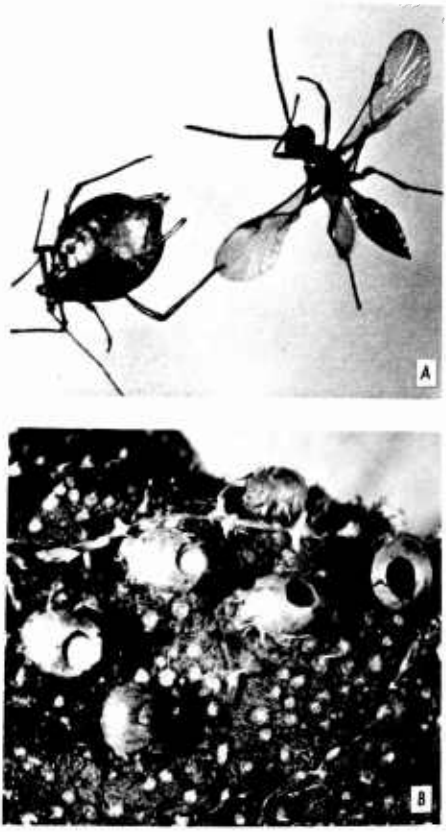


TC–7484

FIGURE 34.—Egg of the green lacewing (*Chrysopa* spp.) on a beet leaf. (× 16.)

TC-7485

FIGURE 35.—Larva of the green lacewing (*Chrysopa* spp.) with an aphid. (× 12.)



TC-7508 and TC-7507

FIGURE 36.—Parasitization of the green peach aphid (*Myzus persicae*): *A*, Parasitized aphid with parasitic wasps; *B*, aphid bodies from which adult parasites have emerged. (× 9 and × 5.)

SEED FEEDERS

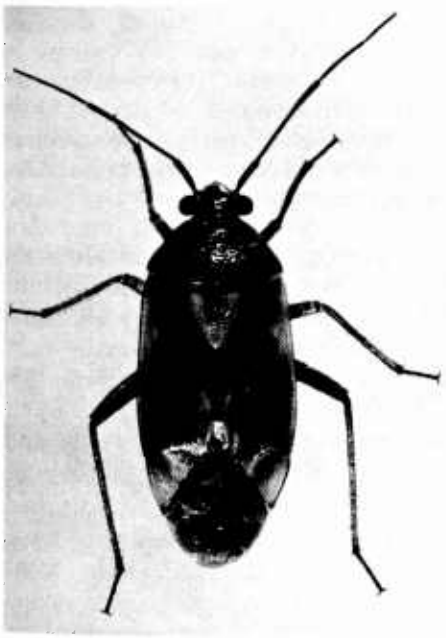
Studies in field cages (*8*) of all potential seed-feeding insects found in the beetfields showed that insects of the genus *Lygus* and several species of stink bugs were the primary cause for the production of nonviable seed and were also responsible for lower yields. Since lygus bugs were found to be the most numerous of the seed feeders, more detailed studies (*9*) were made with single specimens of males, females, and nymphs of the various species in cages on seed spikelets to determine the comparative amount of damage attributable to each.

Lygus Bugs

At least three species of *Lygus* occur throughout the areas where sugarbeet seed is grown. These are *L. hesperus* Knight, *lineolaris* (Palisot de Beauvois), and *elisus* Van Duzee. Occasionally other species may occur in the more northern areas, but they have not been found in significant numbers.

The adults average about one-fourth inch in length and one-eighth inch in width. *L. hesperus* is slightly larger than the other two species and *elisus* smaller. *L. hesperus* is angular with whiplike antennae about two-thirds the length of the body (fig. 37). It varies from yellowish green to reddish brown. *L. lineolaris* varies from green to brownish, often having distinctive yellow spots on the outside edge and toward the rear of the forewings. *L. elisus* is usually pale green. All have a prominent triangular plate in the center of the body at the base of the forewings.

The nymphs resemble the adults in form (fig. 38) but are usually pale green, although the larger nymphs of *hesperus* or *lineolaris*



TC-7486

FIGURE 37.—Adult of *Lygus hesperus*. (× 8.)

TC-7487

FIGURE 38.—Nymph of *Lygus hesperus*. (× 8.)

may have a brownish cast. To the casual observer the smaller nymphs may slightly resemble aphids, except for the prominent antennae and their rapid movement. The very small nymphs appear to be all legs and antennae. *Lygus* adults can easily be seen on the seed heads, but because of their color and size the nymphs are very inconspicuous and can easily be overlooked. Their presence is best detected with a muslin sweep net, or for cursory examination the stalks may be shaken over a piece of white paper or a card.

In the southern areas *hesperus* and *lineolaris* are the predominant species. In northern California and in Oregon *elisus* predominates. All three species feed on the developing seed, causing the embryos to collapse and resulting in hollow, lightweight seed balls (fig. 39). This damage shows up primarily in a reduced percentage of germinating seed balls and also in reduced yield, since many of the lightweight seed balls are discarded in the recleaning process.

TC-7488

FIGURE 39.—Dissected multigerm seed balls of sugarbeet: Upper row damaged by lygus bugs has only shriveled germs; lower row has healthy well-filled seed balls. (× 3.)

L. hesperus and *lineolaris* cause slightly more damage than does *elisus*, and the females and nymphs of all three species destroy more seed per insect than do the males. Usually the *Lygus* population is predominantly nymphs at the time the crop is susceptible to injury by these insects and, therefore, control is ordinarily directed against the nymphs.

Lygus females are attracted to the seed beetfields soon after seedstalk development has started in the spring. They deposit eggs within the tissues of the growing tips of the seed stalks while the stalks are still vegetative, and by the time flowering starts the first brood of nymphs begins to appear.

Sweep-net collections throughout the season in the Salt River Valley of Arizona indicated that one *Lygus* per sweep of a 14-inch insect net at the peak of populations on developing seed will cause a measurable reduction in the percentage of germinating seed. These collections further showed that 20 *Lygus* females per 100 sweeps in the fields when seed stalks are vegetative (usually April 1–15 in the Salt River Valley) are sufficient to produce a damaging population of nymphs by the time the plants begin to flower. Since very few males occur in the beetfields early in the season, a count of total adults at this time is sufficiently accurate.

The *Lygus* species damage only the soft newly formed seed. Although the insects may be present earlier, experiments by Hills and Taylor (*16*) showed that little or no damage occurred until soft seed was present. However, since some soft seed is present soon after blooming starts, it is recommended that the first insecticide applications be made in the early bloom stage if there are as many as one

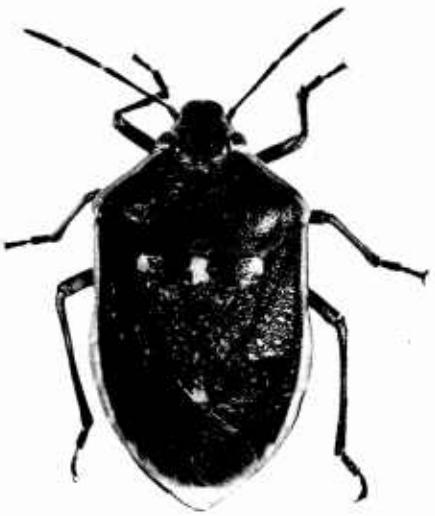
Lygus per sweep of a 14-inch insect net.

Before the development of DDT, *Lygus* control was difficult. Dusting sulfur or pyrethrum extract-impregnated sulfur dust gave partial control. However, the first field trials with DDT in 1944 and 1945 showed remarkable results (*13*). For several years good control of *Lygus* was obtained with DDT, resulting in increased germination and yield of seed (*4*) (*20*). By 1953 some growers reported poor results with DDT, and field-plot tests in 1954 (*18*) showed that DDT was not so effective as it had been in 1944 and 1945. Therefore, since 1954 it has been necessary to use other insecticides either alone or in combination with DDT, and rarely can satisfactory results be obtained with one application. This change in the effectiveness of DDT is attributed to the development of resistance in *Lygus* to this insecticide.

Stink Bugs

Three species of stink bugs commonly infest fields of seed beets—the Say stink bug (*Chlorochroa sayi* Stål), the red-shouldered plant bug (*Thyanta pallido virens spinosa* Ruckes), and the brown stink bug (*Euschistus servus impictiventris* Stål). The small plant bug (*Thyanta brevis* Van Duzee) and the conchuela (*Chlorochroa ligata* (Say)) may sometimes also occur.

The general appearance of these bugs is similar. Each has a prominent pronotum, or plate directly behind the head, and a scutellum, or triangular plate in the center of the back. The anterior of the insect is angular with a distinct head and prominent four-jointed antennae. The posterior is rounded and the wings are plaited on either side of the scutellum. The forewings



TC–7489

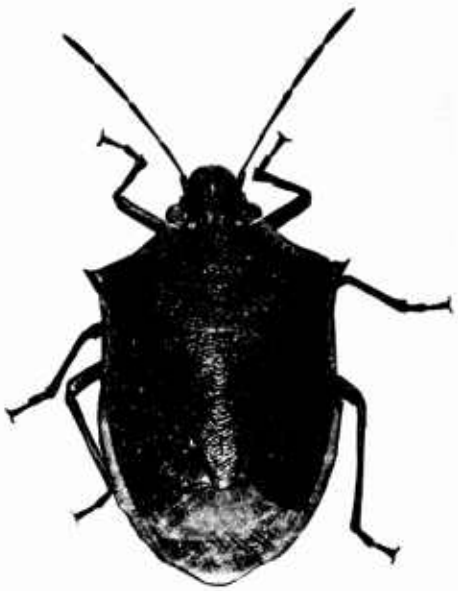
FIGURE 40.—Say stink bug (*Chlorochroa sayi*). (× 4.)

are thickened and heavy except for the membranous tips. The hindwings are entirely membranous.

The Say stink bug is the most common species found in the seed beetfields (fig. 40). These insects vary slightly in size but will average about one-half inch in length and about five-sixteenths inch in width. The overall color varies from bright green to olive green flecked with white. Sometimes there is an orange band around the lateral edges of the abdomen.

The red-shouldered plant bug is slightly smaller than the Say stink bug, averaging about three-eighths inch in length and one-fourth inch in width (fig. 41). It varies from bright green to light greenish brown. The pronotum has points on either side, which are sometimes reddish, or the posterior edge of the pronotum may be reddish, from which it gets the name red-shouldered plant bug.

The brown stink bug is slightly larger than the Say stink bug, averaging about nine-sixteenths



TC-7490

FIGURE 41.—Red-shouldered plant bug (*Thyanta pallido virens spinosa*). (× 5.)

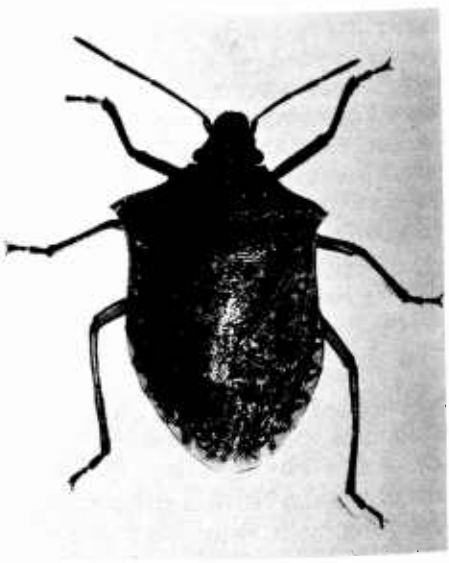
inch in length and three-eighths inch in width (fig. 42). It varies from light brown or tan to dark brown. It is more angular than the Say stink bug and has a prominent point on either side of the pronotum.

The small plant bug is, as the name implies, much smaller than the other species (fig. 43). It is only about one-fourth inch long and three-sixteenths inch wide. The general shape is the same as that of the Say stink bug and it varies from green to light brown.

The conchuela is very closely related to the Say stink bug and resembles this species except for color. It is dark, almost black, with a red band around the edge of the abdomen and a red dot on the back at the tip of the scutellum.

Studies in field cages (*9*) showed that, on an average, one Say stink bug adult confined on a seed spikelet during seed formation caused 206 nonviable seed balls per season as compared to 86 nonviable seed balls for one *Lygus* female or nymph. Cage studies (*8*) also showed that the red-shouldered plant bug caused equally as much damage as *Lygus* but not so much as the Say stink bug. Later studies by Hills and McKinney (*12*) showed that the brown stink bug could cause almost as much damage as the Say stink bug, and further studies by Hills and Taylor (*17*) showed that the Say stink bug could drastically reduce the yield of nearly mature seed and could cause some damage to seed after the stalks were cut and in the windrow. These insects not only caused nonviable seed balls but also killed some of the embryos in other seed balls and thus reduced the number of sprouts per viable ball.

No data are available on the comparative damage that may be caused by the small plant bug, but it has occasionally been noted as numerous in seed beets and appeared to be feeding on the nearly mature seed as do other stink bugs.



TC-7491

FIGURE 42.—Brown stink bug (*Euschistus servus impictiventris*). (× 3.)

TC-7492

FIGURE 43.—Small plant bug (*Thyanta brevis*). (× 7½.)

Although all the stink bugs tested have caused as much or more damage to sugarbeet seed than does *Lygus*, they are not considered as important economically as *Lygus* because of their erratic occurrence. Several years may pass with so few stink bugs that they are of little concern to the beet seed grower. However, these insects are migratory and can suddenly appear in fields near harvest with drastic results. Usually they will appear on the edge of the fields first and can be detected if the fields are closely watched.

During the middle of warm days stink bugs will seek shade and go down deeper into the plants, where they are difficult to detect. They can best be observed during the early-morning hours, when they will be up on the sunny side of the spikelets. Sweep-net collections do not give an accurate estimate of the numbers present, since these bugs have a habit of dropping to the ground at the least disturbance. The best way to detect stink bugs is to carefully examine the fields during the early-morning hours. If stink bugs are readily observed, insecticides should be applied.

VIRUS VECTORS

At least three important virus diseases affect sugarbeets grown for seed. These are curly top, transmitted by the beet leafhopper (*Circulifer tenellus* (Baker)), and beet yellows and beet western yellows, both of which are transmitted by aphids.

Beet Leafhopper and Curly Top

The beet seed producing areas of Arizona, New Mexico, California, Utah, and Nevada are subject to infestation by the beet leafhopper and damage by curly top disease. The beet leafhopper is a slender insect, approximately one-eighth inch long, varying from gray to greenish yellow (fig. 44). When disturbed, it will usually take off for a short flight with a hop. The nymphs resemble the adults in general form (fig. 45). Very young nymphs are a pale yellowish green, but in later stages they have dark-brown or red markings. In the full-grown nymphs, developing wings, or wing pads, can be seen.

Most of the individuals that feed on the beet seed crop develop in surrounding desert areas and migrate to the beetfields. In general there are two movements, one in the fall and one in the spring. The magnitude of the movement is dependent on the abundance of breeding host plants. During the winter and spring the insects breed on winter annual plants in the desert and move to the cultivated areas with

TC-7493

FIGURE 44.—Beet leafhopper (*Circulifer tenellus*). (× 25.)

brood maturity or with the drying of the host plants. During the summer there are other annual plants in the desert on which the insects breed and from which they move to the cultivated areas in the late summer or fall. The magnitude of leafhopper infestations in the seed beets is, therefore, indirectly dependent on winter and summer rains, which help to germinate and maintain these desert plants.

In addition to the influx of leafhoppers from desert areas, there are always some leafhoppers that develop on weeds within the cultivated areas. These insects are especially important economically, not only because of their nearness to the cultivated crops but also because a higher percentage of them are likely to be carrying the curly top virus.

Experiments by Hills et al. (*11*) showed that infestations of curly top-infective beet leafhoppers on seed beets in the spring are of little concern, even on curly top-susceptible beets. On the contrary, migrations of beet leafhoppers in the fall, when the beets are small, can be disastrous, even to curly top-resistant varieties. An average beet leafhopper population of 50 per 100-foot row on small beets in the fall indicates a need for insecticide treatment.

Beet leafhopper populations cannot be accurately counted without a counting cage (*7*). They are very active and will jump and fly from the plants before they can be counted if observations are attempted without this equipment. Experience has shown that the sweep net is of little value in estimating beet leafhopper populations. The activity of these insects varies so greatly with temperature, wind movement, and time of day that sweep-net collections are unreliable.

Field tests by Hills et al. (*14*) from 1944 to 1947 showed that DDT in a spray or dust was effective against the beet leafhopper.

TC-7494

FIGURE 45.—Nymph of the beet leafhopper (*Circulifer tenellus*). (× 20.)

Observations in 1961 indicated that this insecticide was still effective against this insect. Experiments by Hills et al. (*19*) in 1959 showed that leafhoppers can be controlled up to the four-leaf stage by seed or soil treatment with phorate or Disyston.[3]

Aphids and Yellows Viruses

Beet yellows, widely known as virus yellows, was first recognized in sugarbeets in the United States in 1951 (*3*), but it was not reported in sugarbeets grown for seed until 1955 (*1*). The green peach aphid is the most important vector of the yellows virus in seed beets. Bennett (*1*) showed that other aphids are capable of transmitting this virus. However, the green peach aphid is not only an efficient vector but widely distributed and is numerous in seed beetfields everywhere that the crop is grown. This insect also has a wide variety of breeding host plants, which increases the possibility of its carrying the virus from alternate hosts to sugarbeets.

The work of Bennett and McFarlane (*2*) showed that yellows from early-spring infection reduced the yield of beet seed 43 to 70 percent. Later infections resulted in reductions of 19 to 21 percent. There was also a reduction in seed size but not in germination. In 1958 field-plot tests by Hills et al. (*10*) showed an average decrease in seed yield of 35 percent where an infestation of yellows-infective green peach aphids occurred on November 20. Infestations on February 21, March 26, April 8, and April 21 resulted in yield reductions of 27, 18, 14, and 7 percent, respectively. These experiments demonstrated the need for early and thorough aphid control.

In 1960 Duffus (*5*) discovered a virus disease of sugarbeets, which he named radish yellows. Later he called it beet western yellows (*6*). Symptoms are similar to those of beet yellows, although the virus is unrelated. Field tests by Duffus (*6*) showed that western yellows reduced tonnage and sucrose content in sugarbeets the same as beet yellows. The two viruses together reduced beet tonnage more than either one alone, but the reductions were not more than additive.

Field experiments by Hills et al. (*11*) showed that beet western yellows and beet yellows both reduced the yield of beet seed and that a mixture of the two viruses reduced the yield more than either one alone. In these experiments beet western yellows reduced yields 13 percent and beet yellows 17 percent, whereas a combination of the two viruses reduced yields 36 percent. Neither of the viruses affected the germination of the seed.

Studies by Bennett (*1*) and Sylvester (*21*) showed that the beet yellows virus is semipersistent. After acquiring the virus, most of the aphids lose the ability to transmit it in 24 hours, although a few may retain the virus for as long as 72 hours. On the other hand, Duffus (*5*) showed that the western yellows virus is persistent in the aphid. Once the insect acquires the virus, it can transmit western yellows the rest of its life. In all probability, therefore, a beetfield some distance from the virus source would be more likely to become infected with beet western yellows than beet yellows.

[3] Mention of proprietary products does not constitute their endorsement by the U.S. Department of Agriculture.

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