INSECT PESTS OF FIELD CROPS

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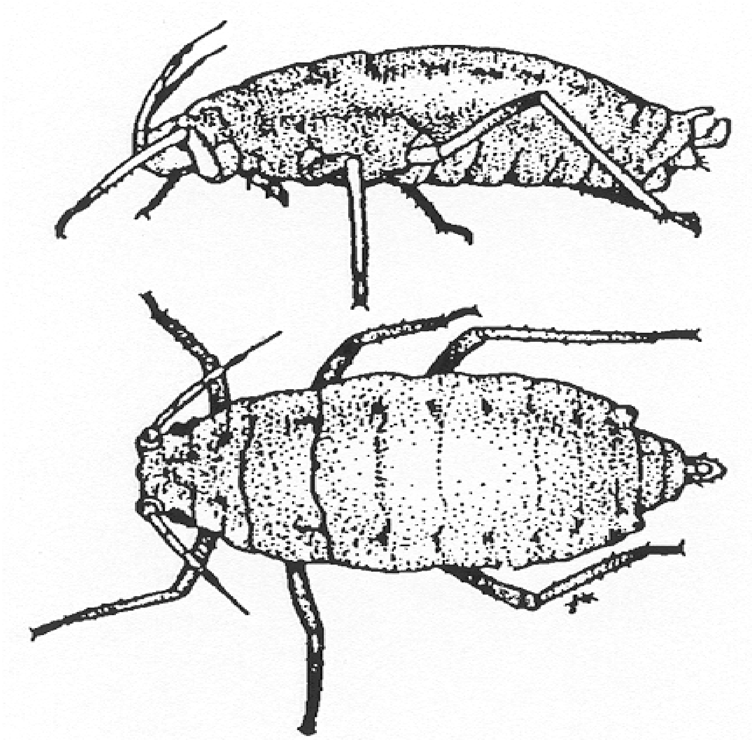

COOPERATIVE EXTENSION SERVICE

College of Agriculture

The University of Wyoming

DEPARTMENT OF PLANT SCIENCES

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INSECT PESTS OF FIELD CROPS

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Insect Pests of Field Crops

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SECTION I - Principles of Field Crop Insect Control

Present-day insect problems, created or aggravated by the concentrations of host plants, are diverse and complex and without simple solutions. Farmers and ranchers must follow the instructions and advice of competent fieldmen carefully in order to cope effectively with damaging pest populations. Specialists who disseminate control information must be able to adapt the lowest cost program which is not hazardous to man and domestic animals, and which does not cause undesirable side effects in the environment.

A knowledge of <u>insect classification</u>, <u>growth and development</u>, and <u>life cycles</u> is a requisite to the conduct of control programs. Life cycle data are essential in the timing of controls. One of the most familiar principles of insect control is that of the "weakest link". Only through a thorough knowledge of a pest's life cycle can one hope to aim control measures effectively at its most vulnerable stage.

<u>Crop value,</u> or the unit value of an agricultural crop, is an important consideration. Control of pest insects is usually justifiable when the increase in marketable yield produced is worth more than the cost of control. In the case of low-unit-value crops, such as certain forage crops, the feasibility of controlling pests is difficult to determine. Costly controls can be applied more logically to floral crops and fruit crops than to field crops and cereals.

<u>Preventive control</u> measures can be applied when one knows through experience that a certain insect pest or pests will develop to a damaging degree in a given area year after year. It is often true that early season applications are more efficient than later ones. Early treatments tend to control a pest species before it has reached its maximum rate of development and reproduction; and before the crop foliage has grown to the point where it is difficult to penetrate with sprays, granules or dusts. In contrast, one should generally wait until a certain pest population level is reached before treating field crops.

<u>Current development</u> of new insecticide formulations and types of application equipment has gone hand in hand with the appearance of new insecticides.

SECTION II - Causes of Insect Outbreaks

Outbreaks or epidemics of insect pests are usually caused by one or more of the following:

1. Large-scale culture of a single crop.

2. Introduction of a pest into a favorable new area without its natural enemies.

3. Favorable weather conditions for rapid development and multiplication of a pest; these same conditions may also be unfavorable to natural enemies.

4. Use of insecticides which kill the natural enemies of a pest, exert other effects favorable to a pest, or reduce the competing species of a pest while allowing it to multiply unmolested or only partially controlled.

5. Use of poor cultural practices which encourage buildup of pest infestations.

6. Destruction of natural biotic communities which otherwise provide regulation of insect population levels.

SECTION III - Types of Control

A. <u>Biological</u> control can be defined as the action of parasites, predators, or pathogens (disease producing organisms) on a host or prey population, producing a lower population level than would prevail in the absence of these agents. Generally biological control refers to manipulations by man, and distinguished from natural enemies and natural control.

Biological control has a number of distinct advantages, three of which are permanence, safety, and economy. Once biological control is established, it is relatively permanent and has no side effects, such as toxicity, environmental pollution, or use hazards. There are three main kinds of traditional biological control:

1. The introduction of exotic species of parasites, predators and pathogens.

2. Conservation of parasites and predators.

3. Augmentation of parasites and predators.

The use of insect pathogens, such as fungi, bacteria, and viruses, is another one of the techniques employed in the biological control of insects.

From the practical standpoint, it should be noted that natural enemies should be able to play a role in most crop ecosystems. One factor which may impede their effectiveness is climate. This is particularly true in Wyoming. Other reasons their activity may be inhibited include environmental factors such as dust, competitors, drift of pesticides from adjoining agriculture, or necessary pesticide use within the crop.

Biological controls are not suitable in many pest situations. It takes time for the parasites and/or predators to reproduce sufficiently to bring the pest under control. A farmer often feels that he cannot wait for the natural enemy to do the job; he needs a marketable crop each year. Other technical difficulties involve such items as determination of which parasites or predators to introduce, whether to use more than one parasitic species at a time, how to eliminate secondary parasites that prey on the beneficial form, and whether a program of continuous liberations may be feasible. Then there is always the problem of protecting such predators and/or parasites from insecticides.

B. Mechanical control is the reduction of insect populations by means of devices which affect them directly or which alter their physical environment radically. These methods are often hard to distinguish from cultural methods. However, mechanical controls involve special physical measures rather than normal farm practices. They tend to require considerable time and labor and often are impractical on a large scale.

Hand picking, shingling, and trapping are familiar mechanical methods of insect control. Screens, barriers, sticky bands, and shading devices represent other mechanical methods; while hopper-dozers and drags are specialized equipment for collecting or smashing pests.

C. Legal control is the lawful regulation of areas to eradicate, prevent, or control infestation or reduce damage by insects. This involves mainly the use of quarantines and pest control procedures. Federal and state officials often work with legally established local, community, or county districts, as in grasshopper control projects.

D. Cultural control is the reduction of insect populations by the utilization of agricultural practices. It has also been defined as "making environments unfavorable for pests". The method more or less associated with agricultural production usually involves certain changes in normal farming practices rather than the addition of special procedures.

Knowledge of the life history or bionomics of a pest species is essential to the effective use of cultural control methods. The principle of the "weakest link" or most vulnerable part of the life cycle usually applies. The environment is changed by altering farming practices at the correct time so as to kill the pests or to slow down their multiplication. In this way, the method is aimed more at prevention than at cure.

Since cultural methods are usually economical, they are especially useful against pests of low-unit-value crops. Such methods are particularly applicable to field crops.

Several types of cultural control practices are:

1. Rotation. Certain kinds of crop rotations may aid in the control of pests. Insects which are reduced effectively by rotations usually have a long life cycle and a limited host range and are relatively immobile in some stage of their development. Changing crops in a rotation system isolates such pests from their food supply. Wireworms, white grubs, and corn rootworms are good examples.

2. Location. Careful choice of crops to be planted adjacent to each other may help reduce insect damage.

3. Trap Crop. Small plantings of susceptible or preferred crop may be established near a major crop to act as a "trap". After the pest insect has been attracted to the trap crop, it is usually treated with insecticides, plowed under, or both.

4. Tillage. The use of tillage operations to reduce populations of soil-inhabiting insects may work in several ways; change physical condition of soil, bury a stage of the pest, expose a stage of the pest, mechanically damage some stage of the insect, eliminate host plants of the pest, and hasten growth or increase vigor of the crop.

5. Clean Culture. Removal of crop residues, disposal of volunteer plants, and burning of chaff stacks are measures commonly applied against vegetable and field crop insects.

6. Timing. Changes in planting time or harvesting time are used to keep the infesting stage of a pest separated from the susceptible stage of the host.

7. Resistant Plant Varieties. The sources of resistance to insects in crops have been classified as non-preference, antibiosis, and tolerance. Insect preference for a certain host plant is related to color, light reflection, physical structure of the surface, and chemical stimuli such as taste and odor.

   Antibiosis is defined as an adverse effect of the plant upon the insect. This may be caused either by the deleterious effect of a specific chemical or by the last of a specific nutrient requirement.

   Tolerance is the term applied to the general vigor of certain plants which may be able to withstand the attack of pests as sucking insects.

Tolerance also includes the ability to repair tissues and recover from an attack.

Advantages of the use of resistant varieties include a cumulative and persistent effect which often eliminates pest damage within a few seasons, lack of dangers to man and domestic animals, low cost (once the program is established), and utility in integrated control systems.

E. Reproductive control is the reduction of insect populations by means of physical treatments or substances which cause sterility, alter sexual behavior, or otherwise disrupt the normal reproduction of insects.

F. Chemical control is the reduction of insect populations or prevention of insect injury by the use of materials to poison them, attract them to other devices, or repel them from specified areas.

Chemicals are still our first line of defense in the management of most pests, despite adverse publicity. They are highly effective and economical, and can be applied quickly to have an immediate impact on a pest populations. When pest populations approach economic levels, and natural controls are inadequate, pesticide applications are the only hope to save a crop so that it can be marketed. It seems clear that pesticides must and will continue to be used in a major way in integrated pest management.

Pesticides are at this point in time, essential for:

1. The maintainence of adequate crop protection

2. The protection of forest resources

3. The preservation of man's health and well being.

One of the advantages of the use of insecticides in many crop ecosystems is that more than one major pest may be controlled with a single application.

The judicious use of chemical pesticides is a critical part of pest population management. Chemical pesticides are especially important as short-term pest management tools. The important consideration is that pesticides be used when possible in a manner that is harmonious with other elements of the agro-ecosystem and augmenting other control agents.

Insecticides do have certain well known limitations which can be briefly listed as follows:

1. Development in many cases of strains of pests that are resistant to pesticides.

2. Only temporary control effects on pest populations, often necessitating repeated treatment.

3. Presence of residues of the pesticide in the harvested crop.

4. Outbreaks of unleashed secondary pests, resulting from the destruction of their natural enemies.

5. Undesirable side effects on non-target organisms, included a) parasites and predators; b) fish, birds and other wildlife; c) honey bees and other necessary pollinators; d) man and his domestic animals, and e) the crop plant.

6. Direct hazards in the application of certain insecticides.

7. Reduction and simplification of the arthropod component of the agro-ecosystem.

The various specific hazards, as well as different formulations of insecticides and types of equipment to apply them are covered elsewhere in this manual or guide book.

G. Integrated control is the management of insect populations by the utilization of all suitable techniques in a compatible manner so that damage is kept below economic levels. It is an ecological approach that not only avoids economic damage but also minimizes adverse effects. Principal considerations of the integrated approach to pest management are the agro-ecosystem, the economic threshold, and the least disruptive program.

SECTION IV - Major Field Crop Pests

In the remainder of this section, the identification, life history, damage, pesticides, pesticide use and environmental considerations are presented for only the major insect or arthropod pests of corn, alfalfa, beans, small grains, sugar beets, and potatoes.

Specific insecticide control recommendation on the various insecticides, formulations and rates for all insect pests of field crops are covered in the Wyoming Agricultural Extension Service Bulletin 543R entitled "Control of Field Crop Insects".

A. Major Pests of Corn

1. Corn Rootworms

a. Identification (see color illustrations Picture sheets No. 4 & 5 in the appendix)

Larvae slender white or pale yellow, 3/10 to 4/10 inch long.
Pupa white and fragile.
Adults (beetles):

Western -1/6-1/4 inch long, yellowish green with three dark stripes or a large dark area on hard wing covers.

Northern - 1/6 to 1/4 inch long, uniform green to yellowish green in color.

Southern - slightly larger than above; yellowish green with all black spots on back.

b. Life History
Western and northern - overwinter as eggs in the soil. One generation per year. Southern over-winters as adults - may have two or more generations per year.

c. Damage
Larvae feed on roots; prune roots, cause lodging. Adults feed on leaves, tassels and silts - may interfere with pollination.

d. Pesticides
Primarily organophosphorus and carbamate. Some fairly toxic - mostly short residual almost entirely granular formulations.

e. Pesticide Use
Should not be used on first year corn nor when rotating crops. When necessary should be used only as granules applied in a 6-7 inch bank over the row preferably at planting time or in some cases as a cultivation (lay-by) treatment.

f. Environment
Granules, if in contact with seed, may cause some phytoxicity. Slightly lighter dosages may suffice in light sandy soil. Heavy soils or soils with high organic matter of pH may require higher rates. Moisture is necessary to activate granules. Non-target organisms are not a problem. Do not apply spray for adult control unless pollination is threatened.

2. Mites (especially Bank's grass mite)

a. Identification
Minute, whitish, eight-legged, varying sizes up to 1/60 inch long.

b. Life History
Usually overwinter as adults in debris. Several generations per year.

c. Damage
Primarily from sucking sap, destroying chlorophyll and causing leaves to dry up and die. Usually start at lower leaves and move progressively upward.

d. Pesticides
Systemic insecticides applied as granules in the whorl or phosphates as foliar sprays.

e. Pesticide Use
Should not be used routinely. Watch for signs of infestation. Non-economic if only on the lower set of leaves. Because of height of corn, chemicals may have to be applied by airplane.

f. Environment
Mite build up is usually associated with hot, dry conditions. Same conditions may decrease efficiency of chemicals. To avoid drift from wind and evaporation, may be best to apply mornings and evenings. Some probability of hitting such non-target insects as lady bird beetles or lace-wings, especially with non-systemic materials.

B. Major Pests of Alfalfa

1. Alfalfa Weevil

a. Identification (see color illustrations Picture Sheet No. 8 in appendix). Larva is yellow (about 1 mm long) with shiny black head when first hatched. Full grown larva is legless, about 3/8 inch long, and green with a brown head and a white stripe down middle of back.

Pupae are tan and encased in small flimsy lace-like cocoons. Adults about 3/16 inch long, light brown with a broad, dark brown strip extending from front of the head posteriorly along middle of the back approximately 2/3 to 3/4 length of body. Older weevils are gray or brownish black.

b. Life History
Overwinter mostly as adults. Eggs laid in spring in alfalfa stems. Larvae hatch. Usually one generation per year with considerable overlapping in stages.

c. Damage
Larvae feed on foliage, especially terminal leaf buds. Skelentonize leaves giving grayish or frosted appearance. Stunts plants and reduced yield and quality.

d. Pesticides
Mostly phosphates and carbamates applied as sprays. Some fairly toxic to man and beneficial insects.

e. Pesticide Use
Should not be used routinely. If damage occurs within 10 days of harvest, should harvest early. Use resistant varieties of alfalfa where possible and avoid use of pesticides. If necessary, apply early morning or evening. Carefully observe waiting periods.

f. Environment
Apply chemicals during favorable climatic conditions. Check for beneficial insects such as predators, parasites and various kinds of pollinators. If these are abundant, try to avoid use of insecticides.

2. Pea Aphids

a. Identification (see color illustration Picture Shee No. 8 in appendix). Small green, long-legged, either winged or wingless soft bodied insects no larger than 1/6 inch long.

b. Life History
Overwinter as eggs or female adults on alfalfa or clovers. In spring migrants spread to peas and other plants as well. Winged females give birth to active young nymphs. May be many generations per year. In fall, males and females appear. Mating and egg laying takes place. Most of them overwinter as eggs.

c. Damage
Suck the sap and possibly also poison the plant. May cause wilting and reduction of quantity and quality of hay on either first or second cutting of alfalfa.

d. Pesticides
Primarily organophosphorus insecticides, some systemic, some non-systemic, applied as sprays. Mostly short residual or none, but waiting periods must be followed where they exist.

e. Pesticide Use
Use only if aphids are numerous. Early harvest or use of resistant varieties may eliminate use of insecticides.

f. Environment
Apply preferably in morning or evening but not if temperatures are below 50^{o}F. Such timing is less detrimental to beneficial non-target insects as predators, parasites and pollinators. Systemic insecticides are more selective against the target insect.

3. Lygus Bugs

a. Identification
Adults about 1/4 inch long, have four wings that lie more or less flat over the back, and are marked by a distinct "V" on the back just in front of the wings. Color may be light green, various shades of brown, or almost black. Nymphs have black spots of various sizes and numbers on their backs.

b. Life History
Eggs, nymphs and adults. Overwinter as hibernating adults; mate in spring; females lay eggs in alfalfa stems. Two to five generations a year.

c. Damage
Forage production and quality of hay are affected. Most serious damage is in seed production. Cause buds to die, flowers to drop, immature seeds to shrivel, become discolored and fail to germinate when planted.

d. Pesticides
Mostly short residual, slight to moderate human toxicity, organophosphorus insecticides, including some systemics. Also the carbamate carbaryl. All are non-persistent.

e. Pesticide Use
For forage, may cut a little early and avoid use of insecticides. If heavy infestations, apply insecticides in bud sage of growth. For alfalfa seed production, time application with bud stage or early bloom to kill newly hatching nymphs.

f. Environment
Major concern here are the non-target organisms. These include parasitic wasps and flies, predators such as lady bird beetles, lacewings, damsel buds, bigeyed bugs and pirate bugs as well as pollinators such as alkali bee, leafcutter bees, bumble bees, and honey beets. Use chemicals only as necessary. Contemplate using a plant systemic insecticide or something like trichlorfon which is relatively non-toxic to most beneficial insects. Morning or evening applications are less

detrimental to beneficial insects but temperature should be above 50°F. Waiting periods between last application and harvest should be carefully observed.

C. Major Pests of Beans

1. Mexican Bean Beetle

a. Identification (see color illustration Picture Sheet No. 9 in appendix). Adults are strongly convex beetles about 1/4 inch long. The wing covers (elytra) are usually copper red in color and are conspicuously marked with 16 black spots arranged in 3 rows over the back. Larvae are yellow and covered with dark, branched spines, fully grown they are about 1/4 inch long.

b. Life History
Overwinter as hibernating adults (beetles) in litter, trash or other protected areas. Females fly to bean fields in spring to deposit eggs after plants are up. Usually one generation per year in this area.

c. Damage
Both larvae and adults chew off portions of the bean leaf, masticate it, and suck the plant juices. Usually feed from the under surface of the leaves. As leaf tissue drys, the unbroken upper membrane tears apart.

d. Pesticides
Numerous organophosphate materials have label approval, some systemic and some non-systemic. Even the chlorinated hydrocarbon methoxychlor can be used. Carbaryl (a carbamate) may be used.

e. Pesticide Use
This pest is difficult to control primarily because both larvae and adults live and feed on the undersides of bean leaves where it is difficult to apply insecticides. Thorough coverage of the plants with spray increases efficiency of insecticides applied.

f. Environment
A community control program is advisable. It is wise to burn or otherwise destroy all crop residue soon after beans have been picked. Plowing under refuse at least six inches deep destroys all stages of the beetle. Beans planted three to four inches apart produce less foliage, are easier to treat and as a general rule are not as heavily infested. Some resistant varieties have been developed. Non-target predators and parasites such as the tachinid fly and a small parasitic wasp are not a factor in Wyoming.

D. Major Pests of Small Grains (esp. wheat)

1. Grasshoppers

a. Identification (see color illustration Picture Sheet No. 7 in appendix). There are several species of grasshoppers which attack small grains. These include the migratory grasshopper, the differential grasshopper and the two-striped grasshopper.

b. Life History
In general most species overwinter in the egg stage as egg pods in the soil. Eggs hatch into nymphs and nymphs develop into adults. Most species have one generation per year.

c. Damage
Grasshoppers relish small grains and injury usually consists of defoliation or destruction of the plant. This may involve feeding on leaves or biting through the stems of small grains, severing the heads, feeding on ripening kernels and thereby causing extensive shattering.

d. Pesticides
A few chlorinated hydrocarbons but mostly carbamate and organophosphorus insecticides (mostly non-systemic) are used applied mostly as sprays. A few are available in bait formulation. Malathion ULV at 8 fl. oz. per acre applied by air has been economical and successful.

e. Pesticide Use
All insecticides should be applied early while hoppers are young and usually concentrated breeding or hatching areas. Insecticides are most effective as broadcast sprays with low gallonage sprayers. Granules of certain systemics may be applied in the furrow at planting time to protect seedlings.

f. Environment
There are many natural enemies such as predators and parasites of grasshoppers. There are robber flies, wasps, spiders, rodents, birds, tachinid flies, flesh flies, bee flies, blister beetles, and ground beetles. Cultural methods include 1) elimination of weeds, 2) planting resistant crops, 3) tilling land infested with eggs, and 4) timing of seeding. Limited use insecticide such as treating field margin or

only a few swaths at edge of field save money and cause less pollution.

2. Pale Western Cutworm

   a. Identification
   The larva is grayish, unmarked by spots or stripes; the skin has fine, flat, pavement-like granules. Adult is a gray medium sized moth or "miller".

   b. Life History
   Eggs are laid in soil in the fall and overwinter as eggs. Hatch in late winter or very early spring, sometimes while there's still snow on the ground. Larvae feed along drill row, mostly underground. Inactive in June and July, pupate in August and adults are out in September. One generation per year.

   c. Damage
   Larvae feed in crowns and on underground portions of the wheat plants. Causes pruning of plants, some loss of stand and stunted and unthrifty plants.

3. Wheat Curl Mite

   a. Identification
   Very small eriophyrid mite, white, spindle-shaped with only four legs near the anterior end of the body. Mites are so small they are barely visible magnified 10 times.

   b. Life History
   Reproduces parthenogenetically (without the necessity of males). Overwinter on grasses or volunteer wheat.

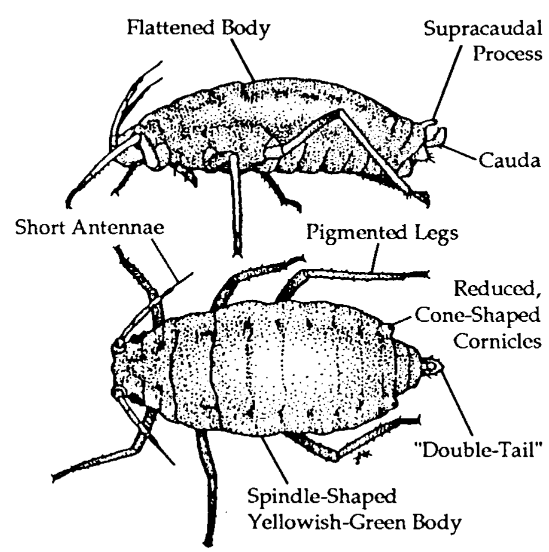
   c. Damage
   Some damage from sucking sap but major damage because mites are vectors of the virus causing wheat streak mosaic.

   d. Pesticides
   See B-543R Control of Field Crop Insects.

   e. Environment
   Hail belt areas are in greatest need of protection from wheat curl mites and wheat streak mosaic. Controlling volunteer wheat will help. Late planting may also be of some help. Formulation, and method of application do not present a hazard to non-target organisms.

4. Russian Wheat Aphid (RWA)

   a. Identification (see drawing). Small, light-green aphid with an elongated , soft spindle-shaped body of about 1/6 inch. It has a short antennae and may be distinguished by the absence of cornicles and has a double or forked tail.



Russian Wheat Aphid Identification Characteristics
Apterous Viviparous Female

Illustration courtesy of the University of Nebraska

   b. Life History
   Aphids reproduce either by laying eggs or by giving live birth to several young each day. The aphid can overwinter as an immature or as an adult in many different grasses. Winged forms occur when the host plant condition declines. Winged forms also occur when RWA are migrating which may occur from early Spring to late summer. When wheat and barley crops mature, RWA will move to later-maturing oats and grasses.

   c. Damage
   RWA inject a toxic saliva into the plant and then will suck plant sap. Most feeding occurs on new growth of the leaf, causing the edges to curl inward. The first sign of damage is a discolored plant with tightly curled leaves and long, white streaks. Tillers may have a purplish or reddish color. Heavily infested plants can become prostrate or flattened. Damage after heading will appear as twisted or distorted heads caused by the head being trapped in the tightly curled leaf.

d. Control

Control is difficult due to the aphid being protected by the curled leaf. Systemic sprays seem to be the better pesticide. Cultural control can be beneficial. Delayed fall planting can help reduce RWA populations. Like most insect pests, RWA prefer stressed plants. Preference of pesticide use should be checked each year due to RWA resistance to some pesticides. Biological control research and work on resistant plant varieties are under way at many research stations.

E. Major pests of Sugar Beets

1. Sugar beet Root Maggot

a. Identification

The adult fly is about 3/8 inch long with a shiny black body and brown legs. The wings are clear except for a very small area at the base of the wings.

b. Life History

Over winters as a larva (maggot) in soil. In March and April maggots move upward within one to two inches of soil surface and pupate. Adult flies emerge in May, mate and females deposit eggs around base of sugar beet plant. Eggs hatch into maggots which remain all summer and the following fall and winter. One generation per year.

c. Damage

Larvae (maggots) attack small beet plants causing seedling death and loss of stand. Plants surviving are often severely dwarfed and stunted, and may show secondary rot infections. Yields are reduced.

d. Pesticides

Systemic and non-systemic organophosphates and carbamates are used to control the maggots. None are persistent but some have high mammalian toxicity. Residues are no problem if label instructions are followed.

e. Pesticide Use

All insecticides should be directed only toward larval or maggot control. Hence they should be applied to the soil as a 4-6 inch band over the row behind the planter shoe but ahead of the press wheel at planting time. Only granular formulations should be used. Granules should not be in direct contact with the seed. Light incorporation of granules into the soil is desirable. Granules must have moisture to become activated.

f. Environment

Greatest violation resulting in contamination of the environment results from a common misuse of insecticides. Such misuse includes the wide-scale indiscriminate use of highly hazardous insecticides like parathion applied aerially for control of adults (flies). Control measures should not be directed toward flies but rather towards the larvae. By carefully placing a lesser amount strategically over the row, more efficient control is obtained at a lower cost and with far less pollution.

2. Beet Leafhopper

a. Identification

The adult, nearly 1/4 inch long, is slender and tapers posteriorly with the widest point of the body just behind the metathorax. Color varies from gray to greenish yellow. Darker individuals have blackish or brownish markings on the front wings, head, and thorax. Older nymphs are usually spotted with red and brown.

b. Life History

Overwinter as adults in waste areas in the Big Horn Basin. Some additional ones may migrate in from the south or southwest in the late spring or summer. Winter and early spring populations are found in various species of wild mustards, Russian thistle and other weed hosts. Eggs hatch and nymphs feed on weed hosts or move into beet fields. One or more generations per year.

c. Damage

Major damage is mostly to sugar beets. Sucking sap is of lesser importance than being a vector of the virus causing the disease curly top in sugar beets. Early symptoms are a clearing of the veins and inward rolling on the margins of young leaves. Then curling of the leaves progresses, veins swell and papillae develop on the underside of leaves. Leaves become dull, dark green, distorted, thick, and brittle. Hairy or woolly lateral rootlets, discoloration of alternate concentric circles, general stunting and often death result.

d. Pesticides

See B-543R Control of Field Crop Insects.

e. Pesticide Use

If used early in over wintering areas, use of insecticides on a large scale basis treating entire beet field can be avoided.

f. Environment
Adequate soil moisture is necessary to activate the granules. They should be applied only to the soil as a band in order to increase efficiency and decrease costs and possible pollution. No aerial application of insecticides for adult control throughout beet fields will be necessary.

F. Major Pests of Potatoes

1. Potato Psyllid

a. Identification
Tiny scale-like flat nymphs, margined with white fringe. Sometimes called jumping plant lice. Vaguely resemble aphids to the layman.

b. Life History
Overwinter as eggs. May be several generations per year.

c. Damage
Nymphs suck sap from shaded parts of foliage, producing rolled or cupped, yellow or reddish leaves ("psyllid yellows"), killing or stunting the plants, and causing tiny malformed unmarketable potatoes.

d. Pesticides
Short residual systemic and non-systemic phosphorus insecticides. Some are available as granules, other as liquids (E.C.) or wettable powders (WP).

e. Pesticide Use
Systemic granular insecticides should be applied in bands both sides of the row at planting time. Approved chemicals in the EC or WP formulations should be applied as a foliar application. Some insecticides may need two more applications at two week intervals.

f. Environment
Should be used exactly as stated on the label. Soil application of systemic insecticides will be less detrimental to beneficial and other non-target organisms.

2. Colorado Potato Beetle

a. Identification (see color illustration Picture Sheet No. 9 in appendix). The adults may be recognized by the alternate black and yellow stripes that run lengthwise of the wing covers, five of each color on each wing cover. They are about 3/8 inch long by 1/4 inch wide and very convex above. The young larvae are small, humpbacked and reddish. The largest full-grown larvae are as much as 1/2 inch long, the back arched in almost a semi-circle, with a swollen head and two rows of black spots on each side of the body.

b. Life History
Overwinters as an adult buried in soil and debris. Eggs are laid in the spring, hatch, and larvae feed on potato plant foliage. Larvae may become full grown in one or two weeks. One to two generations per year.

c. Damage
Both adults and larvae have chewing mouthparts. They are voracious feeders, feeding on leaves and often completely consuming the leaves.

d. Pesticides
Carbamate, organophosphorus and one chlorinated hydrocarbon insecticide (methoxychlor) are approved and recommended. Most are not too toxic or persistent. With proper usage there should be no residue problem.

e. Pesticide Use
Systemics should be applied as a side dress at planting time. Others may be applied as foliar application, preferably shortly after eggs hatch. A second application might be necessary.

f. Environment
The more dense the foliage, the higher the volume of spray in gallons per acre should be. Non-target organisms are not too likely to be involved in potato fields in Wyoming, at least not of any consequence.

3. Potato Flea Beetle

a. Identification (see color illustration Picture Sheet No. 9 in appendix). Adults are small beetles, about 1/16 inch long and nearly a uniform black in color. They have enlarged hind legs and jump vigorously when disturbed. The larvae are mostly whitish, slender, delicate, cylindrical worms from 1/8 to 1/3 inch long, with tiny legs and brownish heads.

b. Life History
Usually overwinter in the adult stage, hibernating under leaves, grass, or trash about field margins, ditch banks, fence rows or

margins of woods. One or two generations per year.

c. Damage
Foliage may be eaten badly enough to cause plants to die. Cause very small, rounded or irregular holes eaten through or into the leaf, so leaves look like they've been peppered with fine shot. These holes provide openings for disease organisms. The potato flea beetle spreads early potato blight.

d. Pesticides
Carbamates and systemic or non-systemic organophosphorus insecticides. Systemics may be applied as granules.

e. Pesticide Use
Systemic granular disulfoton or phorate should be applied banded on each side of the row at planting time. Most other insecticides are applied as foliar application.

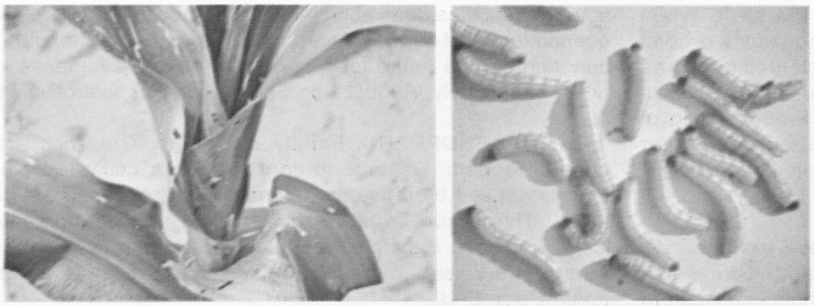
f. Environment
If carefully applied according to label, there should be no detrimental effects on the environment.

APPENDIX

PICTURE SHEET NO. 4 - Corn Insects Above Ground
PICTURE SHEET NO. 5 - Corn Insects Below Ground
PICTURE SHEET NO. 7 - Common Small Grain Insects
PICTURE SHEET NO. 8 - Common Forage Legume Insects
PICTURE SHEET NO. 9 - Common Vegetable Insects

CORN INSECTS—ABOVE GROUND

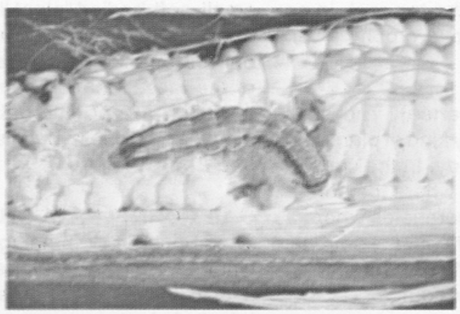
For safe and effective use of insecticides, always identify the problem correctly.



1. European corn borer (early leaf feeding and mature borers)

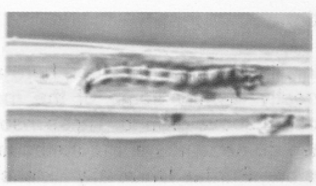
8. Grasshopper

2. Southwestern corn borer

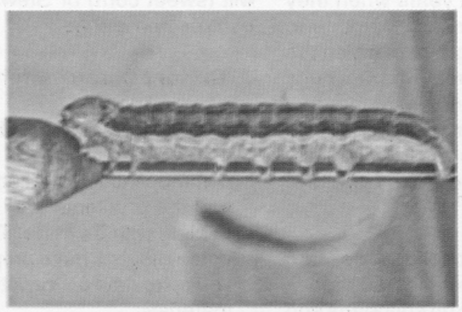


5. Corn earworm

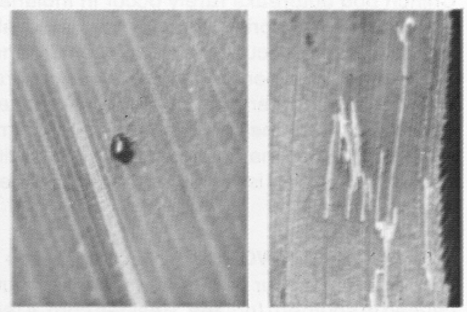
9. Corn leaf aphid



3. Common stalk borer

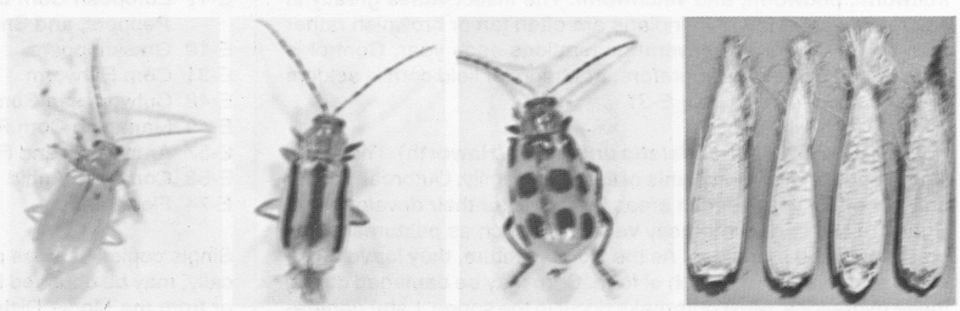


6. Armyworm



10. Corn flea beetle and damage

4. Chinch bug



7. Corn rootworm beetles (left to right: Northern, Western and Southern) These beetles clip silks causing poor pollination shown at far right.

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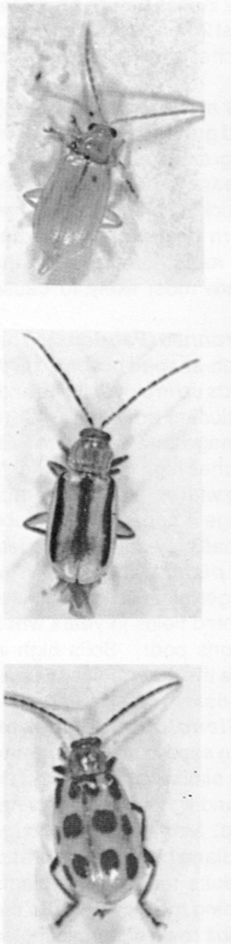
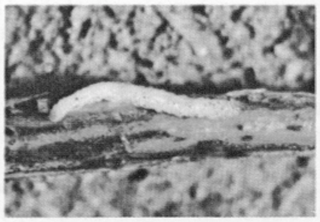
CORN INSECTS—BELOW GROUND

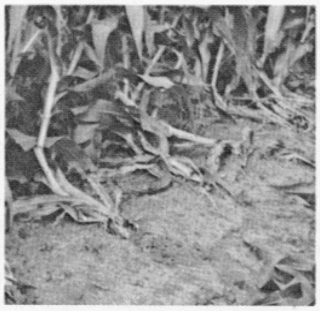
For safe and effective use of insecticides, always identify the problem correctly.



1. Corn rootworm adults (top-bottom: Northern, Western and Southern)



2. Corn rootworm larva

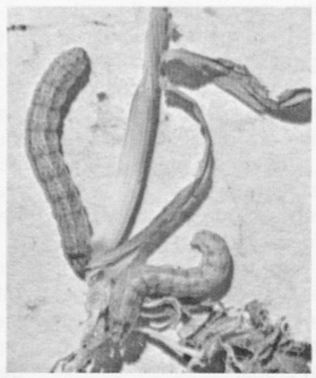


3. "Goose-neck" symptoms of corn rootworm infestation

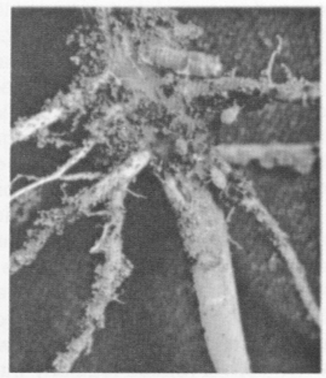
4. Corn rootworm damage

5. Wireworm

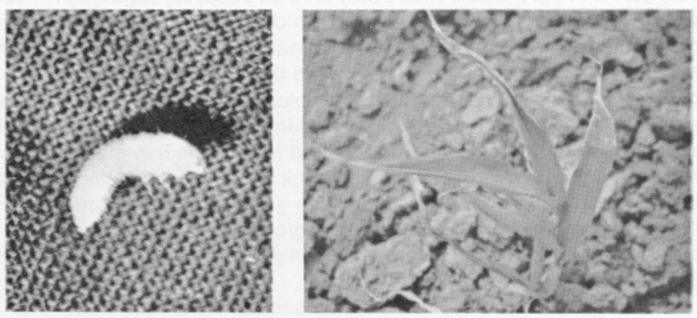
6. White grub



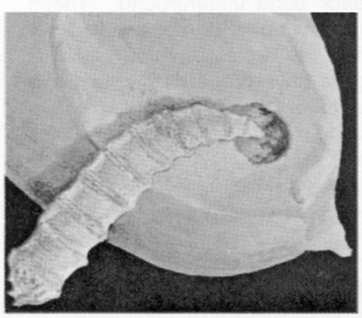
7. Black cutworm



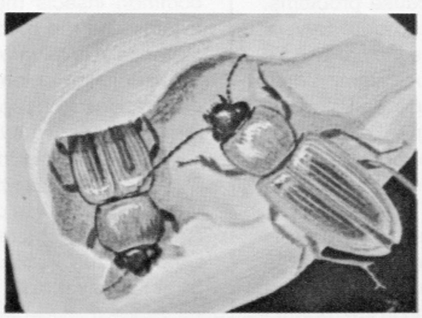
8. Corn root aphid



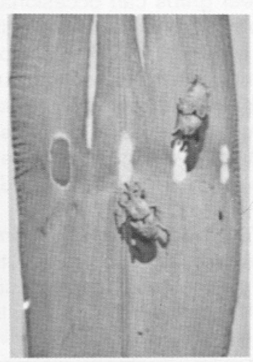
9. Grape colaspis and damage



10. Seedcorn maggot



11. Seedcorn beetle



12. Billbug (feeds on seedling corn plants below ground; holes in lower leaves of larger corn are evidence of this earlier feeding)

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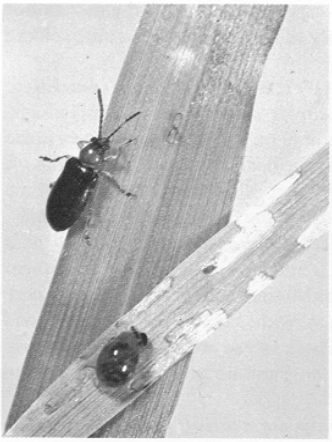
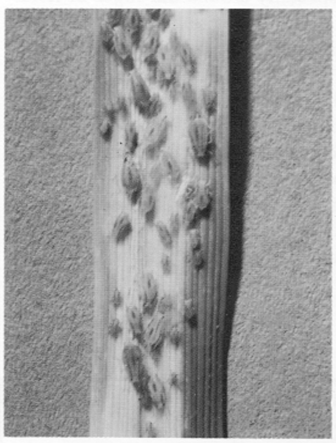
Picture Sheet No. 7

COMMON SMALL GRAIN INSECTS

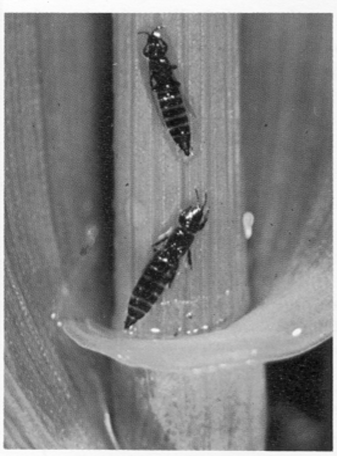
For safe and effective use of insecticides, always identify the problem correctly.



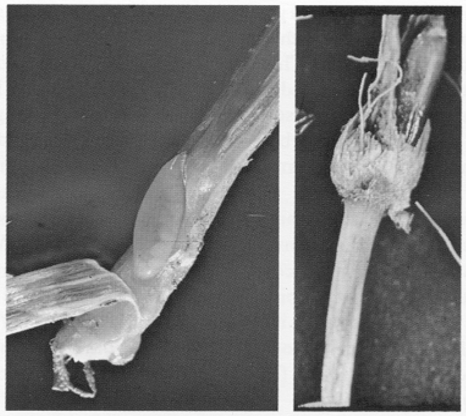
1. Cereal leaf beetle adult, eggs, larva, and damage



2. Greenbug and damage

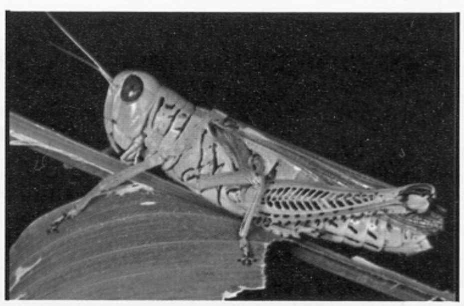


3. Thrips (greatly enlarged)

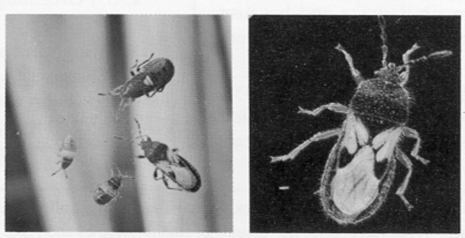


4. Hessian fly larva, and puparium showing location behind lower leaf sheaths

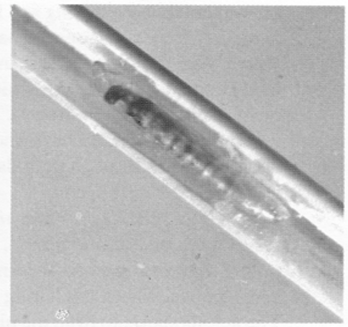
5. Armyworm



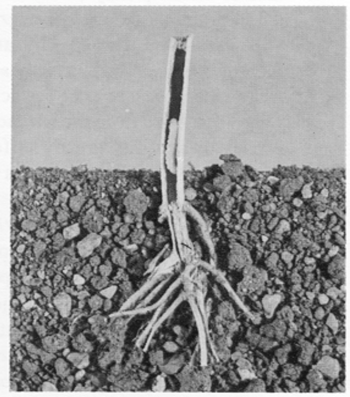
6. Grasshopper



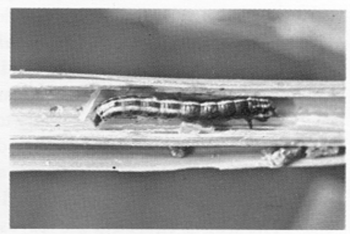
7. Chinch bug nymphs and adult, and adult greatly enlarged



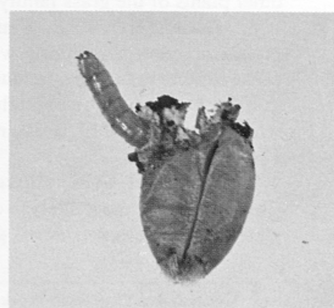
8. Wheat stem maggot



9. Wheat stem sawfly



10. Common stalk borer



11. Wireworm and damage to seed

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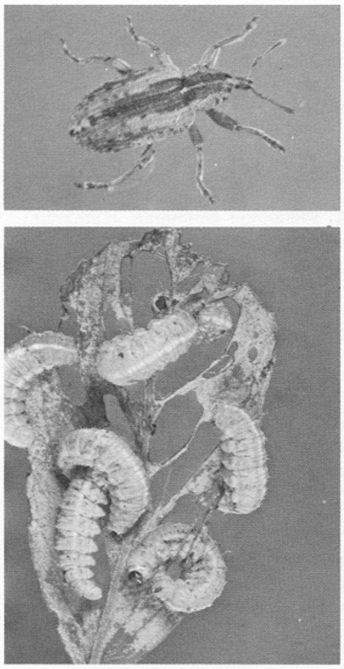
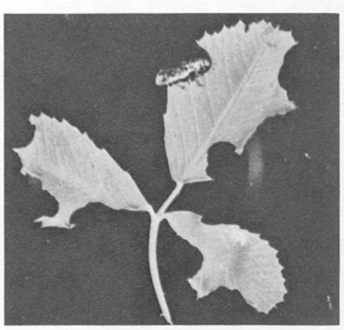
COMMON FORAGE LEGUME INSECTS

For safe and effective use of insecticides, always identify the problem correctly.

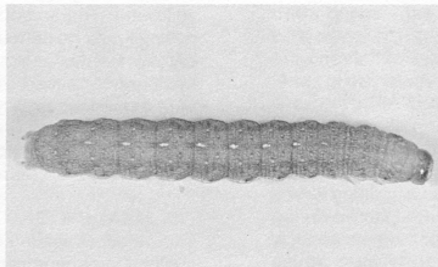


1. Alfalfa weevil adult, and larvae and damage

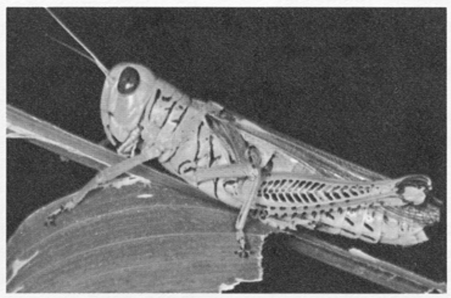
2. Clover leaf weevil larva



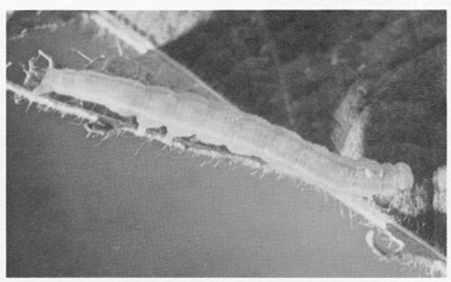
3. Sweetclover weevil and typical damage



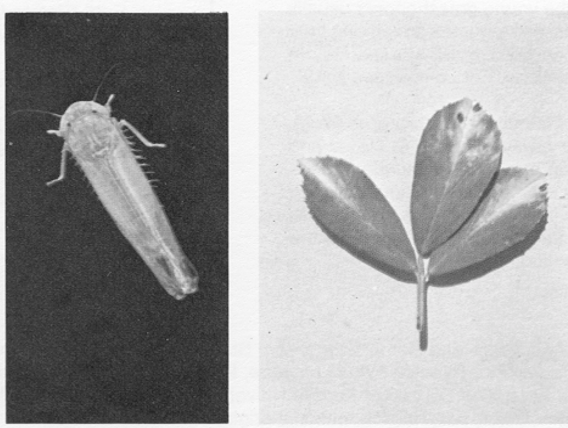
4. Varigated cutworm



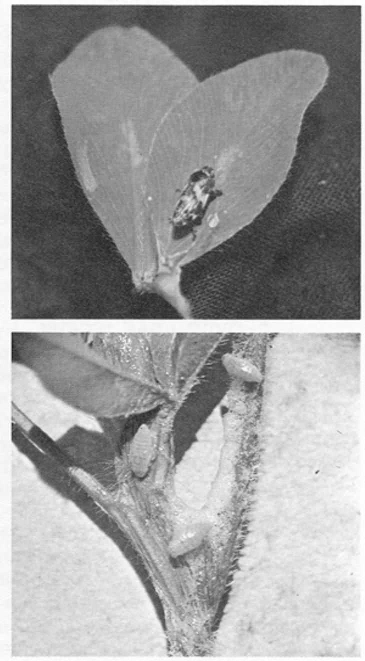
5. Grasshopper



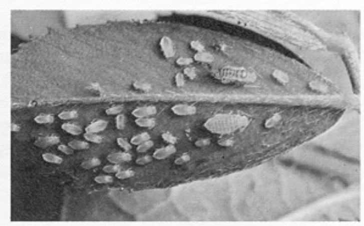
6. Green cloverworm



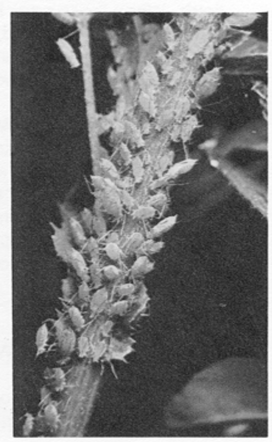
7. Potato leafhopper (greatly enlarged) and leafhopper damage to alfalfa



8. Meadow spittlebug and nymphs



9. Spotted alfalfa aphid



10. Pea aphid

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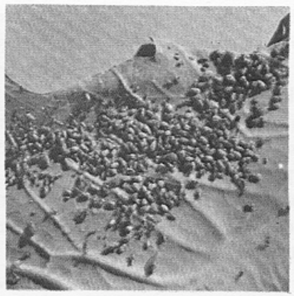
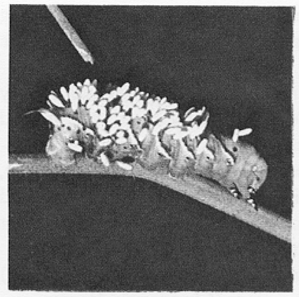
COMMON VEGETABLE INSECTS

For safe and effective use of insecticides, always identify the problem correctly.

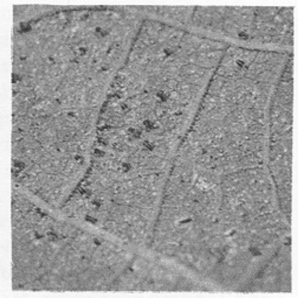
1. Cabbage looper (light green) and imported cabbageworm (dark green)



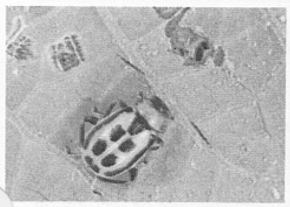
2. Cabbage aphid. Other species damage many crops.



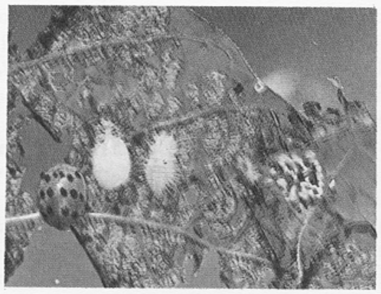
3. Hornworm showing cocoons of parasite on back



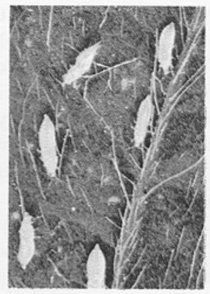
4. Two-spotted spider mite (enlarged). Not an insect.



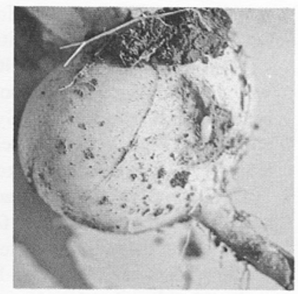
5. Bean leaf beetle



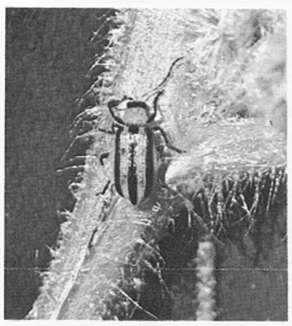
6. Mexican bean beetle adult, pupa, larvae, eggs, and damage



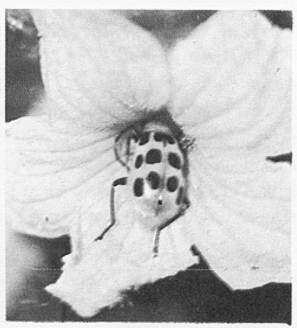
7. Thrips (enlarged)



8. Root maggot and damage

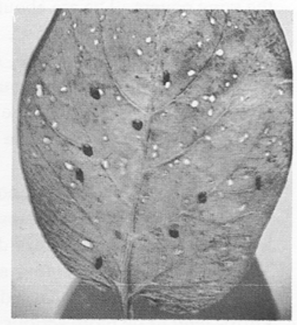


9. Striped cucumber beetle

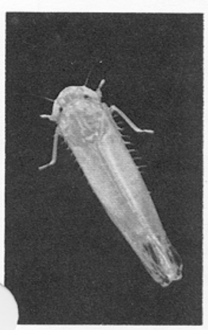


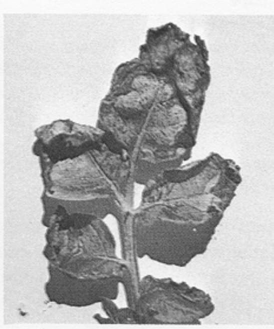
10. Spotted cucumber beetle

11. Colorado potato beetle larvae and adults



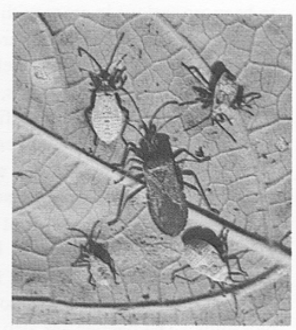
12. Potato flea beetle and damage





13. Potato leafhopper (greatly enlarged) and leafhopper damage

14. Squash vine borer and damage



15. Squash bug nymphs and adult

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