BATTLING BUGS IN BLUEBERRIES

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Blueberry production requires attention to insect management through the growing season to ensure that your investments in land, labor, equipment etc. are turned into revenue from blueberry sales. Depending on your farm's level of pest pressure and the market(s) you are aiming for, insect management may be more or less important to you. But whatever the situation, ignoring insect management is risky because of the zero or low thresholds for contamination by adult or larval insects. People generally don't like finding insects or parts of insects in their food, so your investment in active management of insects The key is to develop a plan *before* the growing season, and to then use regular monitoring and scouting to determine when pests are active and at what density.

This presentation will review the key insect pests that can affect highbush blueberry fields in Michigan, when these pests become active, and how to control them. Cultural and biological approaches are described along with the current recommendations for chemical control options.

Key resources for growers that are interested in learning more about the pest insects, natural enemies, and pollinators that are found in blueberry fields should consult the resources listed below.

1. MSU Blueberry Website: www.blueberries.msu.edu
2. Michigan Fruit Pest Management Guide (E-154). For sale at EXPO.
3. Midwest Blueberry Production Guide. Online only: https://tinyurl.com/y9m8l4lz
4. Minimizing Risk to Bees in Fruit Crops: https://tinyurl.com/y8u2glo2
5. Pocket Guide to Blueberry IPM issues. For sale at EXPO.

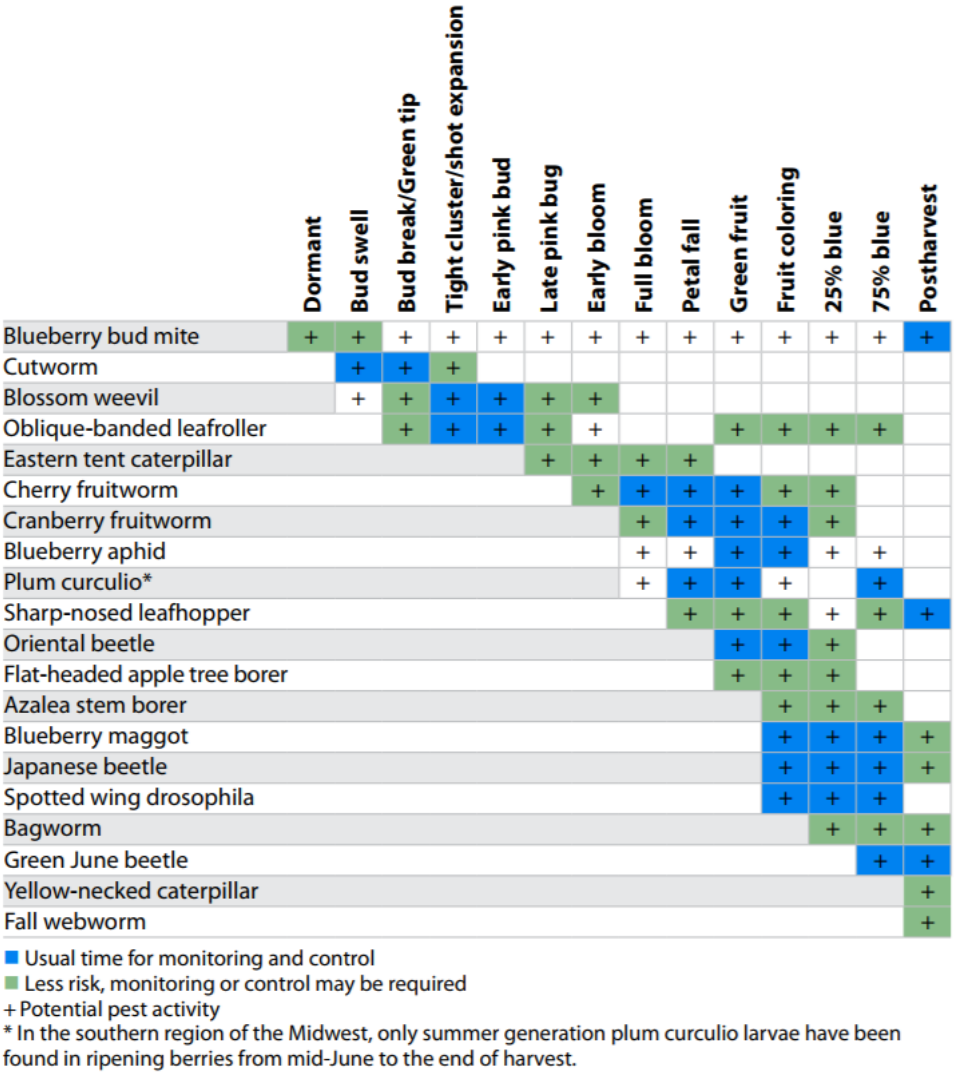
Dormant

Pruning bushes in the winter to remove old canes has multiple benefits including higher light penetration for setting fruit buds, lower canopy humidity making it less suitable for spotted wing Drosophila, increased pesticide coverage, and physical removal of some cane-feeding pests. While this is a costly part of production, from a pest management perspective pruning is one input that can make fields less susceptible to pest problems and make summer management less challenging.

Delayed dormant

As the bushes start to grow due to warmer daytime temperatures through March and April, insects also start to become active. This includes **scale insects** such as Putnam and Lecanium scale as well as the azalea bark scale which has been detected in some farms over the past few summers. Removing old canes in your plant canopy is a simple approach for reducing the risk of scale infestation, so this should be done during the winter or early spring. But if you have a field with a history of scale problems, consider a delayed-dormant

oil application. Because the bushes are not yet leafed out and most natural enemies are not yet active, this is an ideal time to control these overwintering insects by using smothering them. Use a horticultural oil applied before there is new green tissue visible on the bushes, applied in a water volume that will cover the plants.



	Dormant	Bud swell	Bud break/Green tip	Tight cluster/shot expansion	Early pink bud	Late pink bug	Early bloom	Full bloom	Petal fall	Green fruit	Fruit coloring	25% blue	75% blue	Postharvest
Blueberry bud mite	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cutworm		+	+	+										
Blossom weevil		+	+	+	+	+	+							
Oblique-banded leafroller			+	+	+	+	+			+	+	+	+	
Eastern tent caterpillar						+	+	+	+					
Cherry fruitworm							+	+	+	+	+	+		
Cranberry fruitworm								+	+	+	+	+		
Blueberry aphid								+	+	+	+	+	+	
Plum curculio*								+	+	+	+		+	
Sharp-nosed leafhopper									+	+	+	+	+	+
Oriental beetle										+	+	+		
Flat-headed apple tree borer										+	+	+		
Azalea stem borer											+	+	+	
Blueberry maggot											+	+	+	+
Japanese beetle											+	+	+	+
Spotted wing drosophila											+	+	+	
Bagworm												+	+	+
Green June beetle													+	+
Yellow-necked caterpillar														+
Fall webworm														+

■ Usual time for monitoring and control
■ Less risk, monitoring or control may be required
+ Potential pest activity
* In the southern region of the Midwest, only summer generation plum curculio larvae have been found in ripening berries from mid-June to the end of harvest.

Bud swell/bud break
As the new buds become visible in April and start swelling, **cutworm** larvae can become active and feed on the developing tissues. These insects are nocturnal, can move in relatively cold conditions, and will focus their feeding on the fruit buds. Scouting fields during this period of the season should focus on the emerging buds, especially in regions where fruit buds have been damaged in previous seasons. A small level of infestation by this pest (or by spanworms that are also active this early) can usually be tolerated, and they tend to damage fields in specific areas or along specific edges. However, if more than 2% of buds are being damaged an insecticide application in that area is warranted. Contact insecticides and those that are active when ingested work well against cutworms.

Leafrollers and other caterpillars may also become active at this time of year. These generally have a broad host range and can become abundant in adjacent woods, moving into blueberry fields. For this reason we recommend scouting wooded borders more intensively in the spring to check for these pests. Often this damage is incidental and can be tolerated, but if there are high infestations the use of a growth regulator insecticide such as Intrepid can disrupt development of these insects if the infestation is detected early, plus it is selective enough to allow natural biological control to work. Typically, an effective control

program for fruitworms around bloomtime will prevent fields having caterpillar pest infestation at other times of the season.

Bloom

In the weeks in early May before bloom, pheromone monitoring traps for **fruitworms** should be deployed in fields, ideally adjacent to wooded borders and in fields where fruitworm damage has been of concern in previous years. Cherry fruitworm (larvae infest one berry) is generally active a week or two earlier than cranberry fruitworm (larvae infest multiple berries). The pheromone-baited traps are checked weekly to determine the timing of first consistent catch (one or more moths in two consecutive trap checks) of these pests. That sets the biofix date, and in fields with a history of fruitworm problems, protecting the young berries should start at 100 growing degree days later. Check the MSU fruitworm models to determine when egghatch is expected based on the current and predicted temperatures. This can be used to improve timing of insecticides to protect fruit from infestation by fruitworms, using a biological insecticide such as B.t. (DiPel, Javelin etc.), or a growth regulator such as Intrepid. These are registered for use during bloom due to their lower risk to bees. Still, applications made when bees are not foraging can help reduce their exposure to pesticides. Release of parasitic wasps that attach fruitworm eggs is a biological approach that has been used by organic growers, and is compatible with spraying of B.t.

The **blueberry stem gall wasp** is a native pest that is usually not abundant but it has reached greater economic significance recently in some regions of Michigan. The wasps emerging during early bloom, peaking during Jersey full boom, and tailing off over the next few weeks. Throughout this time, the wasps lays eggs into the stems and cause them to swell into galls that limit growth and can also contaminate harvested fruit. This is most problematic in fields of Jersey, with some infestation (but at a lower level) also found in Liberty, Aurora, Bluejay, Pemberton, Duke, and Northland. Planting resistant or highly resistant cultivars (Bluecrop, Elliott), and maintaining an active pruning regime is the best defense against this pest becoming established. In infested fields, broad-spectrum insecticides (pyrethroids and Lannate have shown effectiveness) applied with high water volume immediately after the honeybees are removed from the field have consistently demonstrated a reduction in the number and size of galls. MSU tests of other more selective insecticides that can be used during bloom have not found these to be effective in commercial scale fields.

Current research at MSU is also exploring the biological control agents that suppress this pest, and the genetic basis of the resistance in some cultivars. This shows promise for long term prevention of gall wasp susceptibility in new cultivars.

Post-bloom

This timing in early-late June is the most critical timing for control of fruitworms, aphids, tussock moth, gypsy moth, and gall wasp. Scouting fields during bloom to look for these pests can help growers decide whether some form of control intervention will be needed after bloom. Most growers are concerned with protection against **cranberry fruitworm** at this timing, and it is generally well controlled by one post-bloom application such as a broad-

spectrum contact insecticide, the insect growth regulator Intrepid, or the new biological insecticide Grandevo. In fields with high risk from cranberry fruitworm, i.e. those with a history of fruit infestation and recent evidence of moth flight continuing with warm evening conditions when they mate and lay eggs, a second application 7-10 days after bloom can also help maintain low infestation.

With the honey bee colonies removed from the fields, a wider range of insecticides are available to growers. Still, many other wild bee species are still active after bloom and growers may also have purchased bumble bee colonies, so use IPM techniques to determine whether insecticides are needed and be aware of which pesticides are most damaging to bees. This can be informed by reading this fee downloadable publication: Minimizing Risk to Bees in Fruit Crops: https://tinyurl.com/y8u2glo2. Another way to help reduce risk to bees (and save money!) is to only treat those blocks that require protection. At the post-bloom timing, this would include fields that fit one or more of these criteria:

1) Variety is susceptible to blueberry shoestring virus, and symptoms of the virus and blueberry aphids have been detected. Neonicotinoids such as Admire Pro or ***, would be most effective for aphid control.
2) Field or section of a field has a history of fruitworm infestation and the traps indicate that moth flight started more than 100 growing degree days ago.
3) Has active tussock moth or gypsy moth larval feeding.
4) Has gall wasp activity that caused gall formation (susceptible variety) last year.

Aphids can also be maintained at low levels by avoiding over-fertilizing and encouraging beneficial insects such as ladybeetles, lacewings, etc. Limit insecticide use and use selective pesticide options in this early part of the season to help maintain beneficial these insect populations too.

Consult publication E-154 for the insecticide control options available for post-bloom control of fruitworms and other pests. There are many registered insecticides with activity on the complex of pests active after bloom.

Pre-harvest

With the wide range of cultivars grown in Michigan, there is a short period between last petal fall in late blooming cultivars and first ripening in the early cultivars. Because of this, once fruitworm control is complete growers will typically need to turn their attention to protecting ripening fruit. In Michigan the primary direct pests of fruit are spotted wing Drosophila (SWD), blueberry maggot, and Japanese beetle.

Blueberry fruit and foliage are fed on by **Japanese beetles**, and their presence can also cause a risk of contamination. However, there has been very little concern about Japanese beetle in Michigan blueberry farms in recent years, as the main advancing front of their invasion of the United States has passed beyond our state. Additionally, growers have learned how to make fields less suitable through clean cultivation while at the same time the natural enemy community has found this insect, and bushes have been increasingly protected against SWD.

The **blueberry maggot** remains a threat to fruit quality, and this native insect is still present across the main regions of blueberry production in the eastern US. With all the attention recently on SWD, it is tempting to ignore this pest but its larvae can render a load of blueberries unmarketable to some buyers. There is a degree day model for this pest at www.enviroweather.msu.edu, and it generally predicts first emergence of the adult flies around the last week of June in SW Michigan, with emergence continuing through July and into early August. Yellow traps baited with an ammonium odor can be used to monitor the start of its emergence, and after the first fly is trapped there is typically 7-10 days until egglaying begins. Each female fly can lay about 100 eggs, and since they use a pheromone to avoid laying eggs in fruit already infested this can result in 100 infested berries. Within 7 days of detecting the first activity of blueberry maggot, protection of the berries should be initiated. This could be done on a small scale using exclusion netting, but larger commercial farms generally use broadcast insecticides to protect the fruit during the ripening period when the flies remain active. Generally, sprays every 10-14 days are sufficient to keep this pest under control, and there is a wide range of options available, from those that are broadly toxic to those with more targeted activity and organic certification. Consult publication E-154 for the recommended options.

Blueberry IPM programs have been turned upside down by the arrival of **spotted wing Drosophila** in this region in 2010. The flies become active before blueberry ripening starts and in SW Michigan they have a low period of activity through July with a spike in activity going into August. This has meant that Bluecrop fields generally had lower SWD pressure with much greater need for protection in Jersey and later varieties. However, activity of this pest in 2017 was much greater than in 2016, with the earliest ever first fly captures and over three times as many flies captured. This resulted in much higher than usual SWD activity during Bluecrop season and it highlights the need for monitoring to understand the activity of this pest from year to year. As we describe below, fruit sampling is also very important, to determine if your control program is still working.

Monitoring is usually done with a simple trap baited with an attractive lure (Scentry Inc. supplies the main commercial lure) with a drowning solution to catch the adult flies. A yeast-sugar mix can work well for this too. The males have a spot on each wing but the females do not, making identification quite difficult. It is very likely that SWD are active when the earliest varieties are ripening, and so as these fruit begin to color, growers should be implementing their fruit protection to prevent SWD infestation.

This pest is a menace because it has high reproductive capacity, develops quickly, and is able to infest a wide range of alternative host plants. Because of this, a tight spray program is needed to prevent the larvae from infesting the fruit. Seven day intervals are recommended through the harvest season to keep adult flies at low levels and also to prevent eggs and small larvae from becoming large larvae that are detectable. There are many conventional insecticide options registered for use against this pest and a few organic options too. You can find our recommendations in the MSUE-154 publication. We will also publish an updated SWD management guide for 2018 at the SWD website:

http://www.ipm.msu.edu/swd.htm SWD is challenging to control, and so it is recommended that growers use only products ranked as excellent for controlling this pest, with reapplication after rain to maintain protection, and with a high enough volume of water to get full coverage inside the plant canopy.

The importance of water volume for controlling SWD is illustrated by some recent research results. Blueberry plants treated with 60 vs 30 gallons of water using an airblast sprayer (with the same amount of active ingredient per acre) had much higher insecticide residues on the fruit. Any such approaches that improve the coverage and spread of residues on the fruit should translate to better control of this pest.

Another important consideration for getting better control is to make the blueberry bush canopy less hospitable for SWD. This insect needs high humidity conditions for survival, so pruning can increase sunlight penetration, improve airflow, and reduce the relative humidity in the bush making it less suitable for SWD. Additionally, using black weed fabric is one way to raise the temperature in the canopy and this also provides a barrier to when the larvae are searching for a place to pupate.

Biological control levels on SWD have been monitored through the last few years in Michigan, and in general we find low levels of native wasp parasite activity. This is one explanation for the rapid population growth of SWD during the growing season. This season we have also examined feeding on SWD pupae that have been placed under bushes. These have been fed upon by ground-dwelling insects such as ants so there is some influence of biological control on SWD, but not enough. To build this natural control, a petition has been filed with USDA-APHIS for release of parasitic wasps that attack SWD in its home range. That will require more time and review before approval, but we are hopeful that these non-native parasitic wasps from the home range of SWD can be released to reduce the overall pest pressure from this insect.

In 2017, a relatively new farm with modern varieties and advanced horticultural methods was found to have some bushes where all or part of the bush was dying. Looking at the root system of these plants, it was common to find white grubs and the majority of these were identified as **northern masked chafer.** This is a pest to keep an eye on, and a reminder to look underground for pests as well as on the canopy. The damage was evident in July and August, yet the optimal treatment timing for grub control is in June. Fields where these grubs are found in one year should be marked for treatment the year after, and carefully monitored because some of these grub species have two year life cycles.

Finally, for the 2018 season there will be a few new insecticides available for use by blueberry growers. These include Movento (spiroteramat) from Bayer Crop Science and Cormoron (novaluron + acetamiprid) from Adama USA that are both reflected in the 2018 edition of the E-154 Fruit Pest Management Guide. As additional information on new registrations become available, those will be transmitted through the MSU Extension service.

For more on MSU's blueberry team and our activities – www.blueberries.msu.edu