Grape I

Tuesday morning 9:00 am

Where: Grand Gallery (main level) Room D
MI Recertification credits: 2 (1C, COMM CORE, PRIV CORE)
OH Recertification credits: 0.5 (presentations as marked)
CCA Credits: SW(0.5) PM(1.0) CM(0.5)
Moderator: Brad Baughman, MSU Extension, Benton Harbor, MI

9:00 am — Soil Health: With Special Reference to Nematodes
- George Bird, Entomology Dept., MSU

9:30 am — Grape Leafroll and Tomato Ringspot Viruses (OH: 2B, 0.5 hr)
- Annemiek Schilder, Plant, Soil and Microbial Sciences Dept., MSU

10:00 am — Affordable Technology for Spraying Vineyard Edges
- Mark Ledebuhr, Application Insight, LLC, Lansing, MI

10:30 am — Results of the MSU Winter Injury Survey
- Brad Baughman, MSU Extension, Benton Harbor, MI

11:00 am — Session Ends

Affordable Technology for Spraying Vineyard Edges

Mark Ledebuhr, Application Insight, LLC, solutions@applicationinsightllc.com
Dr. Rufus Isaacs, MSU Department of Entomology, isaacsr@msu.edu
Keith Mason, MSU Department of Entomology, masonk@msu.edu
Bryan Cronenwett, Cronenwett Farms, bryan@cronenwettfarms.com
Mark Gregory, Gregory Farms, bgregoryvpp@yahoo.com

This presentation is a summary of the prior several years work on the Grape Berry Moth Precision Application of Reduced Risk Insecticides Project, future directions, and an opportunity to solicit feedback from the grape growing community.

This project grew from the observation that Grape Berry Moth (GBM) infestations tend to be the most concentrated on vineyard s next to woodland. Given the current economic reality of juice grape production, growers and researchers are actively searching for ways to reduce input costs while maintaining or increasing quality and-/or tonnage. Over multiple years, MSU researchers documented the concentration of GBM damage in relation to vineyard edges, then showed that reduced-risk insecticide applications precisely applied at the field perimeters, hereafter called "precision sprays", can be as effective as the "standard" insecticide program applied to the entire vineyard, while also reducing costs.

While the precision spraying has been shown to be as good as full cover sprays for GBM control, neither strategy has been what most growers would consider "excellent" control. In the 2014 data, the border zones at these high pressure vineyards still suffered up to 70% of clusters exhibiting damage from GBM, as shown below in Charts 1, and field interiors suffered 10-20% damaged clusters as shown in Chart 2. Responding to that in 2015, Isaacs and Mason have shown in the precision spray program that an adjustment in the mid-season spray to a higher low-risk insecticide rate (Table 1 below) provided superior control versus the standard full cover. This effect was seen at the perimeters and vineyard interiors (Charts 1 and 2 below).

Historically, the net cost of grape berry moth control was considered roughly equal to the value of the crop lost to damage, plus it was time consuming at a time in the season when harvest is the main focus. So, many growers opt to skip the sprays and take the loss. However, the problems continue to build up over multiple years and the cost problem is made worse. Further, though growers may desire to use higher cost reduced risk products, full covers would be even more difficult to justify economically. By employing the precision spray concept, the chemical input cost could be reduced to as little as 20-30% of the cost of a full cover. This makes the Precision spray concept more attractive in that a net increase in yield is possible even with reduced overall chemical costs.

All this preceding information suggests that a system that can apply insecticides only at the vineyard border whether the rows are running perpendicular or parallel to the woods, would allow the grower to control GBM (and other border-focused pests) while also saving money. Since no further tractor time, diesel, or equipment depreciation would be required if the insecticide could be selectively applied during a scheduled fungicide application, the application cost of a precision insecticide application would be reduced to the depreciation on the injection equipment, perhaps a few of dollars per acre or less.

Table 1. Timing, application rates and insecticides for each program

Timing	**Standard**	**Precision**
Post Bloom	Bifenture (6.4 fl oz/ac)	Leverage (3.2 fl oz/ac) ***If needed based on scouting***
Mid season	Sevin XLR (64 fl oz/ac). Early July (910 GDD_{47} after wild grape bloom)	Intrepid (8 fl oz/ac) + R-56 (8oz/100 gal) Early July (810 GDD_{47} after wild grape bloom) ***In 2015 Intrepid rate increased to 12oz/acre.**
Late season	Imidan (2 lb/ac) (Use water pH 6 or below). Mid-August (1720 GDD_{47} after wild grape bloom)	Altacor (3 oz/ac). Mid-August (1620 GDD_{47} after wild grape bloom)
Preharvest	Baythroid (3.2 fl oz/ac)	Belt (4 fl oz/ac) ***If needed based on scouting***

Chart 1. Percent GBM-damaged clusters through the season, in border areas of SW Michigan vineyards:, 2014 vs. 2015

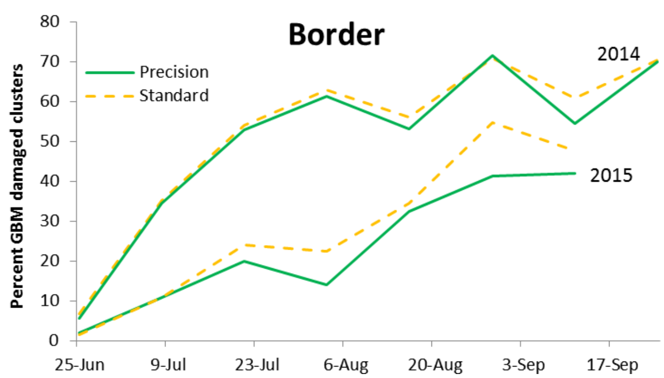
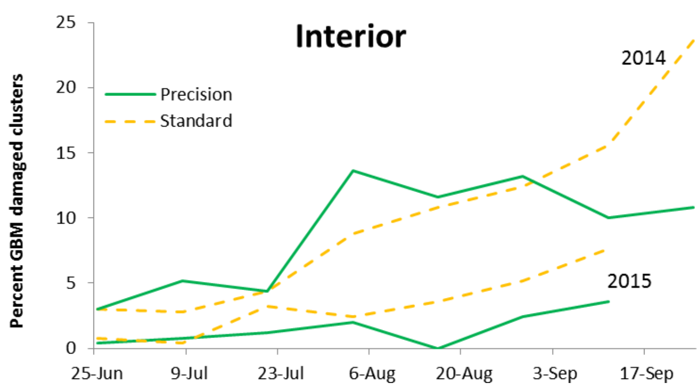


Chart 2. Percent GBM-damaged clusters through the season, interior areas of SW Michigan vineyards:, 2014 vs. 2015



Realizing the need for the right hardware in order for these discoveries to have positive impact for growers, in 2013 Isaacs and Mason brought Mark Ledebuhr of Application Insight LLC into the project to find and evaluate a hardware solution.

Commercial single chemical injection systems do exist that can allow a grower to do these precision applications as part of other scheduled fungicide covers. This equipment is important to eliminate the additional application costs that would otherwise be incurred as a result of additional precision insecticide sprays. A commercially available single chemical injection system was explored in the early stages of this project. Economic barriers including high cost of adoption, and technological barriers including high system latency (the delay between the time of injection and the time the injected material leaves the nozzles), led the team to explore other options that might be more suitable to the needs of juice grape growers. It became obvious that specialized equipment would need to be developed.

A low-pressure injection system (System 1) was developed with just enough features to allow growers to successfully achieve precision sprays. It is a stand-alone system that does not require interface with a rate controller, unlike other commercial systems. System 1 was limited to low pressure (50 PSI and under) chemical metering systems such as those found on Ag-Tec® sprayers. It was operated successfully in 2013, 2014, and 2015.

It was desired to broaden the range of sprayers that could be used with single chemical injection. The majority of the sprayers in the market use diaphragm or piston pumps that operate at pressures too high to inject against. System 2 was developed in 2015 as a parallel spray application system installed on the vineyard sprayer. The insecticide is not injected into the main spray system; rather it is applied as a low volume (LV) or Ultra Low Volume (ULV) spray through a separate spray manifold installed in the sprayer's airblast volute, mixing and diluting with the main spray plume on the way to the crop canopy. This innovation was successful and so allowed the precision spray concept to be used in sprayers using high-pressure systems. Since System 2 is essentially a stand-alone spraying system, it was noted that the use of the system was not only limited to precision perimeter sprays, but also could be used for selective weed sprays by transferring the System 2 control and pump box to a weed spraying setup and adding additional nozzle manifolds. While this has not been done yet, it is technically a fairly simple operation and could potentially add value to a grower who invests in this. It would allow a grower to make a general burndown herbicide application to the whole vineyard while also targeting the more expensive herbicides to regions of the farm with the difficult-to-control weeds.

Developments and improvements in 2014 and 2015 lead to a single control box design and wiring schematic that could be used both in systems 1 and 2, with the added convenience of flow adjustment in the sprayer cab. The original version of System 1 required adjustment of the flow rate by opening the pump box on the sprayer. The wiring harness was also improved to include weatherproof connectors to better resist the environment and improve overall reliability.

At the conclusion of 2015, a new pump system was found that would add additional pressure capability to the System 2 design of up to 150 PSI. It is expected that this design improvement will allow the use of this system as an injection system similar to System 1 that could now be used in diaphragm and piston based chemical delivery systems. This System 3 concept will likely be further developed and investigated in the 2016 field season.

Table 2. Characteristics of each system.

System	injects into main chem feed	requires installation of separate boom	max system pressure can inject into	field capacity of a 30 gallon tank	stand-alone operation:	flow range
System 1: Ultra-low volume peristaltic injection	Yes	No	60	50+ applied acres	No	.7 to 5 oz/min per side, more with larger hoses
System 2: Low volume, parallel application	No	Yes	infinite	7.5 to 15 applied acres	Yes	<.2 gpm to 1.4 GPM per side
System 3: Low volume, medium pressure injection (BETA)	Yes	No	150 PSI	12 to 25 applied acres, possibly more	Yes	<.2 gpm to 1.2 GPM per side

Table 3: Recommended combinations of systems and sprayer types.

Use with this type of sprayer	System 1	System 2	System 3
air-shear type, i.e. Agtec	best	no	good
pneumatic/electrostatic	best	no	possible- may require too much water
rotary atomizer sprayers*	*possible W/O peristaltic metering, not best option	*possible with injector plate mod, best option	possible with injector plate mod, good option
airblast with centrifugal or diaphragm pump	no	yes, if design accomodates second nozzle manifold	yes, if main system pressure kept below 150 PSI
airblast with piston pump	no	yes, if design accomomdates second manifold	yes, if system pressure kept below 150 PSI
hi-volume, high pressure	no	no	yes, if system pressure kept below 150 PSI

Table 4. Relative advantages and limitations of each system.

	Advantages:	Limitations:
System 1	Able to apply highly concentrated chemicals, makes small tank still capable of many acres. Relatively clog-proof with coarse filtration.	Peristaltic pumps are high cost. If in-cab rate adjustment is required, control wiring becomes much more complicated.
System 2	Does not interfere with flow of main chem system. DC diaphragm pumps are much lower cost. No expensive static mixers required. Rate can be adjusted/ controlled from cab. Can "stand-alone" for operation in other spray tasks	Requires custom fabrication of nozzle manifolds in each air volute. May negatively affect air flow. Difficult to nozzle below 4 GPA, so requires much larger auxillary tank to maintain field capacity.
System 3	Higher pressure matches widest range of sprayers. DC diaphragm pumps are much lower cost vs. peristaltic. Rate can be adjusted/ controlled from cab. Can "stand-alone" for operation in other spray tasks. Injects at higher concentration than System 2, so tank mix lasts longer	Requires static mixers. Limited to 150 PSI, may require renozzling or minor reconfiguration of the sprayer to meet pressure needs.

These systems were developed to be simple enough that with a bill of materials and assembly/fabrication instructions, a reasonably skilled grower could build and install such a system. The System 1 requires approximately $4000 in materials and can be made with tools and machinery commonly available to most growers. Once mounted on the sprayer, it requires minor modification to the existing spray delivery system. The System 2 requires less investment in materials, but will require more skill to install due to the need to add an additional spray manifold to the sprayer's airblast volute. The System 3 is anticipated to be similar cost to System 2, with the more simplistic installation similar to System 1.

This is significantly less than the cost of a commercially available rate controller and single chemical injection system. A typical commercial rate controller system capable of operating with single chemical injection is approximately $4000 to $5000; the most basic single chemical injection system starts at approximately $4500 additional, before installation. Therefore, for a grower who does not already have the correct rate controller, using commercially available technology would result in a cost easily approaching $10,000 or more.

The MSU Injector designs will be available in the near future and it is hoped that commercialization will occur. Purchase of a commercially produced unit would obviously add cost to the estimates above, as they only include materials. It is anticipated that it will still be significantly less cost than other commercially available options, while more specifically serving the needs of spray applicators typical to the grape growing community, and hopefully other crops as future needs are identified. To that end the authors are working with the MSU Technologies office to package the technology in a way that it can be widely adopted and maintained.

Although the costs are not yet precisely known, the investment in an MSU Injector system should have a relatively short payback time. The chemical cost of control with the insecticides used was estimated at approximately $60 per applied acre. Precision spraying was estimated to use approximately 20%-30% of the chemical that a full cover would take. With approximately $40 per applied acre in chemical savings, and two to three applications per season, many growers will justify this investment in less than a year, with potential increases in yield due to reduced insect damage further shortening the payback period.

Above: System 2 on Rears airblast

Right: System 1 on Agtec VMC tower with pump box, tank w/agitator, and static mixers

Far Right: Closeup of System 2 parallel manifolds installed in Rears sprayer