Great Lakes Fruit, Vegetable & Farm Market EXPO

Michigan Greenhouse Growers EXPO

December 9 - 11, 2014

DeVos Place Convention Center, Grand Rapids, MI

Tart Cherry

Wednesday morning 9:00 am

Where: Gallery Overlook (upper level) Room G & H

MI Recertification credits: 2 (1C, COMM CORE, PRIV CORE)
OH Recertification credits: 1 (presentations as marked)
CCA Credits: PM(1.0) CM(1.0)

Moderator: Kurt Dowd, MSHS Board, Hartford, MI

9:00 am The Michigan Tree Fruit Commission: Setting A Strategic Path for Michigan's Tree Fruit Industries

- Jim Nugent, Chair, Michigan Tree Fruit Commission, Suttons Bay, MI

9:15 am Investigating Cover Crops for Tart Cherry Orchard Systems

- George Bird, Entomology Dept., MSU

9:30 am Addressing the Challenges of Managing Spotted Wing *Drosophila* for the Michigan Cherry Industry (OH: 2B, 0.5 hr)

- Nikki Rothwell, NWMHRS Coordinator, MSU Extension, Traverse City, MI

10:00 am New Developments Towards the Identification of an *Armillaria* Resistant Rootstock (OH: 2B, 0.5 hr)

- Ray Hammerschmidt, Plant, Soil and Microbial Science Dept., MSU
- Amy Iezzoni, Horticulture Dept., MSU

10:30 am Update on the High-Density Tart Cherry Plantings

- Ron Perry, Horticulture Dept., MSU

11:00 am Session Ends

Investigating Cover Crops for Tart Cherry Orchard Systems

George W. Bird, Professor, Michigan State University

Highly productive tart cherry orchards for the 21st Century must be built on sound ecological and management principles. Orchard systems undergo three phases: 1) an orchard establishment-non-bearing phase, 2) a young through mature bearing phase and 3) an aging-declining phase. Two major objective for the orchardist are to: 1) bring healthy young trees into bearing as soon as possible and 2) maintain the bearing orchard in a healthy and highly productive state for as long as possible (Landis, Bird *et al*., 2002; Epstein, Bird *et al*., 2007). During the past 50 years, cover crops and soil fumigants have been used to prepare sites for replanting. Soil fumigation is used predominately to control both the Penetrans root-lesion nematode that results in weak root systems and the American dagger nematode, a vector the tomato ring-spot virus that causes stem pitting (Bird and Warner, 2014). Currently, specific cover crops are being investigated as substitutes for the soil fumigation part of the process.

During the past two decades, a new concept known as *Soil Health* as evolved. A healthy soil is defined as a soil that resists degradation and responds to management in a predictable manner (http://soilhealth.cals.cornell.edu). In 2012, the Michigan Potato Industry released a White Paper indicating the soil health is a key factor for the future of their industry. Ninety-six Michigan potato sites were analyzed using the Cornell System. On a scale of 0 to 100, the average score was 57.7, indicating a need for improvement (Table 1).

Cover crops can play a significant role in improving soil health through increasing soil organic matter and fertility (carbon and nitrogen mineralization potential), decreasing soil erosion, increasing water holding capacity and soil aggregation, decreasing surface and subsurface soil hardness, increasing soil biological diversity and lowering risk to plant parasitic nematodes ((www.mccc.msu.edu or www.agry.purdue.edu/dtc). Cover crop blends of more than one variety are useful for tart cherry orchard development and maintenance.

Two cover crop tarts cherry trials funded by Michigan growers have been initiated at the Northwest Horticultural Research Center in Leelanau County. The first trial was started in 2012. It includes six orchard establishment cover crop systems followed by soil fumigation. In addition, a block of trees was planted using mixtures of compost and cover in a manner similar to that of a previous trial that resulted in a 20% yield increase over a period of six years (Table 2., Sanchez, Harwood, Bird *et al*., 2002).. The orchard was planted in 2014. The second trial was initiated in 2014 and the orchard will be planted in 2016. The trial includes legumes and grasses for organic matter, fertility, moisture, aggregation, and nutrient mineralization enhancement. Oil seed radish, pearl millet and Essex rape were included to reduce surface-subsurface hardness, Penetrans root-lesion nematodes and American dagger nematodes, respectively

In addition to the tart cherry soil health literature cited above, a list of recommended soil health soil health references is included as Table 3.

Table 1. Soil Health Survey (96 Michigan Sites)

- **Physical**
  - Water Stable Aggregates
  - Water Holding Capacity
  - Surface Hardness
  - Subsurface Hardness
- **Biological**
  - Soil Organic Matter
  - Active Carbon
  - N Mineralization potential
- **Biological** (continued)
  - Root Health
- **Chemical**
  - pH
  - Extractable Phosphorus
  - Extractable Potassium
  - Minor Elements
- **Survey Score**
  - **57.7** (based on 0 to 100 scale)

Table 2. Impact of mulch on tart cherry yield and soil health characteristics.

Six Year Means	Mulch	Tillage and Herbicides
Carbon (mg/kg)	10,750	8,670
Nitrogen (mg/kg)	740	713
C mineralization (mg/g)	675	550
N mineralization (mg/g)	45	35
Good/Bad Nematodes	8	3
Yield (tons/ha)	**18.5**	**15.9**

2015 Soil Health Readings

G. W. Bird, Michigan State University

Fundamental References

- Lal, R. *et al.* 2013. *Principles of Sustainable Soil Management in Agro-Ecosystems.*
- Wall, D. *et al.* 2012 *Soil Ecology and Ecosystem Services.*
- Montgomery, D. 2007. *Dirt: The Erosion of Civilizations.*
- Ingham, R. E. *et al.*, 1985. *Interactions of Bacteria, Fungi and Their Nematode Grazers: Effects on Nutrient Cycling and Plant Growth.* Ecol. Mono. 55:119-140
- Hunt, H. W. *et al.*, 1987. *The Detrital Food Web in a Shortgrass Prairie.* Biol. Fert. Soils 3:57-68.

General References

- Gugino, B. *et al.* 2009. *Cornell Soil Health Assessment Training Manual* (2nd edition).
- Haney, R. 2013. Soil Testing for Soil Health. www.usda.gov/oce/forum/past_speeches/2013_Speeches/Haney.pdf
- Magdoff, F. and van Es, H. 2000. *Building Soils for Better Crops.*
- Ingham, E. *et al.* 2000. *Soil Biology Primer* (Revised edition).
- Wessels, T. 2006. *The Myth of Progress: Towards a Sustainable Future.*

References Cited

Bird, G. and F. Warner 2014. *Nematode Management* (in) *Michigan Fruit Management Guide*. Extension Bulletin E-154. East Lansing. 225 pp.

Epstein, D., J. Anderson, G. Bird, J. Flore, L. Gut, P. McManus, J. Nugent, R. Isaacs, A Schilder, M. Whalon, R, Sirrine and J. Sanchez. 2007. *Tart Cherry Systems*, pp. 74-101 (in*) Ecologically Based Farming Systems.* MSU Extension Bulletin 2983. East Lansing, 140 pp.

Gugino, G., O. Idowu, R. Schindelbeck, H. van Es., D. Wolfe, B. Moebius-Clune, J. Thies and G. Abawi. 2009. *Cornell Soil Health Assessment Training Manual* (2nd ed). 58 pp. http://soilhealth.cals.cornell.edu

Landis, J., J. Sanchez, R. Lehnert, C. Edson, G. Bird and S. Swinton. 2002. Pp 3-7 (in) *Fruit Crop Ecology and Management.* MSU Extension Bulletin. 2759. East Lansing. 101 pp.

Mutch, D., D. Baas, G. Bird et al. 2012. *Midwest Cover Crops and Field Guide*. www.mccc.msu.edu. 136 pp.

Sanchez, J., C. Edson, G. Bird, M. Whalon, T. Willson, R. Hardwood, K. Kizilkaya, J. Nugent, T. Loudon, D. Mutch and J. Scrimger. 2003. *Orchard Floor Management Influences Soil and Water Quality and Tart Cherry Yields*. J. Amer. Soc. Hort. Sci. 128:2277-284.

Investigating Spotted Wing *Drosophila* Efficacy in the Laboratory

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Spotted wing *Drosophila* (SWD) was first detected in Michigan in 2010. SWD prefers to lay eggs in ripening fruit, but this pest can attack less ripe fruit as females have two rows of serrations on the ovipositor that allow them to 'saw' into unripe fruit to lay eggs. This unique characteristic places cherries at high risk of SWD infestation for many weeks prior to harvest.

We conducted laboratory infestation and efficacy trials at the Northwest Michigan Horticultural Research Center (NWMHRC) and Trevor Nichols Research Center (TNRC). In 2013, we placed male and female SWD into deli containers with five green (unripe), five pink (ripening), and five red (ripe) sweet and tart cherries. We found that SWD infests both sweet and tart cherries as soon as the fruit begins to change from green to yellow in color.

In 2013, we tested multiple insecticides labeled for use against SWD in the laboratory. Insecticides were sprayed in the field using a standard airblast sprayer (60gal/acre). Cherries were collected 24H after applications and five fruit were placed into deli containers with male and female SWD; infestation was evaluated after 7D. Data from the 2013 TNRC trials showed that Assail and Movento provided 85-90% control, while Actara and Grandevo provided 60-70% control of SWD; all treatments provided significantly more control than the UTC. At the NWMHRC, we counted larvae in the fruit after 7D. We tested three 3D PHI materials: 10 larvae were detected in the Sevin treatment, 2 larvae in the Pounce treatment, and 8 larvae in the Malathion treatment. Delegate and Imidan provided better control than the 3D PHI insecticides and the UTC: one larva was found in the Delegate treatment and no larvae were detected in the Imidan treatment.

In 2014, we repeated bioassay trials using the above methods at the NWMHRC. In the first bioassay, we evaluated the following compounds: Altacor, Danitor, Delegate, Exirel, and Imidan. Delegate, Exirel, and Imidan provided significantly better control than the UTC, but we still detected 2-5 larvae in each of those treatments. In the second bioassay, we evaluated the efficacy of Rimon, Admire Pro, Sevin, Pounce, and Warrior, and Malathion. Sevin, Pounce, and Warrior provided significantly different control than the UTC, Rimon, and Admire Pro. Pounce and Warrior provided the best control in this trial.

Lastly, we conducted some efficacy trials in the field post-harvest in an attempt to scale-up the lab bioassays. As is typical for tart cherries, fruit remains on the tree after shaking, and these fruit are susceptible to SWD infestation. Fruit was collected prior to insecticide applications to determine level of SWD infestation. We applied Pounce, Delegate, Grandevo, and Imidan to Montmorency tart cherry blocks in Leelanau County. We collected fruit after 7D and 14D; fruit was assessed for larvae using the salt-water method. Grandevo and Imidan provided significantly better control the UTC.

New Developments Towards the Identification of an *Armillaria* Resistant Rootstock

Ray Hammerschmidt, Department of Plant, Soil and Microbial Science, MSU
Amy Iezzoni & Audrey Sebolt, Department of Horticulture, MSU
Nikki Rothwell & Karen Powers, NW Michigan Horticultural Research Center, MSU

Armillaria root rot is a serious disease affecting the tart and sweet cherry production regions of Michigan. The major species causing disease in Michigan is *Armillaria ostoyae*, although other species of this pathogen are also present. *Armillaria* root rot occurs most commonly in sandy soils where stone fruits or other woody hosts have been grown in the past. Currently there are no effective chemical or cultural controls for this disease, and it is difficult to eradicate the pathogen from infested orchards. Because of this, host resistance has the potential to be the best strategy for long-term management of this disease.

<u>Evidence that *P. maackii* has resistance to *Armillaria*</u>*:* Recently the ornamental cherry species *Prunus maackii* (Amur Chokecherry) was determined to have resistance to *Armillaria*, suggesting that it may be possibly to develop resistant rootstocks that could be used for sweet and tart cherry.

A resistance assay was used to search *Prunus* germplasm for resistance. This assay involved colonization of cherry phloem and cambial tissues in three year old stem tissues. It is based on the observation that *Armillaria* causes disease by initially colonizing the tissues between the periderm and the wood. The colonization assay was used to assess 43 *Prunus* species and several breeding lines with *P. maackii* in their background. The assay showed that most *Prunus* species are readily colonized by *Armillaria*. Only *P. maackii* demonstrated a significant degree of resistance to colonization of the cambium tissues. Testing *P. maackii* from different locations, sources and ages gave the same result. The test was also run against 29 *Prunus* spp. using six *A. ostoyae* isolates that differed in virulence with similar results.

The outer bark of *P. maackii* was also determined to contain compounds that are antifungal. These compounds were not detected or only detected in very low concentrations in other *Prunus* spp. These compounds are thought to be part of the defense process of *P. maackii* against *Armillaria*. These may also serve as good biochemical markers for resistance in examination of other species and in hybrids from crosses.

<u>Field data of *P. maackii* seedlings planted in a heavily infested *Armillaria* orchard</u>: Ultimately it is critical to assess whether the *Armillaria* resistance exhibited by *P. maackii* will translate into healthy trees grown on highly infected soils. To test this, *P. maackii* open-pollinated seedlings, purchased from Lawyer's Nursery, Plains, Montana, were grown in the MSU campus greenhouse from March until October 2013. In October, 12 of these seedlings were planted in an orchard on Old Michigan Peninsula that was known to be heavily infested with *Armillaria*. Trunk circumference was measured and trunk cross sectional area (TCSA) was calculated for 11 of the 12 seedlings soon after planting. After one growing season, the TCSA was re-measured to allow a visualization of the increase in trunk diameter (Fig. 1, Fig. 2). To date, all the 12 trees are alive and appear healthy, with all trees exhibiting an increase in TCSA indicative of tree growth. Continued monitoring for at least four more years will be required to determine if the resistance exhibited by *P. maackii* is sufficient to warrant the use of *P. maackii* rootstocks for *Armillaria* infected orchard sites.

Graft compatibility of *P. maackii* rootstock and 'Montmorency' scion: Ultimately, the use of *P. maackii* as an *Armillaria* resistant tart cherry rootstock would require that it be graft compatible with cherry scions. To test this graft compatibility *P. maackii* seedlings were budding with 'Montmorency'. From the limited number of *P. maackii* seedlings available, four grafted trees were obtained and are growing at MSU's Clarksville Research Station (CRS), Clarksville, Mich. Two *P. maackii* seedlings were budded with 'Montmorency' in the greenhouse in spring 2013 and field planted in August 2013. The remaining two grafted trees were from *P. maackii* seedlings planted in June 2013 and budded in August 2014. The 'Montmorency' scions on all four trees are growing well and not showing any signs of graft incompatibility (Fig. 3).

Breeding *Armillaria* resistant cherry rootstocks: Although *P. maackii* is *Armillaria* resistant, it may not be a horticulturally viable rootstock for commercial cherry production. For example, the rootstock scion combination may not be graft compatible. Additionally the resulting trees may exhibit low productivity due to differences in tree growth and spur and flower formation. As a result, a breeding strategy was initiated with the goal of transferring the *P. maackii Armillaria* resistance into a rootstock that would be horticulturally suitable. After two years of hybridization with 'Montmorency' and 'Balaton', 231 seeds and 21 plants have been obtained (Fig. 4). These plants will be screened to determine if they are resistant to *Armillaria*.

Fig. 1. *P. maackii* growing in an orchard heavily infected with *Armillaria*. The tree was planted in October 2013 and the photo was taken in August 2014.

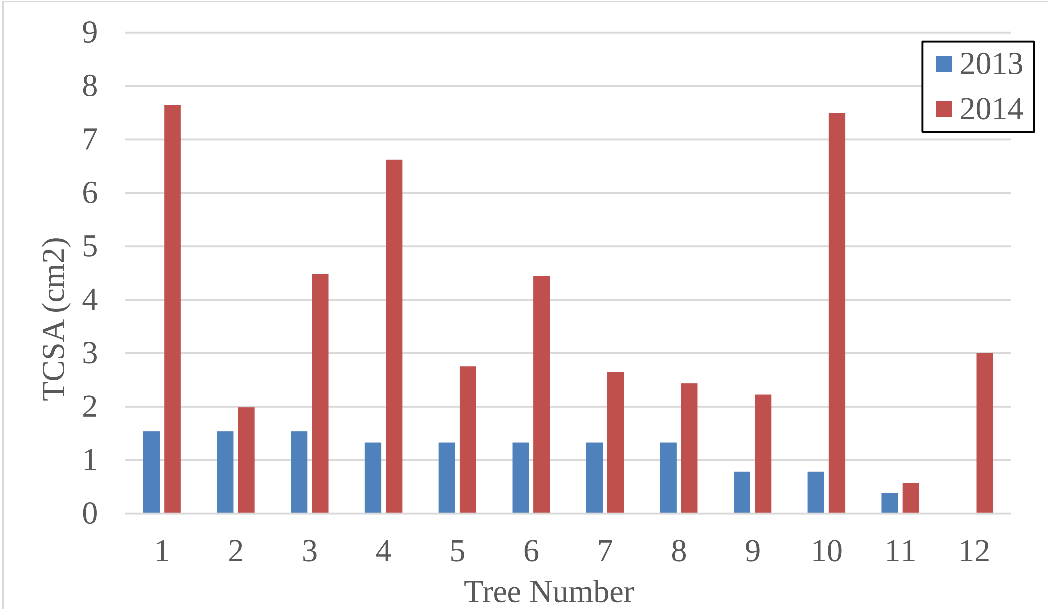

Fig. 2. Trunk cross-sectional area (TCSA) for 12 trees planted in a heavily infested *Armillaria* orchard. Measurements were taken in October 2013 and September 2014. Measurements were not taken at planting for the 12th tree.

Fig. 3. 'Montmorency' grafted on *P. maackii* planted at MSU's Clarksville Research Center. The rootstock was planted in spring 2013 and budded with 'Montmorency' in August 2013. The photo was taken in July 2014.

Fig. 4. A seedling from the cross 'Montmorency' × *P. maackii*. The seedling germinated in spring 2014 and was planted a MSU's Clarksville Research Center in August 2014.