INTEGRATED PEST MANAGEMENT

Unit 1 Lesson 4
Johnny Appleseed Would Be Proud

Focus Areas: Pest Identification and Control; Science, Computer Science, Language Arts

Focus Skills: Using the Internet to access information, reading and summarizing expository material, completing an outline, creating a visual aid, developing an action plan

Level of Involvement: AVERAGE

IPM
INTEGRATED PEST MANAGEMENT

University of Connecticut
College of Agriculture and Natural Resources
Cooperative Extension System

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Dedicated to Reducing Pesticides

Objective

To diagnose and develop an action plan for control of an apple disease

Essential Questions

* What diseases threaten apple crops in the Northeast?
* How can IPM techniques be used to combat these diseases?

Essential Understanding

The use of chemical controls to combat plant diseases can be reduced by applying IPM techniques.

Background

* Read articles on pages 8, 9 and 12 in *Integrated Pest Management in the Northeast Region.*
* Use the web site http://eap.mcgill.ca/CPAP_6.html to become familiar with apple diseases in the Northeast.

Vocabulary

bacteria a single celled microorganism chiefly parasitic or saprophytic

canker a corroding or sloughing ulcer (sore) causing decay

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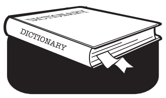
Vocabulary (continued)



fungus thallophytic plants with no chlorophyll (mildew, mold, rust, smuts, mushrooms)

lesion any morbid change in the structure of organs or parts; a hurt or injury

mildew a thin whitish growth produced on plants and organic matter

rust parasitic fungi causing spots or discolorations on the leaves and stems of higher plant orders

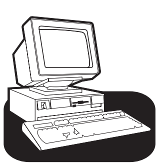
Challenge

Diagnose a given plant disease and develop a plan to combat it

Logistics

Time: two 45-minute sessions
Group size: governed by computer access (no more than four individuals per computer)
Space: computer lab or class room

Materials



computers with Internet access
a list of diseases to be researched (see **Preparations**) *
overheads or copies of pictures of diseased apples *
articles 8, 9, and 12 in *Integrated Pest Management in the Northeast Region* *
Worksheet 1 Apple Diseases *
Handout 1 Steps and Tactics of IPM: The Nuts and Bolts *
Handout 2 Directions for Research of Apple Diseases *
Handout 3 IPM Action Plan *
Assessment for IPM Action Plan *
plain white paper and drawing tools
black/white board or chart paper
overhead projector

* single copy provided

Unit 1 Lesson 4: Johnny Appleseed Would Be Proud

Preparations

1. Schedule time to use computers

2. Write the names of apple diseases on individual slips of paper

Diseases: Apple Scab, Fire Blight, Powdery Mildew, Cedar Apple Rust, Black Rot, Sooty Blotch, Fly Speck, *Phytophthora* Rot

3. Prepare individual copies of the worksheet and handouts

4. Review the vocabulary and background material

5. Procure an overhead projector

Activity

Introduction

1. Have the group list adjectives to describe the perfect apple. Record on a black/white board or on chart paper.

2. Display and discuss the overheads of diseased apples.

3. Have the group speculate on what might have caused apples to appear this way.

4. Write the lesson "Challenge on the board.

Involvement

1. Distribute and discuss Handout 1 Steps and Tactics of IPM: The Nuts and Bolts.

2. Distribute the direction sheet to individuals and review.

3. Distribute the plant disease slips for research.

Activity

Involvement (continued)

4. Assign the groups to Internet-accessed computers. **Note:** Group participants according to the disease to be researched (8 in all) with no more than four individuals per computer.

5. Allow time to research disease and take notes in order to complete Worksheet 1.

6. Have individuals complete Worksheet 1.

Follow Up

1. Distribute Handout 3 IPM Action Plan.

2. In groups of four, formulate an action plan to combat the disease researched.

3. If numbers dictate, allow time for action plans to be shared between/among groups who researched the same disease.

4. Share action plans.

5. Discuss components of IPM involved in each action plan.

Answer Key

none needed

Follow Through

Focus Areas: None
Focus Skills: Comparing and Contrasting

Regroup participants in teams of two (each member having researched a different disease. For example, Apple Scab with Fire Blight). Have the duos create a Venn diagram for two diseases.

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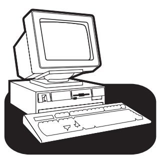
Assessment

Option #1 Collect and evaluate IPM Action Plans produced in initial activity.

Option #2 Collect and evaluate Venn diagrams created in the **Follow Through.**

Resources



Internet Websites

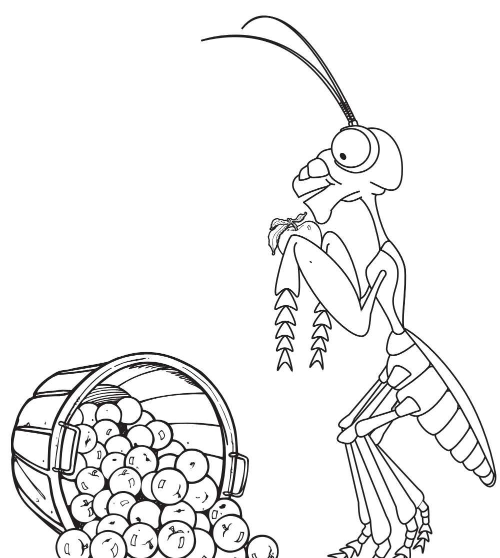
http://orchard.uvm.edu/uvmapple/hort/PresentationsHort/Back%20to%20basics%20workshop.pdf
(**a must**)
http://eap.mcgill.ca/CPAP_6.html
http://www.caf.wvu.edu/kearneysville/wvufarm8.html#apple
http://www.hgic.umd.edu/diagn/main_win1.html
http://pmo.umext.maine.edu/apple/modeintro.htm

Note: Participants should be allowed to explore other websites for information

http://www.hort.uconn.edu/ipm/ipmtrfr.htm
http://www.hort.uconn.edu/ipm/general/misc/contents.htm

Notes

Notes



Notes

Handout 1

Steps and Tactics of IPM: The Nuts and Bolts

Integrated Pest Management is about managing pest organisms scientifically , in a socially and environmentally sound way. As such, IPM is a specialized form of environmental management wherein scientific research and real world application work together. This involves both a step-wise process and tactical components of management. The six steps of IPM are followed no matter which environment is harboring what pests. Tactics chosen will depend upon circumstances. A list of these steps is below. Details follow explaining each step and tactic.

Steps of IPM

1. **Proper identification**
2. **Learn pest/host biology**
3. **Sample environment for pests**
4. **Determine Action Threshold**
5. **Choose tactics (following)**
6. **Evaluate results**

Tactics of IPM

1. **Cultural**
2. **Physical**
3. **Genetic**
4. **Biological**
5. **Chemical**

    "Biorational"
    "Conventional"

6. **Regulatory**

Handout 1

Six Steps of IPM

1. Proper identification of damage and responsible "pest"

Cases of mistaken identity may result in ineffective actions. If plant damage due to over-watering is mistaken for a fungal infection, a spray may be used needlessly and the plant still dies. If a beneficial insect is eating aphids on a sickly plant, the insect might be killed because of circumstantial evidence , and make the problem worse.

2. Learn pest and host life cycle and biology

At the time you see a pest, it may be too late to do much about it except maybe spray with a pesticide. Often, there is another stage of the life cycle that is susceptible to preventative actions. For example, weeds reproducing from last year s seed can be prevented with mulches.

3. Monitor or sample environment for pest population

Preventative actions must be taken at the correct time if they are to be effective. For this reason, once you have correctly identified the pest, you begin monitoring BEFORE it becomes a problem. For example, in school cafeterias where roaches may be expected to appear, sticky traps are set out before school starts. Traps are checked at regular intervals so you can see them right away and do something before they get out of hand. Some of the things you might want to monitor about pest populations include:

* pest present/absent?
* distribution - all over or only in certain spots?
* increasing or decreasing in numbers?

4. Establish action threshold (economic, health or aesthetic)

In some cases, a certain number of pests can be tolerated. Soybeans are quite tolerant of defoliation, so if you have only a few caterpillars in the field and their population is not increasing dramatically, there is no need to do anything. Conversely, there is a point at which you MUST do something. For the farmer, that point is the one at which the cost of damage by the pest is MORE than the cost of control. This is an economic threshold. Tolerance of pests varies also by whether or not they are a health hazard (low tolerance) or merely a cosmetic damage (high tolerance in a non-commercial situation). Personal tolerances also vary - many people dislike any insect; some people cannot tolerate dandelions in their yards.

5. Choose appropriate combination of management tactics

For any pest situation, there will be several options to consider. See Six Tactics section following.

6. Evaluate results

Did your actions have the desired effect? Was the pest prevented or managed to your satisfaction? Was the method itself satisfactory? Were there any unintended side effects? What will you do in the future for this pest situation?

Handout 1

Six Tactics of IPM

The goal of using multiple tactics or many small hammers is to effectively suppress pests below injurious levels and avoid outbreaks. Many tactics keep pest populations off-balance and avoid development of resistance to pesticides. Least-toxic effective methods are used before more toxic ones whenever possible. What are the categories of tactics and specific actions included in each?

1. Cultural methods

Suppress pest problems by minimizing the conditions they need to live (water, shelter, food). Planting plants that are adapted to your growing conditions, planting them in the right place, giving proper attention to their water, nutritional, and other needs. Strong plants resist diseases, outgrow weeds and are less likely to succumb to insects.

2. Physical methods

Prevent pest access to the host or area, or, if the pests are already present, physically remove them by some means. For example, this could mean using barriers, traps, vacuuming, mowing or tillage, depending upon the pest and situation.

3. Genetic methods

Use pest-resistant plant varieties developed by classical plant breeding. Recently, this category has been expanded to include genetically engineered pest resistance, such as *Bt* corn or potatoes. There are also special uses of genetic techniques on pests themselves, such as sterile male insect releases.

4. Biological methods

Use predators, parasites and diseases of pests in a targeted way to suppress pest populations. Use of microbial diseases of pests has become part of the chemical pesticide registration process and is discussed below under Chemical methods. Use of predators and parasites as biocontrol for pests is handled in one or more of 3 ways:

a) conservation and encouragement of naturally occurring biocontrol organisms by cultural techniques or at least avoidance of harming them

b) augmentation of naturally occurring species by purchasing and releasing more of the same

c) classical biological control in which new biocontrol species specific to pests are sought and introduced

5. Chemical methods

There are many chemicals that are used in pest management situations, but not all chemicals are alike from the standpoint of their range of action, toxicity, or persistence in the environment.

Six Tactics of IPM

"Biorational"

Biorational chemicals are those that are less universally toxic and target a specific aspect of pest biology. An example might be diatomaceous earth used to scratch the surface of insects to dehydrate them, or microbial pesticides that affect only a specific group of insects.

There are some biorational chemical tactics that are hard to classify by toxicity or that are used together in innovative ways with other tactics. An example of this would be insect pheromones used together with sticky traps. Pheromones are the chemicals produced by insects to attract their mates, and so these substances are not toxic. But they can be used in large amounts to confuse the mating process or to attract insects to a trap. Other examples of such chemicals are repellants, attractants, and antifeeding agents.

"Conventional"

Conventional pesticides currently refer to synthetically produced compounds that act as direct toxins (nerve poisons, stomach poisons, etc.). There are many new classes of chemicals being added to the older conventional pesticides.

6. Regulatory

Regulatory control refers to the role played by government agencies in trying to stop the entry or spread of pests into an area or into the country via inspection, quarantine, destruction of infested material, and other methods.

Directions for Research of Apple Diseases

You have been assigned a disease that affects apple orchards in the Northeast. Using the Internet sites listed and others you may find on your own, find and record the information needed to diagnose and control this disease.

Internet sites:

http://www.nysaes.cornell.edu/pp/extension/tfabp/pome.shtml

http://www.nysipm.cornell.edu/factsheets/treefruit/index.html

http://orchard.uvm.edu/uvmapple/hort/PresentationsHort/Back%20to%20basics%20workshop.pdf **(a must)**

http://eap.mcgill.ca/CPAP_6.html

http://www.caf.wvu.edu/kearneysville/wvufarm8.html#apple

http://www.agnr.umd.edu/users/hgic/diagn/main_winl.html

Handout 3

IPM Action Plan

Using the information you found:

1. Create a graphic illustrating the life cycle and spread of this disease.

2. With other members of your assigned team, develop an IPM Action Plan to control this disease. **Note:** Consider and incorporate the steps of IPM in developing your action plan. Check the assessment evaluation form to make sure that you have included all parts of your plan.

3. Be prepared to report your findings and IPM Action Plan to the group.

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Worksheet 1

Apple Diseases

Complete notes on the following topics:

1. Name of the disease

2. Cause of the disease

3. Symptoms of the disease

4. How the disease is spread / life cycle

5. Conditions affecting the spread: weather, soil, temperature, etc.

6. Management / control of the disease

You may use this sheet for your notes. Add others as necessary.

Assessment for IPM Action Plan

	Possible points	Points earned
1. The pest is correctly identified.	_______	_______
2. The pest s biology is summarized correctly.	_______	_______
3. Adequate environmental monitoring is included in the plan.	_______	_______
4. An accurate action threshold is determined.	_______	_______
5. The tactics chosen to combat the pest are logical.	_______	_______
6. The choice of tactics is supported.	_______	_______
7. The directions for implementation are clear.	_______	_______
8. The directions for implementation are complete.	_______	_______
9. The directions for implementation are accurate.	_______	_______
10. A procedure for evaluating results is included.	_______	_______

Directions to teams:

Based on the above evaluation form, develop an IPM action plan to control the threat to your apple crop. Be sure to include all focus areas of the above assessment in your plan. Use Handout 1 Steps and Tactics of IPM: The Nuts and Bolts to help you formulate your plan.

Fig. 14 – Apple scab lesions on leaves and fruit.

Fig. 15 – Apple scab lesion on young fruit.

Fig. 16 – Early symptoms of blossom blight (fire blight). Note ooze droplets and discoloration of pedicel.

Fig. 17 – Blossom blight (fire blight) on pear.

Fig. 18 – Shoot blight (fire blight) with characteristic crook at tip.

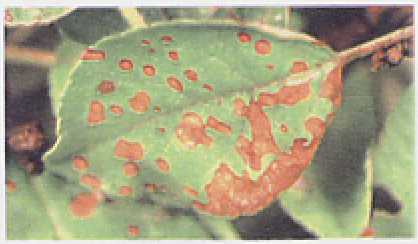


Fig. 19 – Frog-eye leaf spot caused by black rot fungus.

Fig. 20 – Black rot canker.

Fig. 21 – Black rot fruit infection.

Fig. 22 – Bitter rot fruit infection with concentric rings of spore structures.

Fig. 23 – Calyx end rot or Dry-eye rot.

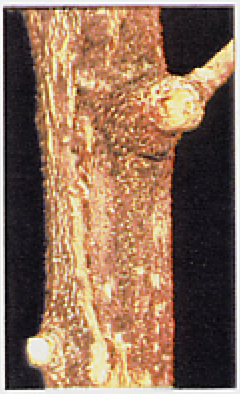


Fig. 24 – Nectria causes twig blight and wood canker. Note characteristic orange-red fruiting structures.

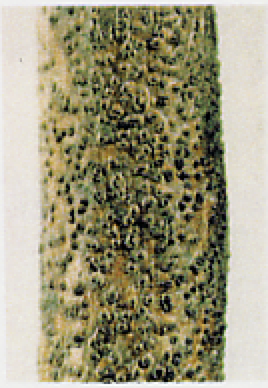


Fig. 25 – Cytopsora is a saprophytic fungus often found on wood which has been killed by freezing, drought or other causes.


Fig. 26 – Flyspeck fungus.


Fig. 27 – Sooty blotch fungus.


Fig. 28 – Powdery mildews causes white powdery covering on leaves that may also be curled and distorted.


Fig. 29 – Cedar-apple rust galls on required alternate host juniper.


Fig. 30 – Cedar-apple rust galls produce gelatinous spore horns during late-April to early-June rains.


Fig. 31 – Cedar-apple rust leaf spots on apple.


Fig. 32 – Quince rust causes fruit deformation in the calyx end.


Fig. 33 – Marginal leaf necrosis attributed to calcium spray burn.


Fig. 34 – Fruit russet attributed to concentrated spray residue.

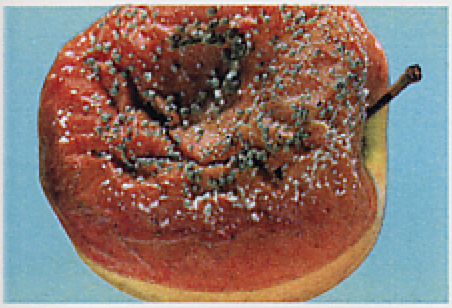


Fig. 35 – Blue mold (*Penicillium spp.*) postharvest storage rot.


Fig. 36 – Gray mold (*Botrytis spp.*) postharvest storage rot.

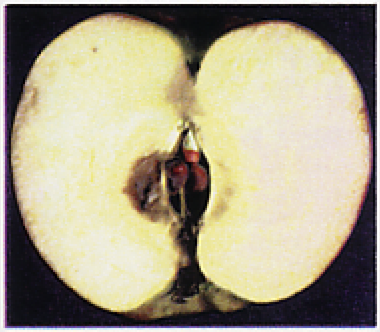


Fig. 37 – Moldy core in seed cavity.

West Virginia

Apple IPM Gets Juiced-Up

FQPA Issue:

Tolerances for pesticide exposure have been based on food consumption patterns of adults. The new law requires the EPA to address the risks of infants and children being exposed to disproportionate amounts of pesticides because their food consumption patterns differ from those of adults.

An IPM Solution:

Researchers develop and demonstrate a pest management system for processing apples that minimizes pesticide use.

An orchard at the West Virginia University Experiment Farm helps the West Virginia IPM Program to bridge the gap between research and on-farm implementation in two ways. First, it is where a better pest management system is being developed. Just as important, it is a commercial-scale demonstration site where growers see how well this system works and learn ways to institute it.

The project compares and contrasts conventional and alternative pest management for processing apples. The apple processing industry is very important in West Virginia, representing 60–80 percent of the crop production. Processing fruit can sustain more blemishes than fresh-market fruit, so it has potential for greater pesticide savings. Processed apples are of special concern from a food safety standpoint because children and infants consume large quantities of apple juice and applesauce. Project results so far are interesting and encouraging.

The 12-acre orchard is split into two replicated treatments. One half is managed conventionally, including use of several pesticides found on the Food Quality Protection Act registration review list. On the "alternative" half, such chemicals are used only early in the season. During the summer, they are replaced with horticultural oil, *Bacillus thuringiensis*, and calcium chloride. Pests are monitored throughout the season in both treatments, and fruit damage is assessed by the USDA Federal Inspection Service at a local processing plant.

Some important secondary pests, such as spirea aphid, spotted tentiform leafminer, white apple leafhopper, rose leafhopper, and European red mite, are less abundant and less damaging in the alternative treatment, partly because of improved biological control. All pest species are naturally afflicted by various predators, parasites, and diseases, which we call "beneficials" because they restrain pest populations. Conventional pesticides, however, can affect beneficial species as much as they do the pests. Pesticides used in the alternative regime are selected in part to minimize impact on beneficials so that these organisms remain effective and reliable.

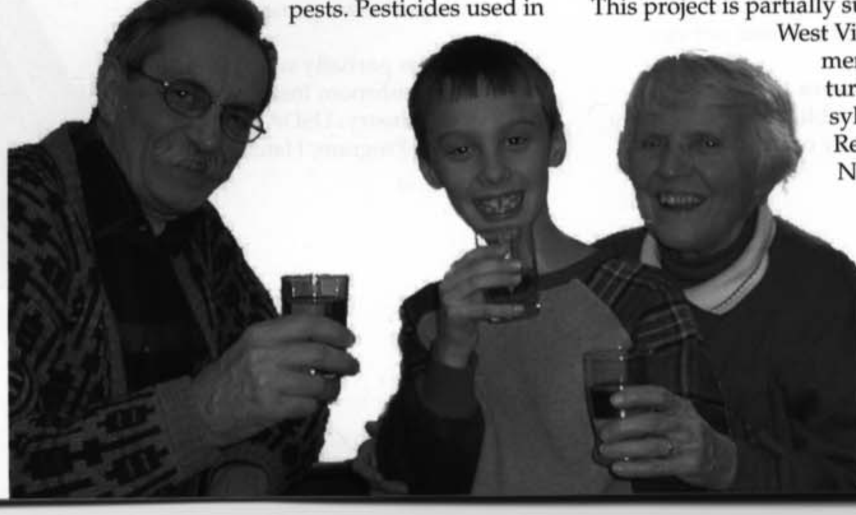
Calcium chloride, a plant nutrient, replaces conventional summer fungicides in the alternative treatment. Alan Biggs, project plant pathologist, points out, "Two summer diseases—sooty blotch and fly speck—cause surface blemishes; control from calcium chloride would not be good enough for fresh market production. But for processing we don't need blemish-free fruit, so this treatment shows promise."

Even though some kinds of pest damage are greater with the alternative treatment, economic loss is not increased. Processing fruit is peeled, cooked, crushed, and juiced, so surface blemishes are not important. Early returns show that fruit from the alternative orchard is worth just as much as that from the conventional orchard.

The multidimensional aspect of the project helps researchers see the unexpected consequences of pest management changes. For instance, apple maggot has started to show up in the alternative orchard. This insect pest is usually controlled in conventional orchards by pesticides actually aimed at other pests. Such observations help to set the research direction for the future. Henry Hogmire, entomologist on the project, notes, "Devising a new pest management approach is not cut-and-dried. We need projects like this to find the weak points and to address them."

The orchard is invaluable as an educational resource, too. Each treatment covers six acres, a size comparable to commercial orchards. Growers know that the methods and results they see are readily transferrable to their own farms. The West Virginia University Experiment Farm hosts grower meetings each year, attended by growers, consultants, industry representatives, and extension agents from several states. More than 100 people visited in 1997. If each one decided to try out only a few of the new methods, the industry would take a long stride forward.

This project is partially supported by West Virginia Tree Fruit Assessment Board; State Horticultural Association of Pennsylvania; USDA (National Research Initiative; Northeast IPM Program).



Massachusetts

Growers Invite Apple Maggots to a Ball

A good joke, one that works, contains a kernel of truth. Such is the half-a-worm joke: "What's worse than biting into an apple and finding a worm?"

—*"Finding half a worm."*

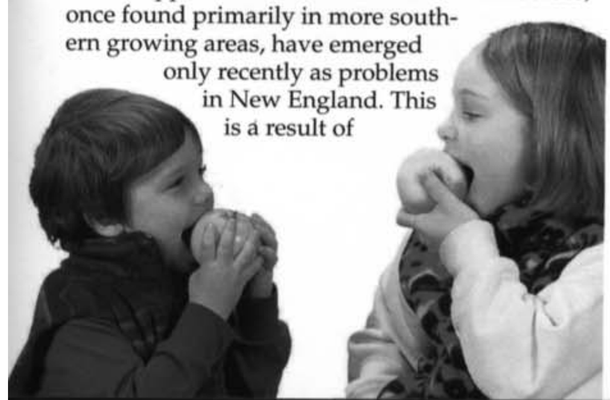
Most American consumers have never bought or eaten a wormy apple, but they're aware that apples can be wormy. In fact, apple growers in the Northeast routinely contend with eight major insect and mite pests and six major diseases. IPM researchers must develop and refine ways to protect the crop while minimizing reliance on synthetic pesticides. University of Massachusetts faculty are among the world leaders in this effort.

The apple maggot is the most important summer insect pest of apples in the Northeast. About 95 percent of the fruit on unmanaged apple trees (for instance, abandoned orchards) is infested, so management of this pest is imperative. Because such methods as biological control, host plant resistance, and habitat management are not yet viable, insecticides are traditionally used two or three times annually in orchards to control apple maggot.

At the University of Massachusetts, entomologist Ron Prokopy and his staff are developing a toxic trap that first attracts apple maggot flies, then kills them. To the pest, these traps look, smell, and taste even more like an apple than the real thing. But each "apple" is really a starch-based sphere that is impregnated with an insecticide. Flies enter the orchard, find the trap, have a meal, and die before depositing any eggs in the real fruit. The sphere biodegrades over the winter.

Prokopy hopes that with further development, apple maggot control will be available for about $20 per acre: less than the cost of one traditional spray application. Annual insecticide use for apple maggot will decrease from about two pounds per acre to less than one half gram per acre—almost a *two thousandfold* reduction.

In another apple IPM project, plant pathologist Dan Cooley collaborates with Northeastern researchers and producers to improve control of two important summer diseases—sooty blotch and flyspeck. Blemishes caused by these diseases render apples unmarketable. These two diseases, once found primarily in more southern growing areas, have emerged only recently as problems in New England. This is a result of



Will the real apple please stand up?

warmer, more humid summers and a shift in fungicides used to manage apple scab, the major early-season disease.

Research on managing sooty blotch and flyspeck is important for several reasons beyond the crop damage they cause. First, the most effective fungicides for these diseases are under regulatory scrutiny and may eventually be prohibited or severely restricted. Also, these treatments must occur late in the season, leaving little time for fungicide residues to weather and disappear before harvest. Finally, many of these fungicides have adverse effects on beneficial predators, thus disrupting the biological control system for mite pests.

Researchers know much about the diseases, including information on alternate host plants, dispersal of disease spores, and weather conditions required for infection. They know that summer pruning of apple trees reduces disease incidence, and suspect that tree size also plays an important role. They've also discovered that calcium chloride, a plant nutrient regularly applied in summer to enhance fruit storage, helps in managing flyspeck and sooty blotch.

Because of this work, New England fruit growers already use about half of the summer fungicides they once did. Cooley's vision for the future includes even less reliance on fungicides. Risk assessment methods will help growers to generate individual recommendations for each orchard. In dry seasons, control might be completely unnecessary region-wide. Even in warm, humid seasons certain orchards might avoid fungicides entirely and others might be sufficiently protected with sprays only around the edges. In all seasons, the knowledge developed by the research program will be used to efficiently and safely protect the crop.

This work is partially supported by Biotechnology Research and Development Corporation; Massachusetts Department of Food & Agriculture; Massachusetts Agricultural Experiment Station; New England Tree Fruit Growers Research Committee; University of Massachusetts State/Federal IPM Program; USDA—SARE Northeast, Smith-Lever 3(d), and Northeast Region IPM.

FQPA Issue:

In situations with few alternatives to pesticides, minimize pesticide use, yet maintain adequate crop protection.

An IPM Solution:

Scientists in Massachusetts are developing a toxic trap that could reduce insecticide use to 1/2000 of the conventional rate. To minimize fungicide sprays, they are also investigating two major apple diseases.

FQPA

Maine

Project *AIMs* to Help Apple Growers

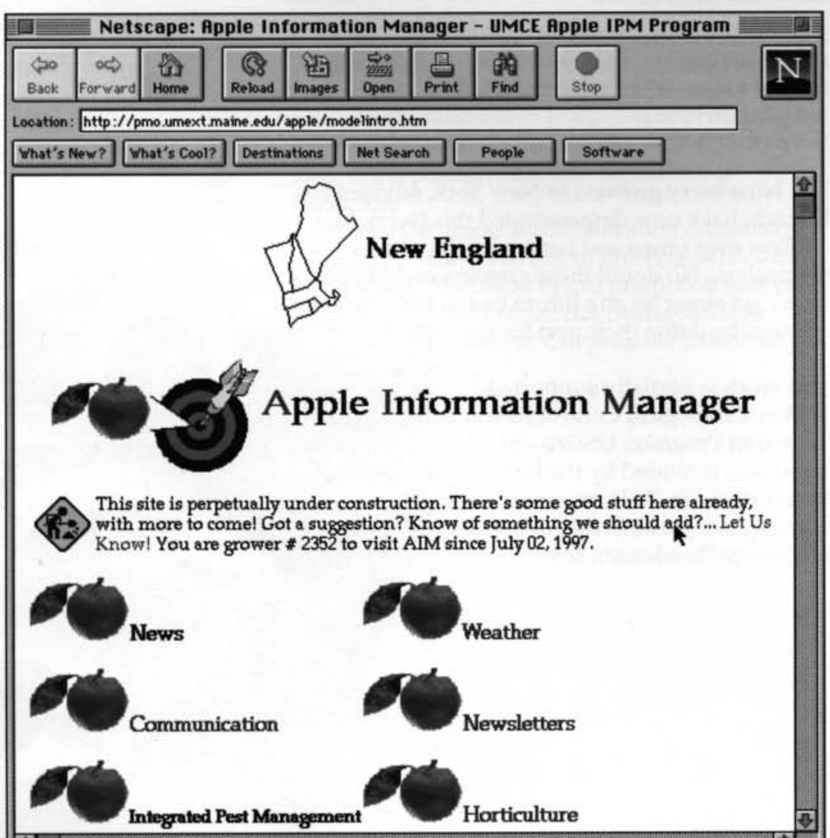
FQPA Issue:
Growers need diverse and timely information so they can minimize reliance on pesticides.

An IPM solution:
Growers and IPM programs in the New England states are developing the Apple Information Manager (AIM) for delivery of computerized information.

Mark Twain said that everybody talks about the weather, but nobody does anything about it. He wouldn't be able to say that about New England apple growers participating in a new project to use weather-based tools for IPM decision-making.

Weather affects the timing and intensity of numerous apple pests. For example, heat accumulation determines the development of many insect pests. Temperature and moisture influence plant diseases. These relationships offer the promise of using weather information to improve crop protection with minimal reliance on preventive pesticide applications.

The Apple Information Manager (AIM) is a cooperative endeavor by growers and University IPM personnel of the six New England states to use the World Wide Web as a resource for enhancing apple IPM implementation. Glen Koehler of the University of Maine IPM Program is working on one aspect of the program: investigating the use of site-specific weather information for use in making IPM decisions. A specific objective is to evaluate the adequacy of weather data from a private vendor as input for apple pest management models. Another objective is to introduce growers to World Wide Web pages with site-specific, daily weather updates. Weather information is linked to pest development models that help growers to improve their pest management decisions.



Why is AIM needed? Ideally, each grower should have access to information that includes the most recent weather observations and an accurate forecast for a specific site. But in reality, growers do not have the resources to collect and process the necessary weather data. Consequently, recent research on pest-weather relationships has not been useful in making day-to-day farm decisions. Nor is there a network of on-farm weather stations in New England. Finally, to be fully useful, models must include forecast data in addition to past observations.

That's the bad news. The good news is that with off-the-shelf computer technology, it is now possible to acquire site-specific weather data, process it into pest model estimates, and publish the estimates on the web.

Using the web to deliver the decision support models has several advantages. Growers do not have to buy and maintain software to manage and analyze weather data. They need only to have a computer capable of browsing web pages. The onerous task of handling voluminous weather data is automated and centralized. Updated model estimates for all the sites are available for viewing within minutes after new weather observations and forecasts are received.

Grower feedback is the most important part of the AIM project. Two to three growers from each cooperating state are part of the AIM project team. They ensure that the weather data and model estimates are useful and grower-friendly.

The AIM project deals with integrated pest management for apples but will also serve as a prototype for other crops. The hard part has been building the software infrastructure to automatically acquire, process, and publish the model estimates for one site. From that base, it is not difficult to extend the system to handle data from more sites or to run models for other crops and pests. The system could be readily extended to provide content for regional IPM web sites that focus on potatoes, other vegetables, woody ornamentals, or field crops.

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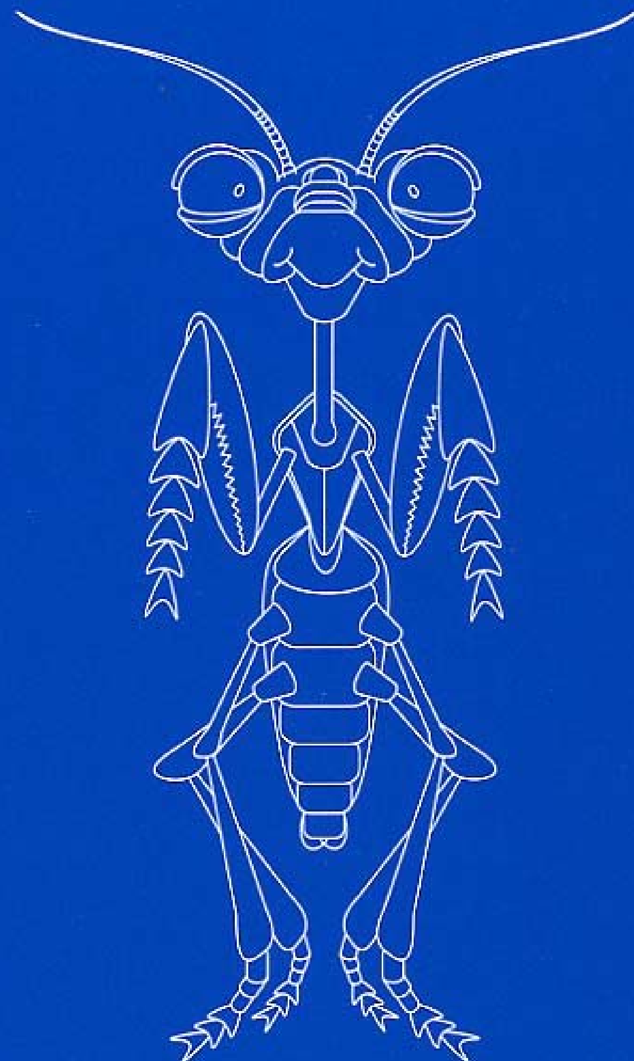

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