Northern Michigan FruitNet 2016
Northwest Michigan Horticultural Research Center

Weekly Update

FruitNet Report – May 10, 2016

CALENDAR OF EVENTS

5/3 – 6/28	**Leelanau County IPM Updates, 12PM – 2PM** Jim and Jan Bardenhagen's Farm (details below)
5/3 – 6/28	**Grand Traverse County IPM Updates, 3PM – 5PM** Wunsch Farms (details below)
5/4 – 6/29	**Antrim County IPM Updates, 10AM – 12PM** Jack White Farms (details below)
5/4 – 6/29	**Benzie County IPM Updates, 2PM – 4PM** Blaine Christian Church (details below

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What's New?

- **Northwest Michigan Fruit Regional Report – May 10, 2016**
- **Managing spotted wing Drosophila in organic small fruit**
- **Secrets in the soil – dig a little, learn a lot**
- **Invest in pollination for success with highbush blueberries**
- **Beekeeping regulations in Michigan outlined in new resource**
- **Nature Change – Conversations about Conservation and Climate**
- **Fungicide Efficacy Update for Cherry Leaf Spot Management**

Northwest Michigan Fruit Regional Report – May 10, 2016

Sweet cherries are blooming across the region, and honeybee hives have been strong and active for pollination thus far.

Emily Pochubay and Nikki Rothwell

GROWING DEGREE DAY ACCUMULATIONS AS OF May 9, 2016 AT THE NWMHRC

Year	2016	2015	2014	2013	2012	2011	26 Yr. Avg.
GDD42	287	318	163	294	536	195	316.7
GDD50	114	147	51	159	262	68	142.9

2016 Growth Stages as of 5/9/16

Bartlett Pear – White bud

Potomac Pear – First bloom

Mac – Tight cluster

Gala – Tight cluster

Red Delicious – Early pink

HoneyCrisp – Early pink

Montmorency – Early white bud

Balaton – White bud

Hedlfingen – Full bloom

Gold – First bloom

Napolean – Full bloom

Riesling – Ear. bud swell

Weather and Crop Report

Spring feels like it has arrived in northwest Michigan over the past few days. Daytime temperatures have risen to the mid-60s, and we have had some sunshine for bee activity in blooming sweet cherries. On Friday, the daytime temperatures reached almost 80 degrees F, and sweet cherry bloom really was accelerated by these warm conditions. Nighttime temperatures are still cool, and one Enviroweather station reported below freezing temperatures (31 degrees F) on the morning of Monday, 9 May. We have accumulated 287GDD base 42 and 114GDD base 50. We are slightly behind our GDD averages here at the NWMHRC: 316GDD base 42 and 143GDD base 50.

Soil moisture continues to decline with the lack of rainfall in the region. The last rainfall reported at the NWMHRC was last week on Tuesday and into Wednesday (4-5 May) where we received just over ¼" of rain. Despite the lack of rainfall accumulation, weather forecasts have been predicting rainfall, so growers have been diligent in covering the growing green tissue in apples and the potential for American brown rot in sweet cherries.

With the dry conditions and still relatively cool temperatures, things have been quiet in the grower community. There is rain and warmer temperatures predicted in the near future, so growers will be prepared for these events. After the brief warm up, cool conditions are predicted for the weekend, so we expect development of trees, insects, and disease slow down again. There seems to be many stops and starts to the season so far this year. We expect to be in bloom in tart cherries over the weekend into the start of next week. We are hoping for warmer temperatures for good bee activity.

Pest Report

Recent dry conditions throughout the region have not been favorable for disease infections, and some growers did not spray for apple scab late last week as the forecast changed and no longer called for rain over the weekend. The region received rain 3-4 May, but most areas did not have an apple scab infection period due to a short wetting event and cold temperatures; however, a light infection was reported at the Elk Rapids station. While there was no infection period, the NWMHRC

Table 1. Apple scab spore discharge

Date Collected	Time Collected	Rod 1	Rod 2	Avg # Spores
4/21/16	1:30 PM	NA	10	10
4/25/16	9:30 AM	37	50	43.5
4/26/16	8:15 AM	9	4	6.5
5/1/16	1:30 PM	0	0	0
5/5/16	8:00 AM	44	77	60.5

observed apple scab spore discharge following last week's rain (Table 1). The NWMHRC set biofix on April 17 and according to the apple scab model, 36% of ascospores are mature and 13% have discharged at this time. Warm weather hastened spore maturity and the degradation of orchard floor leaf litter is noticeable this week. Currently, the forecast is calling for a chance of rain and thunderstorms on Thursday, and growers should be ready to protect for apple scab if rain comes this week. If orchards became infected with scab during 21-22 April or 24-26 April infection events, scab symptoms should show up this week.

Many growers protected sweet cherries from American brown rot infection over the weekend and early this week. Blossom blight is a concern as conditions are predicted to be warm and wet weather mid-late in the week, at least until the weekend when it is predicted for temperatures to cool down considerably. As mentioned in a previous report, several sterol inhibitors are available for American brown rot management; however, Rovral 4 F at 2.0 pt per acre is still the optimal option for excellent efficacy and for resistance management. There are only two applications of Rovral 4 F allowed per season.

Although conditions are predicted to be warm and wet on Thursday, temperatures are also expected to drop into the 40-50s overnight and into the weekend. There is also a possibility of rain over the weekend with daytime highs predicted in the 50s. Hence, European brown rot is a concern in tart cherries if this forecast is correct. All growers with Balatons and European brown rot susceptible orchards should protect these trees from possible infection, as the currently cool and wet conditions predicted over the weekend will favor EBR infection.

Many orchards have cherry leaf spot susceptible bract leaves present at this time, and these leaves and true leaves should be protected before rain this week. Preventing early leaf spot infections will help to minimize the risk of a CLS epidemic this season. This is particularly important for trees stressed by early leaf loss last season to ensure that two years of early defoliation do not contribute to poor tree health in 2017. Most orchards likely have a high level of inoculum going into the 2016 season due to severe infections last season. Furthermore, because temperatures are predicted to be above 60 degrees F during rain, there is the potential for a very high discharge of CLS spores.

The first American plum borer moths were detected in the NWMRHC's trapline this week (2 per trap). Green fruit worm moths are in peak flight, and we caught an average of 26 moths per trap at the station. Green fruit worm have been active for several weeks, and we could see larvae this week. Oriental fruit moth has been detected in other regions of Michigan, but this pest has not been detected in northwest Michigan yet this season. Many apple growers in the region have made tight cluster timing applications targeting mites and sucking insects such as scale and aphids; apple orchards in more southerly areas of the northwest are at approaching pink. Cherries are

blooming, and we encourage growers to avoid applying insecticides that are toxic to bees during bloom to promote good pollinator management practices.

Wine Grapes
Duke Elsner

All varieties are showing bud swell to some degree. In the research center variety trial the buds on canes that were severely injured by last year's hailstorm appear to be swelling at the same pace as buds on uninjured canes. No pest insect activity has been seen. The window for dormant or delayed dormant applications for powdery mildew will be over soon.

Vineyard Volunteers Needed at the Northwest Michigan Horticultural Research Center
Duke Elsner

We still have a lot of pruning and tying left to do at the research vineyard. I'm looking for volunteers to help finish the job this Wednesday and Thursday, May 11 and 12. Weather permitting, we'll start at 8:00 am and work until 5 pm. With a big enough crew it might be possible to wrap it up in one day.

Please contact me at 231-357-8353 or elsner@msu.edu if you can help out or would like more details. Please bring your own pruning shears and loppers. If the weather is questionable, call me before heading over to the research center.

Saskatoons
Duke Elsner

Very little change has occurred since last week; most sites I've seen are still in the white tip stage of bud development. No pest insect activity has been seen. We are not certain of the prime infection periods for Entomosporium leafspot or saskatoon-juniper rust, but these fungal diseases may now be releasing spores if rainy weather occurs.

Fungicide Efficacy Update for Cherry Leaf Spot Management

A review of 2015 cherry leaf spot infection and fungicide efficacy for management in 2016

Emily Pochubay, Dr. Nikki Rothwell, and Dr. George Sundin

Cherry Leaf Spot Infection in 2015

In 2015, spring and early summer conditions were cool and wet in northwest Michigan, and these conditions were favorable for early cherry leaf spot (CLS) development. CLS infections can occur as soon as bract leaves with open stomata are present, which in some areas of NW MI was during the first week of May in 2015. While bract leaf infection is the first opportunity for CLS infection to occur, there were12 'official' CLS infection periods recorded by the Enviro-weather station and CLS model for the NWMHRC between May 10th and the end of July (Table 1). Several of these infection periods were long, and in general, conditions were wet between many of the 'official' infection periods which likely prolonged the wet conditions and contributed to the overall very high potential for disease. In particular, periods of frequent rain events from the end of May into mid-June was a difficult time during the season because many growers were not able to apply fungicides due to poor spray conditions. Furthermore, when ideal spraying weather occurred, the window for spraying was short and growers

Table 1. Cherry leaf spot disease report from Enviro-weather May 10 – August 23, 2015

Start of wetting period	End of wetting period	Duration (Hrs.)	Avg Temp (degrees F)	Rainfall (in.)	Cherry Leaf Spot	Progress towards infection
5/10 9-10PM	5/12 3-4PM	Wet: 33; Span: 43	49.7	0.22	Moderate	178%
5/15 2-3AM	5/16 9-10AM	Wet: 29; Span: 32	48.9	0.35	Low	121%
5/17 6-7PM	5/17 8-9PM	Wet: 3; Span: 3	72.9	0.32	None	40%
5/24 8-9PM	5/25 2-3PM	Wet: 17; Span: 19	59.6	1.6	Moderate	214%
5/26 Midnight-1AM	5/26 3-4AM	Wet: 4; Span: 4	63.2	0.06	None	77%
5/26 5-6PM	5/27 11PM - Midnight	Wet: 7; Span: 7	65.5	0.31	Low	137%
5/27 Noon-1PM	5/27 3-4PM	Wet: 4; Span: 4	57.5	0.03	None	45%
5/29 Noon-1PM	5/30 3-4PM	Wet: 21; Span: 28	54.8	0.36	Moderate	180%
6/7 8-9AM	6/9 11AM-Noon	Wet: 39; Span: 52	57.4	0.6	High	439%
6/11 4-5PM	6/12 11AM-Noon	Wet: 20; Span: 20	55.4	0.55	Moderate	182%
6/13 5-6PM	6/15 10-11AM	Wet: 32; Span: 42	63.9	0.27	High	590%
6/18 3-4PM	6/18 4-5PM	Wet: 2; Span: 2	60.6	0.03	None	31%
6/22 2-3PM	6/22 4-5PM	Wet: 3; Span: 3	71	0.07	None	48%
6/30 8-9AM	7/1 11AM-Noon	Wet: 24; Span: 28	52	0.01	Moderate	169%
7/6 10-11PM	7/7 8-9AM	Wet: 11; Span: 11	59.3	0.41	Low	109%
7/13 10-11PM	7/14 1-2PM	Wet: 16; Span: 16	64.7	0.22	Moderate	308%
7/17 4-5AM	7/17 2-3PM	Wet: 11; Span: 11	64.6	0.03	Low	207%
7/18 10-11AM	7/18 11AM-Noon	Wet: 2; Span: 2	67.6	0.03	None	40%
8/2 11AM-Noon	8/3 9-10AM	Wet: 22; Span: 23	63.1	1.19	High	348%
8/7 6-7PM	8/8 8-9AM	Wet: 15; Span: 15	63.6	0.11	Moderate	280%
8/13 6-7PM	8/14 8-9AM	Wet: 9; Span: 15	69.8	0.3	Low	158%
8/18 7-8PM	8/19 Noon-1PM	Wet: 14; Span: 18	69.5	0.33	Moderate	259%
8/20 5-6PM	8/20 6-7PM	Wet: 2; Span: 2	61	0.02	None	31%
8/23 Noon-1PM	8/23 3-4PM	Wet: 4; Span: 4	67	0.31	None	80%

were faced with prioritizing sprays. Leaf spot took a foothold during this time, and because pressure was so high, control was difficult. Unfortunately, the 2015 season was unforgiving for delayed or missed fungicide applications. We also received reports that some growers had higher levels of CLS in blocks where alternate row middle applications were made and in lower priority/non-bearing orchards.

Fungicide Efficacy 2015 Results

If there is an upside to such a challenging leaf spot year, it is possibly that last season's conditions were ideal for assessing CLS fungicide efficacy on Montmorency tart cherries at the NWMHRC. In this trial, Bravo Weather Stik (4 pt/ac) was applied to all treatment trees for the first and second applications of the season. The following applications of four treatments were as follows: Treatment 1: *Luna Sensation 5 fl. oz. +R56 0.125%* , Treatment 2: *Luna Sensation 5 fl. oz. + R56 0.125% + Captan 80 WDG 2.5 lb*, Treatment 3: *Merivon 5.5 fl. oz. + Sylgard 0.03%*, Treatment 4: *Captan 80 WDG 2.5 lb*, and an Untreated Control (UTC). Applications were made every 9-10 days with a handgun (300 gal/ ac), and data on the percentage of leaves on terminals with infection and percentage of terminal defoliation was collected on 20 July 2015 and 9 September 2015. While growers should not be applying four consecutive applications of fungicides such as Luna Sensation or Merivon due to the risks of fungicide resistance, we need to study fungicide efficacy in this manner on a small scale to most effectively compare compounds.

We found that all of the treatments were significantly more effective for preventing infection and defoliation compared with the UTC (Table 2). Treatments 2 and 4 that contained Captan were the most efficacious against CLS. Furthermore, the efficacy of Luna Sensation was improved by adding Captan. Although the percent defoliation numbers are high on 9 September in this experiment, it should be noted that there are unsprayed control trees in the block and so the disease pressure was consistently high all season. We also found that mildew incidence was significantly lower on trees treated with either Luna Sensation or Merivon compared with the UTC. These results indicate that even during seasons with extremely high CLS pressure, these materials are still providing good CLS control.

Table 2. Cherry leaf spot fungicide efficacy results, 2015

Treatment	**Timing**	**% Infection**	**% Defoliation 20 July 2015**	**% Defoliation 9 Sept 2015**	**% Mildew Infection 20 July 2015**
1. Bravo Weather Stik 4 pt Luna Sensation 5 fl. oz. + R56 0.125%	AB CDEF	62.1 bc	7.3 b	82.2 bc	0.8 c
2. Bravo Weather Stik 4 pt Luna Sensation 5 fl. oz. + R56 0.125% + Captan 80 WDG 2.5 lb	AB CDEF	42.5 d	5.2 b	66.8 cd	1.0 c
3. Bravo Weather Stik 4 pt Merivon 5.5 fl oz + Sylgard (0.03%)	AB CDEF	53.6 bcd	11.3 b	63.4 d	0.0 c
4. Bravo Weather Stik 4 pt Captan 80 WDG 2.5 lb	AB CDEF	45.2 cd	3.5 b	53.0 d	9.7 ab
Untreated Control		95.5 a	31.2 a	99.7 a	23.9 a

Preventing early leaf spot infections will help to minimize the risk of a CLS epidemic in the 2016 season.

This strategy is particularly important for trees stressed by early leaf loss last season; potentially two years of early defoliation will contribute to poor tree health and mortality especially if we have another hard winter. Furthermore, many orchards have a high level of inoculum as we head into the 2016 season due to severe infections last year, and there is the potential for a very high discharge of CLS spores during this week's predicted rain and temperatures above 60 degrees F. Therefore, we would like to encourage growers to protect orchards that have open bract leaves and/or true leaves from infection prior to rain. If retreatment is needed before the 10 day retreatment interval for chlorothalonil is met, Captan 80 WDG (2.5 lb/acre) is a good alternative for CLS.

Measuring spotted wing Drosophila impacts – your help needed!

This survey will help researchers identify impacts of spotted wing Drosophila (SWD) on fruit growers and look for new management tactics and programs, improved insecticide efficacy and SWD training.

Posted by **Rufus Isaacs**, and Larry Gut, Michigan State University Extension, Department of Entomology, MSUE News

Michigan State University researchers are part of a recently funded project, "**Sustainable Spotted Wing Drosophila (SWD) Management for United States Fruit Crops,"** and the team is surveying fruit growers with two goals:

1 Measure the impact of SWD throughout the United States.
2 Guide our project activities over the next four years.

This five-year project, coordinated by North Carolina State University, is developing national research and extension projects to minimize the impacts of SWD. They include new management tactics and programs, improved insecticide efficacy for SWD and information and training on SWD for growers, extension agents and others. In order to achieve this and ensure the research and extension efforts match the needs of growers, the project is collecting information on the impacts of SWD on fruit growers, current management practices and preferences, and your requirements for better management of SWD. Participation is voluntary and the survey does not collect personally identifying information. The data will only be analyzed and reported in aggregate form.

We would like to get feedback from as many growers as possible! So, please complete the survey here: **Sustainable SWD Management Grower Survey**
Contact me at isaacsr@cns.msu.edu for additional information.

https://survey.ncsu.edu/swd/

Funding for this project is provided by the National Institute of Food and Agriculture, U.S. Department of Agriculture Specialty Crops Research Initiative under Agreement No. 2015-51181-24252.

RecycleSmart Household Hazardous Waste Drop-Off – Upcoming

Dates

Growers can bring back pesticides of any quantity to any county, free of charge

Leelanau's HHW Collections are taking place on May 14, July 9, August 27, and October 8.
http://www.leelanau.cc/downloads/hhw_flyer_2016_final_1.pdf

Antrim has two events this year: May 14 and August 6:
http://www.antrimcounty.org/hazardous.asp

Benzie is holding two HHW Collections on June 25 and July 23:
http://www.benzieco.net/Household%20Hazardous%20Waste%20Brochure%202016.pdf

Household hazardous waste products should be handled with care when preparing them for transport to the drop-off event. Keep products in original containers and don't mix products together. Keep containers tightly sealed, packed in a box in an upright, stable position. Transport HHW as far away as possible from you in your vehicle, such as in the bed of a pick up or car trunk.

Items accepted at the HHW collection events include: oil-based paint, latex paint, solvents, automotive fluids, household cleaners, lawn and garden chemicals, pesticides, batteries, fluorescent light bulbs and more.

Small businesses, organizations and schools may qualify to dispose of HHW at a drop-off

event. Visit RecycleSmart.info for details about Conditionally Exempt Small Quantity Generator (CESQG) specifications.

For more information, visit www.RecycleSmart.info or call the RecycleSmart Hotline at 231- 941-5555.

Nature Change: Conversations about Conservation and Climate - A New Multimedia Magazine

Northern Michigan's heritage landscapes are changing as invasive species, urban development and climate change alter, damage or destroy familiar plant and animal communities. These are big challenges to volunteer conservationists, natural resource professionals and the organizations working to manage, protect and preserve the forests, uplands, wetlands and streams of Northwest Lower Michigan. As observers of the natural world, they know that our region's renowned natural beauty and most productive ecosystems are at risk.

Nature Change is a new multimedia magazine developed by the Conservation Resource Alliance (CRA) as a cooperative venture for regional nonprofit organizations involved in protecting and managing the lands and waters of Northwest Lower Michigan. Our mission is to inform a regional public discussion about options for the sustainable management of natural resources during this time of increasingly rapid change. We want to build conservation literacy among citizens and local officials to inform the choices we all must make in preserving, protecting, adapting and re-locating both plant and animal species.

Recently, Dr. Nikki Rothwell was interviewed and featured in a Nature Change publication on Spotted Wing Drosophila. You can view the short write up and video here:

http://naturechange.org/2016/05/09/game-changer-a-new-fruit-fly-puts-northern-michigans-orchards-at-risk/

Managing spotted wing Drosophila in organic small fruit

Michigan State University releases new resource on useful information for managing spotted wing Drosophila in organic small fruit production.

Posted by **Heather Leach**, Rufus Isaacs and Matthew Grieshop, Michigan State University, Department of Entomology, MSUE News

A new fact sheet covering cultural, biological and chemical control of spotted wing Drosophila in organic crops has been developed by Michigan State University.

"Integrated Strategies for Management of Spotted Wing Drosophila in Organic Small Fruit Production" highlights multiple ways organic producers of various farm sizes can integrate non-chemical control practices into their farming. It also includes guidance on monitoring for adult flies and for larvae in fruit, and shows the label restrictions for Entrust SC, the primary organic insecticide used to control this pest, for each of the susceptible crops. The fact sheet also describes new approaches to controlling this pest that are currently in development at MSU.

To view the fact sheet, go to: Integrated Strategies for Management of Spotted Wing Drosophila in Organic Small Fruit Production.

For more information on spotted wing Drosophila and other crop-specific recommendations, visit MSU's Spotted Wing Drosophila website.

Root pruning guide for apple trees to reduce excessive vigor

There are many benefits to pruning roots on apple trees to control excessive tree vigor.

Posted by **Phil Schwallier**, and Amy Irish-Brown, MSUE News

Using root pruning to help control excessive tree vigor has been researched by Dave Ferree of Ohio State University and Jim Schupp of Pennsylvania State University. Root pruning is accomplished by pulling an offset subsoiler blade or a large coulter along the tree row. The blade cuts roots as it passes the trees. The blade should be set at a cutting depth of near 12 inches and pass near the trees at 1-4 feet from the tree on both sides of the row. Generally, pruning deeper has no additive effect on the trees – most major roots are within 12 inches of the soil surface. About 60 percent of the total tree roots need to be cut to have a significant effect on the trees. A lesser percent of root pruning will have less effect on the vigor control of the trees.

Use the trunk diameter as a guide to estimate root pruning distance from the tree. A root pruning distance of three times the trunk diameter will cause severe response; four to five times will cause a moderate tree response and five to seven times will cause a mild tree response. The root pruning effects may be evident for two years, usually always more than one year, but root pruning can be performed every year.

Root pruning should be done starting at apple bloom and up to two weeks after full bloom. Earlier timing will stress trees sooner with greater tree response and later timing will give less stress and, therefore, less tree response and vigor control.
Tree vigor and crop load will impact the success of the root pruning operation. In the situation of high tree vigor and a light crop load, the tree will be less responsive to the pruning. Extremely vigorous trees can be double root-pruned 30 days apart for an increased effect.

According to Michigan State University Extension, bloom time root pruning has no effect on fruit set. Root pruning will generally reduce fruit size by perhaps 0.125 inches, but can reduce diameter up to 0.25 inches in very hot dry years or with very aggressive pruning. Yields will be reduced from the reducing in fruit diameter, but this is typically not extreme. Vegetative shoot growth, branching and trunk diameter will be reduced. Root pruning increases light penetration into trees, improves spur quality and increases fruit color. Root-pruned trees tend to have lower nitrogen (N), phosphorus (P) and potassium (K) in leaves. Root pruning enhances return bloom (perhaps doubling return bloom), and reduced fruit drop near harvest has been reported. Use root pruning on excessively vigorous trees, excessively large fruited varieties and varieties/blocks that resist blooming or setting fruit.

In some cases, trees can lean after root pruning, and with dwarf trees the trellis is important. However, leaning generally is not noticeable. For dwarf trees and in light soil, supplemental irrigation may be needed.

Effects of root pruning include:
3 Reduced tree vigor.
4 Reduced shoot growth.
5 Reduced harvest fruit drop.
6 Reduced fruit size.
7 Reduced trunk diameter.
8 Increased light penetration into trees.
9 Increased spur quality.
10 Increased fruit red color.
11 Increased fruit firmness.
12 Increased return bloom.
13 Increased need for irrigation.
14 Increased root suckers at the pruning cut site.
15 May increase fruit set.
16 Lowered leaf N, P and K.
17 May increase tree leaning.

Secrets in the soil – dig a little, learn a lot

There's a whole world beneath the surface. Learn more about soil health at MSU Agriculture Innovation Day: Focus on Soils on Aug. 24, 2016.

Posted by **Dean Baas**, Michigan State University Extension, MSUE News

MSU Extension educator Paul Gross talks about healthy soil in a root pit at a recent event.

It's not unusual that our view of landscapes, fields and farms is primarily on what is happening above the surface. We survey a world of lush vegetation and vibrant crops with little thought of the soil beneath them. Many of the advancements in modern agriculture have led to increases in yield and productivity even as the world below may be declining in health. In this hidden world, we may be losing suitable habitat for the myriad of soil organisms that support growing plants. Restoring this habitat by managing for soil health is one way farmers can increase crop productivity and profitability while improving the environment. Soil health management includes minimizing tillage, diversifying crops and using cover crops.

The time has come to pay attention to what's happening below the surface in addition to above. To unlock the secrets of the soil, we need to dig a little to learn a lot about how management practices impact soil health. Michigan State University (MSU) will host its first MSU Agriculture Innovation Day: Focus on Soils on Aug. 24, 2016, at the Saginaw Valley Research and Extension Center in Frankenmuth, Michigan. At this educational field day, farmers can get to the bottom of soil health by visiting a root pit comparing two management practices. Join MSU Extension educators and researchers in the pit and see that healthy soil has a certain smell, feel and look. Current research on soil health will be discussed during this demonstration.

The USDA National Resource Conservation Service has a variety of excellent soil health resources. For more information on soil health, contact me at baas@anr.msu.edu, Paul Gross at grossp@anr.msu.edu or Christina Curell at curellc@anr.msu.edu.

Invest in pollination for success with highbush blueberries

For profitable yields, investing in pollination of highbush blueberries is crucial.

Posted by **Rufus Isaacs**, Jason Gibbs, and Emily May, Michigan State University, Department of Entomology; Eric Hanson and Jim Hancock, Michigan State University, Department of Horticulture, MSUE News

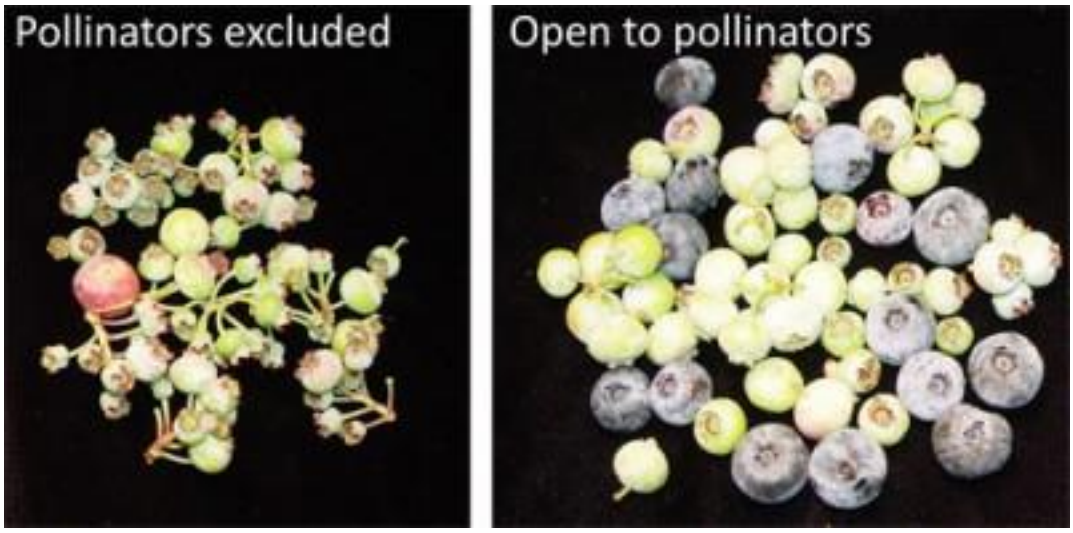

Photo 1. Comparisons of blueberries picked on the same day in July from clusters that had either been bagged to exclude pollinators (left) or were uncovered during bloom (right), allowing bees to visit. Both sets had the same number of blooms during flower

Northern highbush blueberries (*Vaccinium corymbosum*) are common throughout the northern United States and Canada, and are native to eastern North America. They require pollination to ensure that flowers present at bloom turn into large, harvestable berries later in the season. Pollination is achieved by the movement of pollen by bees. By planning ahead for how fields will be pollinated, growers can help ensure they receive the maximum return on their investments in land, bushes and other management inputs. Given the high per-acre input costs of blueberry production, spending money to ensure high levels of pollination makes sound business sense. Other things being equal, well-pollinated fields have larger berries, higher yields, and more even ripening than fields with sub-optimal pollination.

Across Michigan's blueberry industry, most pollination is by managed honey bees that are brought to fields in hives. Many of these colonies have been overwintered in warmer states and they arrive back in Michigan as fruit crops start blooming in Southwest Michigan. Bumble bee colonies can also be purchased for placement in fields and there are many other wild bee species that nest in and around crop fields. By combining these pollinators into an integrated crop pollination strategy, the risk of poor pollination may be minimized.

Pollen is moved by bees

For pollination to occur, sufficient compatible blueberry pollen must be moved from the male part of flowers (anthers) to the female part (stigma) while the flowers are receptive. Bees are responsible for this movement of pollen, so blueberry pollination depends on having enough bees active in the field during bloom to deliver pollen. Each flower must be visited once by a bumble bee or most native bees, or three times by honey bees to get enough pollen so that berries will grow to maximum size. There can be 10 million flowers per acre, so there is a lot of work for bees to do!

The pollen produced by blueberry flowers is relatively heavy and doesn't waft on the wind. It is held inside the flower by salt shaker-like structures called anthers until bees visit. They may release the pollen by jiggling the flower with their legs, as is the case for honey bees. Bumble bees and some other native bees are better adapted to release the pollen using a vibration behavior known as "buzz pollination." When the bees shake the anthers, the pollen collects on their bodies. As the bees move from flower to flower, pollen grains are transferred to the stigma. Flowers are receptive to pollen immediately on opening, and their chance of turning into a berry declines after three days with flowers unlikely to turn into fruit after five to six days. Once compatible pollen is deposited on the stigma, the pollen germinates and fertilizes the ovules that produce the tiny seeds. Fertilized seeds release hormones that stimulate berry growth, leading to larger berries.

Things to know before planting

Northern highbush blueberry bushes can produce berries even when there is no or limited pollen deposition by bees. This means that some proportion of the flowers can turn into berries, even if there are poor pollination conditions or low bee activity during bloom. However, these berries will be small, slow to ripen, may drop off early, and most would not be considered marketable (Photo 1, left). To reach maximum potential yield, it is important that the flowers are visited by bees during bloom to transfer sufficient pollen to the stigma while the flower is still viable so that fertilization can occur, leading to seed set, berry expansion, and larger berries (Photo 1, right). If designing a blueberry field of any appreciable size over a few acres, make sure there will be space for a beekeeper to drop hives on pallets near the field.

For some cultivars, it is not sufficient just to get high rates of pollen transfer from bees because the type of pollen can be important. Some cultivars benefit from the transfer of

cross-compatible pollen, meaning that the field should be designed to have a combination of cultivars that bloom around the same time and that are compatible. For cultivars dependent on having cross-pollination for full yields, this can provide a 10-20 percent increase in yield from the improved fruit set and berry size. Table 1 provides a guide to cultivars and their level of dependence on this cross pollination for full yields. However, many popular northern highbush blueberry cultivars are self-fruitful, meaning they can be fertilized by pollen from the same cultivar (High group in the table), and this is one reason why solid blocks of some cultivars can be highly productive. Other cultivars are intermediate, meaning that a benefit can be gained by interplanting with another cultivar, but for many commercial settings growers might consider the increased complications in management outweigh the benefits.

Table 1. Variation among highbush blueberry cultivars in the need for a pollinizing cultivar to provide cross-compatible pollen during bloom

Dependence on a pollinizing cultivar	Cultivar
Low: no pollinizer needed	Duke, Draper, Bluejay, Nelson and Rubel
Intermediate: pollinizer beneficial	Bluecrop, Legacy, Jersey, Liberty, Elliott and Aurora
High: pollinizer needed	Brigitta, Spartan, Chippewa, Polaris and Toro

In a third group, cross-pollination is needed, and this is achieved by bees moving pollen between cultivars as they fly from row to row. In this situation, planting fields with alternating blocks of co-blooming and compatible cultivars ensures cross-pollination. While alternate rows of two compatible cultivars would be the best for pollination, it would also cause difficulties with harvesting and spraying. Alternating blocks of up to eight rows allows pollen exchange and is easier to manage. Alternating blocks of larger sizes will result in too few exchanges between cultivars that need cross-pollination. Before purchasing blueberry plants, check with your nursery to determine the need for planting fields with alternating cultivars.

Using honey bees for blueberry pollination

Wait until bloom has started to bring in bees

Flowers of blueberries are generally less attractive to honey bees than other flowers due to the relatively low nectar reward. Because of this, it is best to bring in bees once the crop has started to bloom so that bees forage more on blueberries than other flowers (Photo 2). If brought in too early, bees may learn to forage elsewhere, reducing their focus on your crop fields. Move bees into blueberry fields after 5 percent bloom, but before 25 percent of full bloom. Placement near to the blueberry field can also help to keep them focused on the crop. Still, some cultivars, notably Jersey, have low attractiveness, and bees may still fly over this cultivar to reach another.

Photo 2. A honey bee drinking nectar from a blueberry flower. This is the workhorse of blueberry pollination, and to achieve high yields the fields must be stocked with sufficient numbers of healthy colonies during bloom to ensure there are enough bees for sufficient transfer of pollen between flowers. Photo credit: Jason Gibbs, MSU

Renting healthy colonies

If you are renting honey bee hives, you should expect to receive healthy and vigorous bees. A healthy colony contains around 30,000 worker honey bees and will have six frames of brood. Having weak hives will affect how much pollination the fields receive, so it is worth taking time to ensure you have strong hives. If you suspect weak colonies, talk to your beekeeper about getting additional hives or replacing them. One strong hive of 30,000 bees will provide better pollination than two 15,000 bee hives because there will be more worker bees that fly to visit flowers. One way for growers to ensure they receive strong colonies is to establish a pollination agreement that lays out the grower's expectations. This can include the strength of the colonies and how quickly the colonies will be taken out of the field after bloom. Example pollination contracts are available online.

Honey bee stocking densities

There have been many changes in blueberry production and in bees over the past few decades, and yet many people still refer to bee stocking recommendations published in 1992. We consider those to be suitable for fields with lower bloom density, such as in a field affected by frost or when it is still establishing, and these can also be used in small fields surrounded by natural lands that will have higher populations of wild bees. However, if fields have a high flower density as some of the newer cultivars and intensive production systems provide or if field sizes are large without wild habitat nearby, then these recommendations are too low.

The last few decades have also seen the loss of feral honey bee colonies due to the parasitic Varrroa mites, so those colonies are no longer contributing to blueberry pollination. All of these factors can make fruit production more dependent than ever on managed bees, so it is important to stock fields with sufficient bees to supply enough visits to flowers while they are most viable, such as in the first three days after opening. A final point to make here is that if the weather is hot during bloom and flowers open quickly, this increases the chance that they will not get visited before they lose viability. Higher stocking densities can counteract this potential limiting factor.

Research and experience in blueberries has shown variation across northern highbush cultivars in their needs for bee pollination (Table 2) due to the relative attractiveness of different cultivars and their degree of self-compatibility. The table below shows a range of stocking densities from the lower rates recommended two decades ago to the updated double rate that Michigan State University Extension considers the required stocking density for fully productive modern fields. This shows five hives per acre for Jersey and Earliblue, but some growers are using up to eight colonies per acre to ensure good pollination if spring weather is cool and there are only a few good days for honey bee activity. These higher stocking densities can also be considered a form of pollination insurance to make sure that whatever the spring brings there will be the best chance of good pollination.

Table 2. Recommended stocking density of honey bees for highbush blueberry pollination. Cultivars have varying rates of need for honey bees, and within each group we show a range of hives per acre to stock at, ranging from low rates for use in young, frost-damaged, or small fields to high rates for use in mature, healthy, or large fields.

Cultivar	Honey bee hives per acre	
	Low rate	High rate
Rubel, Rancocas	0.5	1
Weymouth, Bluetta, Blueray	1	2
Bluecrop	1.5	3
Elliot, Coville, Berkeley, Stanley	2	4
Jersey, Earliblue	2.5	5

Adapted from Pritts & Hancock, 1992.

A rule of thumb is that you'll need four to eight honey bees per bush in the warmest part of the day during bloom to get blueberries pollinated. Also, if you see flowers turning brown and discolored on the bush, pollination was not sufficient; in well-pollinated fields, the corollas fall off when they are still bright white. Check your fields this season and if needed you can try to get additional hives from a beekeeper or plan on increased stocking next spring.

Hive placement
If possible, place the colonies in sheltered locations with the entrances facing east or south. This will encourage earlier activity as the hive warms in the morning sun. Hives should be spread out around the farm to maximize floral visitation with a maximum of 300 yards between hives. Placement in an open area slightly away from the edge of the fields also reduces the risk of pesticide drifting onto colonies being disturbed by a tractor.

Using bumble bee colonies
Bumble bees are very efficient at pollinating blueberries with activity at lower temperatures than honey bees, faster visits to flowers, and higher rates of pollen transfer per flower visit. A single visit of a bumble bee to a blueberry flower can deposit sufficient pollen to get full pollination, whereas three visits are needed by honey bees. The common Eastern bumble bee, *Bombus impatiens* (Photo 3), has been reared for use as a crop pollinator. These insects are available commercially and can be shipped directly to the farm in eastern United States and Canada. Koppert is one supplier based in Michigan that provides the bees in Quads, each containing four colonies housed within a weather-proof box. Our evaluations with this species in commercial Jersey fields found they provided comparable yield and fruit set to honey bees when tested in small fields at the recommended stocking density of three colonies per acre.

Photo 3. Bumble bees are efficient pollinators of blueberry, so they should be encouraged on the farm. They can also be purchased from commercial suppliers and their colony boxes placed near fields to provide crop pollination. Photo credit: Jason Gibbs, MSU

Growers may also purchase bumble bees to integrate with honey bees, thereby diversifying pollination sources. This approach should help ensure movement of pollen between flowers during conditions that are unsuitable for honey bees. Rearing bumble bees takes time, so orders should be made 14-16 weeks in advance to guarantee delivery. Place Quads through the farm and well away from honey bee hives. A door on the box of the Quads can be used to collect the bees and move them before spraying.

Wild bee pollinators

While ants, butterflies and hover flies will visit blueberry flowers to gather nectar, bees are the most effective at moving pollen. Over 150 wild bee species have been found in Michigan blueberry fields, and about 10 of these were sufficiently abundant during bloom and carried enough pollen to be considered valuable crop pollinators. These bees do best in farms with flowers for them to visit outside the crop bloom period and in farms where there are some undisturbed areas for nesting (Photos 4-5), and farms can be managed to enhance their abundance.

Photos 4-5. Many wild bee species require flowers to visit when the crop is not in bloom and areas of undistubed soil for nesting. Left, a miner bee gathering pollen from an early spring flower. Right, a sweat bee searching for a place to nest in the soil. Photo credits: Jason Gibbs, MSU

Wild bees fall into several major categories, including bumble bees, miner bees, sweat bees, mason bees and carpenter bees. Bumble bees and some sweat bees form social colonies later in the summer, but in spring during blueberry bloom these bees are in a solitary phase. Miner bees, mason bees and carpenter bees are solitary: each nest is built by a single female. Miner bees are abundant during the spring, and some species, such as *Andrena carolina*, are specialists on blueberries.

Wild bees nest in different areas in and around blueberry fields. Miner bees and most sweat bees make underground nests. A female bee tunnels into the soil, preparing brood cells for her young on side branches from the main tunnel. Pollen and nectar is collected and shaped into a ball placed in each cell. A single egg is laid on each pollen ball that provides food for the developing larva. These bees need untilled soil and have been seen nesting underneath blueberry bushes in the weed-free strip. Thick layers of mulch can prevent ground nesting bees from digging tunnels.

Some bees also nest in the undisturbed soil in nearby woods. Bumble bees also need undisturbed soil to nest in abandoned rodent burrows or grass tussocks, but they will also use old mattresses, compost piles and other protected sites with small entrances. Finally, some wild bees such as carpenter bees, some sweat bees and mason bees, prefer to nest in twigs, dead wood or pre-existing cavities. Brambles, logs and tree stumps in adjacent habitat and fence rows can be useful nesting sites for these bees. In small blueberry fields surrounded by natural habitat, wild bees can provide the majority of pollination. However, as blueberry farm size and intensity increase, the high abundance of flowers and the small amount of natural area results in too few native bees for full pollination, and so growers rent honey bees. Still, by creating bee habitat that includes a mix of plants that bloom before and after blueberries, growers can help support native bees as part of an integrated crop pollination strategy.

For more on native plants to support pollinators in the Great Lakes region, visit MSU's Native Plants and Ecosystem Services website. Every little bit of habitat will help, so consider this a long-term process of building bee habitat back into the farm landscape. The Natural Resources Conservation Service (NRCS) can provide cost share for growers interested in establishing pollinator habitat in their farms. See your local NRCS office for details of programs that can support this.

Pest management during pollination

Most insecticides have some level of toxicity to bees, so there are restrictions on their use during bloom. Not spraying while honey bees are in the field is the most effective way to avoid any risk of poisoning, so monitoring for pest problems carefully before and

during bloom can help minimize the need for pest control at this time of the season. However, insect outbreaks do occur and this time of the season is an important one for control of mummy berry. If a pesticide application is necessary during bloom, the compounds that are least toxic to bees should be used with careful observation of the pollinator restrictions on the label. Two insecticides that can be applied during bloom for control of moth larvae in blueberries are products containing *Bacillus thuringensis* (Bt), such as Dipel and Javelin, and the insect growth regulators Intrepid and Confirm. The U.S. Environmental Protection Agency (EPA) has developed new pesticide labeling guidelines for certain insecticides that limit their use where honey bees are present. This information is gradually being added to the labels of some insecticides, including neonicotinoids and the new product Exirel. Since these pesticides have never been labeled for use during bloom in blueberries, this is not a significant change, but it provides more information. EPA's infographic can be downloaded here: The New EPA Bee Advisory Box.

If spraying during the bloom period, one of the most important things growers can do to minimize effects on bees is to apply when the bees are not foraging. Late evening is the best time to apply sprays during bloom because the compounds have time to be absorbed and for the residues to dry before bees are active the following morning. Dust formulations must be avoided because particles can be picked up easily by the bees' hairy bodies.

Recent research has also found that certain fungicides have effects on bees, harming their gut microbes and making them more susceptible to parasite infections. This can in turn result in reduced colony health and increased mortality. Follow the same basic principles of spraying only when necessary and when bees are not foraging to reduce the potential for harming bees during bloom.

More information and a list of pesticides with their toxicity to bees is available from a recently-updated MSU Extension bulletin, "Minimizing pesticide risk to bees in fruit crops" (E3245). This document contains a list of insecticides and fungicides ranked by their relative risk to bees and plenty of other good information on how to prevent bee poisoning.

Summary

Pollination is an essential component of growing blueberries. To attain high levels of fruit set with large, evenly-ripening berries requires bees to deposit enough pollen on stigmas during bloom. This can be done by honey bees, other managed bees and wild bees. As with pest management, reliance on one strategy may not be the most sustainable approach, so diversifying pollination sources can spread risk to ensure consistent pollination and profitable yields every year.

Whichever bees are visiting flowers during bloom, ensuring the health and safety of these insects is an important part of maintaining good pollination. Follow label

restrictions and practice good pollinator stewardship so they can provide the all-important transfer of pollen that will lead to large berries and high yields.

Drs. Isaacs, Hanson and Hancock's work is funded in part by MSU's AgBioResearch.

Beekeeping regulations in Michigan outlined in new resource

New resource outlines the rules and regulations surrounding beekeeping and selling honey in Michigan.

Posted by **Meghan Milbrath**, Michigan State University Extension, Department of Entomology, MSUE News

Do you keep bees in Michigan? Are you thinking about beekeeping or selling honey? Michigan State University Extension has developed a new resource that outlines the rules and regulations surrounding honey bees in Michigan.

Before keeping bees in any state, it is important to know all the rules and regulations to make sure your apiary can run smoothly, and the health of your bees and your neighbors are protected. "Starting and Keeping Bees in Michigan: Rules and Regulations" outlines the rules and regulations for keeping bees in Michigan updated for 2016. This resource includes information about restrictions, honey labeling, organic requirements and more.

To access the resource, go to: Starting and Keeping Bees in Michigan: Rules and Regulations.

Mummy berry springs into action: How to manage this disease

Mummy berry has germinated in Michigan blueberry fields and apothecia or apothecial initials are present. Growers should scout fields for the fungus and be prepared to manage this disease.

Posted by **Annemiek Schilder**, Michigan State University Extension, Department of Plant, Soil and Microbial Sciences, and Mark Longstroth, MSU Extension, MSUE News

Stages in mummy berry germination and apothecium development. Photos by Timothy Miles (top) and Mark Longstroth (bottom).

Mummy berry is caused by the fungus *Monilinia vaccinii-corymbosi* and is characterized by blighting of young shoots, which are referred to as “shoot strikes.” Fruit infection leads to the shriveling and mummification of berries, hence the name mummy berry. These mummies overwinter on the ground below blueberry bushes. At the beginning of the growing season, small, trumpet-shaped apothecia develop on the overwintered mummies and start releasing ascospores which infect young leaves.

Previous research has shown that the optimum temperature for formation of apothecia is 50 to 57 degrees Fahrenheit. These temperatures are also very conducive to leaf infection, which requires four to six hours of continuous leaf wetness under those conditions. Leaf wetness can come from rain, dew, fog or overhead irrigation water. Infection can occur at temperatures as low as 36 F, but a wetness period of 10 hours is

required for infection at that temperature. The risk of infection is reduced at temperatures of 80-86 F and above.

In general, longer wetness periods lead to more infections, observed as higher numbers of shoot strikes. Also, frost injury increases susceptibility of the shoots to infection. In past trials, fungicide applications within 24 hours of a frost event significantly reduced shoot strike incidence.

Mummy berry shoot infection conditions for lowbush blueberries					
Wetness Duration (h)	**Average temperature (F) during wet period**				
	36	**43**	**50**	**57**	**65**
2	0	0	0	0	0
4	0	0	0	0	0
6	0	**Low**	**Low**	**High**	**High**
8	0	**Moderate**	**High**	**High**	**High**
10	**Moderate**	**High**	**High**	**High**	**High**
15	**Moderate**	**High**	**High**	**High**	**High**
24	**High**	**High**	**High**	**High**	**High**

Table source: Paul Hildebrand, Ag Canada, Nova Scotia.

At this time in Michigan fields, mummies have germinated and apothecia or apothecial initials are present. We had already started seeing “apothecial initials,” the horn-like structures developing on overwintered mummies in March, indicating that the mummies were ready. The mummy germination rate is 20 to 45 percent this spring, with higher germination rates and more advanced development at wetter locations. This germination rate is pretty typical of most years in Michigan. Spore release starts when the apothecial opening is about 2 millimeters and continues to increase as the apothecia expand.

Open apothecial cups have been reported and now that the blueberries are at green tip or leaf expansion, this indicates a risk of primary infection. In general, the more apothecia that are present and the larger the apothecial cups, the greater the risk of infection. Michigan State University Extension therefore advises scouting in fields with a history of mummy berry to confirm the stage of development of the fungus. Continued scouting will also help determine when infection risk has passed. Remember that there can be several flushes of apothecia depending on soil moisture. Later flushes of apothecia are actually more risky due to the presence of shoot strikes with fresh spores during bloom.

When soils stay cool and moist, apothecia may last for two to three weeks and release spores on a daily basis, especially in the morning as the relative humidity starts to drop. Ascospores are dispersed by wind, which picks up in speed in late morning. Warm and

dry soils will lead to quicker deterioration of the apothecia. You can use MSU's Enviro-weather website to monitor for mummy berry infection conditions at nearby weather stations. There is no specific model for mummy berry, but blueberry growers can use the Multi-Crop Disease Summary tool in the fruit section of Enviro-weather to find the hours of wetness and the average temperature during the wetting period for all the stations in the region.

Fungicides work best when applied preventatively (before infection) because the fungus grows too fast during optimal conditions for post-infection sprays to work well. While the risk of fungicide resistance development appears to be relatively low for this pathogen, it is nonetheless advisable to alternate fungicide chemical classes as indicated by different Fungicide Resistance Action Committee (FRAC) code numbers. If shoot strikes are controlled well – you can scout fields to confirm this – and no shoot strikes are present during the bloom period, the risk of fruit infection is minimal, unless there is a nearby field where shoot strikes are present. Spores produced on the shoot strikes can be carried by bees to nearby fields that are in bloom. Be careful with fungicide applications during bloom; avoid spraying after bee hives have been placed in the field or spray at night when bees are not active.

Fungicide efficacy against mummy berry in blueberries.				
Trade Name	**Active ingredient**	**FRAC Code***	**Shoot strike**	**Fruit infection**
Systemic Fungicides				
Indar	fenbuconazole	3	Good efficacy	Good efficacy
Proline	prothioconazole	3	Good efficacy	Good efficacy
Quash	metconazole	3	Good efficacy	Good efficacy
Tilt	propiconazole	3	Good efficacy	Moderate efficacy
Protexio	fenpyrazamine	17	Good efficacy	Good efficacy
Omega	fluazinam	33	Moderate efficacy	Moderate/Good efficacy
Pristine	pyraclostrobin + boscalid	11/7	Moderate efficacy	Good efficacy
Quit Xcel	azoxystrobin + propiconazole	11/3	Moderate/Good efficacy	Moderate efficacy
Inspire Super	difenoconazole + cyprodinil	3/9	Good efficacy	Good efficacy
Protectant Fungicides				
Bravo	chlorothalonil	M5	Moderate efficacy	Poor to fair efficacy
Ziram	ziram	M3	Moderate efficacy	Poor to fair efficacy
Serenade + Nu-Film P	*Bacillus subtilis* + terpene-based adjuvant	44	Moderate efficacy	Moderate efficacy

Double Nickel 55	*B. amyloliquefacies*	44	Moderate/Good efficacy	Moderate efficacy
Sulforix	calcium polysulfide	M2	Moderate efficacy	Poor to fair efficacy
Oso	polyoxin D zinc salt	19	Moderate efficacy	Moderate efficacy
Regalia**	giant knotweed extract	P5	Moderate efficacy	Moderate efficacy

*Fungicides sharing the same number belong to the same chemical class and thus have the same mode of action.
**Add Regalia at 1 quart per acre to other fungicides such as sterol inhibitors or strobilurins to improve control.

Dr. Schilder's work is funded in part by MSU's AgBioResearch.

WEB SITES OF INTEREST:

Insect and disease predictive information is available at:
http://enviroweather.msu.edu/homeMap.php

This issue and past issues of the weekly FruitNet report are posted on our website:
http://agbioresearch.msu.edu/nwmihort/faxnet.htm

60-Hour Forecast:
http://www.agweather.geo.msu.edu/agwx/forecasts/fcst.asp?fileid=fous46ktvc

Information on cherries:
http://www.cherries.msu.edu/

Information on apples:
http://apples.msu.edu/

Information on grapes:
http://grapes.msu.edu

Fruit CAT Alert Reports:

http://news.msue.msu.edu