# Research Update - Spring 2011

*The Tart Cherry Integrated Orchard Management Project*

## Efficacy of reduced risk pesticides on pests in cherry orchards

*Mark Whalon, Larry Gut, Pete Nelson, Tyler Ash, Department of Entomology, Michigan State University*

The Risk Avoidance and Mitigation Process (RAMP) studies examined the Michigan tart cherry industry transition from azinphosmethyl (AZM or Guthion) which is an organophosphate insecticide to so called "reduced-risk" pesticides (USEPA AZM Reregistration) insecticides brought on by the passage of the Food Quality Protection Act (1996). The Whalon and Gut labs at MSU monitored the key tart cherry pests – plum curculio (PC) and cherry fruit fly (CFF). Their control was used as a benchmark for how successful the reduced risk insecticides would work in tart cherry IPM programs compared to the traditional AZM control of these pests. Both plum curculio and cherry fruit fly larvae if found in tart cherry fruit at harvest, can result in complete rejection of a truck load and even a whole farm block of cherries by a processor with devastating consequence for a grower.

In all, there were 7 years of research with 8 cooperating growers per year. Each grower provided two ~10A tart cherry blocks side by side where one was designated an AZM comparison (COMP) and the other a so called 'reduced risk' (RAMP) block. Throughout the study, growers applied insecticides at the recommended (E-154) timing in each block under the direction of the researchers. Researchers also monitored insects, disease and fruit infestations in all of the orchards. Special attention was paid to measuring larval infestation at harvest. In addition, functional ecological changes (pollinators, predators and parasite monitoring) in each orchard was carefully carried out through all 7 years of the study. The comparative costs of each pest management program over the 7 years were also measured using within season average costs of pesticides as a standard. The RAMP orchards were only treated with reduced risk (citation) insecticides that were primarily Neonicotinoids, Spinosad, an Oxadiazines, synthetic pyrethroids, Insect Growth Regulators and the organophosphate Imidan®. Standard pre-FQPA insecticides including AZM, chlorpyriphos, and synthetic pyrethroids where used in the COMP block.

Over the 7 year study, reduced risk pesticide programs were found

to have higher plum curculio, cherry fruit fly, Japanese Beetles and mite populations than the COMP blocks (Figure 1). A total of 14 or 28.5% reduced risk orchards failed. Eight were caused by PC larval infestations (87.5%), 4 from cherry fruit fly (14%) and 1 from Japanese beetle larvae (0.5%). The COMP or AZM blocks had no larvae in fruit at

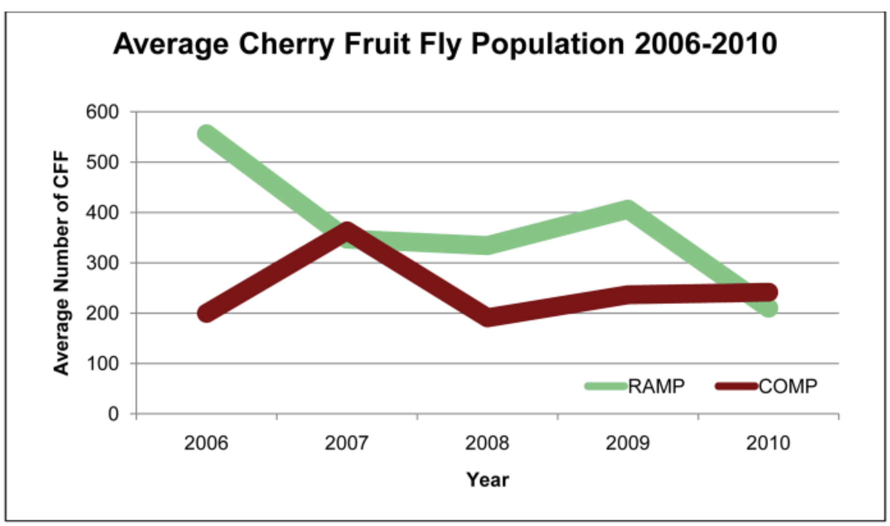


**Figure 1.** Average cherry fruit fly values in RAMP and COMP orchards from 2006 to 2010. Each value is an average of data from 10 growers. RAMP= orchards managed with reduced-risk and OP-alternative pesticides. COMP= orchards managed with organophosphates.

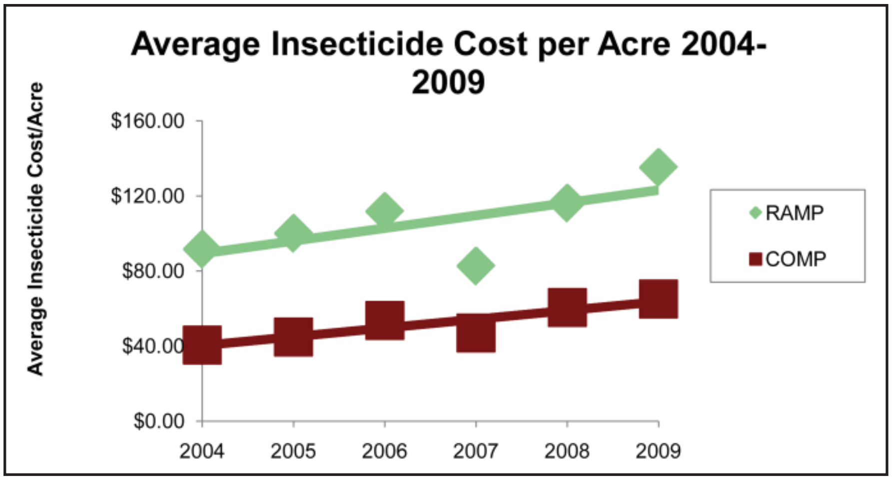


**Figure 2.** Insecticide cost per acre from 2004 to 2009 in RAMP and COMP orchards. Each value is an average of the pesticide input costs of nine growers. RAMP = orchards managed with reduced-risk and OP-alternative pesticides. COMP = orchards managed with organophosphates.

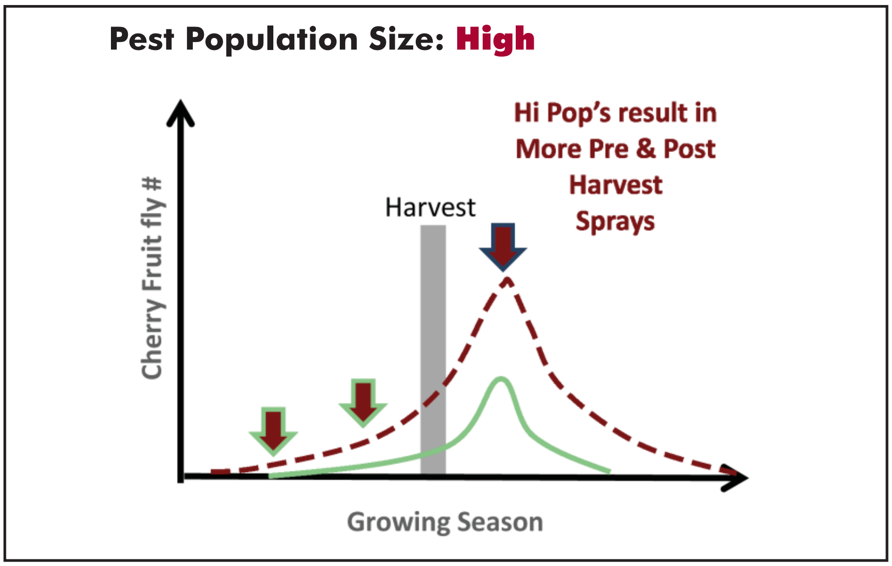


**Figure 3.** The green bar represents the classic population of cherry fruit flies. The red bar represents the recent shift of population size. As pest populations increase (transition from green to red bar) more pre-harvest and post-harvest sprays are needed.

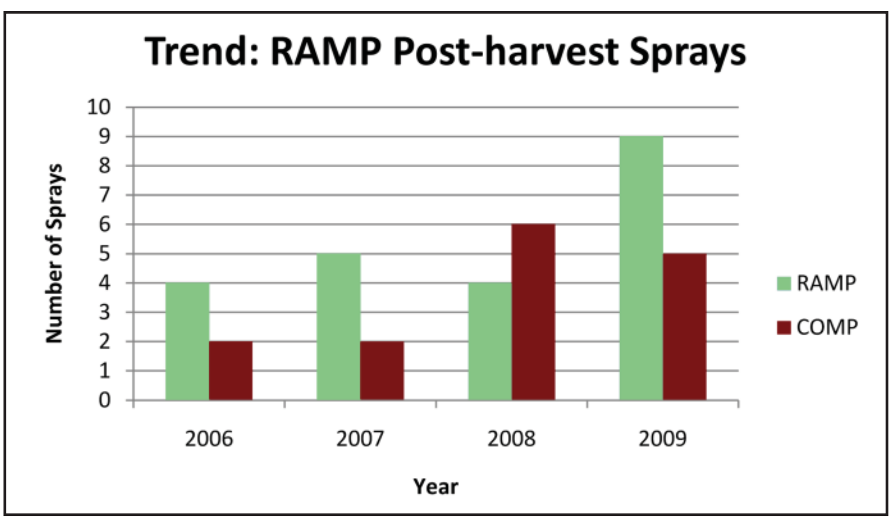


**Figure 4.** This data shows an upward trend of number of sprays needed each year to control the pest populations. Using this information it is projected that the number of sprays needed will continue to rise each season.

harvest in any of the orchards. Both PC and CFF populations around the COMP orchards increased dramatically in the reduced risk RAMP versus the COMP orchards. This was so pronounced that the researchers launched another study to help growers reduce these populations. The postharvest pressure from CFF over the 7 years of this research warranted Imidan treatments postharvest in 2010.

Also, orchards managed with reduced-risk pesticides consistently cost twice as much for insecticides as the conventional AZM orchards (figure 2). The reduced risk pesticides require on average of about twice as many sprays as conventional pesticides. One major finding in this study suggests that the cost of additional insecticide sprays to control PC and CFF will continue to increase as growers may have to annually spray postharvest to reduce both PC and CFF populations (figure 3 and 4).

**References**

"Azinphos-Methyl | Pesticides | US EPA." US Environmental Protection Agency. Web. 24 Mar. 2011. <http://www.epa.gov/oppsrrd1/reregistration/azm/index.htm>.

## Effects of pesticide transition on natural enemies in cherry orchards

*Mark Whalon, Pete Nelson, Tyler Ash, Department of Entomology, Michigan State University*

USEPA partially justified canceling the use of AZM in cherries because of worker exposure issues from AZM compared to reduced risk insecticides. USEPA also asserted initially that AZM was much harder or caused more mortality and dislocation of beneficial species like bees, pest predators and parasites than do the Reduced Risk insecticides that passage of the FQPA and USEPA have forced the cherry industry to use.

The Whalon lab at MSU also evaluated the functional ecology impacts of the pesticide programs, because the benefits provided by native pollinators, predators and parasites are very important to grower's MEAP Certification and also to USEPA's registration and reregistration decisions (Pesticide Reregistration Program USEPA). Therefore, functional ecology monitoring measured (using yellow sticky traps) the numbers and occurrence of 32 different species of beneficial insects in the RAMP and COMP blocks twice annually for the seven year study.

Ecological diversity is an index that calculates the biodiversity or health of the orchard. Evenness measures the differences in diversity between the RAMP and COMP blocks and richness is simply the number of different beneficial species found in the block (Figure 5). These measures were carried out in all 56 blocks over the 7 years of the study. Initially, COMP orchards had much higher functional ecology measures than the reduced risk RAMP orchards probably because the orchard ecosystems had adjusted for many years to the use of AZM. However, over the 8-year period some key

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Green lacewing.

natural enemies in COMP (AZM) orchards like the green lacewing predator decreased dramatically in the reduced risk (RAMP) blocks, but in-time, this predator was displaced by another species that was smaller and probably less abundant, the brown lacewing.

Parasites were also definitely reduced overall early in the study (first 4-5 years), particularly the Tachinid flies, in RAMP blocks, but gradually other species displaced these former species and the diversity indices were not that different between years 6-7. Some species like the coccinelids or lady bird beetles that feed on aphid's recovered both in density and species diversity over the study.

Certainly, it is ecologically demonstrable that the reduced risk insecticides were harder on orchard functional ecology than AZM

| **Figure 5.** Calculations used for functional ecology to determine overall health of cherry orchards. | Shannon Diversity Index (H') $= -\sum p_i \ln(p_i)$<br>where $p_i = \frac{\text{\# of individuals in species } i}{\text{total number of individuals}}$<br><br>Richness (S) = Number of different species observed<br>Evenness (E) $= H'/H_{max}$ ; $H_{max} = \ln(S)$ |
|---|---|

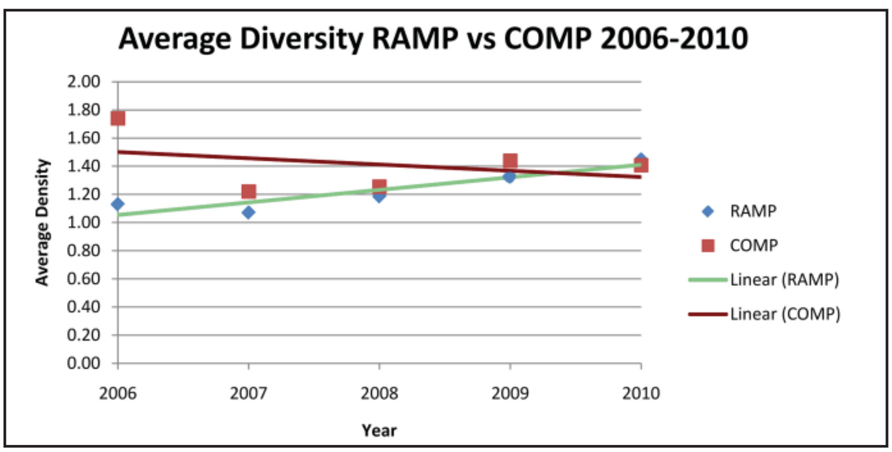



Figure 3. Diversity comparison of RAMP and COMP orchards. Each data point represents the average diversity for ten growers over two collection times. RAMP= orchards managed with reduced-risk and OP-alternative pesticides. COMP= orchards managed with organophosphates.

Joseph Berger, Bugwood.org

The smaller brown lacewing.

orchards were at first. This ecological changeover will likely continue to be the case throughout the Upper Midwest's tart cherry industry since many growers will now have to start spraying reduced risk insecticides both in the season and, for some, as postharvest sprays for PC and CFF control. It is also debatable whether in the long-term that the "reduced risk" insecticides will really be "reduced risk" where the ecology of natural enemies and beneficial pollinators are concerned.

One particular troublesome concern for the long-term impacts of the reduced risk insecticides on biological diversity in cherry orchards is that many of these reduced risk insecticides circulate or are translocated in the tree's sap. Some of these compounds may be excreted and concentrated at the base of cherry leaves in what horticulturists call the 'extrafloral' nectaries at the base of most stone fruit tree leaves. It turns out that these extrafloral nectaries provide moisture, sugar and other nutrients to many cherry orchard beneficial insects (Shearer and Atanassov, 2004). Therefore, IPM programs in tart cherry that used to rely on beneficial insects to reduce secondary pests like scale, aphids and mites maybe severely altered by the loss of AZM and the switch to the so called 'reduced risk post-FQPA insecticides.

**References:**


"Pesticide Registration Program | Pesticides | US EPA." US Environmental Protection Agency. Web. 24 Mar. 2011. <http://www.epa.gov/pesticides/factsheets/registration.htm>.

Shearer, Peter W., and Atanas Atanassov. "Peter W. Shearer and Atanas Atanassov." Journal of Economic Entomology (2004): 789-92. Web.

## Management of western cherry fruit fly using pesticides and killing stations

*Diane Alston, Department of Biology, Utah State University*

Utah produces 3,300 acres of bearing tart cherries according to 2009 Utah NASS data. The majority are grown in southern Utah County, south of Provo. During RAMP I and II projects (2004-10), a total of 32 on-farm plots were compared for performance of Guthion and other organophosphates (OP) to OP-alternatives for management of western cherry fruit fly. Imidan, Malathion, Provado, and spinosad (Success, Entrust, and GF-120) were the primary products compared to Guthion. There were no fruit fly control failures in OP-alternative blocks; however, in 2009, a total of four fruit fly larvae were found in two orchards treated with three or more applications of OPs (Guthion and Imidan). Larvae were detected in mid to late July, just before cherry harvest. In both orchards, the timing of infestation coincided with a gap in protection by the insecticide Imidan. Utah has alkaline water and buffering of spray solution is critical to prevent breakdown of phosmet, the active ingredient in Imidan. Inadequate buffering of Imidan in the spray tank may have contributed to the low levels of fruit fly infestation.

GF-120 and Entrust have performed well in Utah's hot and dry summer conditions, and have been the exclusive insecticides used in organic and organic-transitioning tart cherry blocks. Pre- and post-project grower surveys found an increase in the use of spinosad and Imidan from 4 to 42% and 52 to 74% of cherry growers, respectively. In contrast, use of azinphosmethyl (Guthion) decreased from 83 to 63% of respondents.

Another study in RAMP II was the development and testing of protective killing stations to enhance the spinosad bait insecticide GF-120. The hypothesis was that killing stations could protect GF-120 droplets from UV radiation and rainfall, and yellow color could enhance attraction of fruit flies to the bait droplets. Killing stations were built from 36-inch diameter, plastic, plant pot saucers painted yellow. Saucers were hung inverted from tree limbs or posts and GF-120 sprays applied to the underside. In experimental orchards with moderate to high cherry fruit fly populations, killing stations deployed at 18 and 30 per acre kept fruit infestation at or below 0.3%. Killing stations extended the efficacy of GF-120 droplets up to 14 days as compared to fresh residues. Interestingly, reproductively mature cherry fruit fly females (ovaries contained mature eggs) were more attracted to less concentrate GF-120 dilution (1:5) and GF-120 with the standard ammonium acetate concentration (1%) than to the more concentrated GF-120 (1:2.5 and 1:1.5) and GF-120 with 2% ammonium acetate. In contrast, immature females (without mature eggs) were equally attracted to all GF-120 and ammonium acetate concentrations tested.

These results suggest that reproductively mature females looking for egg-laying sites in fruit can be repelled by ammonium acetate concentrations higher than about 1%. This finding bodes well for attempts to extend the longevity of GF-120 in the orchard through killing stations. Once placed in an orchard, killing stations are relatively easy to maintain with targeted GF-120 sprays every 1 to 2 weeks. Sprays can be applied with a directed nozzle from a hand-pump or electric sprayer mounted on an ATV.

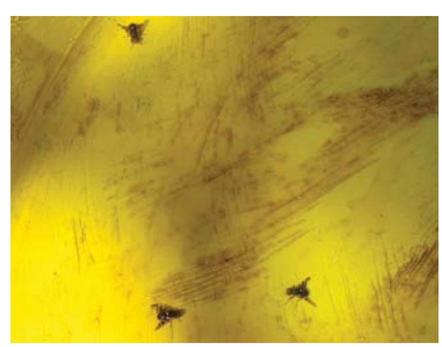
## Effects of integrated copper spray program on disease and leaf bronzing

*Patricia S. McManus, Department of Plant Pathology, University of Wisconsin - Madison*

In 2009, studies were conducted at one commercial orchard (Rocky Ridge, Egg Harbor, WI), at Peninsular Agricultural Research Station (PARS, Sturgeon Bay, WI) in an organic block of tart cherry trees (PARS Organic), and at PARS in a conventional block. One cooperator from 2008 opted out of the study in 2009 because of concerns about the yellowing and premature defoliation of copper-treated leaves. Another cooperator integrated copper-based fungicides into his spray program in some blocks and had good disease control. However, these trees were of different age and vigor than nearby trees treated conventionally. Therefore, we did not take data in an attempt to compare the two programs at that site. At the Rocky Ridge site, the objective was to compare the effects

Shawn A. Steffan, Utah State Univ.

A killing station



WWF feeding on bait

of a conventional spray program and an integrated copper spray program on disease and leaf bronzing. At the PARS organic site, the objective was to compare the response of Montmorency and Balaton cultivars treated with copper sulfate (Cuprafix Ultra 40D) as well as other fungicides approved for organic use.

Cherry leaf spot (CLS) and powdery mildew (PM) disease pressure were moderate in 2009, although by mid-September, cherry trees that had not been protected were nearly defoliated at PARS and near the commercial orchard (Rocky Ridge). Data are summarized in Tables 1, 2, and 3.

Control of CLS was excellent and control of PM was good at the Rocky Ridge site, where incidence of both diseases was lower in the integrated copper program than in the grower's conventional program. Twenty-one percent of copper-treated leaves showed bronzing symptoms compared to zero percent in the conventional program, although overall defoliation did not differ between the programs.

Control of both CLS and PM was excellent in the PARS organic block, with neither disease found on the shoots sampled. Both varieties showed minor amounts of bronzing and defoliation. Although it was not quantified, bronzing symptoms appeared less severe (i.e., less of the leaf surface affected) on leaves with residues of Surround, a clay-based product used for insect control in organic orchards. A similar phenomenon was observed in 2008.

Control of CLS was excellent and control of PM was good in the PARS conventional block, but neither disease was affected by the number or timing of copper applications. Likewise, the incidence of leaf bronzing and defoliation did not differ among treatments. Although the incidence of bronzing was high (56-66% of leaves affected), severity (i.e., the amount of leaf surface affected) was light. Integrated copper programs provided excellent control of cherry leaf spot and generally good control of powdery mildew. Copper-treated leaves exhibited bronzing,

**Table 1. Rocky Ridge Orchard, September 14, 2009**

| Treatment | PM | CLS (%) | Bronzing (%) | Defoliation (%) |
|---|---|---|---|---|
| Conventional | 1.5 | 1.6 | 0.0 | 10.2 |
| Integrated copper | 1.2 | 0.1 | 21.4 | 9.4 |
| P value (Fisher's Protected LSD) | 0.001 | 0.043 | 0.001 | 0.836 |

**Table 2. PARS Organic Block, September 14, 2009**

| Treatment | PM | CLS (%) | Bronzing (%) | Defoliation (%) |
|---|---|---|---|---|
| Montmorency | 1.0 | 0.0 | 8.6 | 7.1 |
| Balaton | 1.0 | 0.0 | 4.8 | 4.0 |
| P value (Fisher's Protected LSD) | 0.151 | --- | 0.146 | 0.067 |

**Table 3. PARS Conventional Block, September 15-16, 2009**

| No. cover sprays of copper (dates applied) | PM | CLS (%) | Bronzing (%) | Defoliation (%) |
|---|---|---|---|---|
| 2 (7/2; 8/17) | 0.40 | 0.5 | 56.0 | 8.8 |
| 3 (6/6; 7/2; 8/17) | 0.25 | 0.4 | 59.4 | 11.0 |
| 3 (7/2; 7/14; 8/17) | 0.15 | 1.3 | 62.6 | 11.5 |
| 4 (6/6; 7/2; 7/14; 8/17) | 0.13 | 0.6 | 65.5 | 13.8 |
| P value (Fisher's Protected LSD) | 0.187 | 0.071 | 0.699 | 0.173 |

but the incidence of bronzing was similar on Montmorency and Balaton and was similar on trees receiving variable numbers of copper sprays. Premature defoliation was not affected by copper application.

## Use of copper and sulfur and its efficacy

*George W. Sundin, Department of Plant Pathology, Nikki Rothwell, Erin Lizotte, and Karen Powers, Northwest Michigan Horticultural Research Station, Michigan State University; Matt Stasiak, Peninsular Agriculture Research Station, University of Wisconsin – Madison.*

Reduced risk pesticides were tested for their ability to control tart cherry insect pests and diseases in a statewide on-farm trial during the 2010 growing season. A total of nine sites were established for this study and are located in the three key tart cherry regions of Michigan (Northwest, Southwest, and West Central). The following results are compiled from the five Northwest sites (2 in Benzie County and 3 in Leelanau County) where there are two, 10-acre blocks at each site. One block received reduced risk insect and disease control strategies (RAMP block) and a second block used grower standard control strategies (comparison block).

In order to determine if copper is efficacious against cherry leaf spot (CLS) at on-farm sites, two grower cooperators used copper in their RAMP blocks and Gem in comparison blocks. Copper was applied at 1.2 lbs actual copper combined with 3-6 lbs of lime. Comparison blocks had Gem applied at 1.6-2 oz. From the 2010 results, copper did not perform as well as the standard fungicide program, however, CLS infection was minimal in both blocks.

Sulfur is often used because of its low cost, and many growers in northwest Michigan use sulfur to combat disease (powdery mildew and brown rot) although the material is often rated "fair" against these pathogens. Entomologists in the western United States discourage growers from using sulfur because it flares two-spotted spider mites (TSSM) in their dry environment.

To determine the impact of sulfur application on powdery mildew, four farms were rated for disease at

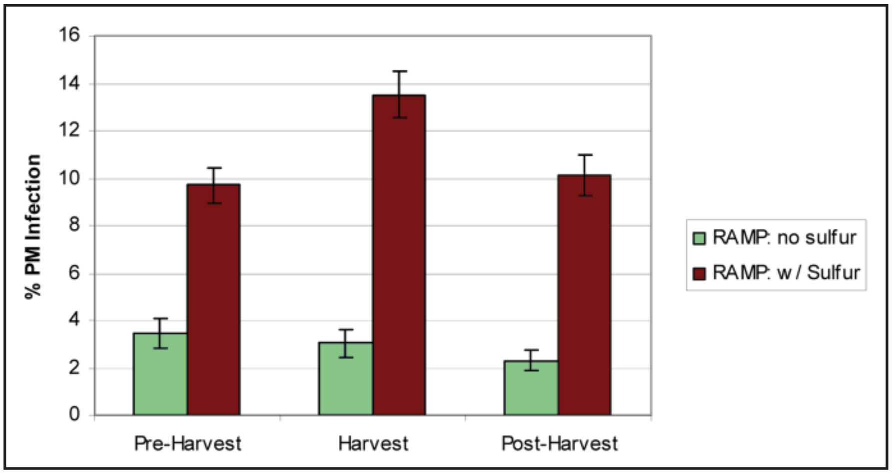



**Figure 1.** Percent powdery mildew infection at Farm A where half of the RAMP block was treated with sulfur and the other half left untreated.

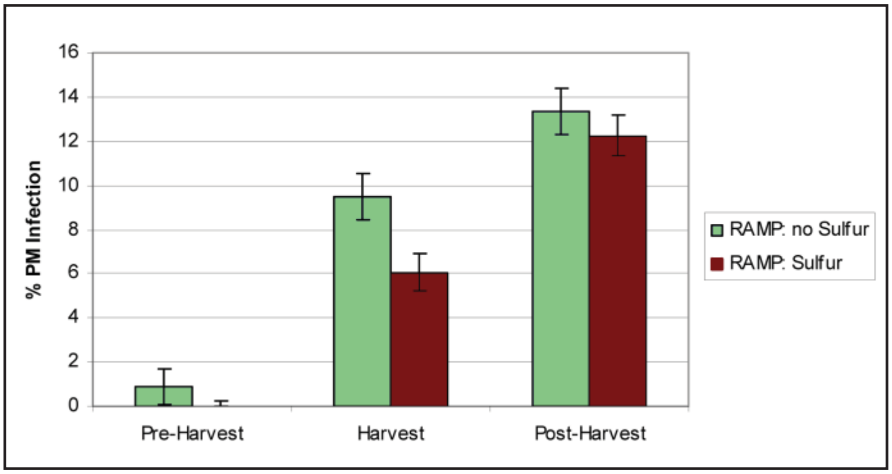



**Figure 2.** Percent powdery mildew infection at Farm C where half of the RAMP block was treated with sulfur and the other half left untreated.

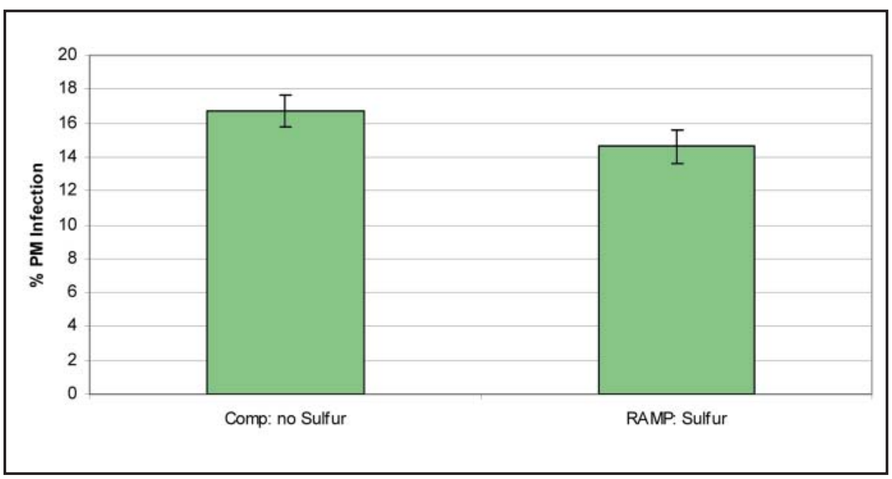



**Figure 3.** Percent powdery mildew infection at Farm E pre-harvest. At this timing only sulfur had been applied in the RAMP block for powdery mildew control and not in the Comparison block.

three timings: pre-harvest, harvest, and post-harvest. Figures 1-3 show percent powdery mildew infection. At Farm A, sulfur did not significantly reduce powdery mildew infection when compared to blocks with no sulfur application (Figure 1). At Farm C there was a significant reduction in powdery mildew in the sulfur treated half but only at the harvest evaluation (Figure 2). At Farm E, powdery mildew infection was significantly reduced in the sulfur treated block at the pre-harvest evaluation (Figure 3).

## Tart cherry IPM Framework for evaluation

*Jean Haley, Haley Consulting Services LLC*

During the final year of RAMP I, a draft framework for defining and measuring tart cherry Integrated Pest Management (IPM) was developed. The framework operates at three levels: strategies, tactics and tools. The project identified three principal IPM strategies for tart cherry orchards: 1) knowledge and education, which includes staying abreast of new technologies as they come on the scene, applying information from best possible sources, and complying with Good Agricultural Practices, such as drift management; 2) monitoring, the foundation of any IPM program; and 3) pest suppression, including insects, mites, weeds, fungi, bacteria, nematodes and viruses.

Once all the major practices were identified, the hard work of assigning points to practices began since not all practices were created equal! The assigned points continue to be revised, and should be revisited every year as new practices come on the scene.

RAMP II work focused on validating the IPM Framework by researchers, industry representatives and growers. The process used to finalize the Framework by assigning points to practices included:

1) project researchers negotiated points for each practice at meetings and phone conferences; 2) tart cherry growers and industry representatives discussed the initial ratings during two focus groups in Utah and Michigan; 3) grower and industry comments were brought back to a group of project researchers and growers to discuss and reconcile differences.

During the meetings with growers and industry representatives, participants agreed that the best format for the IPM Framework would be a workbook that could be used for educational purposes as well as measuring adoption. The workbook will include literature and resources on each of the practices found in the Framework. Where no literature or resources were found for a specific practice, brief descriptions of why a practice is beneficial were developed and included.

The IPM Framework workbook will serve growers in two practical ways: 1) as a compiled resource on tart cherry IPM practices, and 2) as a self-assessment guide to IPM on their operations. Growers will be able to identify areas of strength and areas where improvements might be made, which might also help with the NRCS EQIP program.

On March 31, 2011, the Management Team met and provided feedback on the workbook and finalized the points that were assigned to each of the practices. After edits are made, a select group of growers and consultants will pilot test the workbook before it is finalized for distribution.

**Grower surveys**

To measure IPM adoption among tart cherry growers and determine if any changes have occurred since the beginning of the project in 2003, grower mail-back surveys were developed and implemented in 2004 (for baseline), 2008, and 2010. The final survey in 2010 differs from the original survey in 2004, and even the more recent survey in 2008, because new practices were added as the IPM Framework was developed. This means that we won't be able to measure differences in some practices that were identified after the 2004 and 2008 surveys.

Data analysis continues on the 2010 survey returns. Comparisons will be made among results from the 2003, 2007, and 2009 growing seasons, and where appropriate, statistical tests for significance will be conducted. In the meantime, we have preliminary results for grower opinions, barriers to use, and self-reported use of IPM.

- IPM opinions have remained relatively constant over the three years. While we did see some growth in agreement about the positive attributes of IPM from the 2004 to 2008 surveys, the 2010 results look much like the 2004 results (Figure 1).
- Ratings for barriers to adopting IPM have gone up in all categories except for the expense of IPM (about the middle of the graph on Figure 2) – meaning respondents found these elements were more of a barrier to adopting IPM in

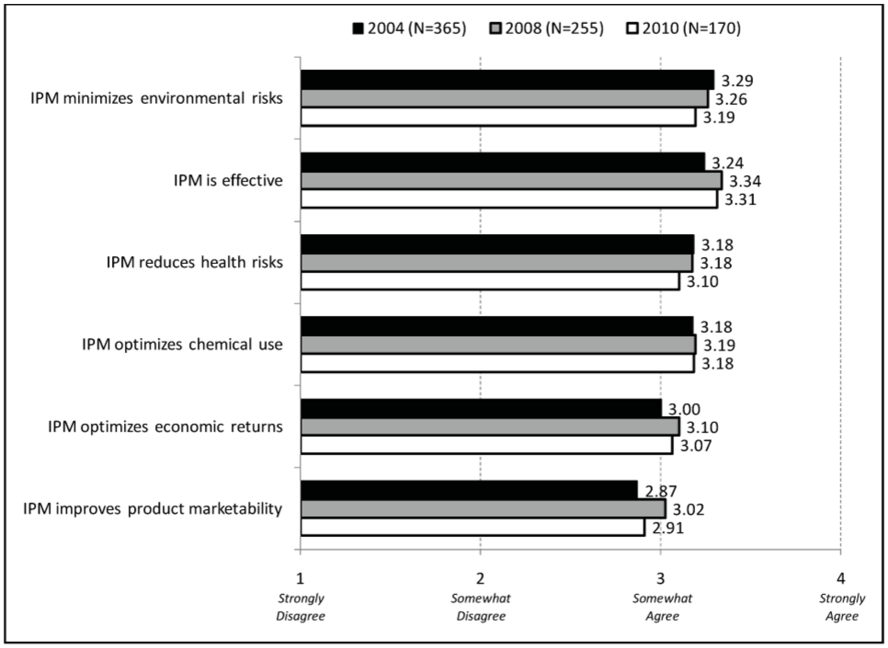



**Figure 1.** IPM opinions 2004-2010.

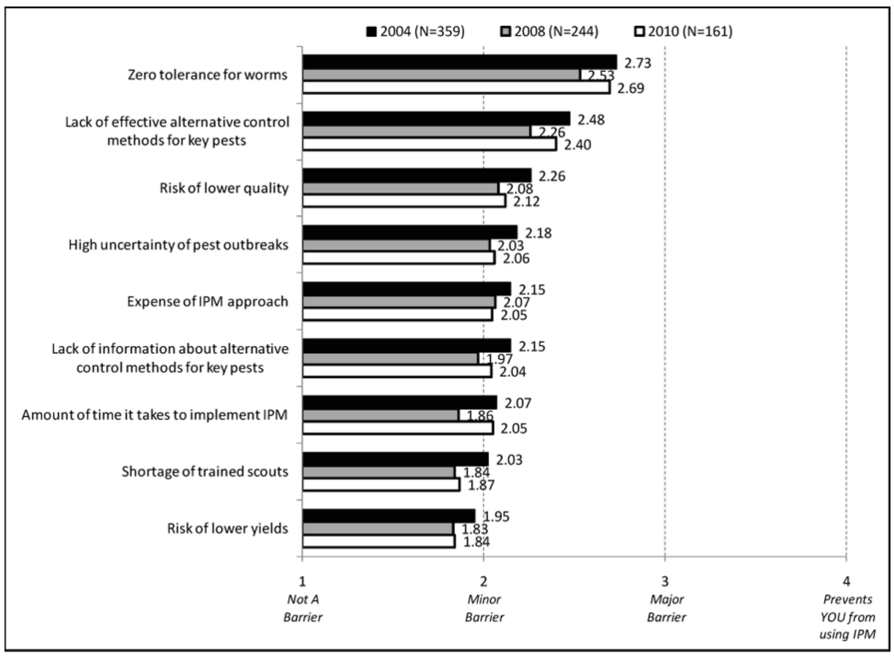



**Figure 2.** Barriers to adopting IPM. 2004-2010.

2010 than they did in 2008. The ratings are all, nonetheless, still lower, if only slightly, from the original 2004 ratings.
- Despite the seeming stagnation of respondent opinions and attitudes towards IPM, their self-reported use has increased during the life of the project from 52 percent in 2004 (2003 growing season) to 69 percent in 2010 (2009 growing season) (Figure 3).

The survey data will continue to be analyzed and mined to determine if any correlations can be drawn between the increase in self-reported use and the project's research and activities. In addition, IPM scores, using the Framework point system, will be calculated for respondents and aggregate scores will be compared against self-reported use to see if there are any disconnects between what respondents believe to be IPM and what the project has just defined as IPM for the industry. As always, survey respondent data is completely confidential and will only be presented and analyzed in the aggregate.

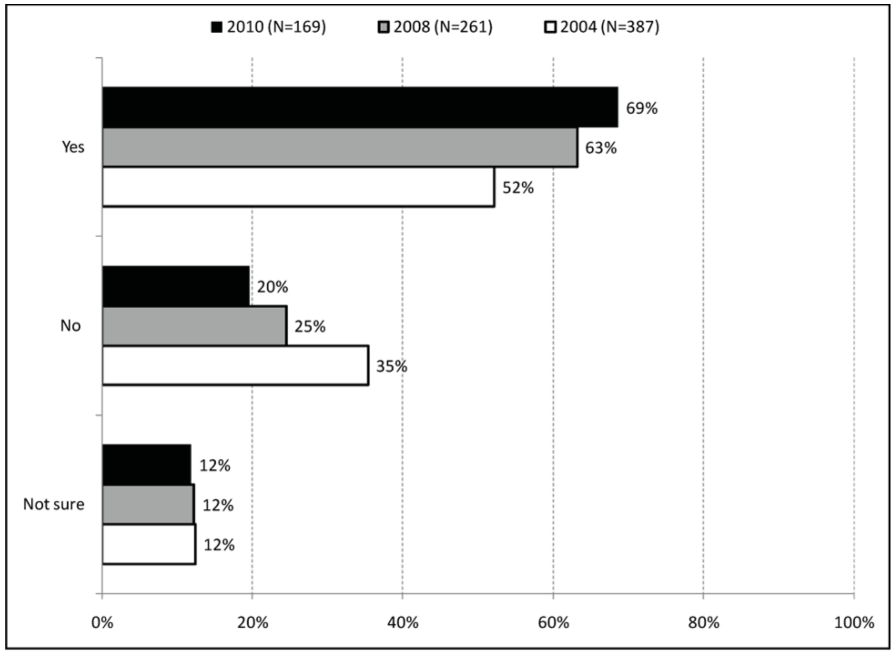



**Figure 3.** Self-report IPM use, 2004-2010.

**Thank you to growers**

We would like to thank all the growers who participated in all our surveys and those who shared in the time-consuming meetings we held to pilot test instruments and validate the Framework. Your input helped inform the research being conducted for this project, and kept us up-to-date with our USDA reporting requirements. Look for the fruit of this work, in the form of a useful IPM self-assessment guide, towards the end of this year.

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