2011 ORGANIC BLUEBERRY INSECT MANAGEMENT PROGRAM INCORPORATING SWD CONTROL
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The detection of spotted wing Drosophila (SWD) in Michigan last year highlights the changing nature of pest management and the need to remain aware and prepared for new challenges. We have developed this short document to assist certified organic blueberry growers and those with interest in organic approaches as they consider how to adapt their IPM program for the arrival of SWD. At the end of the document we provide an overview of potential organic pesticides that may be considered if trapping and monitoring information warrants this approach.

There are a handful of insect pests to scout for with potential to cause direct damage and/or infestation of blueberries in the Great Lakes region. These are cranberry fruitworm, blueberry maggot, Japanese beetle, and spotted wing Drosophila. There may be other insects that pop up during the season, but these four pests should be the focus of your organic IPM planning since they are direct pests of the fruit. Secondary pests of blueberries include aphids, gall midges, scales, mealybugs, mites, and leaf rollers. These pests are often kept at levels below any economic impact by natural biological control in organic plantings. For more information on the range of insects that may affect blueberries in Michigan, see www.blueberries.msu.edu.

A note on insecticide use in organic blueberries: The Organic Materials Review Institute (OMRI) is a non-profit organization that evaluates potential inputs —including insecticides— to determine if they meet USDA National Organic Program (NOP) standards. An OMRI stamp or seal on a product label is a good sign that the product is allowable, **but your organic certifier has the final say on any and all inputs you apply to your blueberries**. Also, in some cases, products may be certified and allowed by your certifier but may not carry the OMRI seal. **It is always recommended that you check with your certifier BEFORE applying a new product.** Some certifiers maintain a printed or online list of common approved inputs —OMRI certified and otherwise.

CRANBERRY FRUITWORM

Adult Cranberry Fruitworm (CBFW) are grayish brown and 5 to 6 mm in length. Cranberry fruitworm adults are about 11 mm in length, with grayish brown forewings that each have two distinctive whitish triangles (Figures 1-2). Adult moths emerge during bloom, and monitoring traps can indicate timing and abundance of male adults. Females begin to lay white, oval eggs in the calyx of berries soon after petal fall, and eggs turn yellow as they develop. Upon reaching maturity, larvae leave the berries and move to over-wintering sites. Cranberry fruit worm larvae crawl to the base of the blueberry bush and form a hibernaculum in the soil. For more information on the Cranberry Fruitworm visit http://www.blueberries.msu.edu/crnbryfrtwrm.htm.

Monitoring. Deploy cranberry fruitworm monitoring traps at wooded borders prior to bloom. Check weekly for the presence of cranberry fruitworm moths. They are grey-brown with two small white patches on each wing. Once they are trapped, egg-hatch will start at about 100 GDD base 50^{o}F from the first sustained catch of moths. Depending on the temperature, this can be as little as a week, or as long as two weeks. Egg hatch typically starts while blueberries are still in bloom.

Cultural/biological control. Cranberry fruitworm is attacked by parasitic wasps that target the eggs and larvae. Organic growers should expect to see higher abundance of these biocontrol agents, but they cannot be relied upon for high levels of fruit protection.

The cranberry fruitworm overwinters in the leaf litter under the bush and is also present on wild blueberry in the woods. Weedy fields and those with wild blueberry are likely to have higher pest pressure.

Chemical control. At predicted start of egg hatch, expected ~100 degree days after the first moth catch, apply *Bacillus thuringiensis* (Dipel,® Javelin® etc.) to bushes to prevent the survival of the fruitworm larvae. Since cranberry fruiworm lay eggs only on young fruit, make sure there is some petal fall before any application. This insecticide must be eaten by larvae to work, so it is essential that it is applied with good coverage to the bushes. Specifically, it needs to coat the young developing berries to be effective. Spray coverage can be improved by addition of a spreader sticker such as NuFilm P.

Bacillus thuringiensis is most effective when the temperature is warm so the larvae are active, but it also breaks down under ultraviolet light. It has a 3-4 day residual control and should be reapplied if the risk of fruitworms continues. Expect to apply 2-4 applications of B.t. to cover the complete period of fruitworm egglaying in high-pressure fields. This insecticide is not active on eggs or on moths. If fresh egglaying is detected (look in the calyx cups of the berries) or moth activity continues, reapplication will be needed to prevent infestation.

BLUEBERRY MAGGOT

Adult flies are dark and approximately ¼" in length. The most characteristic feature is the dark pattern on their wings, which can be used to distinguish it from other fruit flies. Flies also have a white spot on the back of the thorax and three (male) or four (female) white bands across the top of the abdomen. Eggs are 1 mm long, oval and white, and are laid singly in fruit. Maggots hatch in about 5 days and grow to about 7 mm long inside one berry. Infested berries soon become soft, and shrivelled. Mature larvae drop to the ground, where they burrow into the soil to pupate. Visit http://www.blueberries.msu.edu/bbmaggot.htm for more details and images of BBM.

Monitoring. Deploy baited yellow sticky boards at the field perimeter and at the interior of the field in early-mid June, after bloom. Blueberry Maggot (BBM) flies typically become active just as the fruit start turning from green to blue, and their emergence is enhanced by moist soil conditions. Check the traps weekly (preferably twice a week) for the presence of BBM. It is essential that the flies are identified correctly, as there are other flies that can be mistaken for BBM. Learn the distinctive wing pattern. Once BBM flies emerge from the soil, there are 7-10 days until the flies are reproductively mature and can lay eggs. So, if flies are detected an application of a fly control product will be needed soon after detection, especially if the traps are checked only weekly.

Traps are most efficient at trapping flies when they are placed in the upper 1/3 of the canopy, in a V-position, with the sticky surface pointing downwards. Doing this effectively may require use of a metal pole. The traps can be purchased pre-baited with the attractant in the glue, and these remain attractive for about two weeks. After that, a charger should be added to the trap, containing the powder that releases the odor. Refill these as needed to retain the odor until after harvest.

Cultural/biological control. Blueberry maggots are attacked by a species of parasitic wasps that targets the maggot in the berry. Organic growers should expect to see higher abundance of this biocontrol agent, but they cannot be relied upon for high levels of fruit protection. Predatory ground beetles, ants, and other insects also consume the overwintering pupae and may provide some level of suppression.

Blueberry maggot overwinters in the soil under the bush and is also present on wild blueberry in surrounding woody habitat. Achieving good weed control and removing wild hosts from the woods surrounding fields should help to reduce the level of pest pressure.

Chemical control. Protection against blueberry maggot can be achieved in organic blueberry production using Entrust® insecticide. This should be applied soon after the first BBM fly is detected, with repeat applications if flies

continue to be detected. The residual activity of Entrust® is relatively short, so reapplication on a 7-10 day interval is recommended if flies continue to be detected. This product is washed off the plant relatively easily, so keep this in mind if fields experience summer rain showers or if the bushes are irrigated using overhead sprinklers.

Other organic options for control of blueberry maggot include Pyganic® and the many neem-containing insecticides. Because these contain a certain amount of neem oil, there is a risk of spotting on the ripe fruit because they can smother the waxy blueberry bloom. This effect is temporary and the waxy bloom will return in a few days, but may be of concern for growers aiming for the fresh market needing BBM control close to harvest.

JAPANESE BEETLE

This insect is challenging to control using organic methods, and requires an integrated approach of multiple tactics to both reduce the population at your farm and also remove beetles from the bushes if they are detected. Adult beetles are about 1/2" long with a metallic green thorax and shiny, brown wing coverings. Rows of white tufts are distinctive on the undersides of the abdomen. Male and female beetles congregate on the tops of plants in sunlight, where they feed and mate. Adult beetle emergence begins in early June in North Carolina and early July in Michigan. Visit http://www.blueberries.msu.edu/japanesebeetle.htm for more details and images of BBM.

Monitoring. Japanese beetles are easy to see, so do not place Japanese beetle traps in your property. This only serves to draw the beetles to the region of the trap, where they congregate and then lay eggs in the vicinity, thus creating a larger population to control next year.

Scouting for beetles should be done in sunny, hot weather to give the best chance of detecting them on the upper canopy of bushes, where they feed and mate. If the beetles aren't visible, skeletonized leaves are a telltale sign of their presence. Early detection can help prevent their feeding and subsequent attraction of other beetles to your blueberry field. Beetle abundance on bushes tends to be highest on field edges, especially those that are adjacent to grassy areas. These are the best place to start looking for beetles, though it is also worth looking inside the field to see whether the beetles are only at the perimeter. If so, a border spray may be sufficient to control them. Japanese beetles are highly attracted to Virginia creeper, raspberry, sassafrass, and other preferred host plants. Looking on these plants can also provide a focus point for your scouting. These plants can become magnets for Japanese beetles if not controlled (see below).

Cultural/biological control. Japanese beetles prefer to lay eggs in sites with moist soil in July, grassy areas, and suitable host plants. Efforts to reduce these conditions (within the requirements for good blueberry production) will help to reduce Japanese beetle pest problems.

Japanese beetles prefer to lay eggs into grassy soil, and so adoption of a system using clean cultivation or broad-leaved cover crops during July and August when the beetles are active will help to reduce their abundance. If grassy regions are needed for soil structure, erosion control, etc. these areas could be targeted with a biological control agent such as a beetle-active nematode. Milky spore is another organic grub control option, but the results of trials on this product have been highly variable and it tends to be less effective in our colder northern climates.

Removing attractive weeds is essential for good control of Japanese beetle. If your fields contain any of the attractive plants listed above, this will attract beetles that will then lay their eggs in the soil nearby. Maintain good weed control, especially of the climbing perennial weeds using manual removal or cultivation, to help your insect management program.

If only a few beetles are present, an effective but labor intensive approach is to manually remove them and drop them into soapy water. This will kill the beetles and stop them from doing any more feeding or egglaying.

Chemical control. There are a few options for organic chemical control of Japanese beetles, but these are likely to provide only temporary relief because they all have relatively short residual control (1-3 days). Pyganic® and the many neem-containing insecticides are active on Japanese beetle. These all have a short PHI, usually 0 or 1 days and short re-entry restrictions, so they can be used just before harvest to knock beetles off the bushes to allow mechanical harvest.

Because the neem products contain a certain amount of neem oil, there is a risk of spotting on the ripe fruit because they can smother the waxy blueberry bloom. This effect is temporary, but may be of concern for growers aiming for the fresh market needing Japanese beetle control close to harvest.

SPOTTED WING DROSOPHILA (for more information – www.ipm.msu.edu/SWD.htm)
Monitoring: These flies can be trapped using a simple monitoring trap consisting of a plastic 32oz cup with several 3/16"-3/8" holes around the upper side of the cup, leaving a 3-4 inch section without holes to facilitate pouring out of the liquid attractant, or bait. The holes can be drilled in sturdy containers or burned with a hot wire or soldering iron. The small holes allow access to vinegar flies, but keep out larger flies, moths, etc. Pour one inch of apple cider vinegar into the trap as bait. To help ensure that trapped flies do not escape, a small yellow sticky trap can be placed inside. The traps will also work without the yellow sticky insert, but then a drop of unscented dish soap should be added to the vinegar to ensure flies remain trapped in the liquid. Traps should be hung in the bush canopy in the fruit zone, in a shaded area, using a wire attached to the top of the trap. Make sure the trap is clear of vegetation with the holes exposed so that SWD can easily fly in. Check traps weekly for SWD flies, by looking on the yellow sticky trap and in the liquid. At each check, fresh vinegar should be changed and disposed of, away from the trap location. Spotted wing Drosophila captures should be recorded each week in a log book.

Cultural/biological control: Cultural controls may help reduce reproduction and survival of flies. These include scheduling timely harvests and removing over-ripe fruit from fields to minimize host plant resource for SWD to lay eggs into and for larvae to develop on. In small fields this may be done by hand, but that is impractical in large farms. A final cleanup picking to remove the last berries from the bushes may be worthwhile, but this approach has not yet been evaluated. Removing wild host plants that can harbor SWD such as wild grape, pokeberry, raspberry, blackberry, etc. near crop fields is another potential strategy, but again this has not been tested in our region. Recent research in Oregon has compared various ways to prevent survival of SWD in infested berries. Two methods that worked well for this were bagging fruit inside clear or black plastic bags, and solarizing in which 1-2 ml clear plastic sheeting is placed over the fruit in a sunny location and sealed well around the edge using soil. Simply burying infested fruit was not effective.

There is no information yet on biological controls that may suppress SWD populations in Michigan. We expect that natural enemies will move from the native species of Drosophila over to this new invasive species, and will be monitoring populations in the coming years.

Chemical control: The insecticidal control tools available to organic blueberry growers will require timely application to achieve control because female SWD can lay eggs within one day of emergence from the soil. However, experience in the west coast states indicates that SWD can be controlled in organic production through more intensive monitoring, timely application if flies are detected, and shorter intervals between sprays. Where possible to implement, cultural controls will also be important to help reduce the overall population level.

The experience so far in California and Oregon indicates that Entrust® and Pyganic® are the two most effective options for SWD control in organic production. Entrust® is limited to three applications in a 30 day period followed by 30 days without any Entrust® application, and there is a 9 oz/acre seasonal maximum. There is a 2ee Entrust® label for suppression of SWD, with a 2 oz/acre rate listed. Until there is more information available, we are recommending the 2 oz/acre rate of Entrust®. Rotate Entrust® with the organic pyrethrum insecticide Pyganic® to

achieve some resistance management. Pyganic® EC 5.0 is labeled at 4.5-18 oz/acre in blueberries, and using the higher end of this rate range has provided five days of residual control in recent University of California trials.

ORGANIC BLUEBERRY SPRAY PROGRAM FOR TESTING IN 2011 TO DETERMINE EFFICACY AGAINST KEY INSECT PESTS INCLUDING SPOTTED WING DROSOPHILA

Timing	Pest target	Monitoring	Insecticide
Bloom	**Fruitworms**	Moth captures in traps, with first spray 100 GDD after 1st sustained moth capture	Dipel® @ 1.5 lb/ac, once there is some petal fall Reapply 5 days later if needed
100% petal fall		This is a key fruitworm spray	Dipel® @ 1.5 lb/ac Reapply 5 days later if needed
From fruit coloring to harvest	**BBM and SWD**	Timing based on fly captures in monitoring traps at the farm, or in the local area	Entrust® @ 1.5-2 oz/acre + NuFilm P® 12 oz/acre in mature bushes, or 6 oz/acre in small bushes (5 days residual)
5 days after Entrust®, rotate to Pyganic®			Pyganic® at 8 oz/acre (4 days residual)
If ripe fruit are present and SWD are still being captured, repeat Entrust® three to four days after the Pyganic® and then Pyganic® five days after the Entrust® as needed*			
Pre-harvest	**Japanese beetle**	If beetle abundance is too high before harvest	Azadiractin formulations (e.g. Azadirect®, Neemix®, AgroNeem®)

[#] Miller Chemical's NuFilmP® is a spreader-sticker that will improve coverage and will also reduce the chance of wash-off. It is labeled for use at 4-16 oz/acre.

*The combined Entrust® and Pyganic® program is the best available option at this time for organic control of SWD. Depending on the rate of Entrust® used, this can provide 45 days of control, based on the 9 oz/acre/seasonal limit on Entrust®. Because this provides only 45 days protection it will be very important to wait for activity from SWD or BBM before starting the control program for these insects.

The program above is designed to save the highest rates of Entrust® for the pre-harvest period, while also maximizing the duration of protection that the program can provide. If no SWD have been trapped in the field or in the local area and a field is less than 45 days from the last harvest, then the rates for the early Entrust® applications could be raised to 2 oz/acre. These decisions will have to be made once we are further into the growing season.

MSU research this summer will provide information on the trade-off between efficacy and longevity of activity against SWD with different rates of Entrust® and Pyganic®. The insights we gain may allow for lower rates to extend the duration of coverage by this program.

Updates will be posted at www.ipm.msu.edu/SWD.htm