Integrated Pest Management: An Overview for Market Growers

Karen Delahaut, IPM Outreach Specialist

with support from

the Pesticide Use and Risk Reduction Project

at the Center for Integrated Agricultural Systems

University of Wisconsin-Madison College of Agricultural and Life Sciences

December, 2002

This report is made possible by the collective effort of several public agencies:

The report is funded through a grant from the **US Environmental Protection Agency – Region V** in Chicago as part of their Agricultural Stewardship Initiative. For more information on EPA, its regional offices and their programs, go to http://www.epa.gov/epahome/locate2.htm

The report is a product of the **University of Wisconsin – Madison Fresh Market Team** serving the **Pesticide Use and Risk Reduction Project (PURR)**. The Fresh Market Team is made up of researchers and UW Extension outreach specialists who work with fresh market growers throughout Wisconsin. Many are associated with the UW's Integrated Pest Management Program

The **Integrated Pest Management Program** expands the use of IPM in Wisconsin crops to reduce the use of chemical pesticides, increase the use of cultural and biological pest control tactics, improve production efficiency and maintain the competitiveness of Wisconsin growers by producing crops with the lowest pesticide inputs necessary. Go to http://ipcm.wisc.edu or call 608.262.6429 for more information

PURR is the collective effort of 14 agricultural organizations which are working together to reduce pesticide use and risk through Integrated Pest Management and other system strategies. For more information on PURR and its member organizations, go to http://www.thinkIPM.org

PURR is administered by the **Center for Integrated Agricultural Systems (CIAS)**, a research center for sustainable agriculture in the College of Agriculture and Life Sciences, University of Wisconsin – Madison. In addition to its role in facilitating the development of this report, CIAS provided layout and publishing services. CIAS fosters multidisciplinary inquiry and supports a range of research, curriculum, and program development projects. It brings together university faculty, farmers, policy makers, and others to study relationships between farming practices, farm profitability, the environment and rural vitality. Go to http://wisc.edu/cias or call 608.262.5200 for more information

Publication design and layout by Ruth McNair, Center for Integrated Agricultural Systems.

This report is printed on recycled paper.

Integrated Pest Management: An Overview for Market Growers

Karen Delahaut, IPM Outreach Specialist

On occasion, market gardening can be wrought with frustration on occasion. Plants die suddenly, produce doesn't quite look right or is infested with insects, yield isn't what you hoped it would be. These are just some examples of how pest problems can present themselves. So, what should you do when you encounter such problems? Chemicals are not the only, nor often the best, option for controlling pest problems. Integrated Pest Management (IPM) is an alternative that utilizes and incorporates all appropriate pest management methods instead of focusing on a single method. This will often prevent some pest problems from developing in the first place and will reduce the severity of others.

What is IPM?

IPM has been a buzzword in agriculture since the 1970s. It has its fundamental basis in plant ecology and seeks to provide the plant with everything it needs to grow and thrive. In addition, IPM integrates multiple control tactics to provide a synergistic effect of the individual components. By definition, IPM is "a decision-making tool that utilizes cultural, physical, biological, and chemical pest management strategies to prevent economically-damaging pest outbreaks while reducing the risks to human health and the environment."

Each plant has its own set of pest problems. Think about the crops you grow — what are the common insects or diseases that you see regularly? Some plants are more prone to insect pest outbreaks while others may be insect-free but are continuously plagued by disease. The pests that occur regularly are the key pests around which your IPM program should be developed.

Only a relatively small number of insects and plant diseases account for the vast majority of all damage. These pests often occur annually and comprise the key pests. They may be categorized as either generalists, specialists, or opportunists.

- **Generalist pests** attack a wide range of plant species. Wireworms, seed corn maggots, and aster leafhoppers are some examples of generalist insects. Diseases tend to be more host specific, but some of the root rot pathogens such as phytophthora might be considered generalists.

A generalist pest: Aster Leafhopper (adult)

A specialist pest: Common asparagus beetle

Botrytis cinerea, grey mold, is a generalist disease on many fruits and vegetables. In an IPM program, management of generalist pests should be targeted toward the pest, not the host, since the host range is so vast.

• **Specialist pests** are restricted to only one or a few plant species. For example, asparagus beetles are specific only to asparagus while powdery mildew can attack any member of the cucurbit family. Control of such specialist pests is often achieved through host plant resistance or biological control. For example, planting cultivars of vine crops that are resistant to powdery mildew will prevent future outbreaks of powdery mildew, making fungicide applications unnecessary. With specialized pests you only have to monitor the susceptible host plants for the offending insects and diseases.

A specialist pest: Powdery mildew

• Finally, **opportunistic pests** are those that take advantage of stressed plants or overripe fruit. Picnic beetles in raspberries as a result of the fruit becoming overripe is an example of an opportunistic pest. This group of pests shouldn't be a problem because they can be avoided with a little attention to crop management.

An opportunistic pest: Picnic beetle

Monitoring

The second step in implementing an IPM program is to incorporate monitoring. You have to know what's out there in order to do something about it. The first step is knowing what the plant is supposed to look like. You must also know your enemy. Familiarize yourself with the key pests of the crops you grow. Know when they are likely to be a problem, and watch for them at that time of year. Early detection is your best defense in pest management. To be effective, monitoring must be done on a regular basis—at least weekly for most pests.

Monitoring is an ongoing process for market gardeners. Insect pests can migrate into a field unannounced and if you're not actively looking for them, you may not notice they have arrived until they have reached damaging levels; then your choice of control

methods is limited. This also applies to plant diseases. Rainy weather, fog, high humidity, or heavy dews provide ideal conditions for plant diseases. Check your plants carefully when weather conditions warrant. Similarly, the warmer the weather, the faster insects will develop.

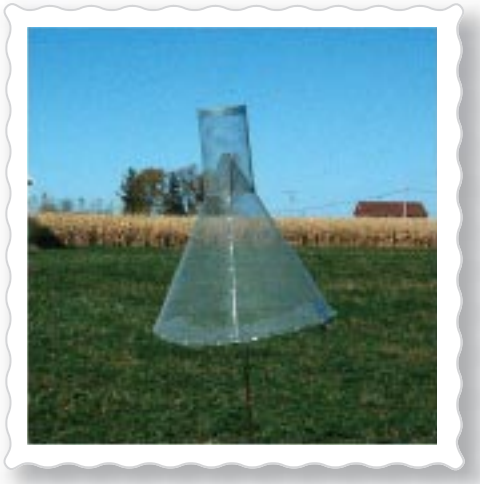
Visual Observation

Monitoring can be as simple as making visual observations of exposed-feeding insects, beneficial insects or parasitism, plant diseases, weeds, environmental disorders such as frost injury or drought stress, or the effect of improper cultural practices (nutrient deficiency).

Sweepnet sampling for monitoring large acreages

Sweepnet Sampling

Small insects or large acreages may be monitored more efficiently with the aid of a sweepnet. Leafhoppers, tarnished plant bugs, flea beetles, and aphids are particularly well-suited to sampling with a sweepnet. However, larger, erect or stiff crops such as raspberries, tomatoes, and peppers don't lend themselves to sweepnet sampling.



Corn earworm pheromone traps are pest specific

Trapping

Traps such as sticky traps, pheromone traps, or dishpan traps can also be used as part of a monitoring program and are available commercially. Yellow sticky traps can be used to monitor many different insect pests such as leafhoppers and some root maggot flies. Pheromone traps are very pest-specific and can be used to monitor such insects as the strawberry leafroller and corn earworm. In these traps, a lure is impregnated with a chemical attractant that simulates a chemical produced by the female insect of the species to attract a mate. The lure is put inside a trap that is then placed in or near the susceptible crop and checked regularly. When insects are observed in the trap, management strategies may be necessary depending on the number of insects caught and the growth stage of the crop. Another trap that is not as specific as pheromone traps is the blacklight trap. These traps are used to monitor the activity of nocturnal insects. Because they

Apple maggot trap

use light as their attractant, they are non-specific and several species of moths, beetles and occasionally bats are attracted to the trap. Blacklight traps can attract and kill beneficial insects as well.

Keeping weather station records helps predict pest outbreaks

Weather Monitoring

Weather monitoring is also important in predicting pest outbreaks or determining the likelihood of disease. When observing weather as a part of an IPM program, keep in mind that weather conditions as far back as six months or more can have an affect on plants today. Recording essential weather data such as the daily maximum and minimum temperature, precipitation, and whether it was sunny, cloudy, or rainy/snowy will go a long way when you're trying to determine the potential cause of a plant problem. For more information on the use of temperature in pest prediction refer to the Wisconsin Garden Facts X1085 *Phenology*, X1086 *Degree Day Calculation*, and X1087 *Degree Days for Common Fruit &Vegetable Insect Pests*.

Migration Monitoring

The previous discussion on pest prediction using degree days works only for those insects that have discrete life cycles and that overwinter in Wisconsin. Some insects go south to overwinter and migrate back into the state each spring. We can watch the migration pattern of such insects as the aster leafhopper, potato leafhopper and corn earworm to see where they are headed, when they can be expected to arrive, and whether they will reach Wisconsin in damaging numbers.

Economic & Aesthetic Injury Levels

Just because you encounter an insect or plant disease while monitoring doesn't mean you must do something. The extent of the infestation and how much pest damage you and your customer can tolerate determines if, or when, control should be initiated. With agricultural crops, thresholds have been developed that relate the amount of damage for a particular pest population to economic loss. This is referred to as the Economic Injury Level or EIL. Basically, if the cost of controlling a pest is less than the amount of money you'll lose because you can't sell the crop, control should be implemented. For example, if it costs $15/A to control corn earworms in a sweet corn field, but if you did nothing you would lose $20/acre because you couldn't sell your wormy corn, you've surpassed the economic injury level. However, because most of the crops grown for fresh market are sold based on their appearance and not necessarily for the yield per acre, Aesthetic Injury Levels or AIL are often used. They

are driven by consumer preference and are more subjective than EILs and therefore will vary from one situation to another. For example, the tolerance level of the amount of flea beetle damage to the tops of radishes packed in a CSA box will be higher if you include a note in your weekly newsletter about why the damage occurred. On the other hand, if you are selling sweet corn to a grocery chain and their customers will reject it because it has worms, you have a zero tolerance and any presence of a pest problem may cause you to lose that grocery chain as a customer. Noticeable numbers of spittlebugs in a pick-your-own strawberry field may deter pickers even though the insects are not causing a loss in yield or quality.

Management Strategies

When pests exceed tolerable limits, some type of action is often necessary to limit their impact. There are many strategies for managing pests, and some begin long before problems develop. In an IPM program there are four types of management strategies: cultural, physical, biological, and chemical. You may use one or any combination to manage pest problems. The use of multiple management strategies will often have a synergistic effect in controlling the pest. Regardless of what you choose, always utilize cultural control as your first line of defense against insects, weeds, and plant diseases. Use chemical pesticides as your last line of defense and only when pest numbers have reached damaging levels (EIL or AIL).

Cultural Control

Plant Health

Growing a healthy plant can go a long way to preventing pest problems from occurring in the first place. Every plant has its own ideal set of environmental conditions to which it is best suited. When selecting a site for a new planting, choose one that offers adequate area for root expansion, sufficient space for canopy growth, adequate moisture and drainage, provides the necessary levels of essential plant nutrients, and has the proper light conditions.

Providing crops with adequate moisture and nutrients is one of the most important cultural practices for maintaining optimal plant health. Most fruits and vegetables require regular irrigation, particularly on sandy soils. Timely irrigation during dry periods so that plants receive at least one inch of water per week is essential, particularly for young, or recently transplanted, plants. If leaves begin to wilt mid-day, plants are moisture stressed. Plants that wilt intermittently yield less, while plants that wilt frequently or that have been allowed to wilt too long may die or shed leaves and fruit due to irreversible cell damage.

Adequate moisture is essential for optimal plant health

Both drip and overhead sprinkler irrigation are effective. Drip irrigation works particularly well with colored plastic mulch that is used as a season extender and will keep the water off the foliage thereby reducing the risk of disease development.

Minimizing the time that foliage is wet will also preserve plant health. Using drip irrigation whenever possible, irrigating early in the day rather than at night so the foliage has a chance to dry more rapidly, avoiding excessive nitrogen fertilization which can lead to lush growth, and weed management to facilitate air circulation around the desirable plant will reduce the development of plant diseases.

Fertilizing plants so they are healthy and vigorous will allow them to out-compete many pest problems. In many cases a single incorporation of fertilizer prior to planting is all that is necessary. However, heavy feeders may require supplemental fertilizer applications during the season. Be careful not to overfertilize as this may lead to lush growth and a completely different set of pest problems.

Crop Rotation

Crop rotation has been around almost as long as farming—which should indicate that there must be some merit to the practice of not planting the same thing in the same location year after year. Rotating crops to different areas of a particular field or rotating fields helps avoid pest problems or depleting nutrients. Don't plant crops that have the same nutrient demands in a given location in successive years. Reduce the chance of insect or disease organisms building up in the soil by not planting the same type of plants over and over in the same spot. Plan ahead before planting—keep track of where crops were planted the previous season and make a plan to put each in a different location in the upcoming season. It may be beneficial to draw a map with the location of each crop and save this map to avoid planting the same crop in that location the next year. "Perennial" crops such as strawberries can also be rotated. Because strawberry beds need periodic renovation, relocate these beds during the renovation process.

A four year crop rotation is best. Anything shorter than that and you run the risk of disease organisms carrying over, although the spores of some plant diseases can remain in the soil for up to 10 years or more. A rotation longer than four years may be difficult to implement, particularly if space and species are limited.

For rotation purposes, crops can be divided into four main groups according to the conditions they require. Onions and other alliums, solanaceous crops, sweet corn, and squash require deep cultivation and a high level of soil organic matter. Beans and peas are legumes capable of fixing nitrogen, so they will not need additional fertilizer prior

to planting but still require deep cultivation. Root crops such as radishes, carrots, beets, turnips, and rutabagas also require deep cultivation for proper root development, but the addition of organic matter or manure will cause the roots to become disfigured. And cabbage and other cole crops require a firm soil with an alkaline pH to avoid succumbing to clubroot.

Plants in the same family are susceptible to the same problems, and should not follow one another in a rotation. When mapping out your farm and planning your rotation, remember that potatoes, tomatoes, peppers, and eggplant are all in the family Solanaceae. Some other plant groups include beans and peas (Fabaceae); all vine crops (Cucurbitaceae); and radishes, rutabagas, and turnips are all related to cole crops (Brassicaceae).

Also, try to plan the rotation so that successive crops benefit from their predecessor. For example, sweet corn is a heavy feeder so it's best to plant sweet corn in an area where legumes were planted the previous year because these crops add nitrogen to the soil. Potatoes and vine crops are easy to weed and will "clean" the soil, thereby reducing weed problems in subsequent onion and root crops that are not easily weeded and have a small canopy that does not shade out weeds.

Remove fallen apples to reduce pests

Sanitation

Sanitation is a cultural practice that reduces or eliminates the source of certain pest problems. It is particularly important in disease management.

- Till infected plant debris deeply into the soil each fall or remove it from the field to reduce disease pressure. Composting of diseased plant material is not recommended unless your compost pile reaches the high temperatures necessary to kill disease-causing organisms.
- Remove dead plant material in the fall to reduce overwintering sites for some insects. Asparagus beetles overwinter as adults in crop residue or trash, so cleaning up all the old ferns will eliminate many places for the beetles to hide.
- Removing weedy vegetation from fence rows, ditches and other areas adjacent to the field will also eliminate overwintering sites for insects, alternate hosts for plant disease, and a source of refuge for pests during the season.
- Removing all ripe fruit from berry plantings will reduce the attractiveness of the field to picnic beetles.

Plant Selection

When deciding which of the many cultivars you might plant, consider not only your customers' preference but also which cultivars are best suited for your growing conditions. Some cultivars are better suited for northern Wisconsin because of their cold toleranceor shorter maturation period. Others may be better able to withstand the heavy clay soils along Lake Michigan. Another important consideration when selecting plants, particularly in the case of strawberries, raspberries, and vegetable transplants, is to purchase your plants from a reputable dealer that sells plants that are certified to be free of certain pathogens. Inspect all plants on arrival and before planting to be sure they are indeed healthy appearing and insect free.

Disease Resistance

Many fruit and vegetable cultivars are resistant to, or tolerant of, specific plant diseases. Resistance is not immunity—these cultivars may still develop some disease, but their yield is not greatly affected. Note that no cultivar is resistant to all diseases. In many cases the use of resistant cultivars can reduce or eliminate pesticide use, or allow the production of a crop when otherwise it wouldn't be possible. Some seed catalogs mention disease resistance when describing the cultivars they offer.

Some heirloom cultivars have not been selected for disease resistance

Growing heirloom cultivars has become popular in recent years. Heirloom plants are old-fashioned selections that haven't been significantly changed by plant breeding. Many of these cultivars were selected hundreds of years ago for characteristics like flavor or color. Heirloom seed is available from several seed companies or it can be obtained from other gardeners. It is important to understand that heirloom vegetables are often the ancestors of modern-day cultivars and that they differ from today's cultivars in that there has been no selection for disease resistance, uniformity, or prolonged storage characteristics.

You should be aware that if you choose to save seed from one year to the next, some plant diseases are carried on or in the seed and this is one way for diseases to survive from one season to the next. Some bacterial, seed-borne diseases can be killed by immersing the seed in a hot water bath prior to planting. The temperature and timing varies depending on the disease; it is critical that you strictly follow the instructions to successfully inactivate the disease but not kill the seed as well. For more information on this topic, see the UWEX publication series *Growing … in Wisconsin* for various crops.

Adjusting Planting Dates

By delaying planting or avoiding certain periods of the year when pest pressure is greatest, you can effectively avoid economically important pest damage. Waiting until the soil has warmed sufficiently before planting seeds of warm season crops such as sweet corn and beans will reduce their susceptibility to soil-borne disease and attack by seed corn maggots. Monitoring degree day accumulations to avoid planting onions when the onion maggot is active is another example of adjusting planting dates.

Row covers allow light and water to penetrate but keep pests out

Physical/Mechanical Control

Physical or mechanical methods may also be employed in an IPM program. They are often used when cultural controls aren't practical or effective. "Squash the bug, create a barrier, modify the environment." This describes physical or mechanical control.

• Physical barriers prevent pests from getting to the plant. Floating row covers, lightweight spun-bonded polyester fabric that allows light and water to penetrate, can keep a broccoli or cabbage crop essentially worm-free. Damage from spinach leafminer or flea beetles can also be prevented by covering the plants with floating row covers. Floating row covers are commercially available and come in various thicknesses for different purposes (thicker ones also hold warmth in, so they can also be used as season extenders). Cardboard or plastic collars can be placed around individual plants to prevent cutworm damage, and a paper or plastic disc can be laid on the soil surface around the base of cabbage transplants to discourage cabbage maggot flies from laying their eggs on the plants.

Plastic and straw mulch suppress weeds

• Another aspect of physical control is environmental modification. Adjusting temperature and humidity are two environmental conditions that can be modified to give the crop a competitive edge over pests. Modify the environment by orienting your garden rows in a east-west direction to allow winds to speed up drying of the foliage. Pruning or increasing plant spacing will increase air movement around fruit or vegetable plants to promote more rapid drying. This

will reduce moisture levels that most pathogens require to infect plants and thereby decrease disease problems. Some insects prefer dense cover and keeping the area open will discourage them. For example, tarnished plant bugs find refuge in weedy field edges. Keeping strawberry beds well weeded and open will reduce tarnished plant bug infestations.

• Organic or plastic mulch can be used to suppress weeds, warm up the soil to allow planting earlier in the season (clear or opaque plastic only), and keep soil from splashing onto the plant.

• Post-harvest humidity and storage conditions are also important in preventing produce from rotting before it's sold. Keep the produce cool and avoid fluctuating temperatures that will result in condensation, which in turn will raise the humidity. Pay close attention to the recommended temperature and humidity conditions for each fruit and vegetable crop you grow.

Biological Control

Biological control can be used to treat certain pests, but is not appropriate for all problems. Biological control uses natural enemies such as predators, parasites, and pathogens that attack pests. You must be able to tolerate a low level of the pest in order for the beneficial organism to survive. Also, there is often a lag time between the outbreak of a pest population and when the control agents become effective. Some natural enemies must be applied when pest populations are still relatively low—which requires monitoring to determine the optimum time to release them. Commercial businesses sell many beneficial organisms that can be used to reduce pests to tolerable levels. For example, you can purchase green lacewing larvae that are voracious predators andwill eliminate aphid infestations within a few days under the right conditions. You can also conserve those natural enemies already in the landscape by reducing indiscriminate pesticide use (that kills both "good" and "bad" insects). Lady beetles will often move into unsprayed areas and eat all the aphids on a plant, sometimes almost overnight. Late in the season aphid colonies are often wiped out by naturally-occurring insect-attacking fungi, if those fungi haven't been killed by chemical fungicide sprays.

Providing a habitat for the natural enemies of crop pests can be a viable way to reduce harmful insects

Other ways to encourage natural enemies include providing a habitat for the natural enemies, providing nectar sources for certain beneficial insects, and reducing the negative impact of cultural practices such as clean cultivation. Insect-attacking wasps need food and shelter, so providing flowers for them to feed or rest on will keep them

around your farm. For more information on biological control refer to NCR publications 471 *Biological Control of Insect Pests of Cabbage and Other Crucifers*, 481 *Biological Control of Insects and Mites* and 581 *Biological Control of Insects and Other Pests* of Greenhouse Crops available through your county Cooperative Extension office.

Chemical Control

Finally, if all else has failed, you may resort to pesticides to reduce pest levels. Regardless of whether you choose to use an organically-acceptible or synthetic chemical pesticide, it's important to properly time the application to the most susceptible life stage of the pest. Most microbial insecticides are effective only when applied to the youngest stages of the pest. It's easy to determine when to apply pesticides for many pests with the use of phenology. Also, when using pesticides, make sure you select the most appropriate material for your situation and read the entire label before buying, using and storing the product. For more information, see the UWEX publications A3422 *Commercial Vegetable Production in Wisconsin* and A1934 *Strawberry and Raspberry Management in Wisconsin*.

A Final Word

Not all maladies that appear in the market garden are the result of insects or plant diseases. In fact, a majority of problems arise because of improper cultural practices or environmental conditions to which the crop is subjected. Because these problems are not caused by living organisms, and because they disrupt the normal structure or functioning of the plant, such maladies are called "physiological disorders." Examples of such disorders include blossom end rot of tomatoes caused by insufficient calcium uptake as a result of irregular rainfall or irrigation. Forking in carrots because manure was added to the soil in the spring is another example. Ricey curds occur when cauliflower is exposed to excessive heat that causes the surface of the curds to separate into very small grains. Sunscald of tomato fruit may result when a plant is defoliated by plant diseases. Catfacing is the development of deep indentations in the blossom end of tomatoes that occurs when the fruit is exposed to temperatures below 50°F. These are just some of the physiological disorders that affect vegetable crops.

When trying to identify the cause of a problem, keep in mind that a plant disease or insect pest may not always be the culprit. Also remember that once a physiological disorder occurs, it can't be remedied, the blemish remains, and there are no pesticides that will correct or prevent the problem.