Research Update

The Tart Cherry Integrated Orchard Management Project

From the Management Team

The Tart Cherry Integrated Orchard Management project, or TC RAMP I project, completed its fourth and final field season in 2007. Originally funded for the time period of September 2003 through September 2007, RAMP I received a one-year no-cost extension through September 2008 to allow the project team to complete the social evaluation objective and report writing obligations of the project. All field research associated with RAMP I ended with the 2007 season. A second Cherry RAMP project (RAMP II), with a start date of September 2007, has been funded at $1.5 million to continue the work of helping the cherry industry transition to OP-alternatives and reduced-risk controls to manage key pests, develop resistance management strategies, investigate cherry tree host plant resistance, and to develop reliable measures of the ecological consequences of orchard management changes.

The funding of a second RAMP project immediately following the original is unusual; and is powerful testimony to the effectiveness of the collaborative partnership between the cherry industry and researchers at Michigan State University, Utah, and Wisconsin in aggressively addressing challenges faced by the industry. With the USEPA mandated phase-out of AZM approaching in 2012, Michigan growers and researchers gathered in northwest Lower Michigan in December 2006 to update the existing Tart Cherry Pest Management Strategic Plan for resubmission to the USDA. In addition to the solid evidence provided by RAMP I of obstacles threatening continuing profitability of the United States tart cherry industry, the re-writing of the Tart Cherry Pest Management Strategic Plan was critical to ensuring consideration of the second RAMP proposal. The funding provided for RAMP II through September 2010 allows us to continue collaborative efforts in structuring the cherry pest management programs of the near future.

Erin Lizotte checking for insect and disease damage during the weekly RAMP scouting.

This newsletter will update readers on progress made and challenges faced to this point in striving to meet the objectives of the project. Our feature article reports on the natural enemies surveys that have been conducted on all nine participating farms to investigate the effects of management tactics on non-target organism diversity in the orchard, and how this information was used in the defense of azinphosmethyl to USEPA. Also provided, are research updates summarizing the work of the project, and a highlight article about one of our Michigan grower-cooperators.

Project researchers will meet in January with the project management team immediately following the 2008 Northwest Michigan Orchard and Vineyard Show in Traverse City, Michigan to review the 2007 season and plan project activities for 2008 – 2010. The Management Team is made up of approximately 15 to 20 members, including growers, consultants, industry representatives, and University researchers and extension personnel from three states. Don Gregory from Cherry Bay Orchards serves as president of the Management Team.

- Dave Epstein, Michigan State University Entomology/IPM.

Winter 2008
In this issue

U.S. cherry growers produce between 275 and 300 million pounds of tart cherries each year.

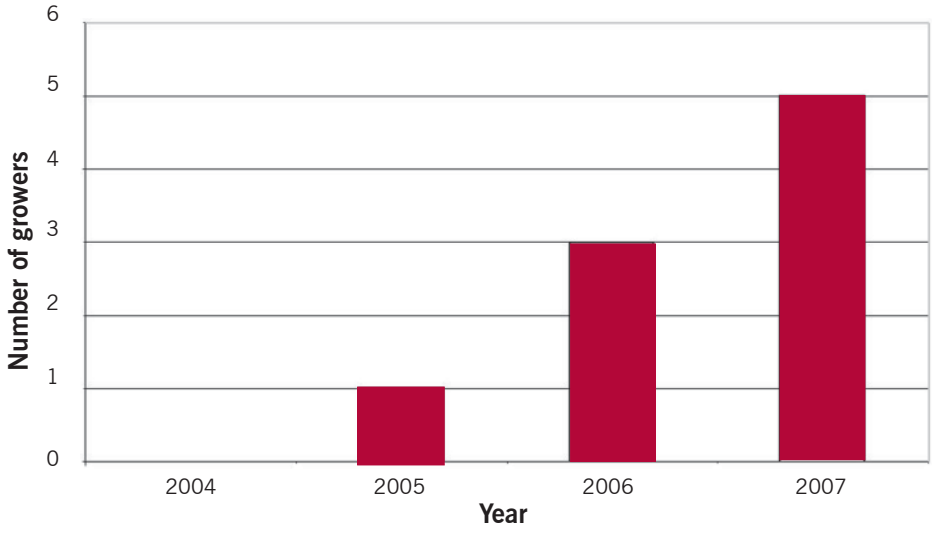
TC RAMP I instrumental in postponing AZM cancellation until 2012

The U.S. Environmental Protection Agency (USEPA) has been moving toward the cancellation of organophosphates (OPs), particularly azinphos-methyl (AZM or Guthion®), and other pesticides through the re-registration processes under the Food Quality Protection Act (1996) and the Federal Insecticide, Fungicide, and Rodenticide Act (1972). These two federal laws direct USEPA to severely curtail or cancel most of the insecticides that have been the mainstay of tart cherry production since the 1960's.

The two Tart Cherry RAMP grants funded for the 2004-2010 field seasons through the USDA are an attempt to find alternative IPM (integrated pest management) means of controlling significant cherry pests across the United States. AZM and other OPs have been critical tart cherry insecticides for three decades. Research from the RAMP I grant led to two key sets of information that have delayed cancellation of AZM use on cherries. This RAMP I data essentially did two things. First, researchers tested whether or not there was a suitable alternative IPM program growers could immediately go to if AZM were cancelled. Second, researchers measured the ecosystem health of both the AZM and the proposed OP-alternative test orchards to see exactly how "ecologically healthy" they actually were. This work was critical because USEPA has been using evidence for decreased ecological health where OP insecticides are used as one of the key justifications for cancelling AZM and other OP's like chlorpyriphos in cherries.

RAMP I researchers set up a direct comparison between standard AZM-based and OP-alternative-based programs at nine sites from southwest to northwest Michigan. In the OP-alternative orchards, the RAMP I researchers tested the only likely OP-replacement program available to growers at the time. This program was compared directly to the standard AZM-based IPM program that cherry producers have evolved over the past 35 years. These tests were done in a side-by-side design with 18 orchards.

Figure 1. The number of growers forced to use organophosphate rescue sprays in RAMP orchards anually.



Each orchard was evaluated for plum curculio, mites, cherry fruit fly, aphids, leafrollers, borers, Japanese beetles, fruitworm, leaf spot, leaf spot resistance, brown rot and other pests and diseases. The program also measured the costs and the degree of difficulty for growers to adopt the alternative IPM program. In all, the RAMP research program represented the largest single tart cherry research project ever carried out.

To compare the ecological health of each of these 18 orchards, the presence, diversity and quality of 16 different groups of beneficial insects (e.g. bees, predators, parasites, etc.) were monitored and compared. This research, known as "functional ecology measures" provides fruit growers with two advantages. First, it is an indicator or measure of how "healthy" or "sustainable" a cherry production system is. This ecological health information was delivered to growers in the form of dollars per acre paid to them in biological control of pests in their orchards. Second, the functional ecology data was submitted to the USEPA to help evaluate whether or not AZM was actually more ecologically destructive than the only OP-alternative program available at the time.

Result #1

The RAMP grant found that the OP-alternative IPM program, composed of Actara® (thiamethoxam) and/or Provado® (imidacloprid), which are neonicotinoid insecticides, and Avaunt® (indoxacarb), an oxadiazine insecticide, were significantly more expensive than the AZM-based program. This AZM-alternative IPM program provided reliable control of plum curculio and cherry fruit fly, the two most important insect pests of tart cherry, in low to moderate pressure orchards, but pest pressure increased over the four-year project in some orchards, especially plum curculio populations. By 2007, five out of nine of the RAMP I alternative orchards were forced to revert to OP rescue or clean-up sprays to prevent worms in the crop at harvest (Figure 1). In two cases, severe defoliation from Japanese beetles warranted the OP-rescue spray.

Result #2

A significant difference was found between AZM orchards and the RAMP I alternative neonicotinoid/oxadiazine orchards. The AZM IPM orchards were actually healthier ecologically than the OP-alternative orchards, based on

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Research updates

Insect control with reduced risk pesticides

Reduced risk pesticides were tested for their ability to control tart cherry insect pests in statewide on-farm trials during the 2004-2007 growing seasons. In Michigan, a total of nine sites with a total of 18 orchards, were established for this study and are located in the three key tart cherry regions of the state. Two approximately 10-acre blocks were established on each site. One block received USEPA defined "reduced risk" insect and disease control strategies (RAMP block). A second block was used to compare the reduced risk control strategies to a decade old IPM strategy that utilized azinphos-methyl (AZM) or other organophosphate insecticides (OP) as each grower's standard pest control strategies (Comparison block).

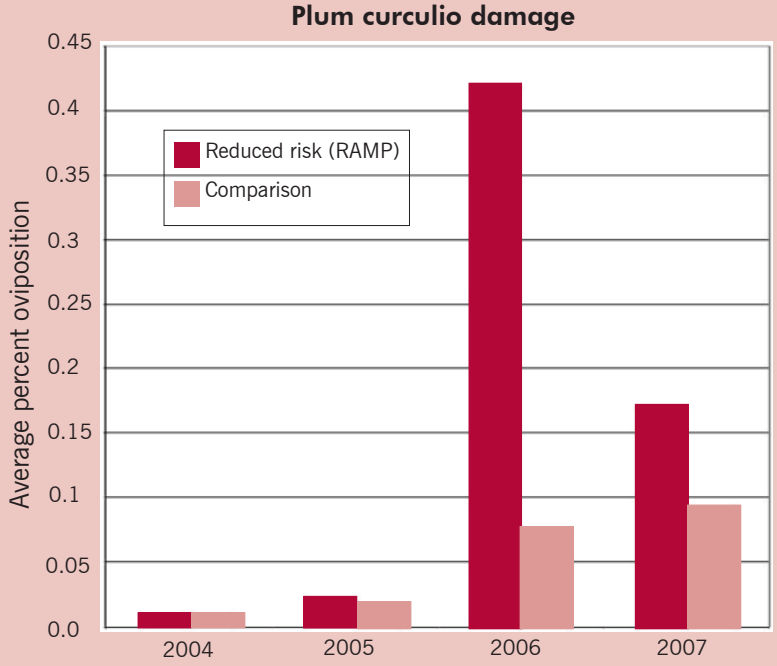

Figure 1. Plum curculio oviposition damage to fruit over the 4 years of RAMP. Two growers in 2006, and four in 2007 required OP rescue sprays to control PC.

Michigan - Plum curculio

The major advancements in understanding plum curculio biology, feeding behaviors, phenological treatment windows of susceptible life-stages, and limited plum curculio susceptibility to reduced-risk organophosphate (OP) alternatives leave little doubt in producers' minds that this is the most important current threat to the industry's viability under FQPA. Pyramid traps continue to provide the best monitoring information early in May through June, with screen traps placed in the tree canopy providing the best monitoring information in August and September. The scouting programs conducted on participating farms show increasing plum curculio population pressure in both non-OP and grower standard plots (Figure 1). The majority of damage in 2006 occurred on two farms that were unable to get their early sprays on in time, resulting in three OP rescue sprays being applied in RAMP plots, two to

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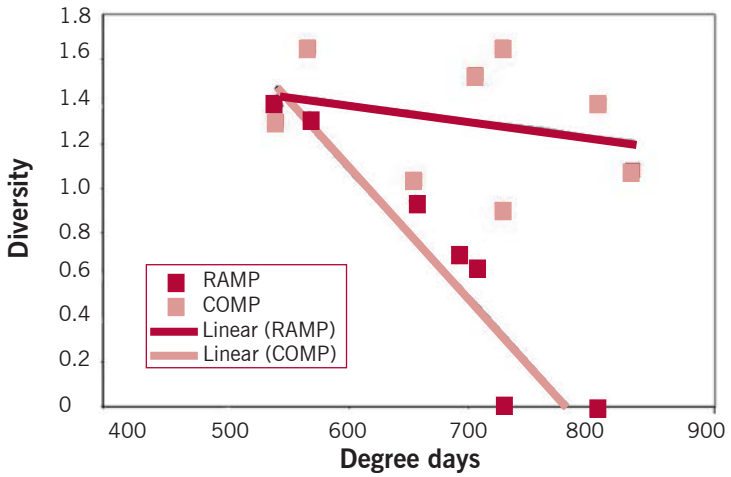
TC RAMP 1 instrumental from page 2.

Figure 2. Impact of AZM (COMP) and the alternative (RAMP) insecticides on natural enemies in 18 tart cherry orchards



both measures of higher natural enemy or beneficial insect diversity, and the higher economic payoff from biological control in AZM orchards to growers.

USEPA persuaded to delay AZM cancellation while USDA funded RAMP II

The RAMP I results were instrumental in USEPA's decision to give the tart cherry industry an extension (until 2012) to transition away from AZM to a more workable OP-alternative IPM program. These data also contributed directly to the justification for USDA's funding of the new TC RAMP II research, which will start in spring 2008. - *Mark Whalon, Michigan State University, Entomology.*

control plum curculio and one to control Japanese beetle. In 2007, damage was even more severe, with four growers applying OP rescue sprays due to plum curculio, and a fifth farm applying an OP for Japanese beetle control.

The RAMP program designed to control plum curculio without the use of OP's has thus far consisted of timing an application of Avaunt® (indoxacarb) at shuck split followed by one to two applications of Actara® (thiamethoxam) in early July. Although Avaunt® was not labeled for use in tart cherry in 2004-2006, a USEPA experimental use permit allowed its use in RAMP project plots. Unfortunately, due to delays in its full registration, no experimental use permit was received to use Avaunt® for the 2007 season, reducing options for plum curculio control in RAMP plots to Actara® alone. Plum curculio population pressures remained high in 2007, with an average of over 25 adults trapped in pyramid and screen traps in May in both RAMP and comparison plots. Intensive sampling performed in each block after the peak plum curculio egg laying period revealed enough damage requiring four out of nine growers to apply an OP rescue spray in their RAMP plots. It is clear that plum curculio populations are building, as previously clean tart cherry blocks are showing low levels of damage and problem blocks are consistently carrying significant damage.

Plum curculio control with reduced-risk compounds will continue to be a focus of RAMP II. The good news for grower participants is that Avaunt® has received a tart cherry label for 2008, and a new option, Assail®, will also be available for the coming season.
- Mark Whalon, MSU Entomology.

Cherry fruit fly management

Like plum curculio, cherry fruit fly pressure appears to be on the rise in Michigan cherry production regions. RAMP cherry fruit fly insecticide protocol calls for the use of Actara® at 4.5-5.5 ounces in late June/early July and Imidacloprid (Provado®) at 6.0-8.0 ounces in July where monitoring records indicate the need for a control application. Consultants working with project researchers continued in 2007 to evaluate the impact of trapping height on fly captures, placing traps attached to poles at about 12 to 15 feet high in the tree canopy, and traps at approximately 6 to 7 feet in the canopy. Where cherry fruit fly populations are low, results show that high trap placement offers better early detection of fruit fly emergence. Throughout the four years of this project, it has been noted that cherry fruit flies in Michigan are emerging later in the season on commercial farms, just prior to and after harvest. Mean captures of cherry fruit fly for all nine farms in 2007 was 7.6 (RAMP) and 19.7 (Comparison) prior to harvest, then increased sharply in July and August to 339 (RAMP) and 344 (Comparison). Fruit injury evaluations were conducted twice in all plots, prior to and two weeks post harvest. For the pre-harvest evaluation, 1,200 cherries were collected from all nine RAMP and Comparison plots. Six hundred cherries were collected from each plot for the post-harvest sample. Collected cherries were placed in racks over containers filled with sand to collect cherry fruit fly pupae after emergence from fruit. In 2007, there were no cherry fruit flies collected from any of the cherries sampled from any farm for either the pre or post-harvest samples. (See Table 1.)

Table 1. Average number of cherry fruit fly trapped from 2004-2007.

	2004		2005		2006		2007	
	Early	Late	Early	Late	Early	Late	Early	Late
RAMP	24.3	191.3	20.7	167.3	79.4	476.4	7.6	339.9
COMP	5.8	65.2	4.2	70.3	41.4	158.2	19.7	343.8

Table 2. Reduced-risk versus conventional insecticide costs from on-farm studies in Michigan tart cherry, 2004-2007.

Year	Per acre insecticide cost		Per acre increase in cost reduced risk insecticides
	Reduced risk	Conventional	
2004	$91.64	$40.52	$51.12
2005	$84.14	$41.90	$46.89
2006	$102.21	$48.45	$53.76
2007	$85.09	$53.42	$31.67
$\bar{x}$ ± SE	$90.77 ± 3.60	$46.07 ± 2.60	$45.86 ± 4.28

Michigan - Insecticide costs for cherry fruit fly

Mean per acre insecticide costs in RAMP plots ($85.09) was $31.67 higher than per acre insecticide costs in comparison plots ($53.42) for 2007 (Table 2). Reducing the costs of control in RAMP plots is one of the aims of the new RAMP project.
- Larry Gut, MSU Entomology.

Utah – Plum curculio and Western cherry fruit fly

Three years of studies on development and testing of two species of entomopathogenic nematodes (*Heterorhabditis bacteriophora* and *Steinernema feltiae)* for suppressing plum curculio in fruit trees were conducted. The efficiency of entomopathogenic nematodes for biological control of insects in the field is highly related to the influence of temperature on their performance and survival. Both species performed the best at 20°C: insect mortality was faster, nematode establishment was greater, and nematode reproduction was higher; however, at 30°C, *H. bacteriophora* was superior to *S. feltiae* in all of the factors.

The two nematodes species exhibited different thermal ranges. At 10 °C, *S. feltiae* was more efficient than *H. bacteriophora* in insect mortality, nematode establishment and reproduction. Three distinctive life stages of plum curculio that are potential targets for infection by entomopathogenic nematodes are the larva, pupa and adult. *H. bacteriophora* was more virulent than *S. feltiae* for all life stages. The adult and pupa were more susceptible than the larva, and a concentration of 500 infective juveniles

per insect was more virulent than 100 infective juveniles per insect for all life stages.

Trials were conducted in 19 orchards during 2004-07. Imidacloprid (Provado®) was efficacious for suppressing western cherry fruit fly densities and preventing fruit injury under most commercial orchard conditions. Spinosad formulated as a bait (GF-120®) prevented fruit injury in all but one on-farm site, but it did not completely protect fruit in any of the four research orchard trials. Fruit fly densities were about two to ten times lower in commercial orchards (0-12 cumulative adults per trap) than in the research orchards (21-1,211 cumulative adults per trap) and is the major reason for the inability of GF-120 to prevent fruit injury in the research trials. However, despite the high densities in the research trials, fruit injury in the GF-120 treated plots ranged from only 0.1 to 4.0 larvae per 100 fruit at harvest when fruit were mature.

Major summary points: Spinosad and imidacloprid offer greater flexibility in Restricted Entry Intervals (REIs) and Pre-Harvest Intervals (PHIs) than organophosphate insecticides. GF-120 offers an alternative application method. The two materials differ in pest target stage: Provado is an ovicide and larvicide, Spinosad is an adulticide. GF-120 cannot protect fruit against migrating females that contain mature eggs. - *Diane Alston, Utah State University, Entomology.*

Plant Pathology: Summary

Fungal disease control efforts on tart cherry are hampered with regards to IPM because of the lack of available compounds and the loss of some of these compounds to fungicide resistance. Also, because of a lack of effective fungicide tools for controlling infection after rain events, growers must be cognizant of weather (i.e. utilizing information resources like Enviro-weather, www.enviroweather.msu.edu). Through this project, we documented a fungicide resistance problem to sterol inhibitor fungicides, identified alternative fungicides and delivered fungicide resistance management strategies to growers. In addition, our breeding efforts have been effective in identifying sources of resistance to cherry leaf spot and moving that resistance into progeny lines in which we predict that leaf spot will be controllable with a great reduction of fungicide inputs. Summary of highlights:

- The strobilurin Gem and the strobilurin plus boscalid, Pristine, and the copper fungicides all provided excellent cherry leaf spot control.
- Programs that included up to three sprays of Cu fungicides were among the most effective for controlling cherry leaf spot, although leaf phytotoxicity was sometimes observed.
- The cultivars 'Balaton'® and 'Montmorency' did not differ in the percentage of leaves with cherry leaf spot or defoliation resulting from leaf spot. Under high disease pressure, eliminating chlorothalonil compromised control.
- The strobilurin fungicide trifloxystrobin provided the best protection against infection of sour cherry leaf disks by *B. jaapii* in a leaf-disk assay.
- 2003-04 survey results indicated that Michigan tart cherry orchards are heavily colonized by SI-fungicide resistant isolates of the cherry leaf spot fungus. Essentially all of the isolates recovered and tested were resistant.
- Disease trials do not appear to indicate any loss in efficacy of strobilurins to date.
- Five selections in the MSU tart cherry breeding program exhibit tolerance to cherry leaf spot that is derived from sweet cherry and/or the tart cherry cultivar Northstar. These selections also exhibit superior fruit quality characteristics suggesting that cherry leaf spot resistance along with superior fruit quality is an achievable goal.

For more information please read the following sections. - *George W. Sundin, Amy Iezzoni, and Nikki Rothwell Michigan State University; Patricia S. McManus, University of Wisconsin.*

Testing copper against cherry leaf spot in field trials

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 did not use copper in comparison blocks. Copper sprays were not combined with sulfur. All copper sprays were combined with 3 to 6 lbs of lime at both farms (Figure 1).

Benefits of sulfur for disease and insects

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. Growers also use sulfur because of its low cost, despite questionable benefit. Entomologists in the western United States discourage growers from using sulfur because it flares twospotted spider mites in their drier systems. To determine if sulfur impacts cherry diseases and mites, one grower cooperator applied sulfur in their Comparison (Comp) block, but left the material out of their RAMP block. At each stage in the growing season, the

Figure 1. CLS infection at two farms at three assessment dates.

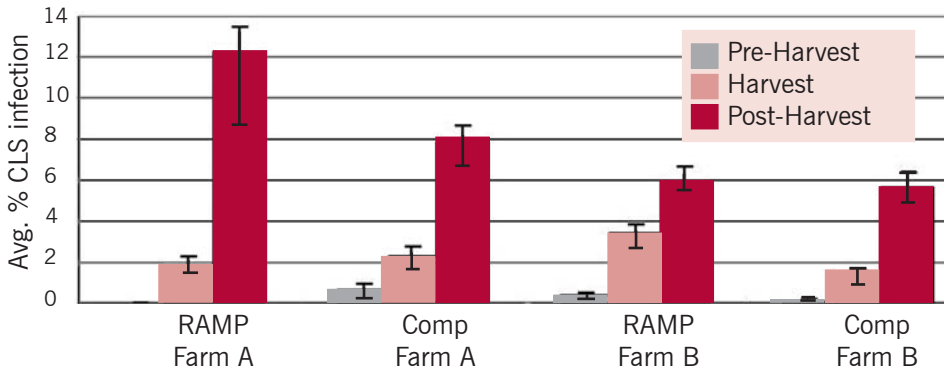
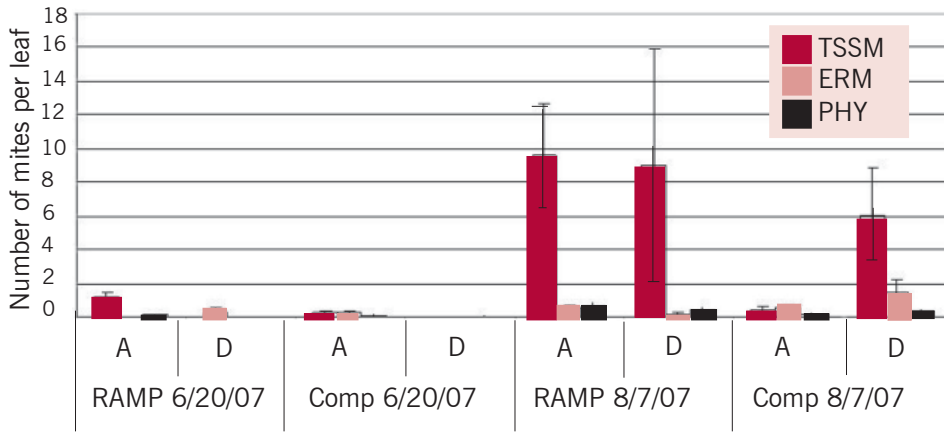


Figure 2. Mean number of mites/leaf at two farms at two sample dates.



use of sulfur for control of powdery mildew was statistically improved when compared to no sulfur application. There were no statistical differences suggesting that sulfur flared twospotted spider mite.

Michigan – Mite control and copper

Mites from both RAMP and comparison blocks were compared two times throughout the season (7/25/06 and 8/18/06) to determine copper's impact on plant parasitic mites, such as twospotted spider mites (TSSM) and European red mites (ERM). RAMP programs incorporated copper applications where comparison blocks had no copper applications. (Figure 2) There were no differences with numbers of mites and the amount of copper used.

Carbon sequestration to estimate tree health. The leaves are the primary organs responsible for photosynthesis in cherry. Carbon produced is utilized to produce fruit, leaves, stems, roots and buds for the next year. Based on published and experimental data, a set of leaf damage thresholds was developed for 'Montmorency' cherry grown under Michigan conditions. Two approaches were used to model the supply of carbon utilized to produce fruit, leaves, stems, roots and buds for the next year: 1) A modification of A. Lakso (Cornell) apple model for cherry (70% complete) - does not predict carbohydrate storage nor does it evaluate the effect of after harvest defoliation on crop yield or cold hardiness for the next year, and 2) Modification of a model based on degree days and past vigor to predict if supply and demand for carbon are in balance. Leaf to fruit ratio models are used to predict fruit growth and development, pre-harvest leaf damage relationships for mites and leaf spot that affect fruit growth and development, and post-harvest leaf damage relationships for loss of healthy foliage, which relates to cold hardiness and flower bud development.

Starch levels in the roots, shoots and buds were not good indicators of tree health or return crop load because of the large variation in concentration during the year. Starch levels in the fall were significantly related to starch concentration, and cold hardiness of the shoots was inversely related to the start of deep winter hardiness (Figure 3).

We have developed the relationship between percentage good foliage and cold hardiness. The percentage of good foliage is estimated by multiplying the degree of defoliation by foliage duration to get a fraction of total full potential. Cold hardiness testing of shoots and buds from Montmorency and Balaton® with different leaf spot control strategies:

- Defoliation ranged from 5.7 to 69 percent for Balaton® and 55 to 100 percent for Montmorency.
- The amount of starch in the tissue was related to the degree of defoliation.
- The amount of starch in shoots was related to cold hardiness.
- Cold hardiness of shoots was greater than buds.
- Cold hardiness during acclimation and deep winter hardiness was inversely

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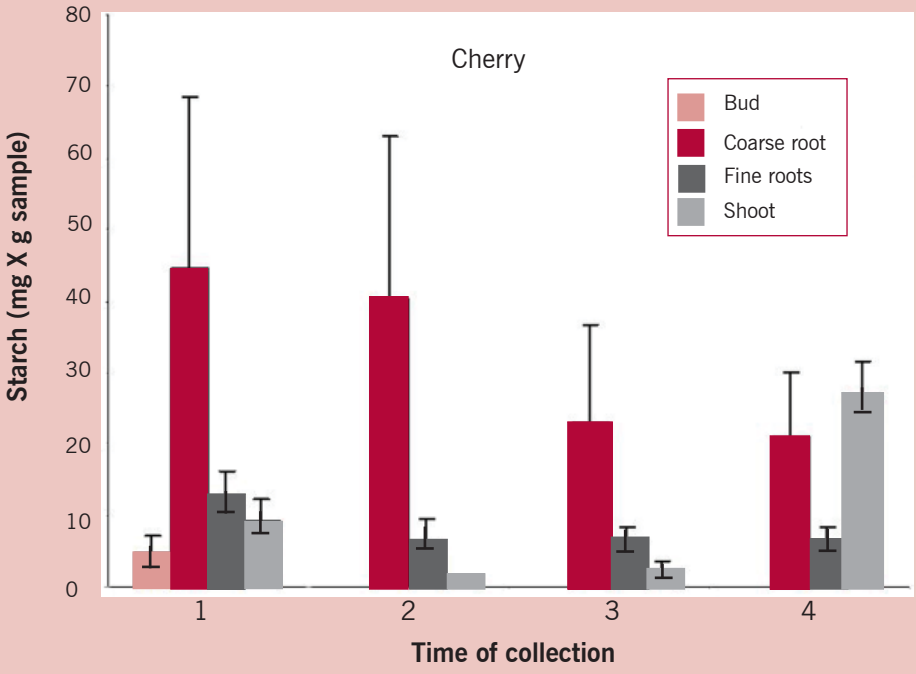
Figure 3. Starch levels in different organs of Montmorency sour cherry at different times of the year.



1=dormant, pre-bloom; 2=bud break 1/2 inch green tip; 3=pit hardening; 4=two weeks after harvest

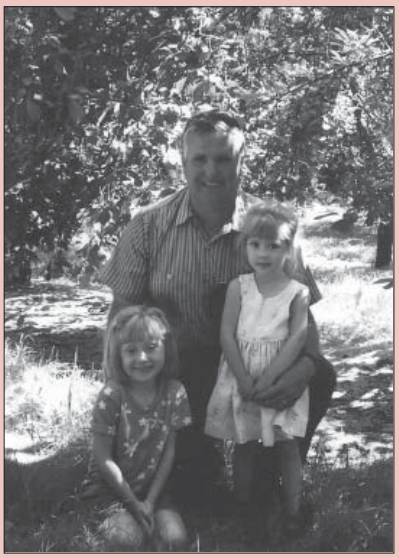
Grower Profile: Mike Vanagtmael

Eight counties make up the West Central region of Michigan, a center of specialty crop agricultural production, including many of the state's fruits and vegetables are produced here. Three crops really stand out: tart cherries, apples and asparagus. The 2006 National Agricultural Statistics Service rotational survey showed that this eight-county area has over 10,700 acres of tart cherries, 5,100 acres of apple and over 15,500 acres of asparagus. Mike Vanagtmael and his brother Bob grow all three of these regionally important crops.

The Vanagtmael farm, located in Oceana County, ten miles east of Hart, is a third generation farm. Mike's grandfather established the farm in 1930, raising potatoes and dairy cows. His father took over in 1955, switching to beef cattle, and planted the first block of tart cherries. During the mid-1980's, the family changed their emphasis to tree fruit and asparagus. Currently, the Vanagtmael brothers raise 90 acres of asparagus and 150 acres of tart cherries along with peaches, plums and apples. The Vanagtmael farm is now MAEAP (Michigan's Agriculture Environmental Assurance Program) certified in farmstead and cropping systems, a progressive step for the environment that made Mike's farm a perfect fit for the RAMP project. As a leader in the fruit industry, Mike serves on the Michigan Cherry Committee and the Michigan Plum Advisory Board, and has been a leader in the West Central Crop Management Association since its inception.

In July 2006, Mike and Bob were getting ready to harvest cherries when a local, but severe storm, termed a wind sheer by the National Weather Service, ripped through their farm costing the brothers their cherry crop for the year. With the crop gone, the Vanagtmaels still had to manage the crop for key pests. Even at the darkest hour, Mike still exhibited a positive attitude and enthusiasm for tree fruit production.

"Mike has been such a terrific cooperator and we are fortunate to have his involvement in the RAMP project. He is a true growers' grower," says Nikki Rothwell, a RAMP researcher in the northwest, and research director of the Northwest Michigan Horticultural Research Station. Mike feels the first four years of RAMP were a success, but recognizes that there are still many battles to be faced in achieving transition to a USEPA directed "reduced-risk" pest management program that eliminates OP insecticides, while still delivering worm-free fruit to the consumer. He looks forward to being a part of RAMP II as some pests such as obliquebanded leafrollers, mites and borers become more problematic as we move away from the organophosphates.



Mike VanAgtmael with his two granddaughters, Emma and Hannah, during cherry harvest.

A cooperator through all four years of the first project, Mike plans to continue participation in RAMP II through 2010. Cooperators support project research by managing two 10-acre blocks: one for pest control with non-OP based controls and the other 10 acres managed under the grower's standard management program. Project researchers are extremely appreciative of the efforts, sacrifices and risk that all participating growers expose themselves to in investigating solutions to key challenges facing cherry producers in the United States. - *Nikki Rothwell, Michigan State University*

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related to percentage of defoliation on September 15.

On vigorous trees, greater than 20 cm of terminal growth, foliage must be reduced by approximately 50 percent for the duration of the season before there is a substantial decrease in deep winter hardiness. Reduced vigor (less than 10 cm growth, shading, or foliage damage due to mites) causes the relationship to move to the right, and hardiness begins to decrease at 65-70 percent foliage. These are estimates, but are based on hardiness observation in different experiments in different years.

2007-2008 Management structure for Tart Cherry RAMP

Name	Project role
Mark Whalon	Overall project management
David Epstein	Project communications
Nikki Rothwell	Field operations in northwest and west central Michigan
Michael Haas	Weekly monitoring program in southwest Michigan

New website to visit in 2008: www.cherries.msu.edu

Tart Cherry Integrated Orchard Management Project

Michigan State University IPM Program
B18 Food Safety & Toxicology Bldg.
East Lansing, MI 48824-1302

Tart Cherry Integrated Orchard Management Project Management Team

Diane Alston, Utah State University
Mike Evans, Evans Brothers Orchard, UAP
Jean Haley, Haley Consulting Services, LLC
Larry Gut, Michigan State University
Phil Korson, Cherry Marketing Institute, Inc.
Jim Laubach, HortSystems, Inc.
Patricia McManus, University of Wisconsin - Madison
Terry Morison, Michigan Food Processors Association
Jim Nugent, MSU Northwest Mich. Hort. Research Station
Ray Rowley, Cherry Hill Farms, Santaquin, UT
George Sundin, Michigan State University
Suzanne Thornsbury, Michigan State University

Executive Committee

Don Gregory, Chair - Cherry Bay Orchards, Inc., Suttons Bay, MI
Jim Seaquist, Vice Chair - Seaquist Orchards, Sister Bay, WI
Mark E. Whalon, Principle Investigator Michigan State University
Nikki Rothwell, NW Michigan field operations manager, Michigan State University
David Epstein, Project Manager Michigan State University

Contact: D. Epstein, Michigan State University, B18 Food Safety Bldg, East Lansing, MI 48824.
Phone: (517)432-4766.
Email: epstei10@msu.edu

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Newsletter production: MSU Integrated Pest Management Program, Joy N. Landis, communications manager (Email: landisj@msu.edu) and Andrea Buchholz, communications specialist.