M I C H I G A N

Blueberry Newsletter

A newsletter from Michigan State University for the Michigan blueberry industry

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News you can use

Crop development. In Van Buren, Jersey in Covert is within 7 - 10 days of first harvest and Bluecrop and Blueray in Grand Junction are between first and second harvest. In Ottawa County, Bluecrop in West Olive is at the beginning of harvest.

Disease management. Protect berries from fruit rots by applying effective fungicides and minimizing fruit wetness duration from overhead irrigation. Ideally, fruit should not be wet more than 4 hours; irrigating in the early morning will allow fruit to dry off fastest. Mechanical harvesters can damage canes and allow Phomopsis to enter during wet weather; adjust harvester if possible to reduce damage and, if Phomopsis has been a problem in a particular field, apply a fungicide immediately after harvest to protect wounds. Keep monitoring bushes for signs of leaf rust and other diseases.

Insect management. Remove cranberry and cherry fruitworm traps for harvest (your harvester will thank you!). Blueberry maggot flies have been caught. Keep checking spotted wing Drosophila traps.

MICHIGAN STATE UNIVERSITY | Extension

Bluecrop in West Olive

Bluecrop in Grand Junction

GROWING DEGREE DAYS

From March 1

	2011		Last Year	
	Base 42	Base 50	Base 42	Base 50
Grand Junction, MI				
7/11	2029	1325	2357	1554
7/18	2262	1502	2599	1740
Projected for 7/25	2526	1710	2840	1925
West Olive, MI				
7/11	1789	1137	2146	1370
7/18	2016	1308	2375	1543
Projected for 7/25	2287	1522	2596	1708

See http://enviroweather.msu.edu for more information.

Very hot conditions forecast for SW Michigan

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July has been hot with highs generally in the 80s. There has been no significant rain since the storms on Monday July 11. Soils are dry and soil temperatures are as warm as the air temperatures. Dry hot conditions are forecast for the upcoming week. The hot summer conditions in June and July have the region only about 3 days behind normal. Check for the closest weather station at: enviroweather.msu.edu.

Blueberries are being harvested across the region. The harvest of Bluecrop continues as well as mid-season berries such as Jersey and Nelson. Shoot growth has stopped with the heat and hot weather. Growers who can irrigate should be replacing the 0.2 to 0.25 inches of water, which is lost each day. A Spotted winged Drosophila (SWD) was trapped in Allegan County on July 7. Growers should monitor for this pest, which has the ability to lay its eggs in thin skinned fruit. Cane collapse from phomopsis cane blight continues. Insects of concern include Japanese beetle and blueberry maggot. Anthracnose fruit rot can be found on ripening fruit.

Hot and humid weather, time for fruit rot control

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Major small fruit crops are in full harvest in the Central Region. Despite a slow start at the beginning of the season, that in some cases amounted to a two week delay in growth and development, currently the harvest of most crops is at most four-five days behind in relation to the 2010 crop season. Hot and humid temperatures occurring over the past two weeks have speeded up the degree-day accumulation and the maturation process.

The strawberry harvest has concluded and growers started the renovation in preparation for the next crop cycle. Because of the weather conditions that prevailed during the past weeks the harvest ended rapidly and yields were not as good as was expected.

Regarding raspberries, the harvest of summer raspberries has continued with fruit of good quality. Raspberries were not affected by winter conditions and at this time the size of the crop is good. There are some problems related to insects, mainly Japanese beetle, Lygus bug and in some fields cane borers. But in general there are no significant problems. For beetles and tarnished plant bugs growers may apply Assail 30 SG, 4-5 oz per acre. This insecticide has a small pre-harvest interval and it will allow continuing harvesting the next day after the application. Another good insecticide for controlling these insects is Sevin (Carbaryl) but it has a 7-day pre-harvest interval. For more options please consult the Michigan Fruit Management Guide 2011 (E-154).

Blueberries are in full harvest. Yields are lower than expected and because of the light crop most fields are producing berries of excellent size and quality. In some cases the sizing of the berries may compensate for yield reductions. The intense heat of the past few days may affect the fruit quality in those fields that are already ripe. Growers need to be alert to fruit roots. The combination of hot weather and ripe fruit are a perfect environment for the proliferation of anthracnose fruit root and Alternaria. To prevent fruit contamination with fungi and bacteria avoid using overhead irrigation during the day hours of intense heat. Also, if the field has a history of fruit root problems do not wait to see the first symptoms of fruit infection because when the symptoms are visible the infection is already established in the entire field. At this time, the recommended fungicides are Pristine (18.5 to 23 oz. per acre) if the main problem is anthracnose or Switch (11 to 14 oz. per acre) if the main problem is Alternaria fruit root. For more options please consult the Michigan Fruit Management Guide 2011 (E-154).

Problems observed at this time are related to insects, diseases and labor. Regarding insect pests, the Japanese beetle is present in most fields but in low numbers. As always, the highest infestations are found in blueberry fields where weeds are a problem. If harvest is already in progress and beetles are creating a food safety problem you may apply either Aqua Marathon 8 AC (2 to 2.5 pt. per acre) or Mustang Max 0.8EC (4 oz. per acre). These two insecticides can be applied one day before harvest. If the harvest is more than three days away you may apply Imidan 70 WP (1.33 lb. per acre).

Other insects of concern are the Blueberry Maggot and the Spotted Wing Drosophila. No problems are reported related to Blueberry Maggot. Regarding the Spotted Wing Drosophila, we are conducting an extensive survey with apple vinegar traps. So far, only one confirmed detection has been reported in Allegan County. In Kent, Ottawa and Muskegon Counties no Spotted Wing Drosophila flies have been found. However, we are continuing its monitoring in blueberries and raspberries.

Insect update

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Both cherry fruitworm and cranberry fruitworm flight and egglaying is essentially over at the farms we scout. Fruitworm traps can be removed from fields to get ready for mechanical harvesting. The amount of fruitworm damage visible in our monitored fields has decreased because much of the damaged fruit has dropped off the bushes and some damaged berries have been removed during harvest. Growers and scouts should note where damage occurred this season to help with planning for the control of these pests in the future.

The abundance of blueberry aphids has decreased at the farms we scout, and the size of individual aphid colonies has also been reduced over the past two weeks. We are also seeing an increase in parasitized aphids and aphid predators in those fields. Growers and scouts should continue checking bushes for aphids, particularly in fields that have varieties that are susceptible to blueberry shoestring virus.

Blueberry maggot flies (Fig. 2) have been captured at the West Olive farm (July 11) and the Covert farm (July 18). We have also received reports of captures of blueberry maggot flies at several other blueberry farms in southwest Michigan. Blueberry maggot traps should be monitored until harvest. See the article in the June 28 edition of this newsletter for additional information on monitoring and control of blueberry maggot.

The number of Japanese beetles in the fields we scouted increased over the past two weeks. Beetles were seen at all the farms we monitored, and Japanese beetle feeding damage can be seen on leaves, but very little damage has been seen on fruit at the sites we monitored. To monitor for Japanese beetle, examine 10 bushes on the field border and 10 bushes in the field interior and record the number of beetles on each bush. Keep in mind Japanese beetles are normally more common adjacent to grassy areas on sandy soils, and they prefer to be in sunny areas. Be sure to check any five-leaf ivy, wild grape or sassafras growing in fields as these plants are very attractive to Japanese beetles. Regular monitoring will aid growers and scouts in timing control measures to keep fields clean of Japanese beetles before harvest, and reduce the possibility of contamination during picking. Read more about Japanese beetle in the in-depth article in this newsletter or at the blueberries.msu.edu website.

Table 1. Insect scouting results.

Farm	Date	CFW moths per trap	CBFW moths per trap	BBA infested shoots (%)	SWD adults per trap	BBM adults per trap	JB per 20 bushes
			VAN BUREN COUNTY				
Covert	7/11	0	0	0	0	0	2
	7/18	0	1	0	0	1	8
Grand Junction	7/11	0	0	20	0	0	6
	7/18	0	1	5	0	0	10
			OTTAWA COUNTY				
West Olive	7/11	0	0	0	0	1	8
	7/18	0	0	0	0	0	1

CFW=cherry fruitworm; CBFW=cranberry fruitworm; BBA=blueberry aphid; SWD=spotted wing drosophila; BBM=blueberry maggot; JB=Japanese beetle

Fig 1. Enlarged image of a blueberry maggot fly on a trap. Note the M-shaped wing marking and the white spot on the back of the fly; *Photo: K. Mason.*

No spotted wing drosophila (SWD) flies have been trapped at the farms we monitor for this newsletter, however the first two flies of the season have been caught in or near minimally managed blueberry fields in Allegan county. For more information about this new invasive pest, please check out the MSU spotted wing Drosophila page.

Managing Japanese beetles in blueberries

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Michigan State University

Japanese beetles have only one generation per year, but these beetles emerge over a long period from late June through August and they live for over 30 days. They feed on the foliage and fruit of blueberry plants, causing damage to the plant and increasing the risk of fungal diseases. Their emergence during mid-summer can also result in their presence during harvest, creating a risk of contamination. They are also highly mobile insects and can fly into fields from surrounding areas. This article provides information on insecticide options based on tests over the past few years conducted at the Trevor Nichols Research Complex and at growers' farms.

Making your farm less attractive to beetles. Many farms have sodded row middles and perimeters around fields, with irrigation being broadcast during the summer months. This is done for good farm management reasons, but it also creates ideal conditions for Japanese beetles to lay eggs, since they prefer to lay eggs in mown grass and in

moist soil. While it may not make sense to do this in all farm situations, removing the grass or using a non-grass cover crop in row middles, or restricting irrigation to the crop row through a drip system are all approaches to reduce the suitability of sites for reproduction of this pest.

Certain weeds are another magnet for Japanese beetles. Beetles are much more abundant in crop fields where there is poor control of wild raspberry, blackberry, Virginia creeper, wild grape, or sassafrass. These weeds are highly attractive and beetles will aggregate on these attractive plants and then lay eggs in the soil nearby. Plan now for a fall application of herbicide to control these plants and reduce the attractiveness of your fields.

A few thoughts about trapping…Traps are sold widely for Japanese beetle monitoring and control. However, these insects are very easy to see so they can be monitored by looking directly on the crop – you will know when they are present from the feeding damage and by seeing the beetles. Traps are highly attractive and draw beetles to them over large distances, so putting a trap near your crop fields will draw beetles from the surrounding landscape. Many of the attracted female beetles do not get trapped and end up landing on foliage nearby and feeding/mating then laying eggs in the soil near the trap, so this creates a hot-spot for next season. Mass trapping of beetles is also not economically feasible in commercial fruit plantings, and there is little evidence that this strategy will work to reduce beetle populations and crop injury. The take-home message is that traps should be avoided because they will not help reduce Japanese beetle damage in fruit crops.

Broad-spectrum insecticide options. The carbamates Sevin and Lannate provide immediate control of beetles present during the application. They are also stomach poisons, so if beetles eat treated foliage they will also receive a higher dose. This can be a good property for control of Japanese beetles since they eat so much that a strong dose of insecticide is taken up. Lannate has a short residual activity of a few days, whereas Sevin provides a week or more of protection. Sevin has a 3 or 7 day PHI depending on the crop, and Lannate ranges from 3- 14 days. The organophosphates Guthion and Imidan (buffer Imidan to pH 6.0 in the spray tank) both provide excellent lethal activity on adult beetles, although it can take a few days for their effects on Japanese beetles to be seen as the beetles take up the insecticide. If considering Guthion, beware of the 2011 restrictions on the total amount of this insecticide allowed this season as part of the EPA phaseout – see the label for details. These organophosphates provide 10-14 days of activity, with 3 (Imidan) and 7 (Guthion) day PHIs. The many pyrethroids registered such as Danitol, Asana, Mustang Max, and Bifenture give instant knockdown and mortality of adult beetles, with 7-10 days of activity. However, note that in high summer heat these insecticides provide shorter periods of activity than in cool weather. Beetles that do not receive a lethal dose of pyrethroid may also be repelled from treated fields, providing an additional mode for reducing infestation of crops at harvest. PHI's for pyrethroid insecticides vary from 1 to 14 days, so check the label before use or consult the table at the back of the 2011 edition of the MSU Fruit Management Guide to compare PHI's.

Reduced-risk insecticides. The labeling of the neonicotinoids such as Provado, Actara, and Assail provides selective options for Japanese beetle management. These insecticides provide 2-5 days of lethal activity from the surface residues before being absorbed into the foliage. Thereafter, beetles must eat treated foliage to get a dose of the insecticide. Once inside the foliage, these locally-systemic insecticides are rainfast and provide repellency and knockdown activity, but with much less direct mortality from the residues. These neonicotinoids will also provide some control aphids and leafhoppers. The rate of these insecticides allowed in different crops will have a large impact on their effectiveness, and growers should consider the higher end of the rate range to achieve some lasting control of Japanese beetles. Most labels will provide guidance on the rate that is appropriate for control of this pest.

Short PHI and organic options. For growers looking for beetle control immediately before harvest or in organically grown fruit crops, some selective insecticides with 0 day PHI's can provide a tool to repel beetles and help achieve beetle-free fruit during harvest. Compounds containing neem (Azadirect, Neemix etc.) have a 0 day PHI and pyrethrum (Pyganic) has a 12 hour PHI. These compounds are labeled for organic use, and have a short but effective impact on adult Japanese beetles, with some mortality, some knockdown off the crop, and some repellent activity. Typically there is only 1-2 days of activity against beetles because the residues do not remain active for long. The non-organic form of Pyganic, called Evergreen, also has a 12 hour PHI, and is much more effective against Japanese beetle than Pyganic due to the addition of a chemical that inhibits the beetle's ability to break down the insecticide. A final option for protection against Japanese beetle is SURROUND WP, a white clay material applied to create a white coating on the surface of foliage and fruit to provide protection against insects. When applied to provide a good coating (typically requiring 2 or more applications), SURROUND has performed very well against Japanese beetle in trials conducted in blueberry and grape. If considering this approach to Japanese beetle control, be aware that the white coating on the fruit may require some removal after harvest to make the fruit marketable. This may be challenging for some types of fruit. For example, in blueberries the white residue was removed well from the surface during processing but deposits in the calyx cup were not removed even after running

berries through a typical wet processing line with food grade detergents.

Soil-applied insecticides. Japanese beetles typically lay their eggs in moist grassy areas and many fruit farms have a large amount of this highly suitable habitat. An additional approach to reducing the impact of Japanese beetles in a farm is to reduce the overall population by targeting the grub stage of this pest to reduce the abundance of beetles in the following year. If the location of high grub densities near fruit fields is known, these areas could be treated with a soil insecticide to get maximum return on this treatment. Our experience in Michigan blueberry fields has been that application of Admire (16 oz/acre) to grassy field perimeters in late June/early July reduced the abundance of beetles on bushes for the first few weeks of their flight period in the next growing season. After that, beetles flying into the area from outside swamped out this effect, so there is only a short-lived benefit from targeting the grubs in fields surrounded by infested grassy areas. However, as part of an overall IPM program to minimize the impact of Japanese beetle, this approach can help reduce the number of beetles growers must control. Platinum is another soil-applied insecticide that can be used for this grub control strategy.

Spotted Wing Drosophila Update

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First 2011 SWD detections. In the past few weeks there have been two detections of SWD in traps located in Allegan County, but approximately 10 miles apart. One of these was a single male SWD found on August 7 in a wooded area adjacent to a blueberry field. Nearby traps in a crop field did not detect any SWD. The second detection was a female SWD found this Monday in a monitoring trap at a different site – an abandoned blueberry field that also had SWD flies detected last season. Monitoring is continuing across the state, and we will update you if there are important changes to this situation.

These first detections of the season are much earlier than 2010, and they highlight the need for growers, scouts, and consultants to be checking traps. It is important to highlight that we have not detected SWD in any traps in any commercial crop fields, or in any fruit. Still, growers should be prepared to manage this pest to ensure the quality of Michigan fruit. The MSU SWD website (www.ipm.msu.edu/SWD.htm) contains information on this pest, including monitoring and identification information as well as a management guide that lists the available and effective management tactics.

Ongoing research. Please be aware that this is our first full growing season of dealing with SWD, and we are working hard to learn more about the most effective management tactics for Michigan conditions. Ongoing research includes field evaluations of various insecticides against SWD, as well as comparisons of ground vs. plane/helicopter spraying. Look for some results later this summer. As soon as that information is available, we will share it with you.

New label. Gowan Company has released an updated label for Imidan 70W that now includes SWD control listed for the susceptible tree and small fruit crops. In our recent bioassays, this insecticide provided very high fly mortality after 24 hours. It was not as fast-acting as the pyrethroid class, but it is expected to provide longer residual control during these very hot and sunny summer conditions, so this label can provide growers with some confidence for SWD control if using Imidan for other pests. As always, be aware of the crop-specific rate, PHI, and REI restrictions. The label will be posted to our SWD website in the next few days.

Website update. Our SWD website has been updated (thanks, Joy) to include some recommendations for organic growers and to include the report on fruit sampling.

Irrigating Blueberries

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Irrigation is vital for maintaining high yields in Michigan blueberries. Blueberries grow best in moist soils. Many Michigan Blueberry plantings are located in areas with a high water table so the bushes have ready access to water located close to the surface. But, blueberries are shallow-rooted and sensitive to drought stress, and most Michigan plantings are on sandy soils that hold very little water. Drought prior to harvest reduces berry size and yield, but drought stress anytime in the summer or fall also reduces bud set for the following year. Severe drought events reduce returns for several years. Most fruit in Michigan is not irrigated but 70% of the Michigan blueberries are irrigated. Irrigation is particularly critical for young plants that have limited root systems. A consistent supply of soil moisture optimizes vegetative growth on young plants by reducing moisture stress during the growing season. For established plants, the goal is to optimize fruit production in the current and future seasons. Irrigate to prevent moisture stress during the June-July fruit development period, when drought stress reduces berry size and yields. Drought in August/September reduces bloom next year, so avoid stress after harvest when fruit buds are formed. Occasionally, soils are dry as blueberries enter winter, and fall irrigation may help prepare plants for winter condtions.

Irrigation Systems. Overhead sprinklers are best where the water supply is adequate and spring frosts are likely. Trickle systems are best if your water supply is limited. Trickle systems apply water directly in the row with little evaporation loss. Traveling guns are economical, but can apply excessive water rates and have poor uniformity.

Table 2. Available water in a blueberry root zone as affected by soil texture and rooting depth.

Soil texture	Available water (inches) Per inch of depth	In root zone (12-18 inch depth)
Sands	.03	.4 - .6
Loamy sand	.07	.8 - 1.3
Sandy loam	.13	1.6 – 2.3
Loam	.17	2.0 – 3.1

The soil water reservoir depends on soil texture and plant rooting depth (Table 1). Assume the rooting depth is 12 inches for young plants and 18 to 24 inches for older established fields. Sandy soils may hold less than 1 inch of available water in the root zone, and half of this can be lost in two hot summer days. Many blueberry fields have slightly elevated areas that dry out quicker than other areas. Hardpan or a shallow water table may limit rooting in other areas of fields. These variable characteristics complicate scheduling. As a rule, irrigate to maintain the most drought-prone areas of your field.

Evapo-transpiration (ET) is the amount of water lost to the atmosphere, and includes the evaporation from the soil plus water lost by the plant (transpiration). Blueberry fields in southwest Michigan lose 0.18 to 0.24 inches per day during the summer. Daily Potential ET values are available on the Enviroweather website (http://www.enviroweather.msu.edu). After selecting the station nearest your farm, select Fruit from the Tools ribbon along the top of the page. After selecting Fruit you can go to the bottom of the center column and at the bottom of the page you will find Irrigation Tools. There are 3 different tools available. Irrigation Scheduling is a web based tool allowing you to set up your own farm fields to use enviroweather data to schedule your irrigation. It requires you to set up your own User ID and track and report precipitation and irrigation on your fields. Potential ET is the potential ET calculated from daily data at the MAWN Enviroweather sites. These MAWN Potential ET values are the best estimates of water use in Michigan blueberry fields. The Potential ET data begins on April first and gives the temperatures and rainfall for each date and calculates the ET and the cumulative water use. The ET will over estimate water use early in the year before the canopy is fully leafed out and underestimate water use when the canopy is fully leafed out and conditions are hot and dry. Maximum water use during the preharvest fruit growth stage is probably 0.20 to 0.25 inches.

Table 3. Estimated Blueberry Water Use in Michigan Blueberries (inches)

Month	Monthly Use	Weekly Use	Daily Use
May	0.48	0.12	0.02
June	2.87	0.72	0.10
July	5.09	1.26	0.17
August	2.13	0.53	0.07

Allowable soil moisture depletion in blueberries is generally considered to be 50%, so irrigate when half of the available water is used. This means that irrigation should be applied before 0.2 to 0.6 inches water is lost from sands and loamy sands, or 0.8 to 1.5 inches are lost on sandy loam or loam soils.

Irrigation scheduling allows water to be applied when it is needed. This reduces costs, the amount of water used and loss of nutrients. You need to how much water the soil can hold. You should irrigate when half the available soil water has been used. If you know how much water the plants are using (ET), you can irrigate when half the available water is used. For example, a root zone of 18 inches on a loamy sand soil (0.07 inches water per inch of depth) holds 1.3 inches of available water:

(18 inches) x (0.07 inches water/inch) = 1.3 inches water

If the root zone were depleted by 50%, you would need to apply 0.65 inches:

(0.5 depletion) x (1.3 inches) = 0.65 inches to apply

If the ET for the last several days was 0.25 inches you would need to irrigate

every 2 days; for 0.2 inches every 3 days and if the plants were only using 0.1 inches then you would need to irrigate every 6 days.

The evapotranspiration rate varies during the year depending on the amount of leaves on the plant and the weather condition (temperatures, relative humidity, wind). The temperature is the most important factor; increased heat increases ET much more than increasing humidity decreases ET.

Sprinkler Systems. The amount of water applied by sprinkler systems is determined by the size of the nozzle and the water pressure at the nozzle. For example a 9/64-inch nozzle at 45 psi will deliver about 0.15 inches an hour. If the system delivers 0.15 inches water per hour, 0.6 inches would be pumped in 4 hours. However, about 20 to 30 % of water from overhead sprinklers may be lost to evaporation, so increase the operating time accordingly. Also, irrigation systems are not completely uniform; they apply more water in some areas than others. The uniformity of sprinkler systems can be measured (Ley, 1994b), but are usually only 70% uniform. This means that to recharge all areas of the field, 30% more water than calculated would need to be applied. In our example, operating time should be increased by 20% to account for evaporation losses, plus 30% due to non-uniformity. So, increase operating time of 4 hours by 50% to 6 hours to ensure all areas receive 0.6 inches.

Trickle Irrigation. The application rate for lower volume trickle systems (48" spacing, 0.42 gph emitters) is about 0.17 inches/hr. The more common moderate flow systems (24" spacing, 0.42 gph emitters) deliver about 0.3 inches/hr. Since evaporation and uniformity are not significant in trickle systems we do not need to increase the application time. We would need to run the lower volume system twice as long to apply the same amount of water. These systems should be run at one to two hours every day to replace the water used by the plants.

There are several rules of thumb for trickle irrigation systems:

- For young plants apply 20 gallons/day per 100 feet of row.
- Mature plantings apply 35 gallons/day per 100 feet of row.

Ontario Canada estimates that peak daily demand for mature blueberries is about 4.5 gallons/day (18 liters/day).

Time to sample blueberry leaves for nutrient analysis

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Leaf analysis is the best way to monitor the nutrition of fruit plantings. This procedure provides a direct measure of the nutritional health of plants, whereas soil tests only provide an estimate. Leaf analyses can be used to diagnose nutritional problems and to identify developing problems before growth or yield is affected. Sample young plantings every 1-2 years and established plantings every 2-4 years. The whole farm can be sampled every 3-5 years, or portions sampled more frequently.

1. **Define sampling units**. Divide the farm into sampling units or areas that have uniform soil types, management history and variety. Farms with variable soils or history will require more sampling units to provide an accurate picture of the nutritional health. If the farm is very uniform with large blocks of the same age and varieties, define units no larger than 10-15 acres.

Fig 2. Leaf sampling for nutrient analysis; ***Photo: E. Hanson.***

2. **Sampling**. Sample leaves in late July to early August. Collect at least 50 leaves from as many different bushes throughout the sampling unit. Select healthy leaves from the middle of this year's shoots. If the leaves are dusty, rinse them briefly in tap water, and lay them out on a table top until they are dry to the touch.

3. **Submitting samples**. Package leaves in clearly labeled paper bags, and send them to a reputable laboratory.

Diagnosing nutritional problems. If you wish to diagnose a suspected nutritional problem, collect one sample from plants beginning to develop symptoms of the problem, and a second from nearby healthy plants. These samples can be collected at anytime during the season as long as a healthy "control" sample is included.

Interpreting results. Deficient, normal and excessive levels for blueberries are well defined for some nutrients (N, P, K) but these ranges for other nutrients (most micronutrients) are not well defined because deficiencies and excesses have not been documented in fields.

The total cost tissue analysis (sampling labor, postage, laboratory fees) can be as high as $40, and discourages some growers from using this important tool. However, if the sample represents 10 acres, per acre cost is $4.00 (equivalent to the value of 2-3 pounds of blueberries). This small input can readily be recovered if results show that fertilizer rates can be reduced. Test costs are incidental if fruit yields or quality are improved due to fertilization changes.

Some Midwest labs offering tissue analysis are listed on the next page. No endorsement is implied.

Labs that offer tissue analysis:

MSU Soil and Plant Nutrient Lab, A84 PSSB, MSU, East Lansing, MI 48824 (517- 355-0218)

A & L Great Lakes Laboratories, Fort Wayne, Indiana (www.algreatlakes.com, 260-483-4759)

Brookside Labs in New Knoxville, OH (419-753-2448, www.blinc.com/ag).

Midwest Labs in Omaha, NE (402-334-7770, www.midwestlabs.com)

Spectrum Analytic, Washington Court House, OH (800-321-1562, www.spectrumanalytic.com)

Control of pre- and post-harvest fruit rots in blueberries

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Some field observations. Currently, blueberries are looking and tasting good! Mummy berry is showing up in some varieties like Bluecrop and Rancocas and causing browning and shriveling of fruit (Fig. 3). While Bluecrop is considered moderately resistant to mummy berry, it seems to show more mummy berry than usual this year. In years with an early flush of mummy berry apothecia like this year, earlier-blooming varieties may actually be relatively more susceptible than later varieties because of timing of shoot strikes in the Bluecrop itself or nearby later varieties like Jersey. Good pollinating weather and many bees/ mosquitos will also lead to more "efficient" spore dispersal, resulting in a high fruit infection-to-shoot strike ratio. To confirm that browning of berries is caused by mummy berry and not by heat scalding or other problem, cut them open to see the white fungal growth filling the carpels (Fig. 4). In some cases, only a few of the carpels are infected, which leads to uneven mummification. Mummies are also pretty tough and may feel rubbery before they completely dry done. Most mummies are already on the ground, but some are still present in the clusters.

Other problems noticed in the field are cranberry fruit worm tunneling in and webbing berries together, reddish or green patches on fruit due to feeding by Putnam scale (Fig. 5), bird feeding pecks, and what appears to be hail damage to some berries (Fig. 6). In the latter cases, there is a corky layer under the papery skin of the berry. Heat scalding may also occur and leave berries brown and soft (Fig. 7). Any softening and berry collapse with a visible hole or maggot in the berry may be blueberry maggot or spotted wing Drosophila infestation. No evidence of leaf rust has been seen yet and infection is probably less likely under hot and dry conditions but careful scouting is recommended. As growers are gearing up mechanical harvesters, adjust settings if possible to reduce damage to canes and apply a fungicide immediately after mechanical harvesting to protect wounded canes if Phomopsis has been a problem and rainy weather is in the forecast.

Fruit rot management. With the warm and humid weather, fruit rots in blueberries are a concern, particularly anthracnose fruit rot (*Colletotrichum acutatum*). Alternaria fruit rot (*Alternaria* spp.) may also be a problem. Currently,

Fig 5. Poor coloring of areas on berries due to feeding by scale insects; *Photo: A. Schilder.*

Fig 3. Mummy berry shriveling up Bluecrop berries; *Photo: A. Schilder.*

Fig 6. Apparent hail damage to blueberry; *Photo: A. Schilder.*

Fig 4. To determine whether berry browning is caused by mummy berry, cut the fruit open ad observe white fungal growth inside carpels. Sometimes only one or few carpels are infected; *Photo: A. Schilder.*

Fig 7. Browning or softening of berry may be due to sunscalding. When cutting a berry open, there is no evidence of fungus or insect larvae; *Photo: A. Schilder.*

anthracnose fruit rot can be seen in overripe berries in some early-maturing varieties. Therefore timely harvesting is an important control measure. Post-harvest rot can develop on berries that look fine at harvest but carry fungal spores on them that can infect and develop in berries during processing and storage. Post-harvest infection is slowed down significantly by refrigerated storage, but will resume on the supermarket shelves and in consumer's refrigerators, lowering fruit quality. Anthracnose fruit rot infections can also contribute to high microbial counts in frozen processed berries, leading to rejection of fruit lots by some buyers. Rapid cooling of harvested fruit is important in reducing post-harvest fruit rot incidence. If the first blue berries are starting to show rot, fungicide sprays can still limit new infections of adjacent healthy berries. Applications 1 to 2 weeks before the first harvest or even between harvests can still be beneficial in preventing these late infections. The anthracnose fruit rot infection model (http://www.enviroweather.msu.edu/homeMap.php). is still useful to recognize high disease pressure conditions, particularly for fruit that is still green.

Examples of fungicides that can be used during fruit development and ripening are discussed below. The strobilurins (**Abound, Cabrio, Pristine**) are all very effective against anthracnose, with Pristine having the most broad-spectrum activity since it contains two different active ingredients. However, it is also the most expensive of the three. Pristine also has excellent activity against Phomopsis, while Cabrio has good and Abound fair activity against this disease. All are supposed to have moderate to good activity against Alternaria fruit rot and distribute well over the fruit surface since they are locally systemic. Do not use strobilurins more than three times per season and preferably no more than twice to reduce the risk of fungicide resistance development. **Switch** (cyprodinil and fludioxonil) also has systemic properties and provides good to excellent simultaneous control of anthracnose, Alternaria, and Botrytis fruit rots. Thus it may be a good choice if several fruit rots are a concern. **Captevate** (captan and fenhexamid) at the high rate will provide good control of anthracnose as well as Botrytis fruit rot, but this disease tends to be less common in Michigan and is more of a concern during cool, wet seasons. **Aliette** (fosetyl-Al) is a highly systemic fungicide that provides good control of anthracnose, Alternaria fruit rot, and Phomopsis. Less expensive alternatives to Aliette are **Phostrol** and **ProPhyt**. Be careful when spraying ProPhyt or Phostrol in a tankmix with adjuvants or foliar fertilizers, as burning of leaves can ensue. This appears to be a particular risk when plants are heat-stressed or when foliage stays wet for more than 6 hours. If the weather is relatively dry, a **Captan**/**Captec** spray alone may suffice for fruit rot control. **Ziram** is more effective at the 4-lb than 3-lb rate but not particularly strong. **Omega** is a new fungicide that has fairly broad-spectrum activity, including fruit rots. For organic production, **Sporan, Regalia** or **Neem oil** have moderate activity against anthracnose fruit rot. **Serenade** is not very effective against anthracnose fruit rot and may actually exacerbate it. Do take note of the pre-harvest and restricted entry intervals for the various fungicides before using them.

Table 4. Effectiveness of fungicides for blueberry disease control. Adapted from E-154 Fruit Mgmt Guide.

Fungicide	Mummy berry		Phomopsis twig blight and canker	Fusicoccum canker	Alternaria fruit rot	Anthracnose fruit rot	Botrytis blight and fruit rot	Phytophthora root rot
	Shoot	Fruit						
Abound	+ / ++	+ / ++	++	?	++	++++	+	?
Aliette	0	0	++ / +++	?	+++	+++	?	+++
Bravo	++	+	+++	+++	+	+++	++	0
Cabrio	+ / ++	+ / ++	+++	?	++	++++	+	?
Captan	+	+ / ++	++	+	+	++ / +++	+	0
CaptEvate	++	++	++	?	+	++	++++	0
Elevate	+	+	+	?	0	0	++++	0
Indar	+++	+++	+++ / ++++	?	+	0	?	0
Lime sulfur	?	?	++*	?	?	++	?	0
Omega	++	++/+++	?	?	++	++/+++	?	0
Orbit	+++	++	+++	?	?	?	?	0
Phostrol	+	+	++	?	++	++	?	+++
Pristine	++	+++	+++	?	++/+++	++++	+++	?
ProPhyt	+	+	++	?	++	++	?	+++
Regalia	++/+++	++	?	?	?	++	?	?
Rovral	0	0	0	0	0	0	++++	0
Ridomil	0	0	0	0	0	0	0	++++
Serenade + Nu-Film	+++	++	+ / ++	?	?	0	?	?
Sulforix	+++	++	?	?	?	+	?	?
Switch	+	++	+ / ++	?	++++	+++	+++	?
Ziram (3 lb)	++	+	++	++	+*	++	+	0
Ziram (4 lb)	++	++	+++	++ / +++	++*	+++	++	0

0 = not effective, + = poor, ++= fair, +++ = good, ++++ = excellent, ? = not known.
Ratings are based on published information and observations in Michigan.
* Based on data from New Jersey and Michigan. Fall and spring dormant application used.

2011 Grower Events

Monthly grower meetings are finished for the season.

Great Lakes Fruit, Vegetable, and Farm Market Expo
December 6-8, 2011
DeVos Place Convention Center, Grand Rapids

SW Hort Days
Early February, 2012
Lake Michigan College, Benton Harbor

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