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. Jersey in Covert and Bluecrop and Blueray in Grand Junction are at mid to late green fruit. Bluecrop in West Olive is at early green fruit.

Insect management. Cranberry fruitworm flight is still going strong and egglaying has been observed. Cherry fruitworm moth flight and egglaying has decreased. Aphid numbers are still increasing, keep scouting for aphids. Hang maggot traps in the next week.

Disease management. Keep an eye on anthracnose fruit rot model - long wetting periods may result in moderate or high infection risk. Use systemic fungicides during rainy periods.

Weed control demonstration on June 28. Blueberry growers are invited to a weed control demonstration at 7 PM on Tuesday, June 28. Eric Hanson will be on hand to discuss spring and fall herbicide treatments, and to demonstrate the effectiveness of new and old blueberry herbicides. The meeting is at Bocock's New Day Blueberry Farm, 6906 103rd Avenue (between 69th and 70th Street) north of South Haven. No charge/no meal, and you do not need to register.

Bluecrop in Covert

Bluecrop in Grand Junction

GROWING DEGREE DAYS

From March 1

	2011		Last Year	
	Base 42	Base 50	Base 42	Base 50
Grand Junction, MI				
6/13	1213	733	1484	904
6/20	1409	873	1696	1059
Projected for 6/27	1580	988	1921	1229
West Olive, MI				
6/13	1020	592	1329	775
6/20	1202	718	1524	914
Projected for 6/27	1384	844	1730	1063

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

Hot and dry after cool and wet has stressed SW Michigan blueberry plantings

Mark Longstroth
Michigan State University Extension
Van Buren County

Weather. June began with warm, dry conditions. High temperatures rose from the 70s, through the 80s, to almost 90, with no significant rains. The increased heat and fully developed leaf canopies increased plant water use and sandy soils began to dry out. Soil temperatures have risen into the mid-60s. Daytime highs have fluctuated from almost 90 to near 70. Rains have brought widely varying amounts of moisture but not enough to keep up with plant demand. The top soil is drying out. Growers should be irrigating to maintain good fruit growth before harvest. Growers should check for nearest weather station at: enviroweather.msu.edu. You can track weather and predict insect and disease problems with the models there. We are close to normal fruit development and I do not anticipate any delay in harvest due to the cool wet spring. Yields will be very light on some farms.

Blueberries have good sized green fruit and shoot growth has started back up in many fields. The crop is very variable with many fields having a light crop. While some varieties are affected more than others, two fields of the same variety close together may have very different crop loads. We are also seeing small blue fruit in some fields that has not dropped from the bush. It is unclear whether this fruit is diseased, a result of winter injury or just poor pollination. Some young blueberry plants planted last year are dying. There appear to be two causes, Drought stress perhaps worsened by winter injury or phomopsis. Where the leaves are turning brown slowly with an irregular pattern, this is due to water stress where the hot dry weather has dried out the small peat root ball in sandy soils and the moisture in the peat is exhausted. Where the plant suddenly wilts down, this is apparently phomopsis infection of the crown from young basal shoots infected last year. The disease moved down the shoot into the crown killing the plant, this spring. Mummy berry fruit symptoms are beginning to show up as brown rotted fruit in the early cultivars such as Bluetta. Otherwise the fruit needs to be cut in half to detect the disease.

Growers need to protect against anthracnose fruit rot and fruitworms. Both cranberry fruit worm and cherry fruit worm were biofixed in late May or early June and controls should be on the fruit. Fruitworm infested fruit, with either cranberry fruit worm or cherry fruit worm larvae are easy to find. Aphids are becoming easy to find in the lush growth at the base of most plants.

Irrigating blueberries in July 2011

Mark Longstroth
Michigan State University Extension
Van Buren County

With all the rain we received in May it seemed that we would never need to irrigate flooded blueberry fields. June brought temperatures near 90 our lighter well drained soils have really begun to dry out. Irrigation is vital for maintaining high yields in commercial blueberries. Blueberries grow best in moist soil. Good soil moisture levels optimize both vegetative and fruit growth. Blueberries perform best when less than half of the availble water has been depleted. 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. For established plants, the goal is optimizing fruit production for current and subsequent seasons.

Soil Moisture. Soil water reserves depend on soil texture and plant rooting depth (Table 1). You can assume the rooting depth of a blueberry is 12 inches for young plants and 18 inches for older plants. Sandy soils may hold less than 1 inch of available water in the root zone, and half of this can be lost in two warm summer days. Loamy sands and sandy loams are also common Michigan blueberry soils and can hold from 1.3 to 2.3 inches in the top 18 inches of the soil. Many blueberry fields have slightly elevated areas that dry out more quickly than other areas. Hardpan or a shallow water table may limit rooting in other areas of fields. This can be seen in older fields where the plants on sandy high spots and wetter low spots are smaller than the rest of the field. These variables complicate irrigation scheduling. As a rule, you should irrigate to maintain the drought-prone areas of your field.

Evapo-transpiration (ET) is the evaporation from the field, plus the water lost by the plant (transpiration). Under the hot conditions we will see in June and July, blueberry fields in can lose 0.18 to 0.24 inches per day. Daily Potential ET values are available on the Enviroweather website. They are located at the bottom of the individual station home pages under irrigation tools. Maximum water use during the preharvest fruit growth stage is probably 0.20 to 0.25 inches per day.

Allowable soil moisture depletion in blueberries is 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 (3 days of 0.20 inches ET) from sands and loamy sands, or 0.8 to 1.5 inches (4 to 7 days) are lost on sandy loam or loam soils.

Table 1. 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

Table 2. Blueberry Water Use in Southern Michigan			
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**

Irrigation scheduling allows you to replenish the soil water while reducing the amount of water used and loss of nutrients. You need to how much water the soil can hold. If you know how much water the plants are using, you should irrigate when the plants has used half the available water. 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. The evapotranspiration rate varies during the year depending on the amount of leaves on the plant and the heat and relative humidity. Temperature is the most important factor; heat increases ET much more than 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. A system that delivers 0.15 inches water per hour, delivers 0.6 inches 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, but they usually have only 70% uniformity. This means to recharge all areas of the field, 30% more water than calculated needs to be applied. In our example, operating time should be increased 20% for evaporation losses, plus 30% due to non-uniformity. So, increase the operating time of 4 hours by 50% to 6 hours to ensure that all areas receive 0.6 inches. With the importance of GAP inspections and certification this year, sprinkler systems are of increased concern. Because the irrigation water comes in contact with the fruit GAP certifiers require tests of the irrigation water. Irrigation water from open ponds or other surface water sources can easily be contaminated with bacteria and if water tests indicate that the bacteria levels are higher than the levels in the growers GAP plan then irrigation should be delayed until after harvest or the problem is remedied

Trickle Irrigation. Trickle irrigation systems can be run daily, or on the same schedule as sprinkler irrigation systems. The area wet by a trickle system is much smaller than the entire field wet by sprinkler systems.

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 can be run at one to two hours every day to replace plant water use.

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 demand of highbush blueberry is about 4.5 G/day (18 liters/day)

Insect update

Keith Mason & Rufus Isaacs
Department of Entomology
Michigan State University

We did not observe feeding by leafrollers at the farms we scout, and insecticides that are applied to control fruitworms and other pests should keep these pests in check through the remainder of the season. Leafrollers are generally not economically important in Michigan, and they are normally very well controlled by insecticide applications targeting fruitworms.

Cherry fruitworm (CFW) moth flight has greatly decreased, and only single moths were trapped at the Grand JUnction and West Olive farms. We expect the flight for cherry fruitworm to continue to end at southern Michigan farms in the next week. Growers and scouts should continue to check cherry fruitworm traps until the start of harvest. We observed cherry fruitworm eggs at all the farms we monitored last week (13 June), but CFW eggs were not observed this week at the farms we visited. Very little single berry damage (much less than 1% of berries with damage) was observed this week at all the farms we scouted. This damage is indicative of cherry fruitworm feeding or the early stages of cranberry fruitworm feeding (Fig. 1).

Fig 1. Early signs of feeding by fruitworms. Note the hole in the berry and premature coloring; *Photo: K. Mason.*

Cranberry fruitworm (CBFW) flight has diminished slightly at all the sites we visit, and moths were caught at all those sites. We are likely a week past the peak of CBFW flight in Van Buren County and just past the peak of the flight of this moth in Ottawa County. Cranberry fruitworm eggs were observed at the Grand Junction farm, but no multiple berry damage (the result of continued feeding by cranberry fruitworm) has been seen yet this season. The cranberry fruitworm model on enviroweather predicts egglaying for this pest will continue for at least another week at the farms we scout in Van Buren County and for at least 10 to 14 days at the Ottawa County farm we scout.

We have seen an increase in the number of blueberry aphids at the farms we scout. We observed single aphids and colonies with 5 to 20 individuals (Fig. 2). We are also seeing an increase in parasitized aphids and predators that eat aphids in the fields we scout. Growers and scouts should continue checking fields for aphids, and with the high levels of rain this spring there will be many vigorous young shoots for supporting aphid colonies.

To scout for aphids, examine two young shoots near the crown on each of 10 bushes and record the number of shoots where aphids are found. Also record the number of shoots with parasitized aphids. Be sure to sample weekly from as wide an area in the field as possible to have a better chance of detecting whether aphids are present. Although natural enemies (parasitic wasps, lady beetles, lacewings, hover fly larvae) can keep this pest in check, aphids can transmit blueberry shoestring virus, so growers may want to consider using an insecticide to control aphids if there are blueberry varieties that are susceptible to shoestring on the farm.

Growers and scouts should hang blueberry maggot traps in the next week to two weeks and these traps should be monitored until harvest. See the article in this edition of The Michigan Blueberry IPM Newsletter for additional information on monitoring and control of blueberry maggot.

Fig 2. Search for aphid colonies on the underside of leaves on young shoots; *Photo: K. Mason.*

As of June 20th, no spotted wing drosophila (SWD) flies have been trapped. Subsequent issues of this newsletter will contain more detailed information on monitoring and control of spotted wing Drosophila. For more information about this new invasive pest, please check out the MSU SWD page at www.ipm.msu.edu/SWD.htm.

Table 3. 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	6/13	2	86	20%	0	-	-
	6/20	0	109	10%	0	set	-
Grand Junction	6/13	2	35	45%	0	-	-
	6/20	1	27	60%	0	set	-
			OTTAWA COUNTY				
West Olive	6/13	3	8	40%	0	-	-
	6/20	1	8	55%	0	set	-

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

Monitoring and management strategies for blueberry maggot

Rufus Isaacs and John Wise
Department of Entomology
Michigan State University

This week has seen the first captures of blueberry maggot flies at a high pressure, abandoned field in Allegan County. This is an early-warning that fly activity will be increasing in the coming weeks, and highlights the need to have blueberry maggot traps placed in fields to identify the start of their flight.

The blueberry maggot goes through one generation per year, over-wintering as a pupa below the soil surface. Most pupae emerge one year after going into the soil, though depending on climatic conditions a small proportion will remain as pupae through another year or two before emerging. Adult emergence typically begins in mid to late June with adult flight continuing through August. Fly emergence is enhanced by moist soils, and the wet spring this year should allow flies to emerge easily from the soil. After emergence, female flies require approximately 7-10 days to become sexually mature and mate, at which point they will begin laying eggs. Eggs are oviposited under the skin of ripening blueberries, with a single egg deposited per fruit. Eggs hatch in about 5 days, at which point the maggot begins feeding, completing their development within a single berry. Upon maturity, the maggot drops to the ground, burrowing up to several inches into the soil before pupating. In Michigan's climate, these pupae will not emerge until at least the following growing season.

Monitoring adult blueberry maggot flight is the foundation of an effective protection program for blueberries against this pest. Initial adult emergence is best monitored using yellow sticky boards baited with ammonium acetate (or ammonium carbonate) as a food attractant, because newly emerged females are actively feeding during this pre-oviposition period. These traps should be placed on a stake or hung on an upper branch of a blueberry bush in a perimeter row (south facing side of bushes) with enough foliage cleared from around the trap so leaves don't stick to it. Hang traps with the colored side down in a V-orientation (see photo). Traps should be deployed before first anticipated flight (late June), since most flies are expected to be immigrating from wild or non-sprayed hosts outside the commercial planting. If a resident fly population is suspected from previous infestation, a trap placed inside the field is a good idea to detect internal infestations. Traps optimally should be checked twice weekly starting just before first fruit coloring until the first fly is caught, triggering fruit protection activities.

After the pre-oviposition period is complete, female flies will begin actively searching for fruit to lay eggs in, and there is a trap available that mimics the visual stimulus of a fruit. A green sphere trap, baited with synthetic fruit volatile lure can be used to monitor fly activity in fields. Again, these traps should be placed in perimeter rows of the field unless there is evidence of a resident population far in the interior. However, if the yellow sticky cards have been used effectively, these should have been sufficient to monitor the flies.

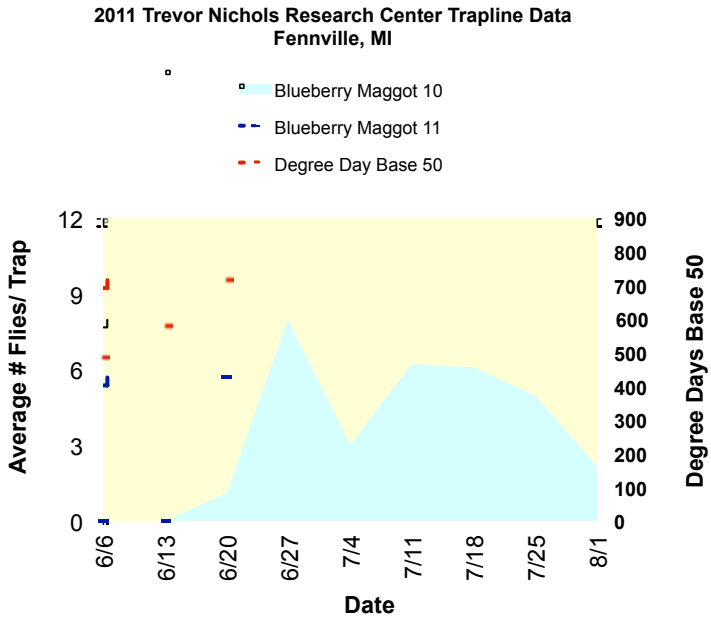
Control of blueberry maggot has been achieved for many years using broad spectrum insecticides. These kill the adult fly on contact and prevent the insect surviving to the point of being able to lay eggs into the fruit. The organophosphates Guthion, Malathion and Imidan are highly active on blueberry maggot, with the latter two products having shorter pre-harvest intervals and potential for use closer to harvest. Note that there is a 1.5 pound per acre limit on Guthion this season. Carbamates such as Sevin and Lannate and the pyrethroids Asana, Mustang Max, Bifenture and Danitol are also active on adult fruit flies. As a general rule, our trials in fruit crops against maggot flies have shown lower activity from the pyrethroid chemical class than from the organophosphates. This chemical class is sensitive to

Fig 3. Left to right: Monitoring trap with V-orientation for monitoring blueberry maggot, fly on trap with distinctive wing pattern, maggot on ripe blueberry; *Photos: R. Isaacs.*

Table 4. Properties and relative performance of insecticides labeled for control of blueberry maggot.				
Compound Trade Name	**Chemical Class**	**Optimal Spray Timing for BBM**	**Residual Activity**	**Effectiveness rating****
Guthion, Imidan	Organophosphates	Within 7 days of the first fly being captured	14+ days	E
Malathion	Organophosphates	Within 7 days of the first fly being captured	3-7 days	G
Lannate, Sevin	Carbamates	Within 7 days of the first fly being captured	3-5 days	G
Asana, Danitol, Brigade, Mustang Max,Bifenture	Pyrethroid	Within 7 days of the first fly being captured	7-10 days	G
Delegate SpinTor Entrust*, GF120 NF*	Spinosyns	Immediately after the first fly has been captured	7-10 days	E G F
Provado, Assail	Neonicotinoid	Within 7 days of the first fly being captured	10-14 days	G-E
Rimon	IGR	Immediately after first fly has been detected	10-14 days	G
Surround WP*	Particle Film Protectant	Multiple applications before fly emergence	As long as thorough coverage of the canopy is maintained	G
* OMRI approved for organic production; ** Effectiveness ratings E = excellent, G = good, F = fair				

degradation from light and heat, so this is something to consider depending on the weather conditions in June and July.

There are several newer insecticide products that include blueberry maggot on their labels. These include the neonicotinoids Provado and Assail that are also active on Japanese beetle and aphids. Small plot trials of these products have shown that they protect fruit from maggot infestation, and in large-scale trials over four years in Michigan blueberry farms we found no blueberry maggot infestation in fields treated with Provado during July and early August. The spinosyn-containing compounds Delegate and SpinTor (non-organic) and Entrust (organic) are highly active on blueberry maggot adults when ingested. Of these options, Delegate will provide the best fruit protection from blueberry maggot. In field trials with high pest pressure and two week application intervals their performance has been rated as good-excellent (see table 4). Performance would be expected to be higher in fields with lower pressure and with less time between applications. Rimon is a new insecticide registered for use in blueberries at 20-30 oz-acre. This is a new chemical class (insect growth regulator) registered for blueberry, and can provide an important component of a rotational program to minimize the chance of insecticide resistance. Because this insecticide is not toxic to adult flies, but it acts to disrupt egg and larval development, it should be applied at the start of fly activity, as determined by monitoring traps.



GF-120 NF Fruit Fly Bait (spinosad) is registered for control of the blueberry maggot and is listed by the Organic Materials Review Institute (OMRI) for use in organic production. Because the primary route of entry into the insect is through ingestion, applying this product during the fruit fly pre-oviposition period is important for optimal performance. GF120 must be applied with specialized equipment, and is designed for low-volume application by air. Field efficacy data is encouraging, but we have limited experience with this novel formulation in large-scale trials in Michigan.

The use of SURROUND WP for fruit fly control is based on creating a protective barrier between the plant and the pest that 1) reduces host recognition of the pest, and 2) prevents adult oviposition (i.e.; egg laying). Because it is not toxic to adult flies like conventional insecticides, complete coverage of the plant is critical. Multiple applications are typically needed to attain initial coverage; further sprays may be necessary to respond to wash-off from rain or excessive wind. Field trials indicate that when adequate coverage is maintained that excellent fruit protection can be achieved, although the white residue makes this not suitable for fruit destined for the fresh market.

North Central IPM Center sponsors publication of Regional Pest Alerts on Blueberry

Annemiek Schilder
Department of Plant Pathology
Michigan State University

The North Central IPM Center has sponsored the publication of two new Regional Pest Alerts entitled "Blueberry Scorch Virus" and "Blueberry Shock Virus". These fact sheets are meant to alert blueberry growers, nursery owners, consultants and extension personnel in the North Central Region to the symptoms, biology and management of two exotic plant viruses which were discovered in a few Michigan blueberry fields in 2009. These viruses are not widespread in Michigan, and we believe that blueberry shock virus has been successfully eradicated, whereas blueberry scorch virus is limited to a few locations identified in a large-scale survey conducted by the MDA in 2010.

These viruses do not pose a health risk to people but can damage blueberry bushes and reduce fruit yield and plant longevity. Their symptoms (flower and shoot necrosis) look very much alike despite the fact that these viruses are very different from each other. Plants tend to recover from blueberry shock virus, while blueberry scorch virus can kill blueberry bushes of sensitive cultivars, i.e. those showing necrosis symptoms. However, many cultivars show no or only mild symptoms in response to blueberry scorch virus infection and may not experience noticeable yield loss. Also, symptoms may be confused with those of fungal or bacterial diseases or herbicide injury. The most distinguishing characteristic of blueberry scorch or shock virus infection is the presence of scattered diseased bushes amidst perfectly healthy bushes. It is important to be vigilant because of the potential damage these viruses can cause to sensitive blueberry cultivars. If a grower suspects that either of these viruses is present on their farm, they can contact their local extension agent or Annemiek Schilder, Department of Plant Pathology at Michigan State University (517-355-0483/7539; email: schilder@msu.edu) for help with disease diagnosis.

Link to Scorch Pest Alert

Link to Shock Pest Alert

Keep an eye on anthracnose infection risk model

Annemiek Schilder
Department of Plant Pathology
Michigan State University

Due to considerable variability in rainfall amounts, different areas of Michigan may have experienced rather different anthracnose fruit rot risk ratings over the past few weeks. During dry periods, infection risk was often none or low. The only wetness that could have contributed to infection risk would have been dew formation at night or overhead irrigation. As we have reported before, the anthracnose fruit rot model is available on the Enviro-weather website and uses data from automated weather stations to calculate anthracnose fruit rot risk. The model is applicable from bloom until harvest assuming that inoculum of *Colletotrichum acutatum*, the fungus that causes anthracnose fruit rot, is present. If you have a susceptible cultivar and have had anthracnose fruit rot in the past, this is a reasonable assumption, particularly in the period from bloom until pea-size berry and during fruit ripening. The risk of infection is based on duration of fruit wetness (from dew or rain) and the average temperature during the wetting period, both of which are needed for spore germination and penetration of the fruit surface. The closer to the optimum temperature (77°F) and the longer the fruit stays wet (from rain, dew or irrigation), the greater the risk of infection. The risk is indicated as "none", "low", "moderate" or "high". Anthracnose fruit rot symptoms are not visible until the fruit ripens.

You can look online to find out what the model indicates for the weather station closest to your farm. To access the model, go to:

1) Enviroweather website,
2) Then pick the weather station of your choice by clicking on the dot on the Michigan map,
3) Then go to "Fruit" (top green bar),
4) Then under "Blueberry" on the left, select "Anthracnose fruit rot".
5) You can change the weather station in the upper left corner and run the model for that weather station by pressing the "Execute" button.

The recommendation is to use "moderate" or "high" risk as a trigger for action if the bushes are not already protected by an effective fungicide. If green fruit was unprotected during an infection period, systemic fungicides such as Pristine, Abound, Cabrio or Switch can be applied within 24 to 48 hours (at most 5 days) after the model has called an infection period to still get curative activity. In the case of ripe fruit, preventive application of fungicides is recommended in advance of major rain events since the fungus grows too rapidly in ripe fruit to have much post-infection efficacy. Once a fungicide has been applied, the plants are protected for the next 10-14 days (depending on the length of the residual activity of the fungicide) and the model does not need to be consulted until the next spray may be due. If more than 1 to 2 inches of rain has fallen since the last application and infection risk is high, you may want to shorten the interval or reapply protectant fungicides. If there is no infection risk, e.g., during a dry period, the model can be used to stretch spray intervals. But keep in mind that if you apply overhead irrigation, this may trigger an infection period which will not be documented by Enviro-weather. In that case, try to keep the time that the plants are wet to less than 6 hours if possible.

Fungicide properties and weather conditions

Annemiek Schilder
Department of Plant Pathology
Michigan State University

Fungicides can be divided into two groups: **protectant** and **systemic** fungicides. Protectant fungicides are contact materials that remain on the outside of the plant surface and kill fungal spores and hyphae upon contact, thereby preventing infection from occurring. Systemic fungicides are absorbed by the plant cuticle and underlying tissues and can act by killing spores and hyphae as well as incipient infections where the fungus has penetrated the plant surface. When they stop infections and prevent symptoms from developing they are called "curative". However, symptoms that are already present will not be "cured" by the fungicide in question. After symptoms appear, some fungicides reduce or inhibit fungal sporulation: these are called "anti-sporulants". The term "eradicant" is often used for products like lime sulfur which kill overwintering fungal structures in woody plant tissues when applied as a dormant spray. However, eradicants seldom eliminate all overwintering inoculum. Occasionally people use the term "eradicant" for fungicides that seem to control the disease so effectively that it seems to have been eliminated from the field. The term "translaminar" refers to the movement of a fungicide from one side of the leaf to the other, providing disease control on both sides of the leaf. Some fungicides have "vapor action", which means they are present in the gaseous phase close to the plant surface.

Systemic fungicides are systemic to different degrees, with some fungicides being locally systemic (they move only a short distance away from the spray droplet, e.g., Elevate), others being more mobile in the plant (systemic) and able to move to the tip of the leaf or shoot (Orbit, Abound), and yet others being highly systemic and able to move throughout the plant including the roots (e.g., ProPhyt, Aliette). Most systemic fungicides are highly effective against their target pathogens regardless if they are locally systemic or systemic. However, products that are highly systemic tend to have longer post-infection activity because they penetrate deeper into the plant tissues and are able to catch more advanced infections. In the latter case, the higher the rate used, the better the post-infection activity.

Both protectant and systemic fungicides are effective when applied before infection occurs, but only systemic fungicides have efficacy after the fungus has penetrated the plant (for a limited time, e.g., 24 to 72 hours, depending on the fungicide, disease, and rate used). Since systemic fungicides are absorbed by plant tissues and get redistributed in the plant, they tend to be less susceptible to wash-off by rain compared to protectant fungicides which remain on the outside of the plant. A general rule of thumb that is used sometimes is that 1 inch of rain removes about 50% of the protectant fungicide residues. However, newer "sticky" formulations (e.g., Bravo WeatherStik) and fungicides applied with spreader-stickers may be more resistant to wash-off by rain. Also, fungicides and formulations differ a lot in their ability to adhere to plant surfaces. Therefore research is needed to describe the effect of rainfall on wash-off on specific products.

In addition, protectant fungicide residues naturally decrease over time due to weathering, such as degradation by sunlight (UV radiation), heat or microbial activity, and redistribution over the plant surface by rainfall, dew, or irrigation water. Rapidly growing tissues will also add to the fungicide dilution effect. In contrast, the concentration of systemic fungicides is reduced mainly due to redistribution and dilution in (growing) plant tissues as well as possible breakdown by the plant itself. A high pH of water used in the spray tank can result in alkaline hydrolysis (breakdown) of some fungicides, notably Captan. In this case, the fungicide could be degraded even before application. Most protectant fungicides are good for about 7-14 days of protection, and systemic fungicides for 7-21 days depending on the product, the rate applied, weather conditions, and disease pressure.

Recent research at MSU with fungicides against **Phomopsis in grapes** (Fig. 5) shows that **1-day-old** residues of fungicides are removed from the plant surface by rainfall at different rates: for instance for Ziram, 0.1 inch of rain removed 25% of the residues, 0.5 inch of rain 30% of the residues, 1 inch of rain 65% of the residues, and 2 inches of rain 75% of the fungicide residues. However, fungicide activity remained pretty good despite low residues remaining even after 2 inches of rain. In comparison, Captec tended to stick better, with a 50% reduction after 2 inches of rain. Efficacy was reduced slightly but was still very good with whatever residue remained. Surprisingly, even residues of Abound, which is a systemic material and considered rainfast, were reduced by rainfall, which suggests that a certain proportion of the fungicides remains on the outside of the plant, probably in or on the cuticle. However, disease control efficacy of the remaining Abound was barely reduced. Efficacy may be reduced more with older (e.g., 1-week-old) fungicide residues where less active ingredient remains. We will investigate that this year.

The question sometimes comes up if it is better to apply a protectant fungicide before or after rain, since it can wash off during the rain event. As you can see from the grape study, fungicide efficacy was still decent even after 2 inches of rain in grapes. However, this only applies to new fungicide residues. Older residues may not be as robust. The other problem is that if extended wet conditions or wind prevent fungicide application soon after the rainfall event, it may be too late to obtain disease

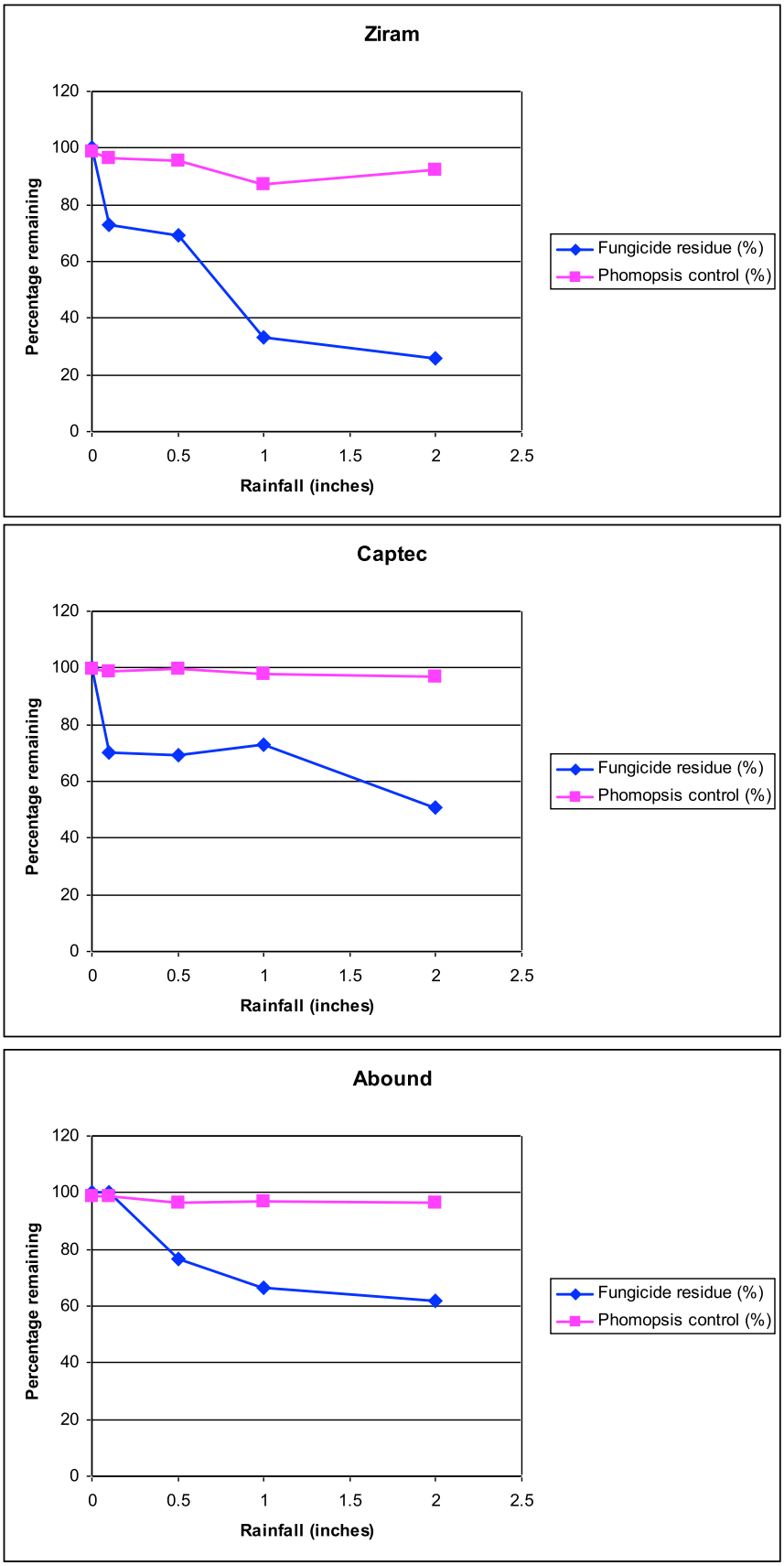


Fig 5. Results of fungicide rainfastness study in grapes with the fungus *Phomopsis viticola*. Fungicide residues were 1 day old when simulated rainfall was applied.

control, since infection may already have occurred. I would suggest that a fungicide should be re-applied if more than 2 inches or rain fell or after 1 inch of rain if the residue is 7 days old or older. A little bit of rain is not all bad, as it can help to distribute the fungicide residue over the plant surface. Be sure that the fungicide has dried well before rain occurs, otherwise it will be lost immediately. It is probably a good idea to apply fungicides at least 24 hours before rain is predicted to start. Most systemic fungicides are rainfast after a few hours, but a longer period (up to 24 hours) may be needed for some fungicides to get absorbed fully by the leaf or fruit surface.

During rainy periods, it is better to rely on systemic than protectant fungicides, since systemic fungicides are less sensitive to wash-off by rain. Applying a mixture of systemic and protectant fungicides may be the best compromise. In addition, spreader-stickers can enhance adherence of protectant fungicides, while penetrants may speed up penetration of systemic fungicides. Read the fungicide label to determine if adjuvants are recommended and if so, which types. Technological advances ensure that many newer fungicides and fungicide formulations have excellent adhesion or absorption properties.

Protectant and systemic fungicides labeled for blueberries:

Protectant/Contact fungicides: Actinovate, Armicarb, Bravo, Captan, Copper, JMS Stylet Oil, Kaligreen, Lime sulfur/Sulforix, MilStop, Omega, Oxidate, Prev-Am, Serenade, Sonata, Sporan, Sulforix, Sulfur, and Ziram.

Systemic fungicides: Abound, Aliette, Cabrio, Elevate, Indar, Orbit, Phostrol, Pristine, ProPhyt, PropiMax, Quilt Xcel, Regalia*, Ridomil Gold, and Switch.

Protectant/Systemic mix fungicides: CaptEvate.

2011 Grower Events

MICHIGAN STATE UNIVERSITY | Extension

Blueberry Weed Control Demonstration June 28, 2011-7:00 p.m.

Please join us for a discussion and tour of weed management options.

We will meet at **7:00 p.m. on Tuesday, June 28, 2011** at the Bocock's New Day Blueberry Farm, at 6906 103rd Avenue,

located between 69th and 70th Street

(just a little north of South Haven)

You will see some very interesting contrasts between various herbicide combinations applied in either the fall or the spring. We will also be observing the efficiency of newer products (Callisto, Chateau, Sandea) on a variety of weeds.

There is no charge for this meeting and you need not to register. If you have any questions however, please contact Eric Hanson, MSU Extension, (517) 355-5191 x 1386 or email hansone@msu.edu.

This meeting is open to everyone who wants to improve their weed management strategies!

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