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Idaho Potato Insect Handbook

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Only those insects of major importance to Idaho's potato production are discussed in this bulletin. They are grouped into those insects that eat the potato foliage, those that suck sap from the leaves and stems, and those affecting the under ground portions of the plant.

Methods to control these potato insect pests are given in **INSECTICIDES FOR CONTROLLING POTATO INSECTS**. This publication is available at all Idaho County Agent offices.

ABOUT THE AUTHORS

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Idaho Potato Insect Handbook

Roland W. Portman and H. C. Manis

Many different insects feed on potatoes. The feeding damage by these insects must be prevented for high quality potato production. In Idaho about two dozen different insects attack potato foliage and tubers. In other potato-producing areas of the United States over 120 different insects may attack potatoes. The severity of the attack depends largely upon the insect, the type of feeding damage, and the acreage involved.

Most potato insect problems can be corrected by the proper use of available control methods. To evaluate an insect infestation and its potential for economic loss, the insect must be properly identified and the feeding damage correlated with the plant development. Field experience is invaluable when determining control procedures.

This publication is a guide for use in identifying the insect responsible for the feeding damage. The description of the insect and its activities will assist in evaluating the problem and will aid in the proper selection and use of control methods.

Insects damage potato foliage by eating holes into the leaves, by defoliating plants, by removing plant sap, by mechanically carrying disease to the plant, and by injecting disease organisms into the plant. They damage the underground portions of the plant by engraving the surface, by eating or by boring into the tubers and roots. These tuber injuries may be invaded by diseases.

Infestations of Colorado potato beetle, green peach aphid, and wireworms may occur state-wide each year. They are major pests. Unless their attack is prevented or they are adequately controlled, they can do extensive damage.

Garden symphylan, leather jacket, Western potato flea beetle, thrips, two-spotted spider mite and white grubs can also reduce quality and yield. Where these insects occur they are also major pests. Occasionally the alfalfa looper, blister beetles, cutworms, false chinch bug, Intermountain potato leafhopper, lygus bugs, long-horned beetle, millipedes, slugs, seed-corn maggot and tomato hornworm will attack potatoes. Generally the attack by these insects is not extensive. (For convenience, garden symphylan, millipedes, slugs and two-spotted spider mite are referred to here as insects.)

Most insects grow in two ways. Lygus bugs, aphids, thrips and leafhoppers hatch from an egg into a form similar to the adult but smaller in size; they grow by shedding their outer skin. Maturity is reached when functional wings have developed. This type of growth is known as incomplete metamorphosis. The immature form is referred to as a nymph.

Flies, beetles and cutworms develop by complete metamorphosis. The eggs hatch into worm-like larvae which grow by shedding their outer skin. Larvae are given different names. For example, the larvae of flies are called maggots, those of the 10-lined June beetle and carrot beetle are called white grubs, those of click beetles, wireworms, those of moths are known as cutworms or caterpillars, and the larvae of craneflies are called leather jackets. When mature the larvae become non-moving or non-eating forms called pupae. This is a transformation stage where the worm-like shape is lost and the insects become adults; usually with functional wings. Using the terms and approved names by which insects are known will help in identifying insects, in reporting or discussing insect activities and in evaluating insect populations.

A Field Guide to Potato Insects

A. Insects that eat holes into leaves or defoliate the plants.

1. Small to 4-inch long greenish or brownish caterpillars that are feeding on foliage.

Alfalfa looper (see D-1)^o

Cutworms (see D-4)

Tomato hornworm (see D-6)

2. Elongate beetles, from 1/2 to over 1 inch long, nearly parallel-sided, not very hard, active, long-legged. These insects can be either black, gray, gray with black spots or stripes, green or purplish-blue. They swarm upon the plants and eat the leaves.

Blister beetles (see D-2)

3. Very convex, nearly hemispherical beetles, about 3/8 inch long, yellow in color, with black spots on the thorax and 5 black stripes and 5 yellow stripes on each wing cover; and brick-red hump-backed soft-bodied larvae of various sizes up to 3/5 inch in length, with 2 rows of black spots along each side of body. Terminal leaves are generally eaten first. Black fecal pellets accompany damage.

Colorado potato beetle (see D-3)

4. Very small, elongate oval, shiny metallic greenish-black beetles about 1/16 inch in length. They rest on leaves and jump readily when disturbed. Eat small rounded holes into the leaves. Leaves look as though punctured with fine shot.

Western potato flea beetle (see D-5)

B. Insects that suck sap from leaves or suck contents from leaf cells.

1. Small, about 1/8 inch long, active, narrow-bodied, gray-brown bugs. Along field margin swarms suck sap from plants which may wilt and die.

False chinch bug (see D-7)

2. Small, 1/16 to 1/8 inch long, green or sometimes pink aphids, some winged and others wingless, cluster on underside of leaves, and terminal shoots causing them to wilt, curl and die. At times vines become covered with sticky "honey dew."

Aphids (See D-8)

^o Detailed information on Section "D" begins on page 7.

3. Small, under 1/8 inch in length, very active, greenish, slender, wedge-shaped jumping bugs which feed by means of their piercing-sucking mouthparts on undersurface leaf cells and cause the leaves to appear yellow or "stippled."

Intermountain potato leafhopper (see D-9)

4. Lemon green, greenish- or reddish-brown, flattened, oval bugs, up to 1/4 inch in length with a small greenish V-shaped mark between the basal attachment of the wings. Cause "flagging" of terminal leaves and malformed leaves by their sucking of plant sap.

Lygus bugs (see D-10)

5. Tiny, up to 1/16 inch in length, slender and agile, light brown to black insects feed mainly on undersurface of leaves causing rasped silvery areas of scar tissue. On rare occasions extensive feeding can cause leaf drop.

Thrips (see D-11)

6. Minute, about 1/25 inch in length, 6- and 8-legged, greenish or yellowish mites with 1 or 2 indistinct large black spots. Crawl about under fine webs on underside of leaves. Feeding on the underside of leaves causes yellowing, browning, mottled appearance and finally leaf drop. Stems may become a pale yellowish-brown color.

Two-spotted spider mite (see D-12)

C. Insects that attack underground stems, roots and tubers.

1. Slick, shining, brown to reddish-brown, slender, smooth, hard, 6-legged worms, up to 1-1/2 inches in length, bore into potato seed in the spring. Later they will tunnel into or eat out funnel-shaped cavities or pits 1/4 to 1-1/2 inches deep. Damage may be intensified by invasion of secondary organisms.

Wireworms (see D-20)

2. Whitish, curved-bodied, 6-legged grubs, from 1/2 to over 1 inch in length, with large brown heads and distinct jaws. Plant foliage wilts and dies when underground stems are destroyed. Tubers with small to large rough surfaced cavities from 1/4 to 1 inch or more in diameter.

White grubs (see D-16)

3. Very delicate slender white worms, up to 1/5 inch in length, with brown heads and 6 very short legs near the head, sometimes found feeding in minute tunnels just under the tuber skin with or without pimple-like rough eruptions on tuber surface.

Western potato flea beetle larvae (see D-5)

4. Sluggish, somewhat roughened with skin-like textured larvae up to 1-1/2 inches in length, are gray to gray-brown with horn-like projections on posterior, eat round punctures into tubers which vary in depth from shallow pits to 1 inch.

Leather jacket (see D-18)

5. Tubers with smooth rounded holes 1/4 to 1/2 inch in diameter. Occasionally cavities are eaten inside the tuber.

Gray garden slug (see D-17)

6. Large yellowish-white legless grubs up to 2-1/4 inches in length, with strong brown jaws and body enlarged but not flattened just behind the head, bore into roots causing foliar portions of potato plant to die.

Long-horned beetle grub (see D-14)

7. Yellowish-white legless maggots, about 1/4 inch in length, burrow into underground stem surface and into potato seed.

Seed-corn maggot (see D-15)

8. Small, up to about 3/8 inch in length, nearly white, very active, many-legged centipede-like animals, strongly repelled by light. Scar and eat off roots and small parts of underground stems and cause small wart-like growths to develop. Surface tunnel scars in tuber skin, resembling those caused by flea beetle larvae, may be invaded by scab disease organisms.

Garden symphylan (see D-13)

9. Long, slender, brown, many-jointed animals up to 1 inch in length, called "thousand-legged worms," feed in diseased lesion areas, invade entire diseased area of tuber, or enter the tuber making slender clean cut tunnels.

Millipedes (see D-19)

The following details of feeding damage, of seasonal habits, and of life history will help to determine the proper control method.

Activities of Potato Insect Pests

D-1. Alfalfa looper

The alfalfa looper rarely becomes a serious pest of potatoes. Although there are several generations each season, a virus disease which attacks the larva usually prevents damaging numbers from occurring.

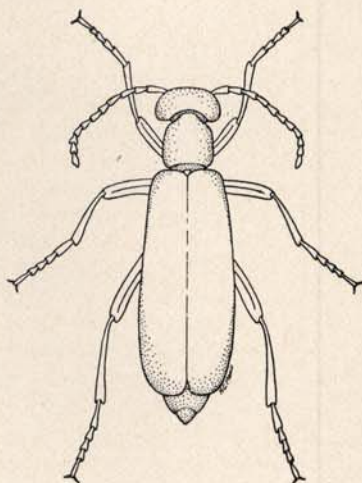
The miller-like adult or moth emerges in the spring. It is grayish-brown in color with a wing span of about 1-1/2 inches. Near the middle of the forewings there is a silvery figure "8" spot. The white striped greenish larvae up to 1-1/4 inches long tapers toward the rear end of the abdomen. The middle of the body is without legs and this region is generally humped up when the insect rests or moves.

D-2. Blister beetles

Damage is most likely to occur in small isolated spots near field margins. Blister beetle larvae live in the ground where some species feed on grasshopper egg masses. Potatoes grown in localities where grasshoppers were numerous the preceding year may be attacked by blister beetles.

Four different blister beetles may strip the leaves from potatoes. The Western spotted blister beetle is the most common. It is from 1/2 to 3/4 inch long, of a gray color with numerous small black spots. The ash-gray blister beetle is somewhat smaller than the spotted blister beetle and is uniformly gray in color. The black punctured blister beetle is about the same size and entirely black in color. Nuttall's blister beetle is green purplish-blue and varies from 5/8 to 1-1/8 inches in length.

The adults appear in great numbers in June and July and live about 45 days. When numerous they can defoliate plants in a very short time. Control of blister beetles is seldom necessary. They are strong flyers and often move to another location before an insecticide can be applied.



D-3. Colorado potato beetle

Most years the adult beetles are already in the potato fields by the time the plants emerge from the soil. Their presence on foliage can be detected by the black fecal pellets and ragged edges of the leaves. Generally, adult feeding does not warrant control treatments. The larvae are usually more numerous and

their feeding injury is always greater than that of the adults.

One thorough insecticide application of an insecticide like methoxychlor should be applied when the first larvae are found. The young larvae that hatch after the treatment will be killed by the residual toxicity of the insecticide when they start to feed. Every care should be taken to select and apply an insecticide in such a way that neighboring fields will not be contaminated by drift.



Insecticides like parathion have short toxic residuals and generally will not contaminate crops growing in neighboring fields. When using an organophosphorus insecticide, two treatments applied at a 10- to 14-day interval will be needed. The second treatment will kill the larvae that were in the egg stage at the time of the first treatment. Moreover, this type of insecticide will kill many of the aphids present at the time of the treatment. Waiting longer than two weeks to apply the second treatment will allow extensive Colorado potato beetle larvae feeding injury to occur. Use extreme care in selecting any insecticide. Remember many are hazardous to pollinating insects.

The adult Colorado potato beetle overwinters in the soil. A short feeding period in the spring is needed before the females deposit batches of up to 30 orange-yellow eggs on the underside of the leaves. Each may lay an average of 500 eggs. In four to nine days the eggs hatch into brick bred, humped-backed appearing larvae with black spots on their sides. They are voracious eaters and mature in two to three weeks. Each descends into the soil, makes an earthen cell where after five to ten days it has transformed into an adult. After emerging from the soil these adults start a second generation. In those fields where the first generation is not adequately controlled the second generation will also require control treatments. At the beginning of the second generation movement of beetles between fields seldom occurs.

D-4. Cutworms

Smooth-appearing worms with three pairs of slender legs and five pairs of prolegs, of varying sizes up to two inches in length and of several shades of gray, brownish to black and sometimes striped may hide near injured plants under dirt clods in curled position during the day.

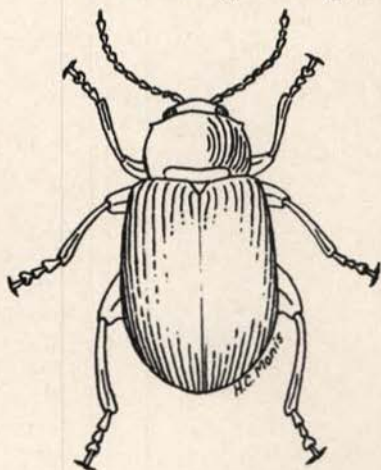
The black, variegated, spotted and army cutworms attack potatoes at night. The Western yellow-striped armyworm feeds

during the day. Cutworms will either cut off the stems or strip the foliage. Damage is usually along field margins.

Cutworms hibernate as partly grown larvae or pupae. The adults are dusky brown or gray moths that fly at night and are the "millers" most commonly observed flying around lights in the summertime. The army cutworm has one generation per season while the others may have several.

D-5. Western potato flea beetle

Foliar damage by adults is seldom severe enough to warrant control. Extensive leaf feeding may be an indication of a later tuber infestation by larvae. Injury on surface of the tuber consists of pimple-like eruptions or rough, winding trails up to 1/16 inch wide and of varying length. Internal tuber injury consists of single or groups of shallow, subsurface narrow, brown "slivers," or feeding tunnels about 1/32 inch in diameter and up to 1/2 inch in length. Fungi often fill the tunnels. When potatoes are processed, the internal injury requires special peeling to remove the brown slivers. Tubers of plants treated for the control of the Colorado potato beetle by foliar applied insecticides are seldom injured by flea beetle larvae.



The adult flea beetles hibernate under leaves, grass or trash about the margins of fields, along ditch banks and other similar protected places. They are about 1/16 inch in length and a metallic greenish-black in color. They become active in May and feed on weeds until the potato plants emerge. The females scatter their very tiny eggs in the soil about the potato plants. In about ten days the eggs hatch and the tiny whitish larvae feed on underground stems, roots and tubers for three to four weeks during which they grow to about 1/5 inch in length. There are one to two generations a year. The tuber flea beetle found in some adjacent states does not occur in Idaho.

D-6. Tomato hornworm

Large green caterpillars, up to four inches in length, with diagonal white bars on the sides and a slender brownish horn at tip of the abdomen.

The adults emerge in May and June. They are large, grayish mottled, swift-flying hawk or hummingbird moths



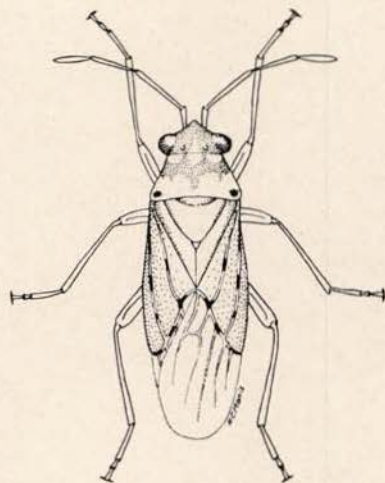
with a four- to five-inch wing spread that are occasionally seen hovering about beds of petunias and other plants sipping nectar with their very long "tongues." The females lay their spherical greenish-yellow eggs singly on the undersurface of leaves. They hatch in about seven days. In about a month and after causing severe defoliation, they complete their development and crawl into the ground, where they overwinter.

Their natural enemies usually prevent outbreak numbers from occurring.

D-7. False chinch bug

Plants along field margins may be attacked by swarms of false chinch bugs from vegetation in adjacent areas which has dried out. Those plants which are not severely damaged will recover after the swarm moves to another location or out of the field.

Both adults and nymphs overwinter in plant debris on the surface of the ground and become active in early spring. The females lay their eggs in the soil and also anywhere on plant foliage. In about four days reddish-brown nymphs hatch. After about a month of feeding by sucking plant sap they become adults. There are several generations each year. Control treatments are rarely needed.



D-8. Aphids

Of the several species of aphids that suck sap from potato plants, the green peach and the potato aphids are the most important. They are important to Idaho potato growers in two ways. Occasionally in southwestern Idaho aphid populations in the absence of their parasites and predators become numerous enough to cause potato plants to wilt from the removal of plant sap. The green peach aphid is also important because it transmits leaf-roll virus in seed potato and commercial potato producing areas.



Aphids can be controlled through most of the season by using a systemic insecticide like disulfoton. The treatment will also reduce populations of the Colorado potato beetle and the Intermountain potato leafhopper. Because aphids may live for several days in treated fields, spread of leaf-roll virus may occur even though total spread is reduced. Re-

duction of virus sources through use of certified seed potatoes is essential for control of leaf-roll virus.

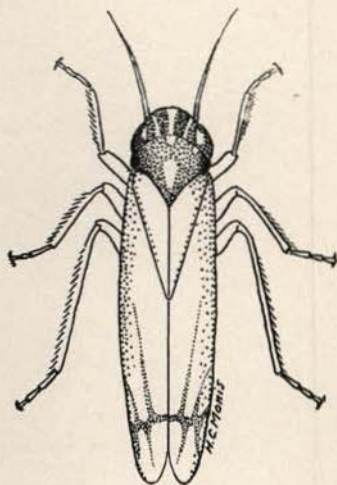
The green peach aphid passes the winter as an egg on the bark of peach, apricot, as active aphids on plants in greenhouses and possibly as active aphids in protected places. It can live on several hundred different plants and can transmit over 30 different diseases. Hatching starts about the time peach buds swell in March or April and continues for three to four weeks. The young aphids are pale greenish-yellow sometimes with three dark lines on the back of the abdomen. After becoming full grown, they begin giving birth to living young. This continues for two or three generations. When winged forms appear, they leave the fruit trees. Some reach potato fields where multiplication continues. Movement within and to other fields occurs all season. When the summer host plants begin to mature some of the winged aphids find a stone fruit tree. Here the winged females give birth to living young female aphids which later mate with small winged males that matured on some summer host plant. These fertilized females lay glistening black eggs on the fruit tree bark, usually the current season twigs. Eggs hatch the following spring.

The potato aphid is of much less importance than the green peach aphid in Idaho. Its life history is similar. It is larger, being about 1/9 to 1/6 inch in length, of a darker green color, and has longer legs and more prominent cornicles or honey tubes.

D-9. Intermountain potato leafhopper

Adults and nymphs feed on the undersurface of potato leaves. This feeding results in a speckled, or white-stippled appearance of the leaves, especially the lower ones. These insects do not cause severe damage or "hopper burn" to potatoes and are not responsible for "early dying" of potato vines. Their control is seldom needed.

The adults pass the winter in grass and weeds along field margins and other areas. They emerge early in the spring. At least one generation develops on weed hosts before they move into potato fields. Both adults and nymphs feed on potato leaves.

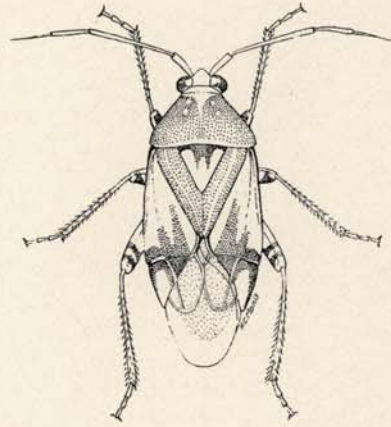


D-10. Lygus bugs

Lygus bugs are general feeders and are found on numerous plants and trees. They are excellent flyers and move from locations where the plants are mature or dying, into fields where the

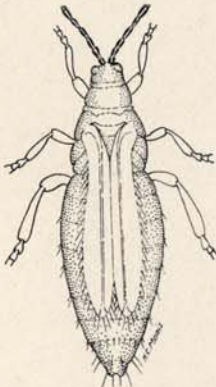
plants are succulent. "Flagging" of potato plant terminals and the malformed leaves are caused by lygus bugs injecting a toxic material into the potato plant as they suck out the plant juices from the leaves. Control of lygus bugs on potatoes is seldom necessary.

The adults pass the winter in alfalfa fields and in grassy and weedy areas. They are active on warm days in late winter. The slightly curved or "cucumber-shaped" eggs are generally laid in the midrib veins of leaves and other similar places. The nymphs move rapidly when disturbed and are a smooth shiny green color in contrast to the slow moving, greenish aphids. There are several overlapping generations. Each requires about six weeks to complete.



D-11. Thrips

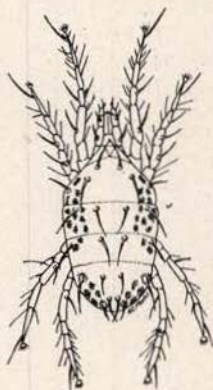
During grain harvest, thrips may fly into and concentrate on potato plants usually in the margin of fields. They destroy the cells on the underside of leaves. Severely scarred leaves become dry and may drop to the ground. Defoliated plants never recover even when the thrips are killed. Infestations are usually restricted to the three to five rows along the field margin adjacent to grain but not always so. Thrips may be found on the underside of the leaves of most potato plants throughout the season, but these do not affect production. Control treatments on more than the heavier infested outside rows are seldom necessary.



The adults and nymphs spend the winter on various kinds of plants along the field margin. The males are wingless and few in number. When females reproduce without mating all the young become males. Thrips have four slender wings made of a fringe of hairs. They rasp and puncture the leaf tissues with their saber-like mouthparts and swallow the sap, together with bits of leaf tissue. The tiny eggs are oviposited into the plant tissues and hatch in about ten days. The nymphs pass through four stages in developing into the adult stage. The last two are spent in the soil where they presumably do not feed. There are several overlapping generations a year. About a month is required to complete each generation. Predatory thrips and other insects generally prevent outbreak populations.

D-12. Two-spotted spider mite

Fields of potatoes growing along side alfalfa or clover hay fields may become infested with the two-spotted spider mite soon after the first crop hay is harvested. The spider mites usually move from one field to another by walking, by ballooning on an air current and on surface water such as that used for irrigation. They normally feed on the underside of leaves and are not noticed until damage shows through the upper side. They puncture the leaf tissue with their mouthparts and extract the plant juices. Loss of chlorophyll and other cell contents produces a characteristic blotching or stippling of the leaves, causing them to become yellowish or brownish in color. The damage first appears as a brown stippling of the basal lobes of the leaves. Severely damaged leaves are killed by desiccation.



Severe infestations progress rapidly across fields in a wave-like manner. Treating a 30-foot area with dusting sulfur from the edge of the potatoes into the adjoining hay field just before hay harvest is very effective. Thorough coverage of the underside of all leaves is necessary for effective control. When an organophosphorus insecticide like Ethion is used, two applications within an interval of nine days is necessary to kill the new hatch before they mature to lay more eggs.

The adult mites hibernate on plants, among leaves and debris or in the soil. They emerge in early spring and lay eggs on the undersides of leaves. A female may lay 20 eggs a day or a total of 300 eggs during her 1 to 1-1/2 month lifespan. After three to five days the eggs hatch. During hot weather the nymphs develop into adults in eight to nine days. There are many overlapping generations. A fine web is spun over the underside of the infested leaf which protects the eggs and mites from wind, rain and larger predators. The small predators which attack mites are small black lady beetles, predatory mites, minute pirate bugs and predatory thrips.

Mite infestations are difficult to control. Miticide dust treatments are generally more effective than are sprays. It has been determined that less than one-tenth of an aerial dust treatment reaches and is deposited on the underside of lower plant leaves where the major mite populations are located. Preventative treatments should be considered in all areas where spider mites are a yearly problem.

D-13. Garden symphylan

To date, this destructive centipede-like animal has been found only in a few isolated fields in Canyon, Cassia, Clearwater, Idaho, Latah, Nez Perce, Washington and Twin Falls Counties. Growing high quality potatoes in symphylan infested soil is an economical impossibility. They eat roots and tunnel over the tuber surface and cause sunken or "pimole-like" scars. The injury is easily confused with those caused by scab and flea beetle larvae.

The adults are white, up to 3/8 inch long by 1/25 inch thick, with a head and 14 body segments. The bead-like antennae are more than 1/3 as long as the body which has 12 pair of short functional legs. They use available earthworm tunnels, soil cracks, and the site of decayed roots as burrows and line them with a silk web. The pearl-like white eggs are laid in small clusters of 5 to 20 during the growing season. They hatch in about a week. To begin with, the tiny young have only ten body segments, six pair of legs and very short antennae. As they mature additional body segments are added and the antennae elongate. About 60 days are required to complete a generation. They are subterranean in habit although they may move over the soil surface at night. They move downward when the soil is dry and toward the soil surface when the soil is moist. They feed on roots of many kinds of plants.

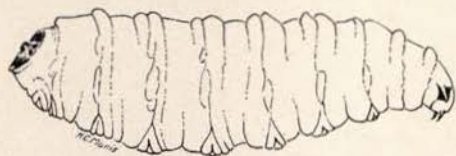
Soil fumigation with materials like D-D or a parathion insecticide treatment only reduces the symphylan numbers. However, such soil treatments allow a crop like corn or sugarbeets to be grown for one or possibly two years before retreatment is needed.

D-14. Long-horned beetle larvae

Long-horned beetle larvae normally live in dead root-wood of arid rangeland woody shrubs found in soils reclaimed for agricultural purposes. When potatoes are planted in these reclaimed soils the larvae will bore into and through underground stems. They require three or more years to complete their development. Generally only a few isolated plants are attacked and control is not necessary. The adult is a long-horned or tiled-horn brown beetle 1-1/2 to 2 inches in length.

D-15. Seed-corn maggot

During cool, wet seasons and in soils containing an abundance of decaying vegetation, small maggots may destroy seedling growth and attack decaying portions of the potato seed. Sometimes replanting may be necessary in limited areas of the field.

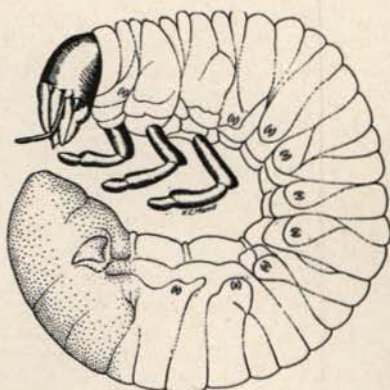


The adult fly is about 1/5 inch in length and appears in early spring. The female prefers to lay eggs in moist soil. At first the young larvae may act as scavengers but later attack living plants. They complete their development in two to three weeks. Feeding injury by maggots of later generations is seldom important.

Well-suberized potato seed pieces are seldom attacked. When the season is cool and the soil is abnormally wet, a delay of planting potatoes in soils containing an abundance of decaying vegetation will prevent damage.

D-16. White grubs

In northern Idaho the carrot beetle and its "white grub" larva feed on roots, underground stems and tubers. Generally in southern Idaho it is the 10-lined June beetle "white grub" which attacks tubers. The injury consists of small to large feeding cavities 1/4 to over 1 inch in diameter. The rough, irregular-shaped cavities are usually wider than deep. At times half or more of the tuber is consumed. Both species are more abundant



where grass-sod or quantities of organic matter have been plowed into the soil prior to planting potatoes.

Carrot beetles are broad, stout, red-brown, and about 1/2 inch in length. They hibernate in burrows deep in the soil and appear in the spring. Eggs are laid in the soil. The white grubs, up to about one inch long, are curved, and white with a blue tinge. There is one generation a year.

The 10-lined June beetle, 1 to 1-1/4 inches long, is brown with ten narrow white stripes on the wing covers. They are awkward flyers and feed on leaves of trees at night during May and June. Two to three years are spent as white grubs before their development is complete when they are about two inches long. They are often found in a "C" shaped or curled position.

As compared to wireworms control larger amounts of insecticide are required to control white grubs. The decaying vegetation found in white grub infested soils ties-up or reduces the amount of insecticide available for white grub control. Like the wireworm control treatment the soil must be thoroughly turned three times to properly mix in the insecticide.

D-17. Gray garden slug

For the past several years slugs have been noticed in high humidity situations in irrigated and sub-irrigated field conditions of southern Idaho. They have not been a potato pest, but they could become one at anytime where a humid environment exists.

They feed on foliage at night or during dark damp days. They always leave a slimy trail as they move. Injury to foliage consists of irregular-shaped holes eaten from the leaves. Tuber injury is readily recognized by the uneaten tissue-thin potato skin covering over large excavated cavities. There is no effective chemical control known.

The gray garden slug is the predominate species found in Idaho. They pass the winter in sheltered conditions and have been found occupying "night crawler" earthworm tunnels about ten inches below the soil surface. The small round, pearl-like

white eggs may be laid throughout the year in clusters of a dozen or more in sheltered, moist situations. They hatch in two to four weeks or may live over winter. Slubs are reported as living 18 months to two years. One year is about average.

D-18. Leather jacket

In certain instances crane fly larva or "leather jacket" damage has been sufficiently severe to reduce the grade of potatoes or make them unsalable. Damage consists of up to 1/4 inch round punctures varying in depth from shallow pits to one inch. Observed damage has occurred in fields planted to potatoes following spring plowing of alfalfa.

The winter is spent as mature or partly mature larvae in the soil. Adults emerge about the third week in May. Eggs seemingly are deposited in the vicinity of freshly incorporated alfalfa refuse. The larvae move to feed on tubers about mid-August. In the absence of potatoes they probably feed on grass and roots of plants growing in the field borders. Fall soil preparation will probably prevent leather jacket field infestation.

D-19. Millipedes

Millipede damage to potato seed is especially noticeable during cool, wet springs and to tubers near harvest time. They make rather large, shallow, irregular cavities with no overhanging or covering potato skin. They may be found in damaged parts of tubers made by other pests and by diseases. Some species make tunnels in the tubers which slightly resemble tunnels made by flea beetles or wireworms.

Millipedes are worm-like, with brownish to grayish bodies that are fairly glossy, thick and leathery. They may have 50 to 75 pairs of legs. The eggs are laid on or in the soil in clusters of 20 to 100. The eggs hatch in about three weeks and the young larvae feed on decaying vegetable matter. They have fewer legs than the adults. Growth is slow and there is probably only one generation per year.

Millipede injury is encountered only occasionally and no control is needed.

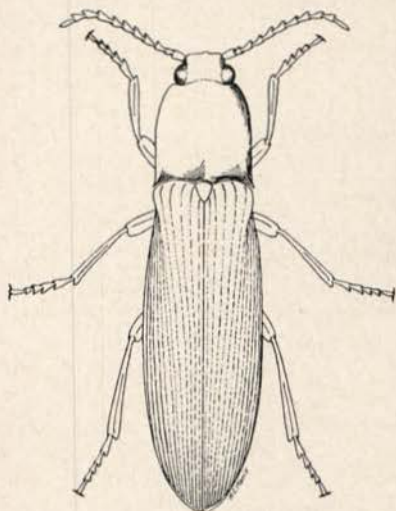
D-20. Wireworms

During the spring, wireworms feed on the potato seed pieces and later in the season on developing tubers. Occasionally spring feeding injury to the seed and underground stems is great enough to require replanting. Wireworm tuber damage may occur as shallow or deep pits, as deep holes or tunnels. Feeding injury while tubers are small may cause them to be misshaped. These early season feeding cavities may be enlarged by fungi while late season injuries generally are not.

There are many species of wireworms. The Great Basin wireworm is the predominate species found in southern Idaho dryland farm and range areas. The larvae spend about three years developing into adults. Many of these dryland soil areas are now being irrigated. Potatoes or other irrigated crops planted in Great Basin wireworm infested soils will be attacked until all the larvae be-

come adults. They deposit their eggs only in dryland soil situations.

The sugarbeet wireworm is the predominate species found in irrigated farming areas of southern Idaho. Most of these larvae require two to five years to complete their development. Sugarbeet wireworm infestations only occur in land that has been under irrigation for five or more years.



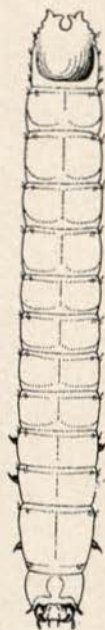
When the spring soil temperatures reach 55 to 65°F in the top three inches, the sugarbeet wireworm beetles emerge from the soil. Egg laying commences a day or two following mating. Each female deposits 50 to 350 eggs beneath the soil surface. They do not lay eggs in dry soil. In about a month the eggs hatch. Many of the tiny larvae die during the first season. Considerable damage to tubers occurs during the second season and thereafter until they mature.

The sugarbeet wireworm is quite sensitive to soil moisture and temperature. As autumn approaches and the surface soil begins to cool, wireworms move downward, sometimes

as deep as 24 inches where they spend the winter. They return to the surface again in the spring when the soil temperature at the six-inch depth reaches 50°F. The largest number of wireworms will be found in the surface soil during May and until the surface temperature exceeds 80°F. Then they move below the six-inch depth unless the soil becomes shaded and the surface temperatures are lower. A few wireworms may return to the surface in September but most remain deep in the soil until the following spring.

The Great Basin wireworm is less sensitive to soil moisture and temperature. They live quite well in dry soils and can be found near the soil surface in February.

Potatoes planted in desert soils freshly put under irrigation may be attacked by the Great Basin wireworm for two to three years or until all have reached maturity. Then for a year or two, potatoes grown in these soils will be free of wireworm damage, or until the sugarbeet wireworm becomes established. Thoroughly incorporating an insecticide into the desert soil as it is being renovated for producing irrigated crops will prevent loss from wireworm



feeding. In those soils where DDT is used the crops will be protected from wireworm attack for about eight years. To prevent illegal DDT residues on sugarbeets, plant other crops the first two years after treatment. Where an insecticide such as parathion is used, crops will be protected from wireworm attack for at least two years and there should be no residue problems. However, short-lived organophosphorous insecticides must be properly timed and applied to be effective.

LIST OF POTATO INSECTS

alfalfa looper, *Autographa californica* (Speyer)

blister beetles—

ash-gray blister beetle, *Epicauta fabricii* (LeConte)

black punctured blister beetle, *Epicauta puncticollis* (Mann.)

Nuttall's blister beetle, *Lytta nuttallii* Say

western spotted blister beetle, *Epicauta normalis* Werner

Colorado potato beetle, *Leptinotarsa decemlineata* (Say)

cutworms—

army cutworm, *Chorizagrotis auxiliaris* (Grote)

black cutworm, *Agrotis ipsilon* (Hufnagel)

spotted cutworm, *Amathis c-nigrum* (Linnaeus)

variegated cutworm, *Peridroma saucia* (Hubner)

western yellow-striped armyworm, *Prodenia praeifica* Grote

false chinch bug, *Nysius ericae* (Schilling)

garden symphylan, *Scutigera immaculata* (Newport)

gray garden slug, *Derocerus reticulatum* (Muller)

green peach aphid, *Myzus persicae* (Sulzer)

intermountain potato leafhopper, *Empoasca filamenta* Delong

leather jacket, *Tipula dorsimacula* Walker

lygus bugs—

Lygus elisus Van D.

Lygus hesperus Kngt.

long horned beetles, *Prionus* sp.

millipedes, several species

potato aphid, *Macrosiphum euphorbiae* (Thomas)

seed-corn maggot, *Hylemya platura* (Maigen)

thrips—

onion thrips, *Thrips tabaci* Lindeman

western flower thrips. *Frankiniella occidentalis* (Pergande)

tomato hornworm, *Manduca quinquimaculata* (Haworth)

two-spotted spider mite, *Tetranychus urticae* (Koch)

western potato flea beetle, *Epitrix subcrinita* (LeConte)

white grubs—

carrot beetle, *Bothymus gibbosus* (DeGeer)

ten-lined June beetle, *Polyphylla decimlineata* (Say)

wireworms—

Great Basin wireworm, *Ctenicera pruinina* (Horn)

sugar beet wireworm, *Limonius californicus* (Mannerheim)



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