Insect Management Strategies

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Effective insect, mite, and slug management relies on applying IPM strategies which include the following tools:

1. Preventive practices.
2. Properly identifying key pest insects, mites, slugs, and beneficial organisms.
3. Monitoring and early detection of insect, mite, and slug populations.
4. Determining the pest's economic loss potential
5. Selecting the proper pest control option.
6. Evaluating the effectiveness of employed control options.

Preventive Insect Management Practices

There are a number of practices that can reduce insect numbers before you actually see the insects in the crop. Often, decisions about these practices must be made based on past experience with the pest.

Many of these practices are good management practices for weeds and diseases as well, so they can easily be incorporated into production practices that yield multiple benefits.

Resistant Varieties: There are not many vegetable varieties that have been bred exclusively for insect resistance. However, there are many varieties that target resistance to insect-vectored plan pathogens. This information is often printed in seed catalogs or available directly from seed suppliers. Varieties that are resistant to pathogens may still sustain direct damage from the pest; ask your seed provider. The information on crop resistance to insects, mites, and slugs directly is harder to find. Some varieties of cabbage are resistant to onion thrips. Selection of sweet corn varieties that have husks that completely cover the ear tip and fit tightly around the ear can reduce the amount of corn earworm damage. Short season varieties of potatoes should be grown when possible to give Colorado potato beetles less time to feed and reproduce. This is not resistance, but it is a method that growers can use to reduce insect damage by varietal selection.

Crop Rotation: Rotating crops can reduce the severity of a number of pest problems. Rotating potato fields can greatly increase the amount of time it takes Colorado potato beetles to colonize a field, thereby reducing the time the beetles have to damage the crop. Rotating cucurbit crops can be equally effective for cucumber beetle management. Don't plant crops that are susceptible to wireworm or white grub damage in fields that were previously in sod or heavily infested with grassy weeds. In addition, it is a good idea not to plant cabbage or onions next to small grain fields, because onion thrips build up to very high levels in small grains and may move into cabbage or onions when the small grains dry down or are harvested. The effectiveness of rotation for pest management relies on the host range of the pest (what crops can/does it feed on) and its dispersal capabilities (how far will it have to go to find a suitable host).

Crop Refuse and Volunteer Destruction: Destroying the plant residue after harvest can reduce the damage experienced the next year from a number of insects. Destroying squash and pumpkin vines after completion of harvest can greatly reduce the overwintering population of squash bugs and squash vine borers. Early vine killing in potatoes will reduce the potato beetle populations for the following year. Volunteers that resprout from last year's crop can serve has a harborage and a source population for insect pests on field edges or as weeds in another crop, and should be destroyed.

Tillage: Fields that receive reduced amounts of tillage or have some sort of grass windbreaks are often more susceptible to damage from insects such as cutworms and armyworms. These cultural practices may have other advantages that outweigh the potential insect problems, but growers should be aware of the potential for increased insect activity. Tillage can also be effective to directly damage insects that reside in the soil over winter or between crops.

Time of Planting or Treatment: Many pest insects go through life according to heat units, and are subject to weather, just like plants. Growing Degree Day (GDD) models and weather forecasting tools have been developed for several pests that detail when they are likely to be at a stage that is damaging, or blow in from another area, or when they are at a life stage that is easy to control or avoid. Because insects tend to become active at specific times each year, varying the time of planting can sometimes help prevent serious insect problems.

Corn earworms and fall armyworms are usually a much more serious problem on late-planted sweet corn. If the option is available, planting sweet corn so that it has no green silks before large numbers of earworm moths are flying can reduce earworm problems. Root maggots are usually more serious during cool, wet weather. Waiting until soil temperatures are adequate for rapid plant growth will help reduce maggot

problems. Here are some resources for tracking weather and predictive models related to insect pests:

- enviroweather.msu.edu
- newa.cornell.edu
- insectforecast.com

Conservation Biological Control: Conserving natural enemies is one aspect of biological control that can effectively reduce pest populations and damage. This can be accomplished in several ways, but the most important is careful selection of pesticides and reducing the overall number of applications. When selecting an insecticide, consider the impact that application will have on beneficial insects. *Bacillus thuringiensis* (Bt) products, for example, only have efficacy against the targeted organisms (most often caterpillars). Other products, such as flonicamid, are selective at killing insects with piercing-sucking feeding habits, targeting aphids and plant bugs. Choosing a chemical option that has been approved by the EPA as a Reduced Risk product is another way to minimize the impact on nontarget organisms, including natural enemies and parasitoid, when an application is necessary.

Proper Identification

Properly identifying pests is the foundation on which a good insect management program is built. If the pest is not properly identified, the chances of selecting the correct control strategies are greatly diminished. Many insects and mites can be correctly identified simply because they are encountered so often. However, it never hurts to back up your knowledge base with some reference materials. Your county Extension office has a number of bulletins available that will help you properly identify insect pests. There also are a number of good books available with color photographs of many of the common insect pests. Most entomologists don't like to admit it, but we often identify unfamiliar insects by comparing them to pictures in a book. For a small fee, samples can be submitted to a local plant and pest diagnostic lab.

Beneficial organisms can be important components of an effective insect management program. Being able to distinguish the good insects from the bad insects may help you avoid unnecessary and possibly disruptive pesticide sprays.

Some common beneficial organisms all growers should be able to identify include lady beetle larvae and adults, lacewing eggs, larvae and adults, parasitized aphid "mummies", minute pirate bugs, and syrphid fly larvae.

In addition to proper identification, it is helpful to know as much as possible about the insect's biology including how to identify the various life stage, location or habitat where each portion of their lifestage occurs and the host range of the pest.

Insects with incomplete metamorphosis have juvenile stages — called nymphs — that resemble the adults, except that they are smaller and don't have wings. The feeding behavior is usually the same for nymphs and adults. For example, squash bugs and aphids are insects with incomplete metamorphosis.

Insects with complete metamorphosis have a larval stage that is completely different in appearance from the adult. Adult insects never grow, so little beetles don't grow up to be big beetles. For example, caterpillars are the immature (larvae form) of moths and butterflies. Insects who undergo complete metamorphosis also have an intermediate stage, known as a pupa, between the larval and adult stages. For caterpillars this is called a chrysalis or cocoon. larvae never have wings and are not capable of reproducing. Larvae go through a series of molts (shedding their skins) in order to grow. Larvae and adults frequently, although not always, feed differently and move between plants or plant parts as they develop. In many instances, the immature stage feeds below ground while the mature is found above, or vice versa. Beetle larvae (think Japanese beetles, wireworms, rootworms) feed below ground on plant roots while the adults (again Japanese beetles, click beetles, rootworms) are found above ground feeding on plant foliage. Thrips spend their larval and adult stages above ground, but pupate in the soil.

For important insect, mite, and slug pests, it also is helpful to know the overwintering stage, life cycle length, and number of generations per year that can be expected. Again, most of this information can be found in Extension bulletins.

Monitoring

Vegetable growers must make insect, mite, and slug pest management decisions on an almost daily basis during the growing season. To make the best decisions, it is often useful to have information regarding the current status of a pest's population. This can be accomplished through some sort of sampling or monitoring program. There are several methods to monitor insect populations.

Pheromone traps can be used to determine when pests are flying, often times in relation to searching for a mate. This information can be used in several ways. First, catching pests in the trap can alert growers to begin looking for the pest in the field. This can save time because the grower won't be looking for the pest before it is present. Second, pheromone trap catches can be used to time insecticide applications. Third, for some pests, such as corn earworms, the need to spray can be determined from the number of moths caught in

the trap. Pheromones are available for many of the moth stages of caterpillar pests of vegetables, and swede midge.

Another method for monitoring insects is by scouting fields. Scouting can be formal, such as counting insects on a given number of plants throughout the field, or it can be informal, with the grower walking through the field and looking for the signs and symptoms of insects on the plants. Formal scouting may be more accurate, but the most important thing is for growers to regularly walk their fields looking for insects or insect damage. Most can be monitored just by close inspection of the plants. Others may require the use of equipment such as a sweep net or a beat cloth. Some pests, such as mites, may require the use of a hand lens to see. Familiarizing yourself with the damage they induce can aid in their detection. For example, the stippling of leaves from mites. Alternatively you can shake the plant over a sheet or piece of paper to dislodge the pest. This is effective for mites and thrips. Regular (weekly) monitoring will allow growers to make informed management decisions.

In protected environments, yellow sticky cards may serve as a passive monitoring method. The cards should be placed strategically around the crops to intercept pests as they move into the growing space (near ventilation openings) or between crops in the same space. Cards will not control pests but can aid in their detection. They should be checked often (at least weekly) and changed when the surface gets full or is no longer sticky.

Determining the Potential for Economic Loss

Unfortunately, we do not have economic thresholds for many vegetable insect pests. Whenever possible, we have listed the best thresholds available along with control options in the crop-specific sections of this manual.

Although some of these estimates have not been verified by research in each state, they have been derived from scientific research or extensive observations. Growers may wish to adjust these thresholds based on past experience. Extension bulletins also are useful sources of information regarding potential losses from insects.

Growers should remember that some crops, such as snap beans and potatoes, can suffer a great deal of defoliation before there is any effect on yield. Sometimes, plants with considerable amounts of insect damage will yield as well as plants that have no insect feeding. If the pest is one that feeds on the marketable portion of the plant, then less damage can be tolerated.

Proper Selection of a Pest Control Option

In vegetable crops, the selection of a control option during the growing season usually means doing nothing or selecting a pesticide. Although we always encourage growers to read and follow label directions, the one area where the label is not necessarily the best source of information is concerning which insects the insecticide will control. The insecticides recommended in this book for control of various pests are listed because they are legal to use and because they have been found to be effective by the authors. Consider insecticide or biological control agent costs, application costs, relative effectiveness, gain in profits that can be expected from the application, whether it will control other pests, and how it will affect predators, parasites, and pollinators. Growers should refrain from “revenge spraying,” that is, spraying after the damage is already done. At that point, spraying is a waste of money and may actually increase pest damage by killing beneficial insects.

Evaluation

Growers should always evaluate the effectiveness of a pest control action. Inspecting the field a couple of days after an insecticide is applied will help the grower determine the necessity for additional control measures in that field, as well as provide information about the insecticide’s effectiveness for future reference. Growers should pay attention to whether the insecticide killed all stages of the pests or if only small larvae or nymphs were killed. They should also notice the effects on other pests in the field and on beneficial insects.

Resistance Management

It is important to rotate products with different modes of action in order to reduce the potential of insect, mite, and slug populations developing resistance to products with specific modes of action. A pesticide’s mode of action is how it affects the metabolic and physiological processes in the pest (in this case, the pests are insects, mites, or slugs). Many product labels contain resistance management information or guidelines that will help vegetable growers determine which products they should rotate with others, including an Insecticide Resistance Action Committee (IRAC) code, that describes the mode of action with a number and/or letter. Try to avoid using products with the same IRAC code repeatedly

to conserve its efficacy on pests. Biopesticides derived from fungal and bacterial insect pathogens and live biological control insects can also be deployed against insect pests, further preserving the efficacy of certain insecticides.

Summary of Nonchemical Insect and Mite Pest Management Practices

Practice	Notes
Floating row covers	Placing floating row covers over vegetable crops during the growing season prevents insect pests, such as caterpillars and beetles, from feeding on vegetable crops.
Trap cropping	Trap plants placed around the perimeter of the main vegetable crops attract insect pests, thus mitigating plant damage.
Reflective mulches	Using reflective mulches reduces insect infestations and the incidence of virus transmission by insect pests such as aphids, thrips, and whiteflies.
Planting time	Planting early or later in the growing season avoids plant damage to vegetable crops from insect pests.
Crop rotation	Rotating among vegetable and non-vegetable crops, such as alfalfa, avoids the build-up of insect populations in the soil.
Weed management	Removing or eliminating weeds is important because many weeds harbor insect and mite pests, and serve as a source of viruses transmitted by insect pests such as aphids, leafhoppers, thrips, and whiteflies.
Overhead irrigation	Overhead irrigation of vegetable crops reduces problems with caterpillar pests such as the diamondback moth.
Crop management	Implementing proper cultural practices such as watering, fertility, and plant spacing helps to alleviate problems with insect and mite pests.
Sanitation	Remove and destroy all vegetable crop debris after the growing season because insect pests, such as the squash bug, overwinter in vegetable crop debris.