BEST MANAGEMENT PRACTICES FOR MONITORING

IPM is information-driven, and monitoring is the front-line for information-gathering. Careful monitoring tells you what pests and beneficials are in your crops, how many and when.

HOW TO MONITOR

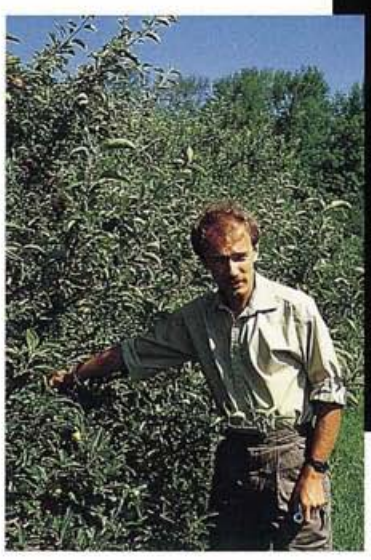
Monitoring begins by taking representative samples of plants, insects and weeds. The size, type and number of samples necessary for each pest and crop combination are determined by research. It's important to sample correctly in order to get an accurate picture of the problem.

Sampling can tell you whether:

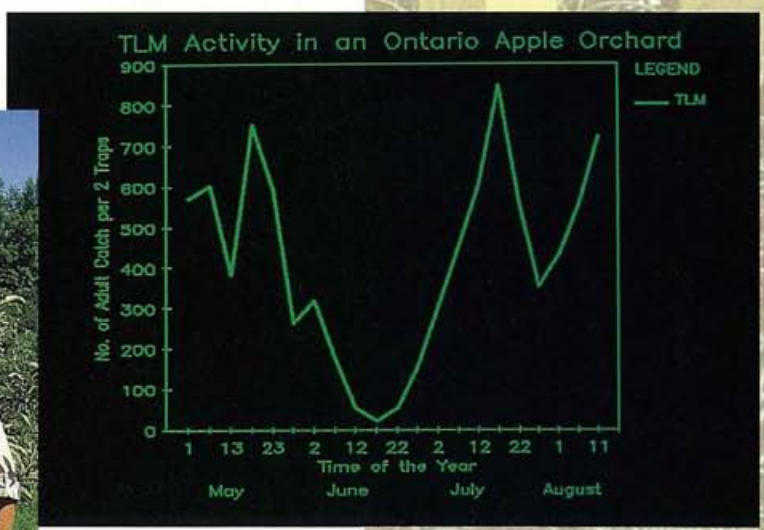
- ▸ the pest is indirect
  - ▷ a certain low level is usually tolerable
- ▸ the pest is direct
  - ▷ its presence should be detected as soon as possible and action taken if thresholds are reached
- ▸ the pest has the potential to increase very rapidly
  - ▷ if so, it will need constant monitoring
- ▸ natural enemies are present
  - ▷ if so, at what level and their contribution to pest control
- ▸ any pest control actions have been successful
- ▸ the pest complex has changed.

Sampling methods vary according to the pest and its stage of development. In the case of leafrollers on fruit, pheromone traps are used to sample for adults, and terminal growth on the trees is checked for larvae.

For weed sampling in field crops like soybeans and corn, sometimes the field is scouted in a W-pattern and 20 quadrants are sampled along the W. Other times, a certain row-length is sampled 10 times in the field and the weeds are counted along these rows.



When monitoring in an orchard, leaves must be chosen correctly in order to get a representative sample.



Monitoring the tentiform leaf miner flight using pheromone traps gives us information that can be plotted on a graph each week. This provides a seasonal picture of the population.

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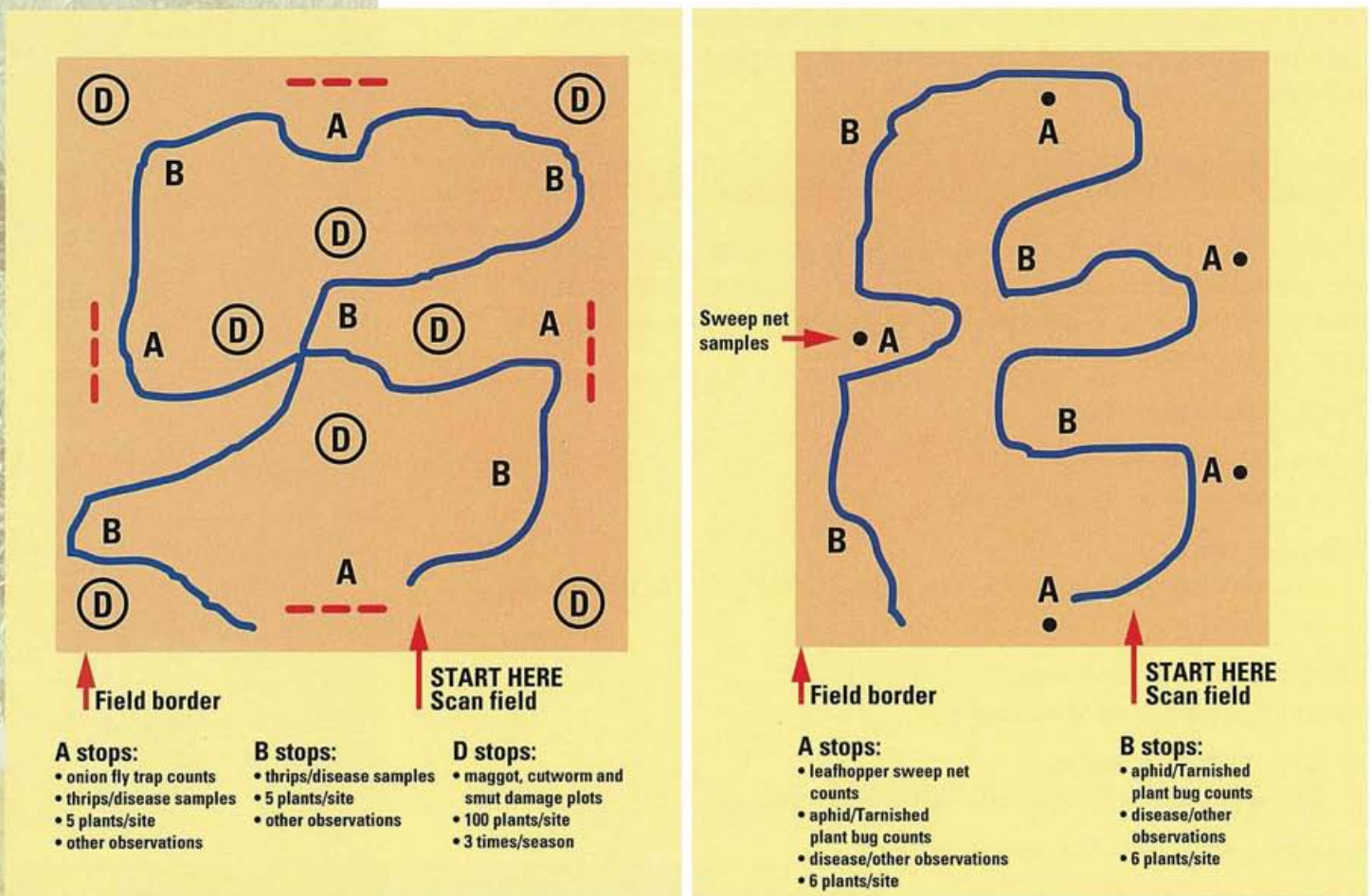

Each field is mapped and sampled by the scout in a prescribed way, depending on the crop and the pests. On the left is a field scouting pattern for onions; a pattern for lettuce is shown on the right.

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The following techniques are used to sample for pest and beneficial species. The method you choose will depend on the biology and stage of the pest. To find out more about pest biology, see page 17.

VISUAL COUNTS

The visual count technique lets you estimate numbers of pests and beneficial species per plant or unit area. It's used for weeds, diseases and insects. Leafhoppers, mites and potato beetles are commonly monitored this way.

A 10x-16x hand lens is often used, and a microscope may be necessary for small insects and diseases. Sampling protocol often prescribes a designated number of leaves when sampling for disease lesions per leaf or mites per leaf.

Apple scab lesions are also visible by the naked eye.

Aphids on the back of a rutabaga leaf can be seen without a hand lens or microscope.

European red mite eggs require magnification to be counted.

In the field, a 10x hand lens is used to see small insects.

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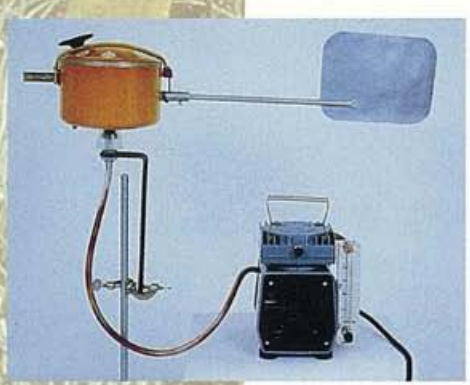
There are several kinds of traps.

TRAPS	
PHEROMONE TRAPS	• sticky cardboard traps with a capsule containing synthetic sex attractants specific to the pest to be monitored • these tell us when the adult male flight of insects begins, when it peaks and its duration • also used to monitor the spread of a pest into a new area, e.g., Japanese beetle, gypsy moth
STICKY TRAPS	• the colour is specific to the pest being monitored – can be yellow, orange, blue or white panels, or red spheres • covered with an adhesive to catch the insects when they land
PITFALL OR INTERCEPTION TRAPS	• trenches or holes are constructed to catch insects as they walk by, e.g., Colorado potato beetle
BLACK LIGHT TRAPS	• many insects are attracted by UV light • useful for monitoring insects that are not easily attracted by pheromones, e.g., cutworms
BAIT TRAPS	• made of the crop itself, or may be bait recipes
SPORE TRAPS	• used to monitor fungal diseases of plants by catching spores that cause infections on the crop • information gathered tells us whether the spores are present and mature • need to monitor the spores, the weather and the growth stage of the crop to determine whether disease will result



Spores that infect plants and cause disease can be monitored with spore traps.

The black light trap attracts many species of flying insects.

Adult male moths of the oblique-banded leafroller can be monitored using a pheromone trap. In a commercial orchard, four traps per orchard are used to monitor adult activity.

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The tentiform leaf miner male moth is attracted to the pheromone emitted by the rubber septum in this trap.

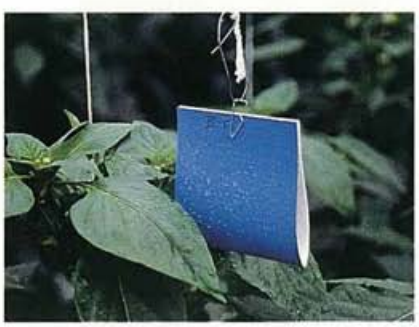
A carrot piece is used to attract carrot weevil.

INTERPRETATION OF TRAP COUNTS

From catches in the traps, we can track the seasonal development of the pest and determine when the population reaches action thresholds. Trap counts reveal activity patterns of a pest population. These counts only give a rough estimate and can be affected by placement, condition of the lure, competition from real females for the pheromone traps, and the density of the traps. Generally, professional help is required to interpret trap counts.

Trenches or pitfall traps are used to trap adult Colorado potato beetles as they return to the potato fields in the spring.

Sticky traps come in different colours because insect species have colour preferences. Orange sticky traps attract carrot rust fly. Yellow attracts onion maggot flies. Blue attracts thrips in greenhouses.



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SWEEP NETS

Sweep nets consist of cloth nets on frames. They are used in the field to determine the presence and the numbers of many foliar insects that can be dislodged, such as leafhoppers on carrots, celery and alfalfa.

TAPPING TRAYS

A tapping tray is made of cloth stretched over a wooden frame. A stick is used to jar insects from the limbs of trees onto the tapping tray. Usually the cloth is white or black so that falling insects can be counted easily. Tapping trays are also useful for monitoring beneficial insects.

Carefully inspect each set of traps on a tapping tray to identify the insects.

A sweep net is used to sample for leafhoppers in a lettuce field.

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WEATHER MONITORING MACHINES

Insect, disease, weed and crop development is temperature- and moisture-dependent, and varies from season to season. This means that weather must be monitored continuously to predict the best timing for IPM practices. Weather data collected by machines are used to drive pest models. For some pests, weather data are very important to time controls.

This solar-powered weather station will monitor weather in a vegetable field.

Weather data form a key part of the IPM equation. This machine is used to forecast early and late blight diseases of potato.

Commercial disease predictors are available. This one measures leaf wetness and temperature, and indicates the occurrence of an apple scab infection period.

HOW TO IDENTIFY PESTS

Control measures will not be effective if they target the wrong pest. That's why correct identification is so important. Sometimes a problem that you might think is caused by pests is in fact due to nutrient deficiencies, air pollution or stress from other environmental factors.

Three types of information should be gathered to make the right identification.

What does it look like?

- the physical appearance of an insect or weed will differ depending on the species and the stage of development – for example, a weed seedling can be quite different from a mature weed, just as an insect in the caterpillar stage doesn't look at all like a butterfly or moth

The roots of the corn plant on the left have been eaten by corn rootworms. Compare them to those of the normal plant on the right.

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Where is it found?

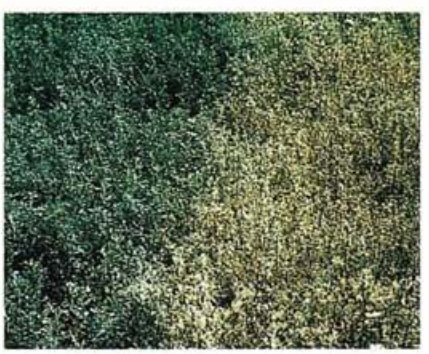
- ▸ understanding where to look for a particular pest helps to streamline monitoring
- ▸ most pests attack a particular part of the host plant, and observing damage may be a good indication of a pest's presence
- ▸ pests have a particular set of hosts that they attack – knowing these can help with identification

When is it found?

- ▸ knowing the time of year when you might encounter a particular life stage of a pest is useful
  - ▷ helps to determine when to spend time and resources on monitoring for the pest problem. For example, both the potato stem borer and the European corn borer tunnel in corn stalks. But the potato stem borer does it in the seedling stage, whereas the European corn borer tunnels in the mature plants.
- ▸ to control weed seedlings through cultivation, you need to know when seedlings are present, e.g., spring annuals versus winter annuals that germinate in the fall
- ▸ to control pests, you should be familiar with life cycles – see next section for more information
  - ▷ if a small caterpillar is found in an apple orchard at petal fall, you can eliminate the oblique-banded leafroller because you know that it would be a very large caterpillar at that time of the season
  - ▷ for corn rootworm, from mid-June to mid-July look for the larvae tunneling through and pruning the roots; in August, the adults feed on corn silks
  - ▷ for alfalfa weevil, the larvae should be checked from mid-May to June, with the peak of the larval attack coinciding with the flower bud stage of the first cut

To identify the European corn borer, look for pinhole feeding on the leaves, and stalk breakage due to seeding on the stalk and holes in the stalk.

The alfalfa weevil lays eggs in holes it has made in plant stems.



This alfalfa field has been seriously damaged by alfalfa weevils.

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LIFE CYCLES OF PESTS

Most pest controls are aimed at a specific stage of the life cycle, when the pest is most susceptible. This makes monitoring of pest development very important. For example, pre-emergence herbicides only work if applied before the weeds germinate. Protectant fungicides won't work after the infection has taken place, Colorado potato beetle sprays are most effective on young larvae, and Colorado potato beetle trenches are only effective for adults.

Some pests require more than one host to complete their life cycles.

Alternate hosts may live on the farm in areas adjacent to the crop. For example, barberry is an alternate host for black stem rust of small grains such as wheat, oats, barley and rye.

Some pests have a wide **host range** and can survive on many different crops. You need to be familiar with the host range of particular pests, and consider it when you plan crop rotations and field locations.

The life cycle of the Colorado potato beetle begins with eggs, which hatch to produce tiny larvae.

Larvae grow quickly and eat a lot of foliage.

The adult is a beetle.

The Colorado potato beetle can inflict heavy damage on a potato field.

Apothecia of *Sclerotinia sclerotiorum* appear on the soil surface when conditions are moist and cool. Spores are discharged from the apothecia and carried by the wind to infect bean plants.

The *Sclerotinia* fungus infects bean plants, causing white mould symptoms to appear.

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USING MODELS

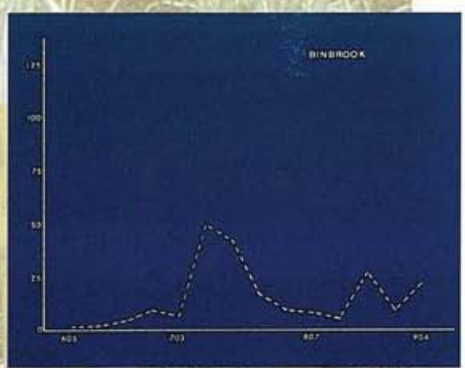
There are several pest models that are used in Ontario, such as Botcast, Tomcast, Machardy-Gadoury revised Mills system, Simweevil, Maryblyt, Blytcast, Bugwatch and Downcast.

Researchers build pest prediction models to predict the development of the crop and pests as affected by the weather. Researchers do not rely on calendar days to predict crop development, but on real events happening in the field.

Models can be simple or complex, and are driven by data obtained by monitoring the pest and weather. They use temperature, humidity and rainfall because insect, crop, weed and disease development is closely linked to environmental factors.

Development is related to accumulated heat units or degree-days. One degree-day is the heat experienced by the pest or crop when the temperature is one degree above the threshold temperature for development for 24 hours. A specific number of degree-days is needed for the pest to develop through each stage.

A model begins with an easily detected event such as a first catch of an adult insect in a pheromone trap. It is then used with heat units to predict difficult-to-detect events like egg hatch or peak moth flight. Models don't replace sampling, but help to predict when we need to sample or implement a control option.



European corn borer catches for the season can be graphed.

RECORD-KEEPING

IPM records should combine all of the information gathered on pest control methods, monitoring records, weather records, cropping practices and yield data.

Record-keeping is a daily job throughout the season. After the growing season is over, records should be analyzed to understand what happened and how things could be improved for the future.

Here are some of the benefits of record-keeping:

- ▸ helps you evaluate your results
- ▸ helps you plan pest control strategies for the next year
- ▸ assists with planting and harvesting schedules
- ▸ solves application or phytotoxicity problems
- ▸ documents your use and costs of pesticides and other alternative controls
- ▸ contributes to the information base for making the best IPM decisions in future
- ▸ helps you plan labour, marketing and equipment needs
- ▸ helps you evaluate your options for applying biological control agents.