INTEGRATED INSECT CONTROL PRACTICES

Daniel F. Mayer, Extension Entomologist
Carl Johansen, Extension Entomologist
Washington State University

Integrated control uses chemical, cultural, and biological methods to prevent crop damage. Insecticides used are effective against target pests but avoid damage to essential pollinators and predators through use of selective materials and careful timing. Accurate sampling of insect populations and careful timing of spray applications are essential in effectively using this sophisticated system.

CONTENTS

BASIC CONSIDERATIONS

Pollinator Protection

Essential pollinators must be protected during pest management of alfalfa grown for seed. Most Northwest growers use alfalfa leafcutting bee, *Megachile rotundata*, as the seed crop pollinator. Its protection from pesticides is a prime consideration. Sprays used during bloom have not been very effective against target pests in order to safeguard this small, susceptible bee. When the alkali bee, *Nomia melanderi*, is the main pollinator, a greater range of insecticides can be applied to blooming fields with relative safety. However, the alkali bee is highly susceptible to the most effective lygus bug control chemicals, necessitating their use well ahead of bloom.

Primary Pests

Lygus bugs, *Lygus hesperus* and *L. elisus*, are primary pests of alfalfa seed crops throughout Washington, Oregon, Idaho, Montana, Utah, and Nevada. Repeated exposure to insecticides has led to the development of resistant strains, especially in the older seed-production localities. Chemical programs must be carefully timed to control these pests successfully. The first three nymphal instars do little or no damage to buds, flowers, or seeds but are the only stages which are effectively controlled with the low-bee-hazard materials used during bloom. Therefore, early season treatments must be applied before development of the more tolerant fourth and fifth nymphal stages. Spray programs usually recommend an insecticide application soon after a hatch of young nymphs is detected in field samples. Careful timing is particularly critical with aerial applications because they are only effective under a narrow range of optimum weather conditions and are rarely as effective as ground applications.

Sizable populations of young nymphs can usually be tolerated later in the season as the seed is

maturing and if predator populations are high. At this point, the fieldman and grower can weigh the potential seed damage against the costs of control, including potential loss of pollinators, and make a control decision. If applications are justified, the best timing is when leafcutting bees have been in the field for six to seven weeks, coinciding with the lull between the two leafcutter generations and minimizing the risk to highly susceptible three- to five-week-old bees.

In Montana, the alfalfa plant bug, *Adelphocoris lineolatus*, is a related pest species whose numbers can be combined with lygus bugs for control considerations.

Under conditions favorable to their development, aphids, the twospotted mite, or the alfalfa weevil become primary pests. However, control programs usually center around lygus bugs as the key pests.

Predators

Bigeyed bugs, *Geocoris* spp., and damsel bugs, *Nabis* spp., usually are the most prevalent and effective predators of lygus bugs. Crab spiders and spined assassin bugs are able to capture adult lygus bugs but are seldom abundant in alfalfa seed fields. Other predators such as lady beetles, green lacewing larvae, and hover fly larvae feed mainly on aphids, and minute pirate bugs prefer thrips. Therefore, integrated programs must be aimed at conservation of the bigeyed bugs and damsel bugs. Typically, bigeyed bugs are more abundant, but damsel bugs show a greater preference for lygus bugs over aphids. Insecticide treatments applied during the bloom period must favor development of the predators. Trichlorfon (Dylox) and oxydemetonmethyl (Metasystox-R) were initially somewhat hazardous to both bigeyed and damsel bugs. With continued use, however, both predators developed a high resistance to these insecticides in most localities by 1970.

Other Pests

Aphids, mites, the alfalfa weevil, the alfalfa seed chalcid, cutworms, armyworms, and grasshoppers must be controlled with methods and materials that do not disrupt lygus bug predators. Aphids are controlled with metasystox-R (oxydemetonmethyl[1]) without serious harm to the beneficial predators. *Aphidius* wasp parasites provide excellent control of aphids under some conditions. Twospotted mites can be effectively controlled with specific miticides such as propargite[1] (Comite) with little or no hazard to either pollinators or predators. If alfalfa weevil larvae reach treatment levels, they must be controlled before bloom to avoid damage to pollinators. Alfalfa seed chalcids are often the most damaging pests of alfalfa seed simply because they have not been controlled. No effective chemical programs are known, but properly applied cultural methods will control them without adverse side effects. These methods are aimed at reducing populations and must be followed on an area-wide basis to be effective. Cutworms, armyworms, and grasshoppers only attain damaging levels sporadically. Usually they can be controlled without serious impairment of the integrated program.

SAMPLING

A major factor in the success of integrated programs is sampling. Precise timing of control measures for maximum effectiveness and minimal disruption of predators and pollinators must be based on detailed data obtained from a regular sampling program. Weekly samples have been adequate in the alfalfa seed programs except when pest populations are developing rapidly.

Basic Unit

The sampling unit which has proven effective in alfalfa seed fields is a series of five 180° sweeps with a 15-inch-diameter sweepnet. The net is swung from side to side with each step covering a total distance of about 5 feet. If sweeps are taken singly, twice as many fast-moving insects such as lygus bug adults will be collected. The net should be held so the lower half of the opening (8 inches) is drawn through the foliage. If foliage and stems are not obtained in the

[1]Check the Pacific Northwest Insect Control Handbook for current information on restrictions, rates and cautions for this material in your area.

sample, the net is not being swung hard enough and/or deep enough. Samples may differ somewhat among individuals according to their reach. For most consistent sampling, one person should sample the same field throughout the season.

Number of Samples

Twenty-five sweeps taken in groups of five about 30 feet into the field from each edge (north, east, south, and west) and near the center provide consistent population estimates of insects in fields of 30–50 acres. Sets of samples can be reduced to three for smaller fields, unless there is quite a bit of variation. Sample units should be increased to nine with 100-acre fields and should be equivalent to one unit per 13 acres for uniform fields of 200 acres or more. Particular attention must be paid to the windward edge of a field where migrating lygus bugs often enter first. Also emphasize chronic "hot spots" of infestation, such as field areas next to concentrations of major wild or cultivated lygus bug host plants.

Sampling Conditions

Samples are usually taken once a week. With bad weather or questionable pest-predator conditions, additional samples are needed. Winds over 8 m.p.h. with gusts up to 16 m.p.h. will quickly drive lygus bugs from the upper canopy of alfalfa foliage. Cool and rainy weather or excessively hot days will also spoil attempts to sample lygus bugs accurately. Bigeyed bugs do not react as quickly to cool, windy weather, which further reduces the reliability of sweep samples taken under such conditions. New sets of samples must be taken as soon as reasonable weather conditions occur.

If small lygus bug nymphs (instars 1, 2, and 3) are numerous and it is questionable whether predators can keep them under control, another set of samples should be taken within three days. If the trend is for a rapid lygus bug buildup, an insecticide application is justified. If the trend is for lygus bug decline, an application is not justified.

Aphid Sampling

Pea aphids and alfalfa aphids are also sampled with a sweep net. Often they are too abundant to count individually but can be estimated in tens or hundreds. An even, green coverage of the flat bottom of the net will usually represent about 1,000 aphids. If one sweep is taken at a time, heavy populations can be estimated with reasonable accuracy. No correction is needed, since these sluggish insects are collected in equivalent numbers per sweep whether one- or five-sweep units are taken.

Blue alfalfa aphids prefer the more actively growing portions of the plant and treatment thresholds are lower than for the pea aphid. Both blue and spotted alfalfa aphids are sampled by cutting stems with a sharp knife, gently lifting them out of the foliage, inverting them, and counting the aphids on the stems and undersides of the leaves. When these aphids build up unusually early in the season, they are sampled by examining the alfalfa crowns.

Mite Sampling

A 10X hand lens is useful in observing twospotted mites and assessing their damage in the field. Control decisions are based on the amount of foliage damage. At each station where sweepnet samples are taken, several alfalfa stalks are pulled and the amount of damaged foliage is estimated. The decision to apply a miticide is based on the percentage of injured foliage in relation to seasonal development of the crop. Mites usually develop first in field edges bordering dusty roads and on weeds such as mallow, *Malva neglecta*. These are prime places to look for early infestations.

Weevil Sampling

Since young alfalfa weevil larvae often are not picked up in a sweepnet, buds must be examined during early season. Numbers of larvae per terminal provide the basis for control decisions. Decisions later in the season (May) are based on the number of weevils per sweep.

TIMING

Selective Program

If alfalfa weevils do not occur in injurious numbers, necessitating an early-season program, then lygus bugs can be controlled in late May or early June with a selective insecticide such as oxydemetonmethyl[1] (Metasystox-R) or trichlorfon[1] (Dylox). It is timed to catch the first hatch of lygus bug nymphs before they reach the more resistant fourth and fifth stages.

During bloom, both insecticides should be applied only during late evening or night, approximately 9 p.m. to 1 a.m. Treatments should not be made on warm evenings when honey bees are clustered on the outside of the hives.

Special effort is needed for best results with trichlorfon. Alkaline spray waters reduce its effectiveness; this problem can be overcome by acidifying the water with a nutrient spray material at 1–2 pints per 100 gallons. Sorba-spray Mg, Nutra Wet, Nu-Trex, Leaf Life, Tri-Fol, WEX, and Nutra Aid have been used successfully. Alkaline spray waters (about pH 8) should be increased to an acidity of pH 5.5 or 6. Trichlorfon is also susceptible to breakdown at temperatures above 100°F. It should be kept in a cool place and mixed with cool spray water (75°F. or less).

As the season progresses, greater numbers of small nymphs can be tolerated as long as predator populations continue to develop. This program has been called "Learning to live with the bugs." It has high dividends in minimal kill of pollinators and high yields of undamaged seed. The producer who has little or no problem with alfalfa weevils and other secondary pests can easily take advantage of an integrated program. Integrated programs are not as effective in diversified crop areas which provide alternate hosts for lygus bugs and encourage heavy use of chemicals likely to kill the needed predators.

Semi-Selective Program

First insecticide applications should be made during the early prebloom stage of alfalfa, usually during early or late May in the Northwest. Commonly used prebloom insecticides are carbofuran[1] (Furadan), methidathion[1] (Supracide), bifenthrin[1] (Capture), chlorpyrifos[1] (Lorsban), dimethoate[1] (Cygon, De-Fend) or permethrin[1] (Ambush, Pounce). By applying the spray early, beneficial predators that enter the fields a few weeks later are not killed. Best results are obtained when daytime temperatures reach or exceed 75°F. Capture, Lorsban, dimethoate, Supracide, and permethrin should never be applied closer than one week before bloom and Furdan should be applied at least two weeks before bloom in order to protect pollinators.

Whenever lygus bugs have been unusually difficult to control in previous seasons, results of the prebloom treatment should be carefully observed. A second application is strongly indicated if cool, rainy weather occurs soon after application, if lygus bug populations are increasing within a week or two, or if there is any other sign that the treatment was only partially effective. Label restrictions may indicate that a different chemical must be applied at this time.

Following the prebloom treatment, an application of Dylox[1], fluvalinate[1] (Spur), Metasystox-R, naled[1] (Dibrom), or mevinphos[1] (Phosdrin) may be made when a hatch of lygus bugs occurs and before any nymphs reach the fourth stage. Remember that trichlorfon is quickly broken down at high temperatures and in alkaline spray waters. Depending upon the effectiveness of the prebloom application, the presence of predators, and other factors favoring lygus bug buildup or decline, growers using a semi-selective program usually require 0–2 applications during the bloom period.

Aphid Control Timing

Low populations of aphids should not be treated because beneficial predators cannot exist without other insects for food. If all lygus bugs and aphids are killed by insecticides, the immature predators will die of starvation and the adults will migrate to other fields.

---

[1]Check the Pacific Northwest Insect Control Handbook for current information on restrictions, rates and cautions for this material in your area.

Normally, there must be 300 or more pea or alfalfa aphids per sweep to justify a special application to control them. Even then, if aphid predators are present in reasonably large numbers, a decision to spray should be deferred for at least one week.

The treatment threshold for blue alfalfa aphids is as low as 10–12 per stem on new regrowth, especially if the alfalfa is less than 6 inches tall and temperatures are below 75°F. Later in the season, 40–50 or more per stem can usually be tolerated without significant loss. Spotted alfalfa aphids require treatment when they average 20–30 per stem or more than 50 per sweep.

Mite Control Timing

Early season (June) control of twospotted mites is only recommended if 25% or more of the foliage shows white speckling damage. Mid-season (July) control is not justified until 50% of the foliage shows damage. Applications are usually not justified during late season (August), even if 100% of the foliage shows damage.

Growers have tended to overtreat for mites in the past. Not all brown or discolored spots in a field are necessarily caused by mites. If control measures are justified, miticides should always be applied alone. Even the specific miticides which are relatively harmless to bees will increase the bee poisoning hazards if applied in mixtures with insecticides.

Weevil Control Timing

During early season, alfalfa weevil larvae should be controlled as soon as they average one larva per terminal. Later in the season, the treatment level for older larvae is 20 or more per sweep. In areas with a history of severe alfalfa weevil problems, treatments are usually applied as soon as damaged foliage becomes obvious in the field. Applications should be made as early as possible because the most effective materials are highly toxic to beneficial pollinators and predators. If a damaging population of larvae develops during bloom, the safest materials are methoxychlor and Spur.

Timing for Secondary Pests

Alfalfa seed chalcid control is based on timing of cultural practices. Irrigation and cultivation to bury infested seeds and cause their breakdown should be done during fall and winter. Hay cutting or other setback operations are usually conducted during early to mid-May to reduce infestation by the first generation chalcids. Chaff stacks or other harvest refuse containing infested seeds must be buried or burned before April 1. Volunteer and roadside alfalfa plants should be removed before they set seed.

Redbacked cutworms. If large numbers (one or more per crown) appear during early season (May), they can be treated with little hazard to beneficial insects. If they are mainly feeding in the crown or roots and the weather is cool, treatments will be largely ineffective. A considerable amount of foliage feeding can be tolerated at this time without measurable effect on seed yields at harvest. Foliage feeding is much like taking an early cutting for setback of the crop.

Alfalfa loopers are typically controlled by virus or bacterial diseases when they become abundant on alfalfa grown for seed. Damaging populations that justified chemical treatment have only developed in one year out of 20 in the Northwest. The preferred material during bloom is methoxychlor.

Western yellowstriped and bertha armyworms are not usually noticed until mid- to late season. Greatest numbers normally occur in limited weedy spots in the field. However, in the drought year 1977, non-weedy fields with lush alfalfa growth were also infested. If one considers the hazards to bees, chemical treatments are seldom justified. If pheromone or ultraviolet light traps indicate a heavy flight of moths during late spring and small worms are found on the ground beneath plants the last half of June, a low-hazard spray of trichlorfon[1] when the armyworms are small and susceptible is the best answer. If the main pollinator is the alfalfa leafcutting bee, the best material after midseason is a

[1]Check the Pacific Northwest Insect Control Handbook for current information on restrictions, rates and cautions for this material in your area.

reduced dosage of methomyl[1] (Lannate, Nudrin) applied to coincide as closely as possible with the lull between peaks of leafcutter emergence, 6–7 weeks after the bees were first active in the field.

Grasshoppers are pests that only develop damaging populations about one year in 10. Federal control programs on rangeland can be very effective in limiting the spread of hoppers from surrounding areas into alfalfa seed fields. Prebloom applications of any of the registered insecticides will control grasshoppers present in the seed fields at the time. If justified during bloom, any of the recommended bloom insecticides will control grasshoppers. Again, such applications should be carefully timed for minimal impact on either alkali or alfalfa leafcutting bees. Baits containing carbaryl[1] (Sevin) are commercially available. Such formulations are not hazardous to bees but are usually only marginally effective when competing with alfalfa foliage.

VARIABLE FACTORS

Pollinators

A major factor affecting the control program is the abundance and quality of pollinating bees. If sizable numbers of pollinators are present, a good crop of seed can be set in as little as two weeks. If only a few pollinators are available, the seed setting period is prolonged and the crop becomes much more vulnerable to lygus bug damage. Invariably, a large force of pollinators reduces the amount of seed damage caused by lygus bugs and other pests.

Crop Condition

When the seed crop is maturing and drying out, it becomes much less attractive to lygus bugs. As long as a field is green and lush, it attracts large numbers of lygus bug adults from surrounding areas.

Obviously, it is advantageous to pollinate the crop as fast as possible and move the bees to other fields. The crop will start drying out and, if necessary, lygus bug controls can be applied without hazard to the pollinators.

If a field is too wet, vegetative growth is stimulated and few or no blooms will develop. Irrigation requirements for maximum seed yields vary considerably between individual fields and geographical regions. One of the best ways for growers to optimize their operation is to experiment with different irrigation timing schedules on a series of strips through the length of their fields.

Adjacent Crops

As crops that harbor lygus bugs are harvested, swarms of adults fly into nearby seed fields. For this reason, alfalfa hay and mint are two of the worst crops in alfalfa seed areas. Sugarbeets also harbor large numbers of lygus bugs; but because they are harvested late in the fall, sugarbeets do not present a hazard to the seed grower.

Volunteer alfalfa along roadsides and in waste areas is a source of alfalfa seed chalcid infestations.

A major problem in diversified crop areas is the use of many kinds of chemicals which are highly hazardous to both beneficial predators and alfalfa pollinators. Severe bee kills have been recorded when onion fields, cherry orchards, mint fields, potato fields, and alfalfa hay fields adjacent to seed fields were treated with malathion, parathion, mevinphos (Phosdrin), or diazinon.

Weeds

There are many interactions between weeds and alfalfa seed production. Weeds compete with the seed crop, reduce pollinator visitation, and reduce seed yields. Weed blooms such as mayweed (dog fennel), yellow starthistle, and wild carrot often attract bees away from alfalfa.

Weeds also act as initial preferred hosts to attract cutworms, loopers, and armyworms into seed fields. Bertha armyworm moths are attracted to lambsquarters, Canada thistle, sandbur, mallow, field bindweed, and redroot pigweed to lay their eggs. Alfalfa loopers prefer fiddleneck, blue mustard, shepherdspurse, redstem filaree, lambsquarters, and mayweed (dog fennel). After the caterpillars strip the foliage on the weeds, they move on to the alfalfa.

[1]Check the Pacific Northwest Insect Control Handbook for current information on restrictions, rates and cautions for this material in your area.

Early season development and increase of lygus bugs is especially associated with wild mustards, hoary cress, fiddleneck, and flixweed. Perennial pepperweed and Russian thistle are major midseason hosts. Lambsquarters, kochia, marshelder, redroot pigweed, and ragweed are major reproductive sites in late season and potential overwintering hosts. When ditchbanks, roadsides, and field edges have a grass cover instead of weeds, lygus bugs are markedly reduced.

Certain weeds, such as willow herb, ladysthumb, wild buckwheat, smartweed, and morning glory are excellent sources of leaf pieces for alfalfa leafcutting bee nest cells. Lambsquarters leaves and mayweed petals are also often used by the bees, but larval mortality tends to be higher in cells constructed with these materials.

Adult checkered flower beetles actively feed on the pollen of mayweed, wild carrot, and yarrow. The female beetle's eggs do not mature until she has fed on such pollens. Removal of these weeds from seed fields and surrounding areas helps discourage this major predator of the leafcutting bee. Adjacent crops of carrots grown for seed have also been associated with increases in checkered beetle infestations.

Plant Diseases and Nematodes

Plant diseases and nematodes are not usually as damaging in seed alfalfa as in alfalfa hay crops. Fewer irrigations and cuttings are the main differences. However, the alfalfa stem nematode, verticillium wilt, and other diseases are sometimes major concerns. More serious problems may occur when alfalfa acts as a reservoir for a disease or nematode which later infects other crops grown in rotation. Root knot nematode in potatoes and certain virus diseases in beans are examples of this interaction.

ECONOMIC THRESHOLDS

No set number of lygus bugs per sweep can be used to determine control measures. Factors such as types, numbers, and vigor of pollinators; time of season; condition of field; and presence of secondary pests must be considered before a decision is made. Certain absolutes usually operate:

1. If one or more alfalfa weevil larva is present per terminal, a suitable treatment must be applied early to minimize killing of beneficial predators and pollinators.
2. If selective materials are applied early in the season, they must be carefully timed to control first-generation lygus bug nymphs while they are still in the vulnerable first, second, and third stages.
3. Early season sprays are almost always necessary in integrated programs to remove the lag time required for predators to both move into the fields and reproduce and to minimize insect damage.

Lygus bug hatches before mid-July are likely to require control because bigeyed bugs and damsel bugs are not numerous yet. Figures from the regional Alfalfa Seed Pest Management Program show that decisions to treat after mid-July depend upon predator populations. Lygus bug populations seldom cause enough damage to pay for the cost of an insecticide application if the ratio of predators to lygus bugs is at least two to one.

From July 15 to the end of the season, lygus bugs must average at least three per sweep per week before seed damage will equal the cost of an application. If the ratio of predators to lygus bugs is below two to one, the field should be checked again within three days to assess the lygus bug population trend. Controls should be applied if the population is rapidly building. Controls should not be applied if the population is stable or declining. If lygus bug nymphs are reaching the fourth or fifth instar, predators are not controlling the population. If only small nymphs are present, the population is being controlled. Populations of 10 to 15 lygus bug adults and large nymphs can be tolerated in late season as seeds are hardening.

Once predators have become established in a field, there is usually no need for further control. Large numbers of predator nymphs in a field are a good indication of establishment. Normally, predators begin to reproduce after green seedpods develop in a field.

Predator populations build faster in fields that are drying and have a good seed set, and lygus bug populations generally decline under these conditions.

The keys to a successful integrated control program are adequate pollinators, good field sampling, early control, use of selective insecticides, proper water management, and no insecticide applications once predator populations have established themselves.