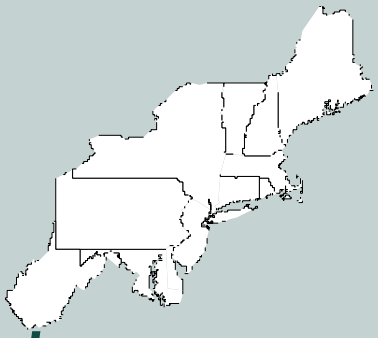

Integrated Pest Management in the Northeast

Recent Highlights from the Regional IPM Grants Program

Research and

Education

Benefiting

People,

the Environment,

and the Economy

A Word from the National IPM Program Leader

It is my pleasure to introduce this report on recent research and education efforts supported by the Northeast Region Integrated Pest Management (IPM) Grants Program. This highly successful program is the result of a partnership involving the 12 northeastern land-grant institutions and USDA's Cooperative State Research, Education, and Extension Service (CSREES).

Congress has provided funds for the Northeast Region IPM Grants Program since 1984, with a goal of addressing farm profitability and environmental issues by developing new pest management technologies and systems and making them available to growers in a timely fashion. And that's just what researchers and extension staff across the Northeast have done! With support from the regional IPM grants program and other funders, they have worked closely with growers and community leaders to develop new pest management tactics that give growers a better chance of farming profitably—and in an environmentally responsible way.

The scope of this grants program has broadened over the past 18 years. Today, the program continues to serve the needs of the region's agricultural producers, but it also addresses the needs of food processors and retailers, managers of golf courses and other recreational lands, and urban residents.

The grants program has accomplished a great deal over the past two decades, but the need for the regional effort continues. Many people—legislators, policy makers, scientists, producers, and consumers—continue to believe that IPM methods provide a rational solution to many of the controversies surrounding pesticides and pest management. IPM provides a science-based approach to addressing these concerns by minimizing reliance on pesticides and, if pesticides are required, promoting their most appropriate use (i.e., choice of proper pesticide, optimal timing of treatment, and best application method).

The regional IPM grants program supports projects that fill knowledge gaps with targeted research, validation and demonstration trials, and education and training programs. This information is critical to extension specialists and consultants as they help producers make the transition to new pest management approaches. The northeastern land-grant universities and CSREES are committed to providing leadership for the Northeast Region IPM Grants Program but recognize that this is possible only with the consent and cooperation of many groups, organizations, and stakeholders who have a direct or indirect role to play in the development and implementation of IPM systems in the region.

Regardless of whether you are an IPM practitioner or a member of a public interest group, once you have read this report I hope you will share my conviction that the Northeast Region IPM Grants Program is making a difference for Americans!

— Michael Fitzner
National IPM Program Leader
Cooperative State Research, Education, and Extension Service
U.S. Department of Agriculture

IPM Contacts

Northeast Region
James VanKirk, Regional Facilitator
315-787-2378
jrv1@cornell.edu

Connecticut
Richard Ashley, U. of Connecticut
860-486-3438
Richard.Ashley@uconn.edu

Delaware
Joanne Whalen, U. of Delaware
302-831-2526
Joanne.whalen@mvs.udel.edu

Maine
James Dill, U. of Maine Coop. Ext. Svc.
207-581-3879
jdill@umext.maine.edu

Maryland
Sandy Sardinelli, U. of Maryland
301-405-7877
ss11@umail.umd.edu

Massachusetts
William Coli, U. of Massachusetts
413-545-1051
wcoli@umext.umass.edu

New Hampshire
Alan Eaton, U. of New Hampshire
603-862-1734
Alan.eaton@unh.edu

New Jersey
George Hamilton, Rutgers U.
732-932-9801
Hamilton@aesop.rutgers.edu

New York
Michael Hoffmann, Cornell U.
315-787-2208
mph3@cornell.edu

Pennsylvania
Ed Rajotte, Pennsylvania State U.
814-863-4641
egrajotte@psu.edu

Lee Bentz, Pennsylvania Dept. of Ag.
717-772-5204
lbentz@state.pa.us

Rhode Island
Richard Casagrande, U. of Rhode Island
401-874-2924
casa@uri.edu

Vermont
Lorraine Berkett, U. of Vermont
802-656-4656
lberkett@zoo.uvm.edu

West Virginia
Rakesh Chandran, West Virginia U.
304-293-6131
Rchandr2@wvu.edu

USDA Contact
Michael Fitzner, CSREES
202-401-4939
mfitzner@reeusda.gov

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Investing in Solutions Throughout the Northeast

This report highlights 45 innovative research and education projects funded by the Northeast Region IPM Grants Program since 1995. Our project leaders respond to the real-world needs of growers and communities—reducing pesticide use in rural and urban areas, producing healthy plants and food, making farms more profitable. We find solutions to tough problems and teach people how to use them so that we all can realize the benefits of smart, effective integrated pest management.

Good for Consumers

When growers use IPM, they minimize human health risks and favor alternatives to the use of pesticides so we can all feel better about the food we eat. Our projects develop and test new IPM techniques and show farmers how to put the latest knowledge into practice. We also help consumers control common pests safely and effectively in their own homes and gardens.

Good for Farmers

Growers need to tackle pests at the most appropriate times and target them effectively to reduce crop damage. Our innovative IPM research projects help northeastern farmers do just that, giving them a better chance to thrive and prosper. The outreach projects we've funded offer powerful informational tools that allow growers to make the best pest management decisions and minimize the risk of economic losses.

Good for Schools, Landscapes, Parks, and Communities

We encourage pest managers to use IPM in buildings and recreational areas, which helps to reduce the health risks associated with pests (e.g., wasps) and with pesticides. IPM can also prevent the proliferation of invasive species and reduce the costs of maintaining areas like golf courses and public parks.

Good for the Environment

Our IPM strategies benefit the environment by protecting water quality, preventing soil loss, avoiding the unnecessary use of pesticides, and preserving nonpest organisms that are vulnerable to pesticides. These environmental benefits may be especially important in the Northeast, where agriculture and urban centers are in close proximity.

Good for Everyone's Bottom Line

Extensive crop damage, pests' resistance to pesticides, and wasteful pest control practices can put agriculture at risk of devastating economic losses. By addressing these threats and identifying cost-effective pest control methods, our projects improve the economic outlook for agricultural industries and consumers alike. Moreover, our grants program encourages cooperation among states throughout the region and promotes efficiency through collaboration, so limited public resources go further.

Fruit

Apples are the most valuable and widely grown tree crop in the northeastern United States, worth nearly $350 million annually. The region's 5,500 apple growers depend on IPM research and extension for help in tackling many important pests, including apple scab, apple maggot, plum curculio, fire blight, and harmful mites. These pests can cause profound damage to the industry. For example, apple scab, the single most important disease of apples in the Northeast, costs growers about $16.5 million in losses and control expenditures each year and can account for about 25 percent of the pesticides used on the crop. The pest management decisions that producers make for this pest and others affect more than 111,000 acres in apple production across the region.

A Training Program to Predict the Risk of Scab in Apple Orchards

- New Hampshire
- U. of New Hampshire Cooperative Extension
- Leader: W. E. MacHardy
- Extension, 1998–2000

Historically, apple growers have applied pesticides repeatedly each year to combat the threat of apple scab. In 1996, new control strategies emerged that would allow growers to more precisely assess the need for early-season sprays. These strategies, which involve a crucial examination of orchard conditions in autumn, could eliminate at least two early fungicide applications during the following growing season. If employed throughout New England, New York, and Pennsylvania, this practice could save more than $1.2 million in some years.

Growers and crop specialists are eager to implement the new strategy, but have voiced concern that they need better "scab-risk" assessment training to use it properly. An assessment conducted incorrectly could result in crop loss and reduced revenue. In response to these concerns, William MacHardy has developed and released a training package that includes a video explaining how to assess an orchard for apple scab in autumn, determine the subsequent risk of scab, and choose the best management practices. Laminated color photographs show scab symptoms and instruct growers on the timing and use of orchard sanitation procedures, which can further reduce the risk of scab infection. Armed with the knowledge that MacHardy's training package provides, orchardists can more effectively target scab while reducing their reliance on pesticides.

Improving Integrated Management of Apple Scab by Quantifying the Probability of Infection

- Connecticut
- Connecticut Agricultural Experiment Station
- Leader: D. E. Aylor
- Research, 1997–2000

Effective apple scab control depends on growers' ability to accurately predict the likelihood of new infections on leaves and fruit. New infections can occur only if enough disease spores are present when weather conditions are conducive to spread of the disease. Donald Aylor has developed a model that estimates the probability of scab infection by focusing on the aerial dispersal of the spores that allow apple scab to spread. This information will help growers use IPM practices like mulch-mowing that reduce the source of apple scab inoculum, minimizing the need for pesticide sprays and potentially saving growers up to $3.5 million annually. It will also enhance growers' ability to take advantage of the variable susceptibility of different apple varieties to this disease.

Biologially Based Methods of Reducing Insecticide Use Against Two Key Apple Pests

- Massachusetts (lead) and Maine
- U. of Massachusetts; U. of Maine
- Leader: R. Prokopy
- Research, 1999–2002

The apple maggot and the plum curculio, both native to the Northeast, are key pests that if left unmanaged can damage apples at rates of up to 95 and 86 percent, respectively. For decades, growers' only option for controlling both pests has been to use organophosphate insecticides. Implementation of the Food Quality Protection Act may eliminate or severely limit use of these particular pesticides. There is currently no alternative to synthetic insecticides for plum curculio control, so elimination of organophosphates could seriously impair growers' ability to produce the high-quality fruit we all enjoy.

Ron Prokopy and his colleagues are developing new approaches for managing the two pests. In the case of apple maggots, they lure and intercept adults flying into the orchard using red traps that mimic apples. This tactic has the potential to suppress apple maggots with the same effectiveness as insecticidal sprays,

but with a fraction of the pesticide use. Prokopy is using similar traps to catch adult plum curculios. Although these traps alone cannot adequately control the plum curculio, the trap captures provide information that will help growers minimize sprays by pinpointing the best time for insecticide applications. This research could enable growers to substantially reduce the use of insecticides against the plum curculio.

Integrated Management of Shoot and Rootstock Phases of Fire Blight on Apple

- New York (lead) and Pennsylvania
- Cornell U.; Pennsylvania State U.
- Leader: H. S. Aldwinckle
- Research, 1998–2001

In recent years, many apple growers in the Northeast have been replanting orchards, creating more valuable, high-density planting systems of dwarf or semi-dwarf trees that produce high-quality, fresh-market fruit sold at a premium price. But some types of these new trees are very susceptible to fire blight, a disease that can kill up to 80 percent of trees in an infected orchard. Because the antibiotic pesticide streptomycin is the only highly effective control for fire blight infection, apple crops would be at great risk if the disease were to become resistant to this pesticide.

Researchers in New York and Pennsylvania have developed an integrated management strategy for fire blight that will reduce reliance on streptomycin. Experimenting with alternatives to pesticides, they found a growth regulator that shows promise of eliminating two to three streptomycin sprays each season. They are also better able to categorize fire blight susceptibility according to rootstock and age of the tree, and have identified plant varieties that can resist the disease. Project leaders will present their results at grower and extension educator meetings and in bulletins, trade journals, county extension newsletters, and scientific journals.

Using Predators to Control Harmful Mites in Apples

- New York (lead), Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
- Cornell U.; U. of Connecticut; U. of Maine; U. of Massachusetts; U. of New Hampshire; U. of Rhode Island; U. of Vermont
- Leader: J. P. Nyrop
- Research, 1998–2001

European red mites (ERM) are significant pests in apple orchards and can account for 25 percent of pesticide costs in the crop each year. Orchards have been managed to produce lush, healthy trees that offer excellent yield and fruit quality, but these conditions also happen to be ideal for ERM population growth. The pesticides used for a variety of important pests often wipe out the predators that might otherwise hold ERM populations in check. To make matters worse, the ERM has developed resistance to many of the miticides once used to control it and is likely to become resistant to newer chemical controls as well. Biologically based alternatives to miticides can slow the resistance process by reducing our dependency on these chemicals.

Cornell's Jan Nyrop, working with other researchers and apple growers in New England, has shown that the predatory mite *Typhlodromus pyri*, which controls ERM, can be used successfully throughout the Northeast. This predator eliminates the need for miticides to control ERM in orchards where it is established and conserved. Methods have been devised for collecting and moving the predator to northeastern orchards where it is not yet present. Nyrop continues monitoring to determine whether this environmentally friendly control strategy can succeed on a long-term basis. If *T. pyri* can be effectively established throughout the Northeast, it could save the industry more than $3.5 million in control costs each year.

Integrating Disease and Mite Management in Apples and Grapes

- New York
- Cornell U.
- Leader: G. M. English-Loeb
- Research, 1997–99

The beneficial mite *Typhlodromus pyri* preys upon harmful mite species that cause damage to grape and apple crops in the Northeast. If uncontrolled, the harmful mites could cause losses up to $45 million annually in New York apples alone. This threat is a good reason to protect beneficial species like *T. pyri*, which will help to limit the destructive mites. Unfortunately, certain types of fungicides that are used to control diseases

Fruit

in orchards and vineyards can have the unintended effect of hurting the populations of beneficial mites.

Greg English-Loeb and his collaborators in entomology and plant pathology have examined the long-term effects of fungicide use on *T. pyri* populations and studied the costs and benefits of managing disease with chemicals that are less toxic to the friendly mites. The switch to less-toxic fungicides would increase populations of the beneficial mites that keep other mites in check, thereby reducing mite control costs. This approach could bring a savings of $17 per acre to grape growers, as well as a significant long-term savings to apple growers. The researchers have shared this information with grape and apple growers, and some producers report that adopting this approach has eliminated their problems with harmful mites altogether.

Developing Traps and Lures for Monitoring Blueberry Maggot Fly

- Rhode Island (lead), Maine, New York, New Jersey
- U. of Rhode Island; U. of Maine; Cornell U.; Rutgers U.
- Leader: S. R. Alm
- Research, 1996–98

The blueberry maggot is a major insect pest of commercially grown blueberries in the Northeast. Blueberry growers are faced with the problem of not knowing when or how often insecticides are actually needed to control the maggot fly. This uncertainty forces growers to apply three to five insecticide treatments per season even if maggot flies are not yet present—a program designed to safeguard against economic injury.

Researchers from Rhode Island, Maine, New York, and New Jersey worked to develop a sensitive monitoring trap and lure system that will maximize pest control while minimizing costs and pesticide applications. They made the traps more attractive to flies and produced traps that successfully control flies in small pick-your-own operations. This strategy will allow growers to control the pest with fewer pesticide sprays, thereby lowering growers' costs, reducing pesticide releases to the environment, and maximizing farm worker protection.

Assessment of Alternative and Conventional IPM Strategies for the Production of Apples for Processing

- West Virginia
- West Virginia U.
- Leaders: A. Biggs, H. Hogmire, and A. Collins
- Research, 1995–98

West Virginia is a major apple-producing state—it ranked eighth in apple production throughout the country in 1995, with an industry value of over $17 million. About half of the state's apple crop is grown for the processing market, which accepts higher levels of insect and disease injury than is normally found in fresh-market fruit. Processing fruit is peeled, cooked, crushed, and juiced, so surface blemishes are not as important.

Researchers at West Virginia University explored the possibility of reducing pesticide use in processing apples. They compared conventional pest management practices with alternative, IPM-based strategies in an orchard where apples are grown for processing. The alternative strategy limited pesticide use to the early season and employed other measures later in the season, including horticultural oil, a microbial pest-control spray, and calcium chloride. The comparison study revealed that some key insect pests, including leafhoppers and mites, were less abundant in the IPM treatment areas, and beneficial insects that restrain pest populations were more abundant. Though the experimental treatment did not provide adequate control of all pests, the test orchard has been an invaluable educational resource visited by growers, consultants, industry representatives, and extension agents from several states.

Apiculture

IPM Practices for Managing Parasitic Honey Bee Mites

- New York
- Cornell U.
- Leader: N. W. Calderone
- Research, 1997-99

The honey bee pollinates more than 90 commercial crops in the United States, increasing annual crop production levels by up to $20 billion. Two parasitic mites, *Varroa destructor* and *Acarapis woodi*, sap the strength of honey bee colonies, threatening crops like apples, blueberries, and cranberries that depend on bees for pollination. The annual value of honey bee pollination of these crops in the Northeast exceeds $300 million. Nicholas Calderone explored effective and reliable controls for the mites, which have begun to develop resistance to available pesticides. He found that formic acid shows promise as an alternative mite-control tool that will help beekeepers manage pesticide resistance. His new approach kills 95 percent of mites, a level of effectiveness that is comparable with that of standard pesticides. This information has been published and is available to beekeepers through an independently funded extension program.

Ornamentals

A Comparison of Herbicides, Fabric Discs, and Mulches for Preventing Weeds in Nursery Containers

- Connecticut
- Connecticut Agricultural Experiment Station; U. of Connecticut
- Leader: T. M. Abbey
- Research / extension, 1998–2001

IPM researchers have focused a great deal of attention on nonchemical weed management for field crops, but little has been done to find similar solutions for ornamental plants grown in containers. As a result, nurseries use primarily herbicides to control weeds, typically applying them three to four times a year. These herbicides can leach or run off, affecting ground- and surface-water. Nursery crops are the top agricultural product in Connecticut. Recent increases in the growth and value of the ornamental plant industry have made finding alternatives to herbicide-based programs a high priority.

Connecticut researchers evaluated a weed management system that eliminates most of the uses of herbicides in container nursery production. They found that fabric discs and mulches can effectively control weeds, improve convenience, and avoid the loss of herbicides to the environment. Product costs for fabric discs and mulches are higher than those of herbicides, but time and labor costs are reduced because these treatments need to be applied only once. The project team is spreading the word about these results via lectures, on-site demonstrations, and journal articles. The new information is also being disseminated on websites for the Connecticut Agricultural Experiment Station (caes.state.ct.us) and the University of Connecticut's IPM program (hort.uconn.edu/ipm/ipmprog.htm). The research and outreach efforts are providing nurseries with effective, nonchemical weed management alternatives, while helping to reduce environmental impacts and human exposure to herbicides.

Selling the Nursery Industry on Sustainable Trees and Shrubs

- Rhode Island
- U. of Rhode Island
- Leader: B. K. Maynard
- Research / extension, 1996

New England's homeowners and its $3.7 billion ornamental plant industry combat weeds, plant diseases, and insects with costly pesticides that can contribute to environmental problems. Brian Maynard and his colleagues have identified approximately 300 pest-resistant, noninvasive trees and shrubs that can thrive in southern New England without pesticides. They are helping nursery growers market these new plant species, encouraging consumers and landscapers to substitute sustainable plants for susceptible ones and thus reduce or eliminate the need for pesticide treatments.

Maynard's group has promoted awareness of sustainable plants through publications, workshops, television promotions, and the internet. They describe the pest-free landscape plants in a manual called *Sustainable Trees and Shrubs for Southern New England,* showcase the plants in a garden where the university conducts workshops, tours, and classes, and promote them on a television show that reaches almost half a million households twice a week. As a result of this effort, 68 percent of the landscape plants now sold in Rhode Island can be defined as sustainable, up from 30 percent before the project began. The benefits of this project include a savings of $14,000 per year for the average nursery in pesticide and associated labor costs, fewer problems with pests and invasive ornamental plants, and a reduction in pesticide use.

Integrating Insect Growth Regulators and Biological Controls for Whiteflies on Poinsettia

- Massachusetts (lead), New York
- U. of Massachusetts
- Leader: R. Van Driesche
- Research / extension, 1996–99

More than 9 million poinsettia plants are produced annually in the Northeast, with a value that exceeds $15 million. Whiteflies are the only major insect pest of the crop, and conventional control techniques rely solely on the pesticide imidacloprid. Therefore, it is likely that whiteflies eventually will develop resistance to imidacloprid. Whitefly parasites may help growers combat the pests if resistance develops, but parasite-based control is more expensive than pesticides and could thus pose economic challenges to the industry.

Researchers in Massachusetts and New York set out to reduce the cost of whitefly control in poinsettias by combining the use of a whitefly parasite with use of an insect growth regulator (IGR) that will not harm the parasite. They found that low release rates of the parasite *E. eremicus* along with IGRs are effective and affordable. This combination reduces costs from $1.18 per plant to $.18, providing a potential savings of approximately $7 million for the industry. Moreover, this strategy does not contribute to the risk of pesticide resistance development, a problem of the conventional pesticide-only approach. This integrated approach represents a feasible alternative that will be ready for immediate use when the pests do become resistant to the pesticide.

Vegetables

Potatoes in the Northeast are worth about $200 million each year, covering an estimated 117,000 acres across the region. The most serious insect pest of potatoes is the Colorado potato beetle (CPB). Notorious for developing resistance to pesticides, these pests feed on leaves, reducing yield and killing plants. Northeastern growers can spend more than $50 per acre on imidacloprid, the chief pesticide used to control CPB. Without imidacloprid, growers could expect tremendous losses, so the specter of resistance to this chemical is a major concern.

Potato production in the Northeast has also been threatened by a disease called potato late blight, the same disease responsible for the Irish Potato Famine during the mid-nineteenth century. Caused by a fungus called Phytophthora infestans, *late blight is devastating—it has brought about total crop loss and severe economic hardship for many growers. Recently, epidemics have become worse as new, more aggressive strains migrate into and throughout North America. Aware of the explosive nature of the disease, growers may apply fungicides as often as two or three times in some weeks to minimize the risk of infection. These control costs can reach $400 per acre. To make matters worse, the new strains of late blight are usually resistant to the systemic fungicide that has most effectively controlled the disease in the past.*

IPM specialists throughout the Northeast are developing strategies to overcome these threats. Multistate collaboration is particularly strong among potato IPM researchers, who have combined resources and worked cooperatively to maximize the impact of their individual efforts.

Economic Decision-Making and Biological Management of European Corn Borer in Potatoes

- Maine, Virginia
- U. of Maine; Virginia Agricultural Experiment Station
- Leader: E. Groden
- Research / extension, 1999–2001

For years, growers controlled Colorado potato beetle (CPB) using insecticides that also suppressed a secondary potato pest, the European corn borer (ECB). But this approach changed abruptly in 1995 with the introduction of imidacloprid, which specifically targets CPB but is ineffective against corn borer. Since then, ECB infestation levels have reached 100 percent in some areas. Recently, growers in affected areas have applied one to three sprays each season for ECB control. This pest has been a priority for IPM research in the Northeast because we know so little about the damage it causes in potatoes or how to manage it.

Eleanor Groden and colleagues are studying ECB's impact on potato yields and have found that low to moderate levels of infestation do not cause measurable crop loss. Their findings tell us that growers may be able to reduce pesticide applications by 75 percent without incurring economic damage. The savings in pesticide sprays represent a cost savings for farmers and will also diminish the risk of pests developing resistance to insecticides, protect beneficial insects that control plant pests, and reduce the overall insecticide load in the environment.

Use and Risk Reduction for Imidacloprid in Colorado Potato Beetle Management

- Maryland (lead), Delaware
- U. of Maryland; U. of Delaware
- Leader: G. P. Dively
- Research / extension, 1996–98

Researchers in Maryland and Delaware are experimenting with ways to limit the use of imidacloprid so that Colorado potato beetle does not develop resistance to this important pesticide. Working in cooperation with Rufs Potato Company, Galen Dively examined the effectiveness of treating only the perimeter of potato fields with the pesticide, taking advantage of the beetle's behavior of walking into fields in the spring from overwintering sites. The "perimeter barrier" succeeded in preventing most of the beetles from entering potato fields and reduced the total use of imidacloprid by 50 to 90 percent. Because less pesticide was applied to the soil with this method, potential risks to groundwater were diminished and control costs were reduced by 55 percent. This application strategy is now being applied to 45 percent of the potato acreage in Maryland and, if adopted to its fullest potential throughout the Northeast, could save the region's potato industry over $1.9 million.

In related research, Dively found that greenhouse tomatoes planted in imidacloprid-drenched soil required one-sixteenth the usual amount of the pesticide. This finding provides another example of how altering the method of application can reduce pesticide costs and limit their release to the environment.

IPM for Aerial Dispersal Risk of Potato Late Blight

- Connecticut (lead) and New York
- Connecticut Agricultural Experiment Station; Cornell U.
- Leader: D. E. Aylor
- Research, 1999–2002

To improve the management of potato late blight and reduce chemical pesticide applications, growers will require improved methods for predicting the risk of infection. Donald Aylor is working to strengthen our understanding of the aerial dispersal of *P. infestans* spores and is using this knowledge to predict infection probabilities. With better knowledge of late blight risk, growers can better control the disease through integrated use of sanitation, scouting, weather forecasting, late-blight-resistant potato varieties, and fungicides. This strategy could have an effect on more than 50,000 acres of potatoes, with the greatest impact in regions where there are several growers within a few miles of each other. If fully implemented with an intensive monitoring system, this new approach could allow growers to reduce sprays by 10 to 20 percent, which translates to a potential regional savings of more than $5 million.

Integrated Management of Immigrant Potato Late Blight in Area-Wide Systems *and* Area-Wide Decision Support System for Potato Late Blight

- New York (lead), Connecticut
- Cornell U.; Connecticut Agricultural Experiment Station
- Leader: W. E. Fry
- Research, 1996–2000

William Fry is working to develop a computer-based decision support system (DSS) for the management of late blight caused by *P. infestans*. The DSS would warn growers about blight risk in their area based on weather factors, disease characteristics, and the susceptibility of the potato variety. Potato and tomato farmers throughout the Northeast will be able to use this system to identify the most appropriate strategy for controlling late blight in their fields. The DSS may allow some producers to eliminate as many as seven sprays per season, which will lower farming costs and reduce pesticide use. It should also provide significant peace of mind to farmers, who have felt extremely vulnerable to potential late-blight damage and will now be better able to understand the real risks in their area.

Many disease-forecasting models rely primarily on temperature and wetness as weather-related indicators of conditions that are conducive to outbreaks. Fry's work has revealed that another factor—solar radiation—can also have an impact on late blight. The spores survive only a short time when exposed to direct sunlight but live much longer when radiation is filtered through a heavy cloud cover. Thus, cloudy conditions can allow the disease to spread further when spores are transported from field to field on the wind. The addition of solar radiation data will improve the accuracy of the late-blight forecasting model used in the DSS. The system should help growers improve their strategies for timing sprays and minimize unnecessary fungicide use.

Northeast Pepper IPM Project

- Connecticut (lead), New York, New Jersey, and Massachusetts
- U. of Connecticut; Cornell U.; Rutgers U.; U. of Massachusetts
- Leader: T. J. Boucher
- Research / extension, 1997–2000

Researchers from Connecticut, New York, New Jersey, and Massachusetts worked cooperatively to assemble a complete IPM approach that targets the region's major pepper pests. They explored and field-tested a broad range of IPM techniques for disease, insect, and weed control that included new monitoring systems, action thresholds, and combinations of biological, cultural, mechanical, and genetic control strategies. The project leaders and extension specialists throughout the region then collaborated to publish the *Northeast Pepper Integrated Pest Management (IPM) Manual*, a comprehensive growers' guide with 23 chapters and more than 200 color pictures that help to simplify pest identification. The manual

Vegetables

sold more than 400 copies in the first two months and promises to extend IPM benefits to most of the 3,000 pepper farmers in the Northeast, as well as to growers and IPM practitioners in other regions and countries.

Team members have also spread the word about pepper IPM at grower conferences and on-site demonstrations for farmers, crop consultants, extension personnel, and others in the agricultural community. Growers who've adopted the complete IPM crop system have reduced pesticide use by up to 96 percent while improving crop quality and farm profitability. More than half the pepper producers in the region have received training in IPM strategies as a result of the project. If fully implemented in the Northeast, the IPM system could save almost $1.3 million per year in pesticide costs and bring more than $4.5 million to the industry by improving quality and yields.

Sweet Corn IPM in Diversified Cropping Systems

- Pennsylvania (lead) and Maryland
- Pennsylvania State U.; U. of Maryland
- Leader: S. J. Fleischer
- Research / extension, 1999–2001

Commercial vegetable production in the Northeast exists mainly on diversified farms that grow more than one crop. The high-cash crops on these farms, such as tomatoes, potatoes, sweet corn, and leafy greens, contribute significantly to the economy of the region. In Pennsylvania alone, for example, vegetable production has a farm value of $300 million, with sweet corn accounting for 22 percent of the farm income. Grown on more than 100,000 acres in the Northeast, sweet corn receives more insecticides than most vegetable crops—often two to five applications per season per planting.

Researchers in Pennsylvania and Maryland found that through IPM, they were able to reduce sprays for European corn borer on sweet corn by up to 33 percent, which may allow them to improve IPM on related crops that share the same pests. They continue to study other innovative IPM strategies that could be beneficial on a whole-farm scale.

The project leaders have created a website that links with geographic information systems in a way that can dramatically improve the monitoring of pests that infest sweet corn, potatoes, peppers, and snap beans. The Northeast Region IPM grant led to the creation of a monitoring band that stretches from the Atlantic to Lake Erie, creating a "southern front" for monitoring pest immigrants into the Northeast. This five-state collaborative effort allows growers to understand what's happening on their farms in the context of the region and will potentially give them advance warning of pest pressure. The website is catching on: the number of user sessions almost tripled over the last two seasons, reaching 2,851 in 2000, a significant improvement over previous outreach efforts.

IPM of Beetle Pests in Cucurbits

- New York
- Cornell U.
- Leader: M. P. Hoffmann
- Research, 1996–2000

Vegetables in the cucurbit family, such as cucumbers, pumpkins, and winter squash, are grown on thousands of acres across the Northeast. In New York, the pumpkin crop alone is valued at $26 million annually. Cucumber beetles and related rootworm species are the most important insect pests of cucurbits, and it has been common for growers to treat these plants with insecticide regardless of the degree to which plants are infested.

Michael Hoffmann studied infested plants to find the point at which the cost of crop loss due to untreated infestations exceeds the cost of treating pests (this is the "economic injury level"). He found that in pumpkins, crop loss occurred only when 80 percent of the leaf area was removed during early plant growth stages. His work has led to new guidelines that advise applying pesticides only when justified by high levels of infestation. Eliminating even one treatment per year will reduce grower costs by about $15 per acre. Hoffmann also learned that beetles

tend to aggregate on certain preferred plant varieties where they can be trapped or controlled, an approach that enabled him to reduce beetle damage by 50 percent on pumpkins. More than 250 growers have been trained in these new cucurbit pest management methods through presentations and on-farm demonstrations.

Biologically Based Controls for Fungal Diseases of Greenhouse Tomatoes

- New York
- Plant Pathology Dept. (Geneva) and NYS IPM Program, Cornell U.
- Leaders: H. R. Dillard and J. S. Lamboy
- Research / extension, 1997–99

Greenhouse tomato sales exceed $15 million in the Northeast, with more than 225 facilities located both on farms and in industrial urban settings. On cloudy days, moist dark microclimates can develop under large greenhouse plants, allowing fungal diseases to flourish. One such disease is gray mold, which causes infections in the fruit and can even kill tomato plants. There are no fungicides that completely cure gray mold, nor are there any tomato varieties that can fully resist the disease.

When a gray mold epidemic broke out in a commercial tomato production greenhouse, Cornell researchers tested biological control measures to increase the plant survival rate and yield per plant. They found that certain microbes can suppress the disease, increasing tomato yields by almost 2 lb. per plant compared to commercially available fungicides. In a year with cloudy spring weather, the use of beneficial microbes could increase profits by 20 percent in greenhouses where gray mold is present. Avoiding the use of chemical fungicides also creates a safer environment for the beneficial insects and bees that are used in greenhouses. The research results have been distributed to the

public through fact sheets, presentations at trade shows and conferences, trade journals, and grower demonstrations.

Cultural Practices for Managing Onion Pests

- New York
- Cornell U.
- Leader: C. Eckenrode
- Research, 1996–98

Onions are an economically important vegetable crop in New York, worth over $41 million annually. Grown on more than 3.5 million acres throughout the state, the crop has a history of heavy dependence on pesticides. Onion maggot and the northern root knot nematode are two of the pests that threaten this commodity each year.

When surveys showed that damage by the nematode was increasing, Charles Eckenrode and colleagues explored whether certain grass species might effectively suppress the pests when used as cover crops and windbreaks in commercial onion fields. Their tests identified five grasses that would *not* serve as hosts for nematode and four that were nonhosts to onion maggot, suggesting that these grasses were good candidates for pest suppression. The researchers also learned that one of the grasses could be incorporated as a green manure to curb the nematode and its damage to onions and other vegetables.

Integrating Crop Rotation and Plant Resistance in Onion Pest Management

- New York
- Cornell U.
- Leader: M. A. Mutschler
- Research, 1996–97

Two of the major pests that threaten onion crops in the Northeast are Botrytis leaf blight (BLB) and onion maggot. Without controls, these pests could bring about complete economic losses for onion growers. An interdisciplinary research team explored practices that might reduce pest pressure on onions and allow growers to manage onion pests effectively and economically with less pesticide. They are in the process of developing two onion varieties that can resist BLB, one of which might be available to growers in the near future. Adoption of these BLB-resistant varieties could substantially reduce dependence on fungicides in onion production. The project team (Martha Mutschler, Roy Ellerbrock, James Lorbeer, and Charles Eckenrode) has also explored the benefits of crop rotation for slowing the development of pesticide resistance among onion maggots, improving onion yield, and reducing weeds and soil-borne pathogens. The results show promise for reducing levels of onion maggot and other pests in the crop. This work is helping to increase grower interest in crop rotation techniques, and growers are now testing rotations themselves.

Cultivation & Weeds

Row Cultivation for Zone-Till: Implications for Reduced Inputs and Soil Conservation

- New York
- Cornell U.
- Leader: H. Van Es
- Research / extension, 1998–2000

Field crop growers strive for a delicate balance in cultivation: they need to minimize soil loss, control weeds, and optimize growing conditions, all while keeping down the costs of farming. Tilling the soil controls weeds and enhances seedbed conditions, but it aggravates soil loss. "Zone-till" is a reduced-tillage system that limits the loss of soil by allowing farmers to till and plant in a single pass, barely disturbing soil in a limited area on the planted row. One of the challenges posed by most reduced-tillage systems is the lack of control options for weeds, which are estimated to cause more than $6 billion in agricultural losses each year nationally. Farmers who use reduced-tillage systems must rely almost exclusively on herbicides for weed control. But a new type of "high-residue" row cultivator—one that controls weeds with minimal soil disturbance and low potential for clogging with residue—offers a new option for weed control in reduced-tillage systems.

Harold Van Es evaluated a high-residue, reduced-tillage cultivation system using field corn and soybeans. He identified an approach that affords excellent weed control and up to a 75 percent reduction in herbicide use without reducing yield. This method could save growers about $10 to $15 per acre in herbicide costs. The evaluation included input from a broad-based coalition of growers and agricultural experts who participated in research station experiments, on-farm trials, grower meetings, and the development of outreach publications. Van Es is also getting the word out through presentations, conferences, and training sessions. This work addresses soil health and water quality, important considerations on agricultural land throughout the Northeast.

Impact of Weed Management Approaches on Population Shifts

- Delaware
- U. of Delaware
- Leader: M. J. VanGessel
- Research, 1999–2002

Corn and soybeans are major food crops of the Northeast, grown on more than 5 million acres in the region. Nationwide, weeds cause an annual combined loss of $1.2 billion in these crops. Herbicide-resistant crops are a recent and increasingly popular weed-control tool. About 75 percent of soybeans and 15 percent of corn hybrids planted in and around Delaware are resistant to herbicides, so maintaining the long-term viability of these crops is essential. These crops may allow growers to use a type of herbicide that can kill a broad range of weeds but has a very low toxicity, does not leach into groundwater, and does not persist in the soil. There is concern, however, that repeated use of any weed management approach, including this one, might select for weed species that resist treatment.

Mark VanGessel and colleagues are investigating potential weed species shifts that might result from long-term rotation of herbicide-resistant corn and soybeans. Their work will identify species that are favored by changes in weed control practices, enabling us to develop new, better-targeted weed management systems. At completion, this research will be incorporated into recommendations on the most effective ways to use herbicide-resistant crops over multiple years.

A Comprehensive Weed Management Approach for Lima Bean Production

- Delaware (lead), Maryland
- U. of Delaware; U. of Maryland
- Leader: M. J. VanGessel
- Research, 1996–99

The 13,000 acres of lima beans grown in Delaware alone are worth nearly $5.5 million annually. Although weeds are a major concern for lima bean producers, growers have very limited options for weed control. VanGessel and his colleagues evaluated a comprehensive IPM system for lima beans that considered the impact of weeds on crop yield and quality. They explored strategies for maintaining acceptable weed control while reducing the amounts of herbicide by one-half the normal rate. They found that a viable alternative in lima bean production is to switch from a chemically intensive system to low-use-rate system complemented with mechanical cultivation. Under some conditions, their system allowed them to reduce the amount of herbicide applied by 84 percent while still maintaining effective weed control.

Field Crops

Evaluation and Implementation of New Alfalfa Cultivars for Pest Management

- Maryland and Pennsylvania
- U. of Maryland; Pennsylvania State U.
- Leader: W. O. Lamp and A. Hower
- Research / extension, 1998–2001

Alfalfa has an estimated crop value of $840 million per year in the Northeast. A principal insect pest of this crop is potato leafhopper. With about 800,000 acres of alfalfa in Maryland and Pennsylvania, losses due to leafhopper can run from $10 million to $22 million each year in just these two states. In 1997, varieties of alfalfa that are resistant to potato leafhopper were introduced. Growers wanted to plant the new varieties, but they needed information about yield, crop quality, and effects on nontarget species.

William Lamp and Art Hower are meeting this need by examining both the benefits and the potential pitfalls of the new types of alfalfa. They've identified at least one new cultivar that reduces leafhopper densities and increases crop yield by up to a third. To spread the word about their findings, Lamp and Hower are developing "on-farm" demonstration sites across alfalfa production areas so growers can get a first-hand look at the effectiveness of new varieties. They're also constructing a website that shows their results, along with those from similar trials in other states, to provide sound, research-based information about the value of leafhopper-resistant varieties. These outreach efforts will set the stage for growers to use the new crops in the coming years.

Refugia for Resistance Management of European Corn Borer on Bt-Corn

- New York (lead), Pennsylvania and Delaware (cooperating)
- Cornell U.
- Leader: J. E. Losey
- Research, 1998–2000

The European corn borer (ECB) has been a major pest of field corn in the Northeast, causing annual losses of about $24 million. Scientists have used biotechnology to produce a new type of corn, known as Bt-corn, that reduces ECB populations and their damage. There is concern, however, that widespread use of Bt-corn hybrids might lead to the development of ECB populations that are resistant to the Bt toxin. This resistance could devastate not only the corn industry but also other crops that are prone to ECB damage, such as potatoes, peppers, and even apple trees. Growers use resistance management programs to prevent or delay the development of resistance, planting non-Bt-corn on some of their acreage to provide a refuge where ECB are not exposed to Bt. This practice ensures that a pool of susceptible corn borers remains to mate with insects that have greater resistance, and thus maintains susceptibility in the species as a whole.

John Losey examined the ability of plants other than corn to act as a refuge for a portion of the ECB population. Typically, growers must set aside as much as 20 to 30 percent of their corn acreage as refuge, but experts were uncertain whether it was necessary to establish such a large corn refuge area. Losey found that non-corn species did not provide an adequate supply of susceptible ECB to prevent or slow resistance. His finding suggests that growers should maintain their on-farm refuges of non-Bt-corn in order to promote the long-term, sustainable use of Bt-hybrid corn as a powerful control tool.

Education & Websites

Creation of a Distance Learning Center to Aid Grape IPM Adoption

- New York and Pennsylvania, cooperating
- NYS IPM Program, Cornell U. ; Penn State U.; National Grape Cooperative; Lake Erie Regional Grape Program
- Leader: T. Weigle
- Extension, 1999–2001

Grapes grown in the Lake Erie region of western New York and northwestern Pennsylvania are worth over $33 million each year and rank second in production value among fruit crops in the two states. The region's 30,000 acres of Concord and Niagara grapes are used for juice, jam, and other grape products. When growers asked for information that would help them make management decisions quickly during the growing season, IPM specialist Tim Weigle and members of the Lake Erie Regional Grape Program (LERGP) responded by creating a web-based learning center. The center connects with growers scattered across this wide area, providing easy access to weather data and pest information. It furnishes electronic crop updates with tips on IPM, farm business management, and viticulture that enable grape growers to make informed IPM-based decisions in their vineyards.

Visitors to the site hail not only from the Lake Erie area but from New England and beyond, and include growers, processors, extension agents, agribusiness, and researchers. The knowledge users gain from the site has made a difference: more than half of survey respondents have improved their pesticide spray programs or scouting practices with the help of online crop updates. By adopting these economically and environmentally sound IPM practices, growers will maintain the viability of the industry and reduce risk to the environment.

The grape IPM learning center started in 1999 as part of LERGP's own website, and is now located at lenewa.netsync.net/public/lergphom.htm.

AIM: An Interactive, Dynamic Apple Information Manager for New England

- Vermont (lead), Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island
- U. of Vermont; U. of Maine; U. of New Hampshire; U. of Massachusetts; U. of Connecticut; U. of Rhode Island
- Leader: L. P. Berkett
- Research / extension, 1997–2000

To enhance apple IPM implementation in New England states, apple growers, industry, and university IPM personnel collaborated in developing ways to incorporate information onto the World Wide Web. The Apple Information Manager (AIM) website (orchard.uvm.edu/aim/) provides growers with pest model estimates based on site-specific weather data, enabling growers to improve crop protection with minimal reliance on preventive pesticide applications. The AIM site serves as a clearinghouse of IPM resource material so that orchardists throughout the region can share and benefit from valuable IPM knowledge.

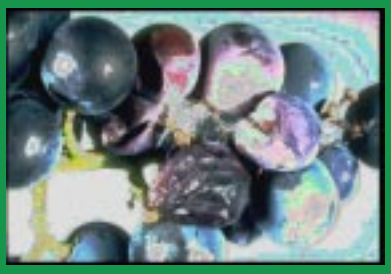
Since its startup, the frequently updated site has had more than 11,000 visitors. Almost 85 percent of New England growers surveyed report that AIM has helped them reduce or minimize their pesticide use. Site visitors say that AIM has played an important role in their decisions about the need for and timing of pesticide applications. The site represents a particularly strong collaborative effort, with cooperators from six states (Lorraine Berkett, Glen Koehler, William MacHardy, Daniel Cooley, Lorraine Los, and Heather Faubert). The powerful IPM education tool is highly rated by users not only from New England but around the world.

A Diagnostic Website for Plants, Pests, and Landscapes

- Maryland (lead), Connecticut, Delaware, New Jersey, Pennsylvania
- U. of Maryland; U. of Delaware; U. of Connecticut; Rutgers U.; Penn State U.; National Parks Service; Longwood Gardens
- Leader: M. K. Malinoski
- Extension, 1998–2000

Most urban dwellers and homeowners are accustomed to solving pest problems using pesticides. Lacking high quality information, these folks often run the risk of overusing chemicals, using them ineffectively, or applying them around foods, children, and pets. Maryland's Home and Garden Information Center, aided by researchers from several northeastern states, has developed a website (agnr.umd.edu/users/hgic/diagn) that helps the public accurately diagnose plant problems and identify indoor pests, beneficial insects, and wildlife damage.

WHAT TO LOOK FOR NOW:



Click here for more pictures of phomopsis, downy mildew, powdery mildew, black rot, grape berry moth, and phylloxera

Grape fact sheets - Fruit Pathology, Penn State Department of Plant Pathology

Grape References for Pennsylvania Growers - Where to get information

A page from the Lake Erie region grape IPM learning center

The award-winning site also serves as an educational resource for students, master gardeners, industry, faculty, and extension professionals. The service teaches people about the latest IPM strategies and least toxic means of dealing with pests. In a single year, the website had 33,000 user sessions. On average, visitors spent 20 minutes during a session, indicating that they value the site and learn from its content. The site's users give it high marks for usefulness and overall quality, and many indicated that they expect to return in the future. An extensive promotional campaign, a CD version of the site, and a field guide for use by homeowners and professionals will further broaden the impact of these services.

Linking Northeast Pest and Crop Models to Electronic Bulletin Boards

- New York
- NYS IPM Program, Cornell U.
- Leader: C. Petzoldt
- Extension, 1997–98

Weather plays a key role in many pest forecasting models because pests respond to such factors as heat and moisture in the air. In 1995, cuts in governmental support for agricultural weather services led producers and other agricultural experts to explore alternatives for collecting and disseminating crucial weather data and forecasts to growers in the Northeast. Some farmers, processors, consultants, and agribusiness groups who owned field weather instruments got together to form the Northeast Weather Association (NEWA), an organization that makes expert use of existing resources by compiling the data from these instruments to develop and run pest forecast models.

IPM specialist Curtis Petzoldt identified models that predict pest development for key crops and made them available through NEWA's electronic weather network (newa.nysaes.cornell.edu). The network provides NEWA's 50 members with user-friendly downloads and faxes that translate weather information into IPM recommendations. This service can help growers to (1) reduce pesticide use by 50 percent on grapes, (2) reduce fungicide use by 50 percent on onions and potatoes, and (3) reduce fungicides by 30 percent on apples and tomatoes. For some growers, these reductions have translated to savings as high as $20,000 per year, a great return on a membership fee of less than $500. NEWA's consultant and agribusiness members extend the knowledge to non-members, and researchers use the data to develop new models for pest forecasting.

Determining the Impact of an IPM Educational Effort to Field Crops Producers

- New York
- NYS IPM Program, Cornell U.
- Leader: J. K. Waldron
- Extension, 1997–98

In New York State, field crop farmers manage nearly 95 percent of the state's cropland. Some of these field corn and alfalfa growers have participated in IPM training with the New York State IPM Program and Cornell Cooperative Extension. Keith Waldron studied the effectiveness of these programs in convincing farmers to use IPM methods, such as monitoring crops, keeping weed maps, scouting for pests, and rotating crops, which can prevent unnecessary losses and alleviate the need for pesticides to manage certain pests.

Waldron's survey of producers showed that more than 80 percent of farmers who had participated in a hands-on training program called "TAg (**T**actical **Ag**ricultural) Teams" were using multiple IPM practices. About 74 percent of those who have been involved with other cooperative extension programs but not with the TAg Teams also incorporate multiple IPM practices into their farm management scheme. In contrast, only 62 percent of producers with no cooperative extension participation were using IPM in this way. Waldron's study provides excellent baseline data, allowing extension specialists to assess the effectiveness of outreach programs and to see where IPM implementation can be improved.

A Model IPM Recommendation Document

- New York
- NYS IPM Program, Cornell U.
- Leader: C. Petzoldt
- Extension, 1997–99

The *Cornell University Pest Management Recommendations for Vegetable and Potato Production* is a manual that New York growers have used for almost 40 years as a definitive guide. The manual was originally produced in an era when pest control practices focused on chemical pesticides, and the document reflected this emphasis. Curtis Petzoldt of the New York State IPM Program has updated and revised this widely used manual to integrate alternatives to pesticides, including cultural practices, biological control, fertility practices, and the use of resistant plant varieties. The new document, which sells about 1,500 copies each year, has a concise, reader-friendly format that helps growers more easily make use of IPM options. And now it's posted on the Web (nysaes.cornell.edu/recommends/), where it is updated annually with new information and takes advantage of hyperlinks. The revised manual has received very positive feedback from growers and serves as a model for other states that want to make IPM information more accessible.

New Projects in the Northeast Region, 2000-2001

The Northeast Regional IPM Grants Program funded six projects in each of the fiscal years 2000 and 2001. These projects promise to make significant contributions to the development and implementation of IPM over the next few years.

The 2000 grants program funded one extension project, three research projects, and two combination research and extension projects.

- A four-state (MD, CT, DE, PA) collaboration, led by Mary Kay Malinoski of Maryland's Home and Garden Information Center, will extend the educational and diagnostic services currently offered by the center to the rest of the region, taking advantage of popular online technologies.
- At the University of Rhode Island, Richard Casagrande leads a three-state research project (with MA and CT) to improve biological control of the lily leaf beetle, an important pest of lilies throughout New England, by evaluating natural enemies of the pest.
- Research on a sanitation procedure to manage scab, leafminers, and voles in apple orchards is led by William MacHardy at the University of New Hampshire. This project could eliminate many applications of fungicide for apple scab, insecticides for leafminers, and rodenticides for orchard voles by removing the leaf litter critical to the life cycles of each of these important pests.
- At Cornell, Michael Hoffmann leads a cooperative research project with Michigan State to develop an integrated strategy for managing flea beetle and Stewart's wilt in sweet corn. By improving our knowledge of the relationships between sweet corn and these pests, Hoffmann hopes to refine predictive models and in turn develop more effective control strategies that minimize pesticide use.
- In Connecticut, Jude Boucher is working to reduce or even eliminate the insecticides now required to manage two important pests of bell peppers, the European corn borer and pepper maggot. Boucher keeps the pests out of the main sweet pepper crop by planting hot peppers, which the pests greatly prefer, around the perimeter of the sweet peppers.
- Penn State's William Curran leads a three-state research/extension project (with DE and NJ) to investigate relationships among field conditions, tillage, weed emergence, and crop yield in field corn. The results should help refine weed management programs to minimize herbicide use while maintaining adequate control.

In 2001, project leaders are starting one extension project, four research projects, and one research/extension project.

- In cooperation with Ohio State, Curtis Petzoldt at Cornell leads an effort to improve the usefulness of the environmental impact quotient (EIQ), a formula used to standardize the comparison of environmental and safety parameters for most commonly used pesticides. This new project will provide data about the effects of pesticides on beneficial species.
- Dennis Calvin of Penn State is working in partnership with the University of Maryland and Cornell to compare the economic benefits of using Bt-corn hybrids to using conventional hybrids for European corn borer control in field corn. Results will help growers make informed planting decisions.
- William Turechek of Cornell and Alan Biggs of West Virginia University are collaborating on research to improve management of fire blight, a devastating disease of apples. They will refine the *MARYBLYT* predictive model to account for varietal susceptibility, orchard age and inoculum potential, and will also develop a more user-friendly interface for the model.
- At the University of Massachusetts, Roy Van Driesche investigates biological control—using a "good" species to control pests—for managing the most important pest in greenhouse bedding plants, the western flower thrips. Results from this project will be used throughout the region's bedding plant industry, which generates over $300 million in the Northeast.
- Sridhar Polavarapu of Rutgers is developing IPM methods for managing oriental beetle, a major pest of turfgrass, nursery stock, greenhouse ornamental crops, and blueberries. This research carries the promise of important region-wide benefits.
- European corn borer attacks most field corn plantings in the Northeast and causes significant yield loss, but until now control has been impractical at best. In sweet corn, research has shown that this pest can be successfully controlled by establishing populations of a tiny beneficial wasp. Cornell's John Losey is now leading a multistate research project (NY, PA, DE, VA) to apply the same methods in field corn, which may significantly improve farm profitability by protecting the corn without resorting to pesticides.

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