# New England-wide Demonstration of an Integrated Pest Management (IPM) System for Apples and Consumer Education in IPM as a Pollution-prevention Strategy

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The strategies known collectively as IPM have been recognized as one way to reduce the amount of agricultural chemicals released into the environment. IPM has been shown to address the needs of New England agriculture, and pollution prevention, by reducing and optimizing pesticide use.

Many New England growers have been in the forefront of widespread early adoption of these new technologies, partly as a consequence of aggressive, regional Cooperative Extension outreach programs. In Massachusetts, for example, approximately 40% of the state's cranberry and apple acreage, and about 20% and 9% of strawberry and sweet corn acreage, respectively, receive some form of IPM monitoring and advice from private-sector scouts or consultants, and still larger acreages are managed under IPM by the growers themselves. Such widespread grower adoption of IPM has set the standard for environmentally responsible agriculture.

However, although consumers typically express concern about perceived public-health and food-safety risks associated with agrichemical use, a very small percentage of the general public has even heard of IPM, and still fewer recognize its potential benefits and the extent of its use. More widespread demonstration and consumer education of the environmental benefits of IPM are likely to enhance positive consumer attitudes towards local agriculture.

In spite of the potential benefits to

agriculture of increased adoption and consumer awareness, successful IPM strategies demonstrated in one state have not always been adopted regionally. This is partly due to a tendency of growers to emphasize uncertainty associated with farm-to-farm or state-to-state differences in pest complexes, weather, normal cultural practices, intended markets, etc. Since IPM adoption has not been universal, there remains a need for regionally-consistent systems to evaluate progress toward the Federal-policy goal of IPM implementation on 75% of managed acres by the year 2000.

One possible way to measure extent of grower IPM adoption is by use of commodity-specific IPM definitions, known as IPM Guidelines, originally developed in Massachusetts. These guidelines, in the form of checklists and a related point system, have been used since 1990 as the basis for successful implementation of the state Farm Services Agency (formerly ASCS) cost-sharing program in Integrated Crop Management (ICM) and a related state-endorsed consumer education and marketing effort known as *Partners With Nature*.

With this background in mind, in 1994, a small group of New England Extension and research specialists successfully acquired a Region I USEPA Pollution Prevention Incentives to the States (PPIS) grant which sought to address some of the issues identified above.

The principal goals of the project, for which the University of Massachusetts served as lead unit, were: to develop consistent, well-defined, and quantifiable apple IPM guidelines for each New England state; to test state IPM guidelines as a pollution prevention methodology at the state and regional level; and to educate the media and the general public about IPM and its benefits.

Our specific objectives were: to involve University research and extension staff, growers, and private-sector IPM professionals in the design of apple IPM Guidelines for each of the New England states; to demonstrate the resultant state guidelines on one 5-to-10-acre block in each state, and compare results to a similar sized check block managed with a calendar-based spray program without pest monitoring; to calculate and compare the Environmental Impact Quotient (Kovach et al., 1992) for each block, as a measure of pollution prevention; and, to hold a field day in each state on the farm of the demonstrating grower to which the press and general public are invited.

To the best of our knowledge, until this project, no successful attempt had been made within Region I to develop consistent IPM guidelines for several states in a region, to carry out an extensive and regionally-coordinated IPM demonstration for any crop, nor to use the results to educate the general public about environmentally-sound agricultural practices.

An initial project planning meeting of several state collaborators was held in conjunction with the New England Fruit Meetings in January, 1995. Due to delays in getting the project organized, no growers participated in this meeting. Subsequently (Spring 1995), however, ME, CT, RI, and NH formed a Guideline Design Committee (GDC) consisting of 6-14 members, and each committee met at least once. The University of Massachusetts investigators participated in the ME and RI meetings. Each committee reviewed the University of Massachusetts guidelines template, and elected to modify it to fit the pest-management situation in that state. Modifications included: elimination and addition of some practices in the MA guidelines and changes to the point system used.

In Massachusetts, an IPM Certification Study Committee was formed by the Massachusetts Fruit Growers' Association late in 1994, and this group solicited input on guideline modifications from growers, private IPM consultants, and University staff independently of the EPA-funded project. Modified guidelines were compiled by the University of Massachusetts investigators. Development of all state-specific apple IPM guidelines was completed by June, 1995.

Each state identified one or more demonstrating growers (DG) who implemented the farm-specific IPM system, and conducted other planned activities. Cooperating growers who agreed to demonstrate the IPM system were:

Massachusetts, Joe Sincuk (University of Massachusetts Horticultural Research Center, Belchertown); Connecticut, Ken Shores (Johnny Appleseed's Apple Orchard, Ellington); Rhode Island, Randy McKenzie (Phantom Farms, Cumberland); New Hampshire, Ben Ladd and Melanie Stephens (Great Brook Farm, Canterbury), Steve Gatcomb (Manager of Upland Farm, Peterborough); and Maine, Reed Markley (Lakeside Orchards, Manchester).

Table 1. Number of spray events in traditional and IPM blocks, University of Massachusetts Horticultural Research Center, 1995.

| | Conventional | IPM |
|---|---|---|
| Acaricides | 3 | 4 |
| Fungicides | 10 | 6 |
| Insecticides (incl. 2 oil) | 7 | 5 |
| Herbicides | 1 | 1 |
| **TOTAL** | 21 | 16 |

Original plans called for each cooperator to demonstrate the state IPM system, and compare results to a "conventionally managed" block. However, given that all cooperators had been identified because of their knowledge and use of IPM, none were willing to "go backward" (i.e., apply pesticides on a preventative basis), even when funds to purchase extra chemical were offered. Although this development compromised the original project design somewhat, it provided testimony to the level of commitment to IPM common in the region.

Hence, only the demonstration at the University of Massachusetts Horticultural Reserch Center (HRC) included both an IPM block, and a conventional (i.e., modified preventative spray program) block. The HRC, while a University research facility, is also a commercial orchard, with support for the farm dependent almost completely on fruit sales, just as with a private-sector orchard. The site has a long history of IPM adoption.

**Pesticide application results in HRC IPM and "conventional" blocks**. IPM blocks received regular monitoring and spray recommendations by University-affiliated staff. The sole comparison block was designed to reflect the number of sprays that could be applied if a grower were inclined to use a preventative spray program. In actual fact, the "conventional" program was very conservative, using as it did only one spray for apple maggot fly, not the 2 to 3 that might normally be applied.

As shown in Table 1, weekly monitoring of the IPM block and use of appropriate action thresholds resulted in 24% fewer spray application events compared to the modified preventative spray program. While this represents a savings in labor and other costs associated with spray application (e.g., fuel, oil, wear and tear) and one can hypothesize a reduced potential impact on the environment, the number of spray events alone gives no information on potential environmental impacts of IPM use.

One measure of potential environmental benefit from IPM, calculation of the Environmental Impact Quotient (Kovach, et al., 1992), which takes into account toxicity of individual pesticides, is reported on elsewhere for all participating demonstration sites. A second measure, the dosage equivalent (DE), which reflects the rate of pesticide used as a percentage of the recommended rate, was completed for the HRC (Table 2). From Table 2, it can be seen that the IPM block received nearly 32% fewer pesticide DE's than the traditionally managed block. We believe this difference represents a typical situation in a grower orchard, where full recommended rates, which are known to have a wide margin for error, are rarely used. The implication of using dosage equivalents rather than spray events is

Table 2. Dosage equivalents of pesticide used in conventionally managed and IPM blocks, University of Massachusetts Horticultural Research Center, 1995.

| | Conventional | IPM | Difference | % Difference |
|---|---|---|---|---|
| Acaricide | 3.2 | 3.0 | 0.2 DE | 7% |
| Fungicide | 13.6 | 7.9 | 5.7 DE | 42% |
| Herbicide | 1.4 | 0.7 | 0.7 DE | 52% |
| Insecticide | 6.1 | 3.6 | 2.5 DE | 40% |
| Oil | 1.3 | 1.1 | 0.2 DE | 15% |
| Total | | | | |
| Non-oil | 21.3 | 14.5 | 6.8 DE | 32% |

most noticeable in the case of herbicide, where both blocks received a single application, but 52% less actual pesticide was applied in the IPM block.

In spite of the lower dosage equivalents of pesticide use, pest damage appeared to be no different among the two blocks. No harvest survey data are presented because the entire crop was heavily damaged (over 80% injury) from a hail storm in late May. As a consequence of this extensive damage, normal harvest surveys could not be conducted easily.

**Pesticide residue analysis, HRC.** Although not originally proposed as a project activity, location of the Massachusetts Pesticide Analytical Lab (MPAL) at Amherst, presented an opportunity to conduct a comparison of pesticide residues in the IPM and traditional blocks at the HRC. Such comparative residue data largely are lacking, and should provide useful baseline information for gauging the true environmental and public-health impacts of IPM use. Fruit samples were collected from each block type and frozen for later analysis during fall and winter. The authors would like to offer special acknowledgment for the cooperation and assistance offered to us by John Clark, Lab Director, and his staff, Dan Tessier and Andy Curtis.

Table 3 shows results of residue analysis performed for 9 of 11 pesticides applied. No data are presented for azinphosmethyl (Guthion$^{th}$) due to applicator error, and no analysis was attempted for the acaracide fenbutatin oxide (Vendex$^{th}$). It is important to note that no residues were detected at a limit of detection of 0.2 ppm for seven of the materials applied in either the IPM or Conventional block. This finding is consistent with residue test results in the literature, which typically show that a minimum of 50% of all produce samples tested contain no detectable residues. Unfortunately, it is often assumed that the percent of produce containing pesticide residues is much higher than it actually is. This discrepancy offers further compelling evidence of the need to educate the media and the general public about the realities of agriculture.

For the benzimidazole fungicide benomyl, residues were no different in IPM and conventional blocks, but both showed residues in the parts per billion (ppb) range, orders of magnitude below the allowable tolerance. Residues of propargite, registration of which was recently canceled voluntarily by the registrant, also were well below tolerances, and represented the sole example of significantly lower residues in response to an IPM strategy. In this case, although more propargite

Table 3. Pesticide residues on apples at harvest in IPM and Traditional blocks, University of Massachusetts Horticultural Research Center, 1995.

| Chemical | Brand name | Total pesticide residues: IPM | | Total pesticide residues: Conventional |
|---|---|---|---|---|
| Benomyl[z] | (Benlate[tm]) | 0.02 ppb | | 0.02 ppb |
| Captan | (Captan[tm]) | ND[y] | | ND |
| Carbaryl | (Sevin[tm]) | ND | | ND |
| Endosulfan | (Thiodan[tm]) | ND | | ND |
| Fenarimol | (Rubigan[tm]) | ND | | ND |
| Mancozeb | (Penncozeb[tm]) | ND | | ND |
| Permethrin | (Ambush[tm]) | ND | | ND |
| Phosmet | (Imidan[tm]) | ND | | ND |
| Propargite[x] | (Omite[tm]) | 0.49 ppm | * | 0.75 ppm |

[z]Tolerance of benomyl = 7 ppm.
[y]ND = nondetectable, limit of detection = 0.2 ppm.
[x]Tolerance of propargite = 3 ppm.
*Statistically significant difference existed between IPM conventional at odds of 19 to 1.

applications were used in the IPM block based on monitoring results, a lower rate was applied, and resultant residues were lower statistically. Such a low-dose strategy may represent a way for the material to be used again in the future.

**Environmental Impact Quotient (EIQ)**. Although each of the measures described above (i.e. numbers of sprays applied, dosage equivalents applied, and harvest residues) gives some information on potential reduction in environmental and other pollution, the actual measurement of such reductions is another matter. In addition to the fact that there is no agreement on the best techniques for measuring environmental impacts of pesticides, environmental testing of any sort is very expensive and demands the utmost care in sample collection and analysis.

Partly in response to the need for some measure of environmental impacts of agricultural chemicals, Kovach and his colleagues at Cornell University devised the Environmental Impact Quotient (EIQ). The EIQ assigns values to chemicals based on such parameters as mode of action (i.e., non-systemic, systemic); toxicity to humans, bees, rabbits, birds, beneficial arthropods, and fish; soil residue half life; plant surface residue half life; and leaching and runoff potential. Although the resultant EIQ numbers have no meaning *per se*, they are intended to provide growers and others with a means to determine relative differences among pesticides or pest-management strategies.

It should be noted that a number of flaws in the EIQ have been pointed out by Dushoff et al. (1994) in the journal *American Entomologist*. In addition to problems with scaling, weighting of effects, and inert ingredients, those authors point out that "...even benign substances are given ... an EIQ of at least 6.7." By way of illustrating an extreme example, "...if water were considered a pesticide, it would have an EIQ of 9.3. This means that 20 lbs per acre of water would be considered worse than a 1 lb application of parathion..." Of course, water is not a pesticide. However, another example using actual orchard pesticides can be seen in a comparison of the **EIQ Field Use Rating** for dormant oil (EIQ value of 37.7) and a 25 WP formulation of permethrin (EIQ value of 56.4).

The EIQ Field Use Rating is determined by multiplying the EIQ Value (from a table) **times** the percent active ingredient (% A.I.) Of the material **times** the rate of pesticide application per acre, or:

EIQ Field Use Rating =
EIQ Value * % A.I. * Rate per Acre

For Permethrin, used at 5 oz. per 100 gal. and applying 300 gal. per acre (or 0.9 lbs. per acre), this results in an EIQ Field Use Rating of 13 (56.4 x .25 x 0.9 lbs). This is obviously much lower than the field use rating of 226 for oil used at a rate of 2 gal. per 100 gal. and applying 300 gal. per acre (37.7 x 1 x 6 gal), because oil is 100% active ingredient, and is used at a much higher per-acre rate. In spite of the flaws in the EIQ, no other more appropriate model is in widespread use, to the best of our knowledge, although several were reviewed in 1994 by Lois Levitan and colleagues at Cornell in a report to the Northeast Sustainable Agriculture Research and Extension (SARE) program. Hence, with all the provisions noted above, the EIQ for each of the blocks in our demonstration is presented in Table 4.

If nothing else, the EIQ numbers point out that IPM is not a “one size fits all” strategy, and that differences in pest pressure, environmental conditions, and grower management style often govern both the choice of pesticides and their application frequency. For example, while fungicides contributed the largest portion of the EIQ number in five out of six IPM blocks, one site in New Hampshire, which used a new insecticide (imadacloprid) which is very safe to predator mites but highly toxic to bees, had a much higher insecticide/acaricide EIQ than any of the other blocks. This probably does not actually represent greater environmental damage, however, because imidacloprid is applied after petals have fallen, and bees are no longer foraging in fruit trees. Nonetheless, use of the material results in a substantially higher EIQ rating.

Total EIQ numbers ranged from as low at 50% of the comparison traditional block to as high as 87% of that block, once again pointing out the normal differences among blocks for reasons described above. Ideally, had it been possible to set up a comparison block in each state which would have been subjected to the same weather and pest pressure, such comparisons would have had a much stronger biological basis, and their validity would have been strengthened.

**Field days**. Field days were held successfully in four participating states in 1995. Maine held their event on May 24, 1996

Table 4. EIQ calculations for IPM demonstration blocks in five New England states, compared to a traditionally-managed block at the University of Massachusetts Horticultural Research Center, 1995.

| Pesticide type | Conventional block MA | IPM block by state | | | | | |
|---|---|---|---|---|---|---|---|
| | | MA | RI | CT | NH1 | NH2 | ME |
| Insecticides/ acaricides | 586 | 438 | 765 | 222 | 1007 | 439 | 306 |
| Fungicides | 1341 | 617 | 865 | 777 | 334 | 1288 | 1047 |
| Herbicides | 52 | 57 | ** | ** | ** | ** | ** |
| EIQ Totals | 1979 | 1112 | 1630 | 999 | 1341 | 1727 | 1353 |

**Not calculated

to coincide with bloom, a time when orchards are very attractive. In facilitating planning for these events University of Massachusetts distributed information to collaborators on how to stage and run a field day, and how to write a press release. In addition, we provided examples of press releases and other related materials. Press releases sent, informational handouts about each farm, and educational materials handed out at the events included: a 3-page fact sheet on disease-resistant apples, a fact sheet on IPM in Connecticut Apple Orchards, an "IPM Impacts" fact sheet, a 8-page handout on the Maine IPM Program, fact sheets defining relevant terms, a seven-page handout on insect and mite pests of apples, an apple pest chronology calendar and a description of selected biological control agents (both taken from the *New England Apple Pest Management Guide*), and a summary of comparative results (at the Massachusetts site only).

Each field day consisted of a "walking tour" of the demonstration block with stops at various points of interest. For example, Connecticut collaborators (L. Los, G. Nixon, J. Clark and S. Olsen) staged a self-led walking tour which directed attendees through the orchard to view 12 different IPM "stations". Each station had a poster (approximately 2 x 2 feet) which explained an important apple pest and included pictures of life stages, damage, etc. Next to each poster, insect traps with appropriate insects affixed, or weather monitoring equipment for monitoring apple scab infection periods were displayed. In addition to displays within the orchard, the Connecticut IPM group provided two large display boards in a movable stand used for the orchard's pick your own operation. One board displayed the impacts of all IPM projects in the state, and the other dealt with beneficial insects. A total of about 700 people either came by the booth or took the walking tour. The large turnout was partly due to having a "built-in" audience available at a large pick-your-own orchard on a good fall day. Results were such that Connecticut plans to hold a similar event (self-funded) next fall as well.

The Rhode Island field day also consisted of stops at sites in the IPM blocks, as well as samples and displays (i.e., display board of "Pest Control Then and Now", photos of insect and disease pests, fruit and leaf damage, beneficial insects, samples of scab-resistant cultivars, and several insect monitoring traps). An estimated 1,000 people participated in the field day, and the event received publicity on local TV channels. In addition, a front-page article about the project also ran in the *Woonsocket Call*.

Although attendance at the Massachusetts field day was less spectacular, the University of Massachusetts *Daily Collegian* (circulation of 17,000 throughout the 5-college area) sent a reporter who later wrote an article. New Hampshire had the greatest success in publicizing IPM by virtue of one front page article in the, July 16 *Concord Monitor* (circulation 23,500), a second front page article in the September 24 *Sunday Union Leader*, one Associated Press article sent out on the wire and at minimum picked up by the July 17, 1995 *Union Leader* (cir. 89,000), and reported on by WTSN, Dover, NH (listenership 63,000), a live interview on WNHQ, Milford, NH on July 17 (listenership 45,000), and a second AP article picked up by the September 25 *Union Leader*. In addition to the two IPM demonstration sites identified earlier, two other sites (the Hardy family's Brookdale Fruit Farm in Hollis, and Chuck and Diane Souther's Apple Hill Farm in Concord) also participated in the media tours.

Cooperators in Maine arranged for the Governor to proclaim May 24 as "Maine IPM Technology Day", and the Commissioner of Agriculture delivered the Governor's proclamation at the event. The field day was announced to the apple grower community at the Trade Show in January, at the preseason IPM meeting in March, in the Pesticide Control Board *Communicator* newsletter, in the *Apple Pest Report* newsletter, at meetings of the Maine State Pomological Society Executive Council, and was advertised in several newspapers. The event was attended by about 75 persons and featured displays from the Maine State Pomological Society; the USDA/

Downeast Resource Conservation & Development Cranberry IPM Program; the University of Maine Strawberry, Potato, Sweet Corn, Greenhouse, Blueberry, and Apple IPM Programs; the Maine Department of Agriculture; and the Maine Pesticide Control Board. In addition to the hosts, five other apple farmers agreed to serve as spokespersons and to answer questions. Arrangements were made to have a live Internet/World Wide Web connection, projector, and screen at the event, to demonstrate a developing technology with potential applicability for IPM users.

## *Conclusions*

By virtue of the successful development of state-specific IPM guidelines in 5 of 6 New England states, by demonstrating (once again) that IPM can result in lower pesticide applications, lower dosage equivalents, and a lower EIQ rating, and by generating substantial media and consumer exposure for IPM throughout the region, the investigators believe that all project goals were achieved.

## *Acknowledgments*

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