Blueberry I

Wednesday morning 9:00 am

Where: Grand Gallery (main level) Room A & B
MI Recertification credits: 2 (1C, COMM CORE, PRIV CORE)
OH Recertification credits: 2 (presentations as marked)
CCA Credits: PM(2.0)
Moderator: Doug De Leo, MSHS Board, Bangor, MI

9:00 am	Tactics for Controlling SWD, the Spotted Weapon of Destruction (OH: 2B, 0.5 hr) • Hannah Burrack, Entomology Department, North Carolina State Univ.
9:30 am	Effective Spray Application in Blueberries; How to Get the Most out of Your Sprayers (OH: CORE, 0.5 hr) • Jason Deveau, Application Technology Specialist, OMAFRA, Ontario, Canada
10:00 am	Understanding Pesticide Residue Declines to Improve Pest Control and Blueberry Exports (OH: 2B, 0.5 hr) • Rufus Isaacs, Entomology Dept., MSU
10:30 am	Gall Wasp, an Emerging Pest in Michigan Blueberries (OH: 2B, 0.5 hr) • Phil Fanning, Department of Entomology, MSU
11:00 am	Session Ends

Tactics for Controlling SWD:
The spotted weapon of destruction

Hannah Burrack, Lauren Diepenbrock, Katherine Swoboda-Bhattarai, and Jesse Hardin
North Carolina State University

We will provide an overview of the results of recent SWD research projects. A key focus of these projects was to measure real-world pesticide residues associated with insecticide rotation programs for SWD.

The chart below is provided to supplement the discussion of these results. Materials were applied as part of a weekly pesticide rotation for spotted wing drosophila management. The "order in rotation" indicates when during the program a material was applied. Residue samples were collected each week, simulating when fields would be harvested.

How long is an insecticide detectable?

Active Ingredient	year	Treatment	Order in rotation	Lowest residue detected (ppm)	Days after application
Acetamiprid (Assail)	2013	Red. Risk	2,4	0.0000	6
Cyantraniliprole (Exirel)	2014	Red. Risk	1,3,5	0.0630	16
Fenpropathrin (Danitol)	2013	Exp1	4	0.0660	14
	2014	Exp1	4	1.7060	14
Malathion (8F)	2013	PHI	2,4	0.0000	5
	2014	Exp1/PHI	2	0.0000	21
Methomyl (Lannate)	2014	Exp2	1	0.0370	41
Phosmet (Imidan)	2013	Exp1	1,5	0.0020	28
	2014	Exp1	1	0.0090	36
Spinetoram (Delegate)	2013	Red. Risk	1,3	0.0000	15
	2014	Exp1	3	0.0060	23
Zeta-cypermethrin (Mustang Max)	2013	PHI	1,3	0.0000	15
	2014	PHI	1	0.1140	14

Take home messages from these data:

1. There are differences in the number of days after application were needed to reach zero residues **between years**. It look less time to reach zero residues in 2013 than in 2014. This may be due to rainfall differences.
2. Residues for some materials **never** reached zero during our observation period in either year: Danitol, Imidan, and Exirel.
3. Some materials reached zero in **2013 but not in 2014**: Delegate and Mustang Max.
4. Malathion reached zero in both year, but again, it took longer in 2014 than in 2013.

Sustainable Spotted Wing Drosophila Management for United States Fruit Crops

A USDA Specialty Crops Research Initiative (SCRI) supported project (Award number 2015-51181-24252)

Project information
Four years: 15 Sept 2015 through 14 Sept 2019

Participants:

NC State University
Hannah Burrack, Entomology
Max Scott, Entomology
Zack Brown, Ag & Resource Economics
Jean-Jaques Debois, Southern IPM Center
Rhonda Conlin, Extension IT
Michigan State Unversity
Rufus Isaacs, Entomology
Larry Gut, Entomology
Ke Dong, Entomology
University of Maine
Frank Dummond
University of Notre Dame
Zain Syed
University of Georgia
Ash Sial
Oregon State University
Vaughn Walton
Nik Wiman
Cornell University
Greg Loeb
Miguel Gomez
Rutgers University
Cesar Rodriguez-Saona
University of California, Davis
Joanna Chiu
Frank Zalom
University of California, Berkeley
Kent Daane
USDA-ARS
Kim Hoelmer
Stakeholder advisory board members (13)

Goals:
To integrate SWD management practices with those necessary for other pest species, to reduce the reliance on insecticides as the sole means of SWD management, to deliver this information to stakeholders, and to facilitate stakeholder adoption of recommendations.

Mechanics:
Our project is headquartered at North Carolina State University and directed by Dr. Hannah Burrack. Activities are grouped by primary objectives, and each activity is led by a team member. Activity leads develop standard methods, design projects, coordinate data collection, and summarize and interpret results.

Specific objectives and activities:
1. Implement and evaluate SWD management programs
    1.1. On-farm evaluation and optimization of SWD management programs (Lead: Burrack)
    1.2. Build bioeconomic models that measure SWD impact, predict losses, and suggest mitigation strategies (Lead: Gomez)

1.3. Provide stakeholders with results, applications, and interpretation (Lead: Burrack)
2. Develop tactics and tools that predict SWD risk
2.1. Field validate population models (Lead: Walton)
2.2. Determine sources of SWD populations before and during growing seasons (Leads: Loeb and Chiu)
2.3. Develop monitoring tools that accurately estimate SWD populations and predict infestation (Lead: Rodriguez-Saona)
3. Optimize sustainable SWD management programs
3.1. Reduce reliance on insecticides in management programs (Lead: Isaacs)
3.2. Detect, monitor, and minimize insecticide resistance (Leads: Sial and Brown)
3.3. Discover natural enemies capable of contributing to SWD population reduction (Lead: Daane)
3.4. Reduce infestation rates in fruit post-harvest (Lead: Burrack)
3.5. Develop genetic SWD management tactics (Leads: Scott and Brown)

For more information and future updates, see:
SWDManagement.org
or contact Hannah Burrack (hjburrac@ncsu.edu)

We need your help to measure SWD impact and guide future project direction

Please complete this approximately 30 minute survey:
https://survey.ncsu.edu/swd/

Effective Spray Application in Blueberries
How to Get the Most Out of Your Sprayers

Dr. Jason Deveau
Ontario Application Technology Specialist
jason.deveau@ontario.ca @spray_guy www.sprayers101.com

In the last eight years of working with airblast sprayers, I have only twice advised an operator to buy a new sprayer. In both cases, it was because the sprayer was woefully underpowered for the crop (an apple orchard and a hopyard) and wrong for the field conditions it was expected to work in (high winds and hilly terrain). Given the parade of sprayers I've seen, that's an interesting ratio. It suggests that in most cases, there's always something an operator can do to improve their efficiency and effectiveness. It also implies that when a sprayer is mismatched, an overpowered sprayer can be toned down, but an underpowered sprayer may not be capable of salvation.

Let's talk about how to improve the match between a sprayer and a highbush or cane berry crop. First, recognize that the crop, sprayer and weather have to be addressed together. Beware the sprayer salesman that parks an airblast sprayer on a gravel road and sends up an impressive wall of mist. If you really want to assess performance, drive it through the crop in weather conditions you would normally spray in. Let's get the obvious parts out of the way before we dive into sprayers.

The Crop:
An overgrown, unmanaged crop canopy can make or break an application. It becomes that much more difficult for a droplet to navigate through all those obstacles to eventually land in the densest part… and that's quite often where the disease and insects are. Everyone knows to prune to improve air flow and light penetration, but prune to improve spray coverage as well.

Also, your sprayer settings should reflect the stage of crop development. Would you use the same settings on your first application of the season as you would the last? The crop canopy changes significantly throughout the season, and so should your sprayer.

The Weather:
The smaller the spray droplet, the more difficult it is to predict what it will do when it leaves a nozzle. High humidity, lower temperatures and light wind (not dead calm) help keep spray droplets intact and on course. Hotter, drier and windier conditions make droplets smaller and take them off course. A sprayer calibration established in one set of conditions is generally not appropriate for the other.

The Sprayer:
In my experience, most sprayers used in highbush and cane berry are trailed, axial fan, airblast sprayers that may (or more often, may not) have air deflectors or ducting. They employ conventional hydraulic nozzles and drive every row spraying from both sides. Less frequently, I see cannon sprayers that use a duct to direct spray over multiple rows from one direction. They employ either conventional hydraulic nozzles, or some manner of air-shear misting nozzle. Finally, and most rare, there are vertical or horizontal boom sprayers with no air-assist. Conveniently, their commonality is also my order of preference, which stems from how I like to adjust them.

Adjusting the sprayer:
Start with air direction and speed.

1) Adjust deflectors (if available) to just overshoot the canopy and drop fan gear to low (if available).
2) Set your tractor rpms (~540 rpm but preferably less) and ground speed (~5.0 k/hr or ~3.0 mph).
3) Attach 25 cm (10 in) lengths of flagging tape to the far side of the plant canopy you wish to spray. If spraying in a light cross wind, choose the upwind target so the tapes are blowing into the canopy, not away from it. Do this at the top, middle and bottom of the canopy for three plants in a row.
4) With a partner standing in the next alley watching the tapes, bring up the rpms and drive by with the fan on and the spray booms off.

If the ribbons stand out taut, or hang limp, you are using too much or too little air, respectively. Make changes until the ribbons flag briefly as the sprayer passes.

Next, adjust the nozzles.

1) Place water-sensitive paper in three locations (top, middle and bottom of the canopy, centre vertical axis). Put two papers in each position, back-to-back, yellow side facing the alleys. Do this for three plants.
2) Spraying clean water, drive the down-wind side of the crop. Stop and inspect the papers without removing or disturbing them. Then, spray up the other alley on the upwind side. Check them out again.

Trouble shooting coverage is too involved to include it all here, but go to this article for a guide to interpreting water sensitive paper: http://sprayers101.com/spray-coverage-diagnostics/. Basically, if there isn't enough coverage, you need more volume from the corresponding nozzle position. If there's too much, you can cut back. This is accomplished by changing operating pressure, or preferably, the individual nozzles.

Which sprayer is best for you:
Returning to my preferences, you might note that certain sprayers don't fit the adjustment process as well as others. An axial airblast sprayer with a positive displacement pump (i.e. not centrifugal) can have its fan speed, pressure and nozzle rate/spray quality adjusted independently. It is a very flexible option.

A cannon sprayer may seem more efficient, but trying to cover too many rows in a single pass can compromise coverage. Typically, too much closest to the sprayer and too little at the far end of the swath. Additionally, cannons with air-shear nozzles need higher air speeds to create spray, so you cannot adjust air without affecting spray quality and flow.

Finally, vertical or horizontal booms with no air assist rely entirely on hydraulic pressure to propel spray; Wind influences the spray too much, and canopy penetration is hard to achieve consistently.

Last thoughts:
Only after coverage is confirmed should you measure all the settings for a spray record (e.g. volume-per-acre and travel speed). Those figures will inform how you mix your tank. Be aware of changing weather conditions and crop development, and recognize that sprayer settings have to change to compensate.

"Sprayer calibrations, like milk, expire over time."

Further reading:
Read more and watch videos about matching sprayer settings to the crop:
http://sprayers101.com/the-right-sized-sprayer-for-the-job/

Pre-Harvest Intervals to Comply with the Maximum Residue Limits (MRLs) of Selected Export Markets for Thirteen Registered Blueberry Insecticides - July 11, 2016

Bifenthrin (Brigade) - single or double applications

Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	Green	Green	Green	Green	Green	Green
Australia	Green	Green	Green	Green	Green	Green
Canada	Red	Red	Red	Red	Red	Red
EU	Red	Red	Red	Red	Red	Red
Hong Kong	Red	Red	Red	Red	Red	Red
Japan	Green	Green	Green	Green	Green	Green
Korea	Red	Red	Red	Red	Red	Yellow
Taiwan	Green	Green	Green	Green	Green	Green

Carbaryl (Sevin)

Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	Red	Red	Red	Green	Green	Green
Australia	Red	Red	Red	Green	Green	Green
Canada	Red	Red	Red	Green	Green	Green
EU	Red	Red	Red	Red	Red	Red
Hong Kong	Red	Red	Red	Red	Red	Red
Japan	Red	Red	Red	Green	Green	Green
Korea	Red	Red	Red	Red	Yellow	Yellow
Taiwan	Red	Red	Red	Red	Yellow	Yellow

Cyantraniliprole (Exirel)

Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	Red	Green	Green	Green	Green	Green
Australia	Red	Green	Green	Green	Green	Green
Canada	Red	Green	Green	Green	Green	Green
EU	Red	Green	Green	Green	Green	Green
Hong Kong	Red	Red	Red	Red	Red	Red
Japan	Red	Green	Green	Green	Green	Green
Korea	Red	Green	Green	Green	Green	Green
Taiwan	Red	Red	Red	Red	Red	Red

Esfenvalerate (Asana)

Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	Red	Red	Red	Red	Green	Green
Australia	Red	Red	Red	Red	Green	Green
Canada	Red	Red	Red	Red	Red	Red
EU	Red	Red	Red	Red	Red	Red
Hong Kong	Red	Red	Red	Red	Green	Green
Japan	Red	Red	Red	Red	Green	Green
Korea	Red	Red	Red	Red	Red	Red
Taiwan	Red	Red	Red	Red	Green	Green

Fenpropathrin (Danitol)

Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	Red	Green	Green	Green	Green	Green
Australia	Red	Red	Red	Red	Red	Red
Canada	Red	Green	Green	Green	Green	Green
EU	Red	Red	Red	Red	Red	Red
Hong Kong	Red	Green	Green	Green	Green	Green
Japan	Red	Green	Green	Green	Green	Green
Korea	Red	Red	Red	Red	Yellow	Yellow
Taiwan	Red	Green	Green	Green	Green	Green

Imidacloprid (Provado) - single or double applications

Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	Red	Green	Green	Green	Green	Green
Australia	Red	Red	Red	Red	Red	Red
Canada	Red	Green	Green	Green	Green	Green
EU	Red	Green	Green	Green	Green	Green
Hong Kong	Red	Green	Green	Green	Green	Green
Japan	Red	Green	Green	Green	Green	Green
Korea	Red	Red	Red	Red	Yellow	Green
Taiwan	Red	Green	Green	Green	Green	Green

Malathion - single or double applications

Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	Green	Green	Green	Green	Green	Green
Australia	Green	Green	Green	Green	Green	Green
Canada	Green	Green	Green	Green	Green	Green
EU	Red	Red	Red	Red	Red	Red
Hong Kong	Green	Green	Green	Green	Green	Green
Japan	Green	Green	Green	Green	Green	Green
Korea	Green	Green	Green	Green	Green	Green
Taiwan	Red	Red	Red	Red	Red	Red

Methomyl (Lannate) - single or double applications

Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	Red	Green	Green	Green	Green	Green
Australia	Red	Red	Red	Yellow	Green	Green
Canada	Red	Green	Green	Green	Green	Green
EU	Red	Red	Red	Red	Red	Red
Hong Kong	Red	Green	Green	Green	Green	Green
Japan	Red	Red	Red	Red	Yellow	Green
Korea	Red	Red	Red	Red	Yellow	Green
Taiwan	Red	Red	Red	Yellow	Green	Green

Phosmet (Imidan)

Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	Red	Green	Green	Green	Green	Green
Australia	Red	Green	Green	Green	Green	Green
Canada	Red	Yellow	Green	Green	Green	Green
EU	Red	Green	Green	Green	Green	Green
Hong Kong	Red	Green	Green	Green	Green	Green
Japan	Red	Green	Green	Green	Green	Green
Korea	Red	Green	Green	Green	Green	Green
Taiwan	Red	Red	Red	Red	Red	Red

Key to colors used in charts:

RED means that the product *should not be used during this time* either because of EPA label restrictions or due to a high risk of exceeding MRLs for a given market.

YELLOW means that the product *should be used with caution during this time* given all the variables (e.g. tank mixes, application method and calibration, use of adjuvants, environmental conditions, and post-harvest handling) that can impact the time it takes for a residue to degrade in order to meet the MRL for a given market.

GREEN means that the product is likely to be safe for use at this time with low risk of residue remaining at harvest that would exceed MRLs for a given market.

Spinetoram (Delegate)						
Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Australia	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Canada	RED	GREEN	GREEN	GREEN	GREEN	GREEN
EU	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Hong Kong	RED	RED	RED	RED	RED	RED
Japan	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Korea	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Taiwan	RED	GREEN	GREEN	GREEN	GREEN	GREEN

Spinosad (Entrust) - single or double applications						
Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Australia	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Canada	RED	GREEN	GREEN	GREEN	GREEN	GREEN
EU	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Hong Kong	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Japan	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Korea	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Taiwan	RED	GREEN	GREEN	GREEN	GREEN	GREEN

Thiamethoxam (Actara)						
Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Australia	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Canada	RED	GREEN	GREEN	GREEN	GREEN	GREEN
EU	RED	RED	RED	RED	YELLOW	YELLOW
Hong Kong	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Japan	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Korea	RED	GREEN	GREEN	GREEN	GREEN	GREEN
Taiwan	RED	GREEN	GREEN	GREEN	GREEN	GREEN

zeta-Cypermethrin (Mustang) - single or double applications						
Intended Market	Time before harvest					
	1 day	3 days	5 days	7 days	14 days	21 days
USA	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN
Australia	RED	YELLOW	YELLOW	GREEN	GREEN	GREEN
Canada	RED	RED	RED	RED	RED	RED
EU	RED	RED	RED	RED	RED	RED
Hong Kong	RED	RED	RED	RED	RED	RED
Japan	RED	YELLOW	YELLOW	GREEN	GREEN	GREEN
Korea	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN
Taiwan	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN

Purpose & Methods: This tool was developed to aid blueberry growers in selecting materials to manage key pests close to harvest with a particular export market in mind. Selected markets have been included, some of which have more restricted maximum resiude limits (MRLs) or tolerances than required by the US for particular materials. The MRLs used to develop this tool come from those published by globalmrl.com as of July 11, 2016. The data used to determine whether a longer pre-harvest interval would be necessary for a given market and its published MRL, are based on a single application, unless noted otherwise, made near the legal U.S. PHI for each material tested, in replicated trials conducted at one location in Michigan over two years, one location in Oregon over three years, and three locations in Washington over three years. For those treatments that received two applications ("one or two applications"), the second application was made 7 days after the initial application. All samples were extracted by the QuEChERs method and analyzed by GC/MS/MS and LC/MS/MS.

Acknowledgements: This work was made possible in part through grants funded by Michigan Department of Agriculture and Rural Development through the Strategic Growth Initiative and MBG Marketing, Oregon Blueberry Commission, Washington Blueberry Commission, Washington State Commission on Pesticide Registration, USDA, WSDA Specialty Crop Grant from 2013 through 2015, and a donation from two Oregon blueberry growers. Field collaborators include: Rufus Isaacs and Steve VanTimmeren (Michigan State University); Dave Trinka (Michigan Blueberry Growers Association); Joe DeFrancesco and Peter Sturman (Oregon State University); Alan Schreiber and Tom Balotte (Agriculture Development Group); Lynell Tanigoshi, Hollis Spitler, and Bev Gerdeman (Washington State University); and Steve Midboe (CHS, Whatcom County). Sample analysis and generation of these charts was done by Camille Holladay and Keith Crosby (Synergistic Pesticide Lab).

***Disclaimer**: These charts are just a guide. The authors of this tool cannot guarantee that any of these MRLs have not changed since July 11, 2016, therefore, the user assumes all responsibility for its use subsequently. Current MRLs can be verified at: www.globalmrl.com We also cannot guarantee that a material listed for use in Michigan, Oregon, or Washington is registered for use outside those states (pesticide registration status is determined by the USEPA and State Governments where 'special uses' are concerned). Users outside these states are cautioned to consult with their local extension service to determine what is allowable. We also make no guarantees that any of the products listed will be effective against a particular pest. Finally, given all of the variables that can affect degradation rates - in particular the use of adjuvants and tank mixes, environmental post-application conditions, and post-harvest handling - we cannot guarantee that if a product is used according to this tool it will not leave residues that exceed MRLs for the selected market.*

Key to colors used in charts:

RED means that the product *should not be used during this time* either because of EPA label restrictions or due to a high risk of exceeding MRLs for a given market.

YELLOW means that the product *should be used with caution during this time* given all the variables (e.g. tank mixes, application method and calibration, use of adjuvants, environmental conditions, and post-harvest handling) that can impact the time it takes for a residue to degrade in order to meet the MRL for a given market.

GREEN means that the product is likely to be safe for use at this time with low risk of residue remaining at harvest that would exceed MRLs for a given market.

Gall Wasp, an Emerging Pest in Michigan Blueberries

Philip Fanning, Steve VanTimmeren & Rufus Isaacs
Department of Entomology, Michigan State University, East Lansing, MI 48824
Contact Dr. Fanning at fanning9@msu.edu

The blueberry stem gall wasp (BSGW), *Hemadas nubilipennis*, has rapidly become a key insect pest of highbush blueberry in Michigan over the past few years. This native insect causes damage when eggs are laid in young growing shoots around bloom-time and the resulting larvae feed on the plant tissue. Infestation sites are stimulated by the insect and they form galls up to 2 inches wide that harden and disrupt developing shoots (Shorthouse et al. 1986, West and Shorthouse 1988). This pest primarily infests new and actively growing shoots in lowbush and highbush blueberries. There is strong variation in susceptibility, with the Jersey and Liberty cultivars being very susceptible, Aurora, Bluejay, Dukes and Elliot being of low susceptibility and others (e.g. Bluecrop) being resistant.

The phenology of this species makes it particularly challenging to control. Adult wasps of BSGW emerge from galls formed in the previous year, during bloom time in May and June. An emergence model for this pest has been developed based on degree-day accumulation and can be found at www.enviroweather.msu.edu (look under Fruit>Blueberry for the model to run on a nearby weather station). Once emerged from last year's galls, females of BSGW immediately begin laying eggs inside the stems of nearby blueberry bushes. The site at which females lay eggs then develops into a gall, and these galls are green and kidney shaped earlier in the year, turning brown in the Fall (Figure 1).

Figure 1. Mature gall with adults of blueberry stem gall wasp in the background and a parasitoid of BSGW in the foreground.

To manage BSGW growers should implement multiple tactics to reduce the risk it poses to your business, including cultural and chemical controls. Cultural controls are an essential aspect of any management program for this pest and using resistant cultivars is the most effective way to prevent this gall wasp from being a problem. Consider replanting susceptible cultivars if gall wasp is a problem there, and avoid planting new fields to the most susceptible cultivars.

Control programs should also include annual pruning out and removal of galls from infested fields during the winter or early spring when they are most visible. Galls must be destroyed by burning or very deep burial. This removal technique is essential in fields where gall wasp is starting to move in, as it is still manageable and there is a good chance of collecting a high proportion of the galls in this situation.

Natural enemies of the species have been found in Michigan blueberry fields, and four parasitoid species have been reared from galls collected in west Michigan. These have some ability to reduce populations of BSGW, but our surveys indicate that their presence is highly variable among farms, and they are mostly absent in fields that commonly receive broad spectrum insecticides for control of spotted wing Drosophila. Therefore, we expect the effects of these biological control agents to be greatest in wild habitats outside commercial fields and in some organic farms.

Chemical control has been shown to be effective at reducing infestation of gall wasp, with timely application of effective insecticides reducing the size and number of galls. In 2015, fields receiving a program that included immediate post-bloom insecticide (applied once the honey bees were removed) and followed 7-10 days later with a follow-up application had fewer and smaller galls. Additionally, fields treated using higher water volumes of ~60 gallons of water per acre had consistently better control than those fields treated with only 20-30 gallons. In fields where chemical control of gall wasp was effective, applications after bloom were of either Lannate, Exirel, or the pyrethroids Brigade, Mustang Maxx, Asana or Danitol. These were applied with a penetrating adjuvant such at Exit, Wetcit, or Dynamic to help deliver the insecticide into the tissues of the stems where the eggs and larvae are developing. Each of these products will also control fruitworm pests if used at this timing. Reapplication after seven days is recommended to ensure treatment of potential late emerging adults.

While some effective insecticides were identified in 2015 trials with treatments applied post-bloom, we have continued the search for additional insecticide options. Recent experiments spraying galls in the lab prior to the emergence of adults of BSGW indicate application of Diazinon (1 lb/arce) or Brigade 2 EC (6.4 oz/acre) reduce the number of adult BSGW emerging from these galls. Both lead to a ~60% reduction in emergence (Figure 2). This suggests that Diazinon should also be considered for gall wasp control, providing an additional chemical class for control of this pest as soon as the honey bees are removed from the area. It may also have a potential for use well before bloom in a delayed-dormant timing to reduce the emergence of wasps without affecting spring-active bees, although this still needs to be tested.

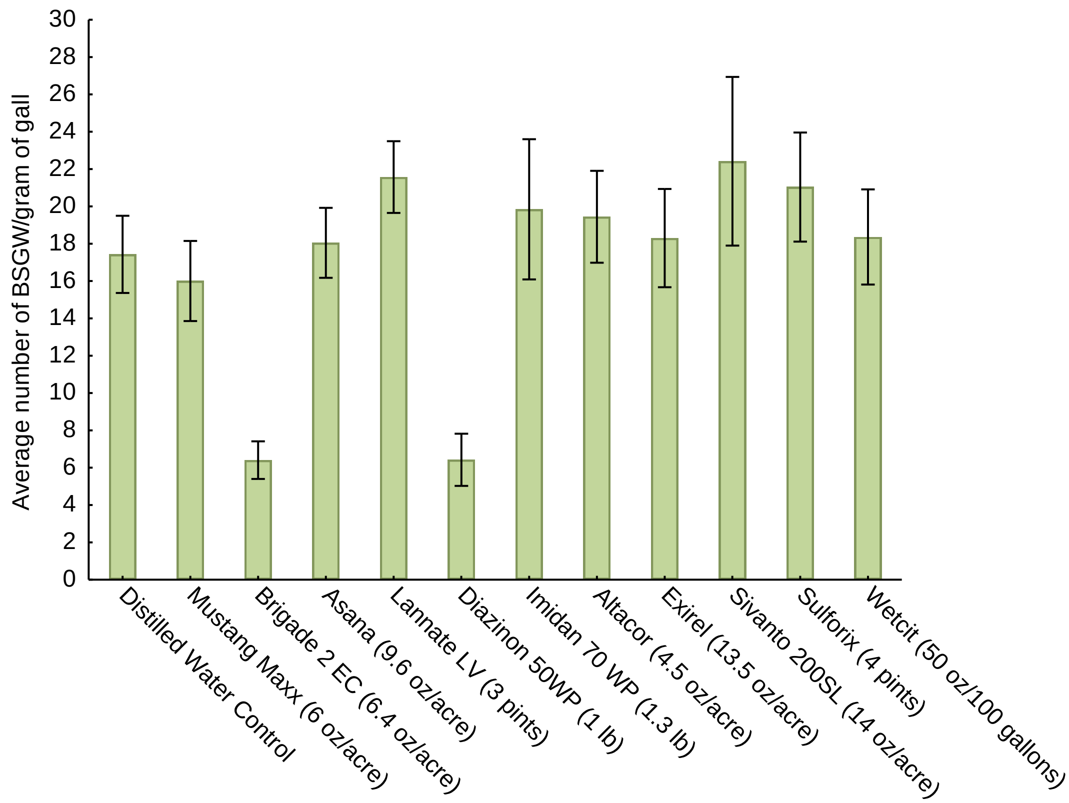

Figure 2. Average number of adults of Blueberry Stem Gall Wasp (BSGW) emerging from galls treated with different insecticide treatments in combination with Wetcit® adjuvant.

Screening experiments on emerged adults of BSGW have also recently been conducted in the lab. In these experiments, Mustang Maxx, Brigade, Asana, Lannate, Diazinon and Imidan all proved highly effective at targeting live adults. In addition to these, the new chemical class Flupyradifurone (Sivanto ®, Bayer) showed high efficacy, and could be effective in post bloom sprays to targeting adults (Figure 3).

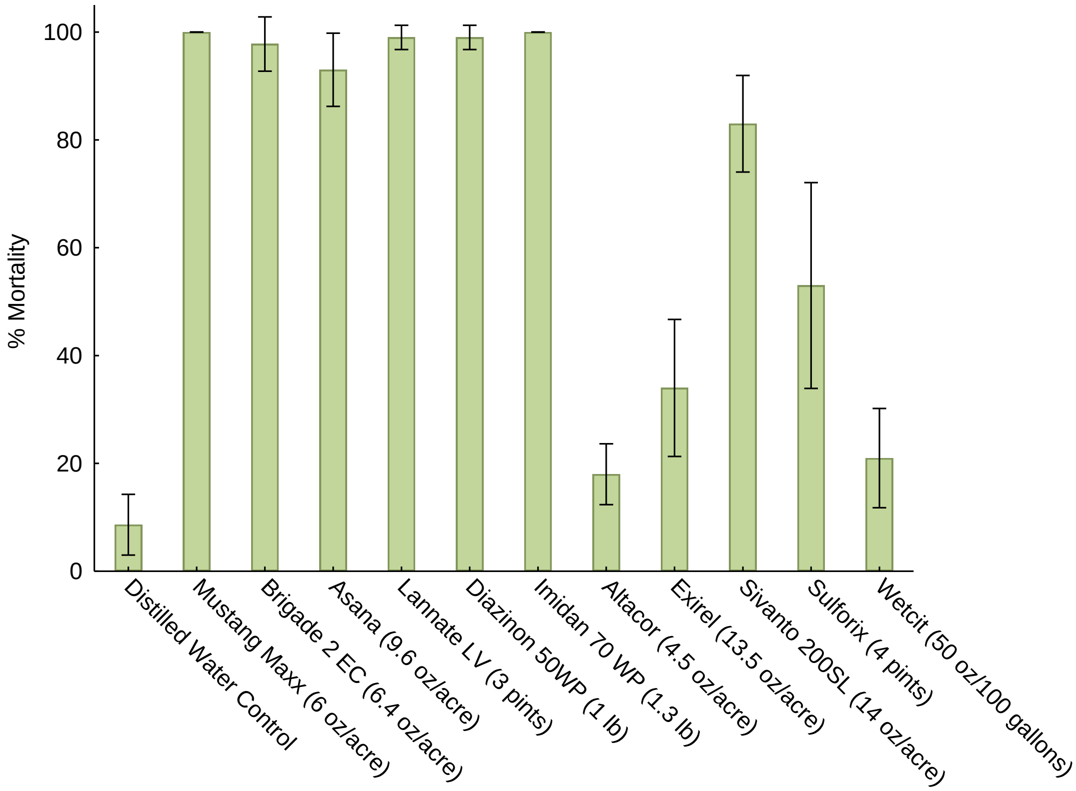

Figure 3. Average percent mortality after 24 hours of adults of Blueberry Stem Gall Wasp (BSGW) directly sprayed with different insecticide treatments in combination with Wetcit® adjuvant.

Conclusions

- Pruning and the destruction of galls is a vital part of control.

- Natural enemies are present in west Michigan blueberry fields, but their efficacy seems reduced by sprays from spotted wing Drosophila.

- Research continues to identify spray programs to reduce infestations. Post bloom applications of effective insecticides (Mustang Max, Exirel, or Lannate), immediately after the honey bees have been removed from the field, has been the most effective thus far. However high gallonage (over 50 gallons per acre) is essential, along with the inclusion of an adjuvant to aid penetrations into galls and stems.