Some Insect Pests of Important Seed Crops

F. V. Lieberman, F. F. Dicke, and Orin A. Hills

The harmful insects that seek food and shelter in forage legumes, grains, and sugarbeets must be controlled if crops of seeds are to be produced profitably.

Modern chemicals have made it reasonably easy to prevent much of the damage they inflict, particularly when the crop leavings are not to be used as feed. For controlling others, we rely on helpful farm practices and resistant varieties. Parasites, predators, and the diseases that attack the insects often help.

Most of the harmful insects attack the plants when they are in the vegetative, or growth, stage. Controlling these root and foliage feeders is the first order of business in protecting a seed crop, for a healthy plant with normal growth is the best foundation for successful seed production. In fact, in combined effect the insects feeding on the roots, leaves, and stems often are responsible indirectly for most of the loss in yield and also reduce the quality of seeds.

Different conditions over the country influence the choice of chemical treatment. The stage of development of an insect and the particular pest complex present at the time of treatment also must be considered.

County agricultural agents give advice on the insecticides to use and suggest the dosage that gives good control. They also know the restrictions placed on the use of various chemicals to protect the health of people. Some of our most effective insecticides must not be used on a seed crop if they leave a residue on any part (chaff, straw, stalks, leftover seeds) that is to be fed to livestock.

Some insects that feed on plants in the early stages of development, like the beet leafhopper (Circulifer tenellus) and the green peach aphid (Myzus persicae) on sugarbeets, carry plant diseases.

The insects that feed on the buds, flowers, or seeds can more truly be called seed-crop pests. Many are the same ones that earlier fed on the stems or leaves or, in another developmental stage, on the roots. They are best controlled therefore before they directly attack the fruiting parts.

Some destructive insects specifically seek the buds, flowers, or seeds. They ordinarily cause damage out of proportion to their numbers and their feeding. Their damage is often swift or hard to detect. Some are thought to inject toxins into the plants. Controlling them is further complicated by the need to protect pollinating bees from destruction while they are visiting flowering fields or flying to and from their hives or nests.

Everywhere where seed alfalfa is grown, the lygus bugs must be controlled. Their tremendous importance was first shown by G. J. Sorenson at the Utah State Agricultural Experiment Station before 1932. Growers of alfalfa seed generally did not regard them as their chief tormentors until after DDT was developed, and the great benefit of their control was demonstrated. Now they are recognized as the chief pests of seed crops of alfalfa and sugarbeets. They do great damage in cotton, other legumes, and a number of vegetables.

Three species of the genus Lygus, L. hesperus, L. elisus, and L. lineolaris, are important. The last is sometimes called the tarnished plant bug. The lygus bugs are pale-green to reddish or dark-brown sucking insects about three-sixteenths inch long. Their young are yellowish or bluish green. The
adults insert their eggs into the top growth of plants they attack.

No distinction is made in a control program among the Lygus species. We do know, however, that differences exist in their relative abundance from place to place and from crop to crop. *L. lineolaris* is the common species in the eastern half of the United States. *Hesperus* dominates in the Southwest, but on seed sugarbeets *lineolaris* is equally abundant. *L. elisus* tends to be most abundant in the Northwest. Within these regions, the composition of the lygus bug population on cultivated crops may vary considerably; often it is influenced locally by the abundance of various wild host plants.

The damage the several species do also varies. *L. hesperus* and *lineolaris* favor the seeds of alfalfa and sugarbeets and can do more damage to them than *elisus*, which prefers to feed on the buds and flowers.

Lygus bugs live and feed on many kinds of crops, weeds, and native vegetation. The adults are strong fliers and have an uncanny knack of seeking out alfalfa at just the right time to lay their eggs so that hatching begins when the first buds appear. The bugs have been known to destroy 99 percent of the potential crop in a field of alfalfa by blasting the flower buds as fast as they are formed. When not enough of them are present to prevent flowering, they will feed on the blossoms and cause most of them to drop. Then they suck the juice from the seeds.

DDT was first tried against lygus bugs in 1944. The results on alfalfa were spectacular. In Utah, for example, a DDT-treated plot yielded 24 times the amount of seed produced on an untreated check plot. Soon all producing areas were utilizing DDT to control lygus bugs. Yields started an upward climb. The average yield was tripled by 1956. A part of the gain was due to better control of other insect pests, better crop management, and increased use of honey bees for pollination. But the lygus bug had to be checked before such gains could be registered.

During the late 1930's, when the large-scale production of seed of sugarbeets was getting started in this country, growers were troubled by the occurrence of a high percentage of nonviable seedballs. The corky balls would contain two to four seeds; all would be dead; but the grower might not know that until harvesttime.

At first the dead seed was attributed to adverse weather, insufficient water, or alkaline soil—factors that do cause seed embryos to abort. But researchers of the Department of Agriculture questioned that the severe losses were caused entirely by soil or moisture conditions. They suspected insects.

At Phoenix, Ariz., in 1938 various harmful insects found in seed beet fields were caged alone on developing seedballs. Then the balls were dissected to appraise any damage done. It was learned that the same three species of lygus bugs that damage seed alfalfa were the main offenders. Both adults and the nymphs inserted their mouthparts through the balls and into the seeds, drawing out the sap and destroying the embryos. The nymphs and the female adults of all three species damaged more seeds than the males.

Additional cage tests showed that the greatest amount of damage done to the beet seed crop by lygus bugs was to the soft, newly formed seeds. Little or no damage was done to the crop before or after this stage.

Efforts to develop an insecticide treatment that would kill the bugs before the crop of beet seed attained the soft-seed stage were rewarded when DDT was tested. By application of DDT, growers could consistently produce good yields of good seed.

MOST CHALCIDS are beneficial insects and destroy many common pests. A few chalcids attack crops.

One species destroys the seeds of alfalfa and certain clovers and trefoils. It is a tiny, black wasp that lays its
eggs singly in their seeds. It does not attack any other part.

No differences were observed for many years among the chalcids in alfalfa, clovers, and trefoils.

A. N. Kolobova, a Russian scientist, in 1950 demonstrated that chalcids raised on alfalfa would not lay eggs on clover, and vice versa.

Now we know that there are at least three biological races of legume seed chalcids. One infests alfalfa and other Medicago species. One develops on red clover and other Trifolium species. A third lives on birdsfoot trefoil and other Lotus species. They are all called the clover seed chalcid (*Bruchophagus gibbis*).

This pest has attracted special attention in California since 1957. Kern County has a relatively new certified alfalfa seed industry. It started in 1949 when the seed supply of certified varieties was short, and it was learned that seed of new varieties could safely be grown outside their region of adaptation. Good crop and pollination management and insect control provided excellent yields. As it was a new area, chalcid damage was not a problem at first. By 1957, however, the clover seed chalcid was cutting deeply into yields of seed despite good practices conducive to its control, and it became clear that better control measures were urgently needed. Greatest hope lies in new systemic insecticides or in the development of resistant varieties. Research workers undertook studies of both.

Each egg of the variety of seed chalcid that lives on alfalfa is laid inside a partly developed seed of alfalfa or burclover. The newly hatched larva gradually devours the contents of the seed, pupates, and changes to an adult wasp. The wasp chews its way out through the seedcoat and the pod. It leaves a hole in each.

One to several generations may develop, depending on the latitude and altitude of the area, each season. The winter is spent as full-grown larvae within the hollowed-out seedcoats. These infested seeds are the source of infestation for the new year wherever they may be—in cleaning plant or warehouse, in the thresher, on the ground, or on volunteer or other uncut plants that have gone to seed.

Control measures recommended in 1961 were based on destroying as many of the larva-bearing seeds as possible. To do so, one should clean all seed carefully and destroy or use the cleanings, prevent seed from forming on volunteer plants, clear the field after harvest, work all chaff into the soil, and, if necessary, provide moisture to encourage the growth of fungi present in the soil that will kill the overwintering larvae in the seeds.

STINK BUGS, particularly the Say stink bug (*Chlorochroa sayi*), occasionally cause great damage in the West to alfalfa and sugarbeet seed crops as well as to small grains.

An outbreak of stink bugs usually depends on unusually good conditions for their development in the uncultivated areas. During wet years on the deserts, a lush growth of host plants can produce a huge population. The adults fly to cultivated areas, often far away, when the desert plants dry up. They usually attack grains first, but may fly directly to alfalfa or sugarbeets. They suck the sap from the immature seeds and have been known to destroy excellent seed sets completely. In sugarbeet fields they can damage mature seed and may even do damage after the seed growth is cut and windrowed.

Of the many organic insecticides that have been used to kill stink bugs, toxaphene, benzene hexachloride, and dieldrin are particularly effective. More than one application may be necessary, because the adults move about freely and the migration may be prolonged. Nymphs are seldom a problem, because eggs laid by the migrating adults usually are heavily parasitized or hatch after the crop is harvested.

TIMING the crop is the most successful cultural method used against insects.
It is used in the production of clover seed to control the clover seed midge (*Dasyneura leguminicola*). This is a tiny, delicate, mosquitolike fly that has a bright-red abdomen. It lays eggs on or near the flower heads of clover crops, principally red clover. The newly hatched larvae wriggle into the unopened flowers. They suck the sap from the ovaries and keep the ovules from developing. The seed crop may be heavily damaged or destroyed.

Development of the clover midge is closely correlated with weather and is particularly dependent on rainfall. Three generations are produced each year in the Northwest. The seed crop is grown from May to August; it is the summer generation of midges that damages it.

Control is effected by timing the appearance of the flower heads so that the midges find few suitable heads on which to lay their eggs.

Pasturing the field in the fall after the seed crop is harvested or in the spring before the seed growth is started will prevent most midges of the fall or spring generations from finding suitable flower heads. In consequence, the summer generation of midges will be small, and little damage will be done to the seed crop.

Clipping the spring hay growth for mulch about May 20 times the seed growth so that neither the spring nor summer generation midges find suitable flower heads.

If a hay crop is raised first, cutting and removing it promptly from the field in early June will kill most of the mature spring-generation larvae in the crop as well as time the blooming of the seed crop so that most summer-generation midges will have disappeared before the flowers become attractive for midge oviposition. It is important to remove the hay promptly because the mature spring-generation midge larvae, needing the moisture to move, will leave the flower heads for the soil and develop into adults if enough rain falls on the hay.

Another midge, *Dasyneura gentneri*, closely related to the clover seed midge, attacks Ladino and alsike clovers. It is less important than the clover seed midge, and no control has been developed.

Two tiny weevils frequently ruin seed crops of clovers. *Tyshius stephensi* is mainly a pest of red clover. *Microtrogus picirostris* attacks white, alsike, and Ladino clovers. Both are gray and long beaked.

Like most weevils, they hide in winter in field trash or in heavy vegetation nearby. They become active in spring near their winter quarters. Often they feed on such plants as dandelion and wild strawberry. Later, when clover comes into bloom, the weevils move into the fields and feed upon the flowers. They lay one or two eggs in each young pod they encounter. Larvae hatching from these eggs devour most of the ovules. Both adults and larval feed on the developing seeds, eating irregular holes into or through them. The larvae cause the greater damage.

DDT controls the seed weevils. The treatment must be applied after most of the weevils are out of hibernation but before many eggs are laid—about the time that 20 percent of the first set of blooms have turned brown.

Two other weevils, *Hypha nigrirostris* and *H. meles*, attack the heads and seeds of various clovers. The latter is particularly damaging to crimson clover seed in the Southeast. The larvae of both feed on the flowers, ovules, and growing seeds. The adults cause lodging of the heads by feeding on the stems. Control can be obtained by an early season application of aldrin, dieldrin, or heptachlor in granulated form.

The vetch bruchid is a little weevil that hollows out the seeds of hairy vetch. It ruined the production of hairy vetch seed in several Eastern States and then found its way into the Pacific Northwest and Midwest. It does not damage other vetches very much.
The bruchids lay eggs on the seed pods just after they are formed. Worms hatch from the eggs and bore into the pods from the underside of the eggshell without exposing themselves. They enter the green seeds and devour the contents. Each larva takes one seed. Each bruchid produces about 100 worms. They usually are abundant on hairy vetch and may destroy most of the seeds.

To control these weevils, a single application of DDT just as the pods begin to form is recommended. Because the bruchids congregate on the vetch for egg laying at that time, most of the seeds thus are protected. Bruchids survive in dry vetch seeds for months, but they do not feed on them.

Most producers of hybrid corn seed now have a well-planned insect-control program, which includes preventive measures, superior hybrid varieties, and insecticides.

Prominent among the pests of corn is the European corn borer (Pyrausta nubilalis). It is the larva of a moth that ordinarily has two broods or egg-laying periods annually in the major production sections of dent seed. The fully developed larvae are about an inch long. The first brood is more serious in causing loss of yield and chaffy seed in early planted corn. Early hybrids of sweet corn are subject to severe ear damage.

Planting early is a preferred farm practice in the production of dent corn seed. This practice facilitates processing the crop and is a safeguard against fall weather hazards. Well-timed applications of DDT, endrin, heptachlor, or toxaphene granules and DDT and endrin sprays can be depended on to control borers.

Late-planted or late-maturing corn is more likely to be damaged by the second brood, which becomes established in July and August. Worm survival is high on such corn, and about 50 percent of the infestation develops on the ear. Invasion of the shank and internodes above the ear cuts off the flow of nutrients to the ear. Direct injury to the kernels, with subsequent introduction of molds, lowers the yield and quality of seeds and makes costly hand culling necessary in the processing operation. Insecticides directed to the ear zone have given satisfactory results in protecting the ear against second-brood infestation.

Inbred lines have varying resistance to borers. It commonly is referred to as first-brood early leaf-feeding resistance. At least three resistant lines are required in a commercial hybrid to achieve effective resistance. Resistant hybrids are recommended and available for certain localities in the Corn Belt.

Another serious corn pest is the corn earworm, Heliothis zea. This moth larva destroys kernels and introduces molds to the ear. It is also known as the cotton bollworm and tomato fruitworm. It is a pest every year in the South, where it has several generations, and periodically in the North, where it may have only one or two generations. The moths are attracted to the fresh corn silk for depositing eggs. As the young larvae hatch, they begin feeding on the silks and gradually penetrate to the kernels.

The fall armyworm (Laphygma frugi-perda) has feeding habits like those of the corn earworm on corn, but is of much less importance in the major areas of seed production.

Corn varieties differ in the husk qualities that protect the ear against damage by earworms. Through many years of selection, good husk protection is typical of southern varieties. Loose husks, characteristic of varieties in the Corn Belt, enable earworm larvae to damage the surface of the ear out of proportion to the actual grain destroyed.

For sections of the Central and Eastern States where seed is produced, early planting is desirable to avoid seed injury. Intermediate plantings are desirable in Southern States to avoid early and late season peaks in ear damage.
The rice weevil (Sitophilus oryza), which often follows earworms, enters the ears through holes the earworms make. Poor husk coverage and damage by birds or rodents late in the season also expose ears to field infestation by the rice weevil. Such infestation of standing corn is the principal source of populations that develop during storage.

Both adults and larvae of the rice weevil injure the kernels. Besides feeding, the adults eat out a cavity, usually one to a kernel, in which to lay each egg. Eggs laid in kernels that have higher than 65 percent moisture do not hatch. The larvae devour most of the contents of the kernels and then pupate within them. Adults emerge from the kernels a few days later, and the new females soon begin to lay eggs. The infestation may thus increase rapidly.

Entomologists at the Louisiana Agricultural Experiment Station reported that when harvest of corn is delayed in the South, up to 90 percent of the kernels may become damaged in the field. The rice weevil causes most of this loss, but other pests of stored grain, particularly the Angoumois grain moth (Sitotroga cerealella), cause some.

The corn leaf aphid (Rhopalosiphum maidis) sometimes becomes a problem in seed production. It is known to overwinter only in warm climates on small grains and wild grasses. On corn, the colonies of small, green, soft-bodied plant lice escape observation in the early stages of development down among the whorl leaves. The farmer and seedsman usually see heavily infested plants, which have a sooty or reddish appearance, at about tasseling time or later. Then the damage has been done and plants often are partly or wholly barren.

Some inbred lines of corn are subject to barrenness. Other lines are attacked only lightly and show little effect on yield. Insecticides, as they have been used against the aphids, have not prevented barrenness.

Pollination in corn sometimes fails as a result of persistent feeding on the emerging silks by certain insects. The commonest are adults of the northern corn rootworm (Diabrotica longicornis), the southern corn rootworm (Diabrotica undecimpunctata howardi), the Japanese beetle (Popilia japonica), and several species of grasshoppers. All are attracted to fresh silk and congregate in their feeding long enough to interfere with pollination.

The sap and fungus beetles (Glis groupus q. quadrisignatus and species of Carpophilus) often infest corn. These little black beetles are attracted to fermenting plant wounds, such as the entrance holes of the corn earworm and the European corn borer in corn. Sometimes they enter ears with loose husks without the aid of these worm tunnels.

The beetles will displace and even incidentally kill borers in the ear or stalk. They may lay eggs on the decaying plant tissue. The larvae of Carposphilus beetles sometimes hatch and feed among the kernels. Adults usually feed in worm-damaged areas and cause ear rot molds to spread. Their net effect on seed corn sometimes is considered beneficial because their presence causes the more destructive earwolves and corn borers to abandon their burrows.

The sorghum midge (Contarinia sorghicola) is the most important insect in grain sorghum in the Gulf States. The gnatlike flies deposit their eggs in the flowers. On hatching, the gray or red maggots begin to extract the contents of the developing seed. Heavily infested heads have a blighted appearance. Multiple generations result in high seasonal populations. Johnsongrass and sudangrass are important hosts of the midge in the spring before sorghum heads appear. They also harbor puparia over winter.

A recommended control measure is to dust the heads with DDT. In controlled pollination work, paper bags treated with a streak of aldrin give protection against the sorghum midge.
as well as the corn leaf aphid and the corn earworm, which attack sorghum when they are unusually abundant.

The earworm in particular is a corn pest that is becoming more of a problem on grain sorghum. Eggs are deposited on the leaves before heading and later on the peduncle and head. Feeding on leaves is comparatively minor. The larvae do most of their feeding on the developing grain; they devour kernels, sever lateral branches of the panicles, and create conditions for development of mold. Half of the seed often is destroyed.

The sorghum webworm (Celama sorghiella) is the moth stage of a somewhat flattened, hairy, greenish caterpillar, which sometimes attacks sorghum in the more humid areas. Newly hatched caterpillars feed on the flowers. When about half grown, the worms shift to the seeds and hollow out the kernels one by one. They spin a light amount of silk to attach themselves to the plant when they are ready to molt or when disturbed. Sometimes the worms become abundant enough to cover the heads. Half the crop may be destroyed.

The full-grown caterpillars spin cocoons on the plant and pupate. The whitish moths that emerge from the cocoons dart about at night from plant to plant, laying their eggs one at a time on the sorghum heads. Because damage becomes more severe as the season progresses, early planting is suggested as a means of keeping down loss. The worms overwinter only on host plants; it is possible therefore to reduce populations by plowing under the crop leavings in the fall and burning off nearby areas of johnsongrass, the principal host plant of the webworms, early in the season before sorghum attracts them.

The English grain aphid (Macrosiphum granarium) and the apple grain aphid (Rhopalosiphum fitchii) feed on developing seed of small grain and cause blasting of heads. Both species attack the leaves in the fall and spring before active head growth. Reproduction is greater in cool weather. Parathion, methyl parathion, and tetraethyl pyrophosphate are used to control aphids. These materials are highly poisonous and should be used strictly according to directions.

Insects have caused little damage to rice in California. In the Southern States, the rice stink bug (Oebalus pugnax) has been responsible for serious annual losses. Rice stink bugs overwinter, feed, and multiply on grasses and migrate to rice when it begins to head. They suck the juices from the developing seeds. Their feeding produces empty seed or pecky rice—kernels that have discolored spots, which appear when the seed contents are only partly consumed.

Another sucking bug (Paromius longulus) causes damage similar to that of the rice stink bug but is of less economic importance.

The common chinch bug (Blissus leucopterus) has been observed in some places to cause direct damage to developing rice heads by invading fields after they are drained. The bugs feed on the plants at the nodes and under the leaf sheaths, and often cluster heavily just below the panicles, blasting them.

Aldrin, dieldrin, and toxaphene are used against the rice stink bug and chinch bug.

DDT and the outstanding insecticides that have since been developed and marketed solved some of the vexing problems of insect control that faced seedgrowers one or two decades ago. There are indications, however, that these chemicals have not provided permanent solutions. Some insects that were remarkably well controlled in the 1940's developed measurable tolerances for DDT and several others.

Most of this resistance to insecticides in seed production has occurred in the Southwest. In the Salt River Valley of Arizona, sugarbeet seed of low
quality reappeared in 1953. Experiments there in 1954 demonstrated that the residual action of DDT was no longer great enough to kill the nymphs of the lygus bugs that hatch after the DDT is applied.

Similar results were encountered in various localities on alfalfa and cotton. In Kern County, Calif., entomologists of the University of California found that lygus bugs taken from alfalfa seed fields became progressively more difficult to kill with DDT as the crop matured. By the end of the seed-crop period, the lygus bugs in seed fields were three to five times more tolerant of DDT than those in hayfields. They also found indications that nutrition may influence this change in susceptibility to DDT.

In later years, insect resistance to DDT has been met with additional applications or by substitution of other insecticides that provide better control.

In sugarbeet seed crops, for example, a second application of DDT or an application of toxaphene, benzene hexachloride, and dieldrin have been used.

Toxaphene, which kills better than DDT in warm weather, was substituted successfully on alfalfa for a time, but later in some localities tolerance for toxaphene also appeared.

Other insecticides under development in 1961 may meet this deficiency.

F. V. Lieberman joined the Entomology Research Division of the Agricultural Research Service in 1929 as a scientific aid. Since his graduation from Iowa State University in 1936, he has studied western forage insect problems in Colorado, Utah, Montana, California, and Arizona.

F. F. Dicke is an entomologist with the Entomology Research Division and associate professor of zoology and entomology at Iowa State University. He joined the Department in 1927 and has been engaged in research on the biology and control of insects on cereal and forage crops.

Orin A. Hills is Leader of Western Vegetable Insect Investigations of the Department of Agriculture, at Mesa, Ariz.

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Insects, Viruses, and Seed Crops

Orin A. Hills, Kenneth E. Gibson, and W. F. Rochow

Many serious plant diseases are due to viruses that insects carry. Some of the viruses may be transmitted in other ways, but the diseases would have little importance without insect vectors.

Sometimes a single species of insect is the carrier. Sometimes many different insects, usually of a related group, are to blame.

The aphids are the worst. The green peach aphid exists everywhere, is not overly particular about the plants it feeds on, and is said to transmit more than 50 plant viruses.

One reason therefore is that it is active. One winged aphid can spread more disease than a whole colony of comparatively inactive wingless forms.

Leafhoppers, next to the aphids in destructiveness, also are active. Often they feed for a comparatively short time in one locality and then move on, spreading disease as they go.

Several hundred virus diseases are spread by insects.

One group of them is nonpersistent,