Management of insect pests on potatoes

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Potatoes are subject to attack by several species of insects, of which the two most important in California are the potato tuberworm, *Phthorimaea operculella* (Zeller), and the green peach aphid, *Myzus persicae* (Sulzer).

Tuberworm

The potato tuberworm attacks foliage and infests tubers in the field and in storage. Tuber infestation may be so severe that portions of fields, or occasionally entire fields, must be abandoned at harvest time. Even comparatively light tuberworm infestations affect out-of-state shipments of potatoes, necessitating fumigation of the shipments and adding to production costs. Insecticide resistance and inadequate means for monitoring tuberworm populations have resulted in the excessive use of insecticides. The tuberworm problem is most severe in the south coastal area of California, the Salinas Valley, and the southern San Joaquin Valley. It is not a problem in northern California potato producing areas.

The discovery of potent sex pheromones produced by the female tubermoth as an attractant for males has opened the way for a practical monitoring of field populations of this insect. A trapping technique has been developed using the sex attractant as a lure in simple, specially designed water-pan traps.

The 1977 season marks the second year of field studies with the sex attractant. Water-pan traps baited with the synthetic pheromone are highly specific and few insects other than male tubermoths are found in the traps. Populations vary widely from field to field and from area to area. Depending upon the field and time of year, catches have ranged from less than one to more than 300 moths per trap per night.

Population measurement is essential to the development of a pest management program, and provides a sound basis for determining the need for insecticide applications and will permit more accurate timing and evaluation of treatments. But additional time is needed—perhaps several years—to fully ascertain the economic significance of tubermoth populations as indicated by trap catches.

Current University of California studies are attempting to correlate moth populations with various physical factors and agronomic practices in the field and to relate these to tuberworm infestations in the harvested potatoes. For example, the irrigation method used greatly influences the susceptibility of a field to tuberworm. Furrow-irrigated fields tend to have more soil cracking than sprinkler-irrigated fields, thus allowing moths and larvae access to the potatoes. Sprinkler irrigation, now widely used in potato production, reduces the amount of soil cracking and has significantly reduced need for insecticide applications for tuberworm control.

The potato variety being grown may also influence infestation. Those varieties that tend to set tubers close to the soil surface are frequently infested.

Green peach aphid

The green peach aphid occurs in all of the potato producing areas of California and can be a limiting factor in the production of Irish potatoes. Large aphid populations may debilitate the plants, causing premature decline and reduced yields. Perhaps even more important, the green peach aphid is an efficient vector of potato leaf roll virus (PLRV) and is the most abundant of the known vectors occurring in the potato growing areas of California.

The virus is tuber-borne, and plants grown from infected tubers are commercially nonproductive. PLRV is especially severe in the Russet Burbank ("Netted Gem") variety because the tubers of a current-season plant infected with the virus may develop a net-like browning of the phloem tissue, a condition known as net necrosis, and cannot be marketed as U.S. No. 1 grade. The virus is spread from field to field or from volunteers to commercial fields by winged aphids.

Research on this project is centered in northern California in the Tulelake basin. Winged aphid populations have been assessed annually from 1970 through 1977 at bi-weekly intervals from mid-May to mid-October. The aphid populations were monitored with yellow water-pan (Moerick) traps at 20 to 30 locations throughout the basin. Annually the populations begin to rise about the last week in July and reach peak numbers from late August to mid-September. Wingless aphid populations are monitored on the plants by examining compound leaves selected from the lower portion of the plant.

Green peach aphid populations were extremely high in 1971 and 1972 and have declined annually since. The reasons for the decline are not fully understood, but are believed to be the result of improved weed control in the area and the use of highly effective insecticides. However, when virus inoculum is abundant in volunteer potato plants and in plants grown from infected seed, insecticide treatments that provide virtually complete control of the aphids on the plants have not greatly reduced the incidence of potato leafroll infection in experimental plots. Although the winged aphids are unable to colonize their young on the treated plants, they are able to feed briefly and thus transmit the virus they carry.

In the Tulelake area, initial populations of the green peach aphid are not uniformly distributed over potato fields. Aphids are usually first found on the field margins, especially along the north borders extending into the field for 10 to 20 feet. In checking fields for the presence of the green peach aphid, growers should first examine the outside plants on the north field margins. If aphids are present, the remainder of the field should be sampled.

We are uncertain what constitutes an economic population level; however, the present practice in market potatoes in the Tulelake area is to apply a foliar spray when an average of 5 percent of the leaves in a sample taken within the field is infested with the green peach aphid. Data from experimental plots indicate that perhaps even higher levels can be tolerated. An important difficulty in determining economic levels, however, is how many of the aphids are viruliferous (carrying the virus), and there is now no practical way of assessing this.

Cultural practices

The key to controlling potato leafroll virus is the elimination of virus sources. The principal source is infected potato plants that have grown as volunteers from old tubers left after harvest or from infected seed pieces planted in the fields. Certain solanaceous weeds may also harbor the virus but are not the primary source. An effective program calls for community-wide action involving the planting of virus-free seed stock, the early destruction of virus sources such as infected volunteer potato plants and weeds known to harbor virus, and control of the green peach aphid. If fields are virus-free to begin with, other sources of virus are eliminated, and the vectors are controlled, there should be little or no spread of PLRV from one field to another.

These cultural practices have been combined with improved field inspection techniques that result in insecticide treatments being applied only when 5 percent of the leaves are infested.

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Integrated pest management on vegetable crops in Southern California

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Many new approaches are being studied by scientists seeking improved insect control in the vegetable industry of southern California. Among these are insect monitoring systems using sex attractants in potatoes and tomatoes; new ways of using economic thresholds (critical pest numbers) in cole crops and lettuce; cultural methods of controlling insect pests on potatoes and squash; biological controls for tomato insects; and safer, more effective pesticides—with improved delivery systems—on all vegetable crops.

California farmers produce almost 50 percent of the nation's fresh produce. The industry is extremely intensive, providing 15 to 20 percent of the state's total agricultural return from less than 3 percent of the available farm land. Crop losses caused by insects are high (10 to 15 percent) and marketing standards are so strict that insecticides have been used heavily to achieve acceptable productivity. Because quality standards are unlikely to be relaxed in the future, pesticides will continue to be major tools for controlling the numerous insect pests on vegetables.

However, the supply of effective pesticides which the grower has relied on in the past cannot be expected to continue indefinitely. The industry has reached a stage where alternative control strategies and reduction of pesticide dependence are vital.

Insecticidal control practices often are directed against insects regardless of the extent of the populations, how they might fluctuate, or the impact they might have on crops. Nowhere is this practice more prevalent than in the vegetable industry, where high crop values and cosmetic standards, and low tolerance levels for damage and contamination, encourage rigid adherence to pesticide application schedules to produce a marketable product.

Monitoring systems can enable growers to break away from scheduled spraying by assessing insect populations and the need for pesticide applications. Two such systems have been developed. Potent sex attractants have been isolated for the potato tuberworm and the tomato pinworm. Adult populations can be accurately measured in individual fields, and the crop damage caused by the immature stages of the next generation can be accurately predicted. Necessary control measures can then be timed and unnecessary applications eliminated.

Even in cases where populations can be measured, however, levels of insect populations that inflict economic damage have not been determined. A knowledge of economic thresholds is thus extremely important in determining appropriate control measures.

Aluminum foil on zucchini squash provides protection from aphid-transmitted mosaic viruses. Aphids see blue light of reflected sky, fail to land on the squash.

Economic thresholds can be developed on many vegetable crops. Even those crops with zero tolerance levels can benefit from higher thresholds when these are applied to growth stages that are not marketed. Broccoli exhibits a high tolerance to lepidopterous feeding injury in the growth period between thinning and heading. If seedling and heading stages are protected from insect damage, high yields of marketable produce can be produced with only limited protection during the long pre-heading stage.

Insecticides will continue to play an important role in integrated programs, and research is continually directed toward identifying more effective and safer materials. Pest-specific materials are desirable in integrated control programs, but their development by the chemical industry cannot be expected to increase because of the limited demand for such compounds. Safe, broad-spectrum materials such as the synthetic pyrethroids are being developed and have great potential in the vegetable industry when used correctly. Improved pesticide delivery systems often can overcome the adverse side effects caused by existing broad-spectrum pesticides. For example, the application of insecticide/nematicide materials to tomatoes through drip irrigation systems is being investigated.

Biological control of insect pests generally does not achieve the required levels of control for vegetable crops when used alone, but it forms an important part of integrated programs. When repeated pesticide applications eliminate natural controlling factors, secondary pests often reach economically damaging proportions. This situation is seen on tomatoes when pesticide applications to control the primary lepidopterous pests often result in serious outbreaks of dipterous leaf-miner by eliminating its natural controls.