Michigan Blueberry Azinphosmethyl Transition Strategy

The current role of azinphosmethyl for controlling key insect pests in the primary region for production of highbush blueberry, the potential for alternative approaches to maintain the current level of control, and a proactive plan for assessing the ability of this industry to adapt to the EPA phaseout plan.

Rufus Isaacs
Dept. of Entomology, Michigan State University, East Lansing, MI 48824

and

Dave Trinka
Director of Horticulture, MBG Marketing, Grand Junction, MI

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Introduction

The United States Environmental Protection Agency is implementing a phase-out of the insecticide azinphosmethyl (typically applied as the Guthion 50WP formulation) in blueberry production in the United States, with complete phase-out proposed by 2012.

This phase-out presents an immediate and serious challenge for producers, processors, and marketers of highbush blueberries in leading production regions of the United States, because azinphosmethyl is a central component of growers' ability to control damaging fruitworm pests that bore into blueberry fruit. In the Great Lakes and the southeastern US, a majority of growers are dependent on azinphosmethyl for ensuring the supply of insect-free blueberries to the global market. Our focus in this transition plan is on Michigan as the leading producer of blueberries in the nation. However, the information presented here will be of relevance to other blueberry-producing states where transition away from this insecticide is mandated under the EPA's phase-out plan.

The phase-out restrictions will force a rapid change in blueberry growers' insect control programs, and necessitates rapid development of effective *and* economical alternatives. In addition to expedited evaluations of potential alternatives, this industry needs a concerted IPM implementation effort to ensure that the affected producers are able to maintain productivity and quality.

Even if effective alternative programs can be developed, the lack of MRLs (Minimum Residue Limits) for most potential alternative insecticides in the primary export markets means that US blueberry exports will be hurt by the phaseout. If not addressed in the next 2 years (when aerial application will be banned for blueberry), this situation will cause great economic harm through restricted ability to export fruit into the numerous countries with which the US highbush blueberry industry does business.

This document presents a strategy to prepare the Michigan highbush blueberry industry for the phase-out of azinphosmethyl, and to measure the ability of the current and future alternatives to maintain fruit quality, through the following five key steps:

1. Review currently available alternatives for insect control

2. Test most promising alternatives for management of key insect pests

3. Educate diverse blueberry industry audience to ensure widespread implementation of IPM programs that integrate alternatives

4. Create benchmarks to measure progress toward phase-out and challenges

5. Regular reports to EPA and blueberry industry on progress

Background
Guthion is a dominant insecticide in blueberry production: azinphosmethyl is applied on 58% of Michigan's blueberry acreage[1]. This dominant position in the pest management program is because it is a very effective insecticide for control of some key insect pests that would otherwise make the crop unmarketable. Applications are applied by ground in 20-30 gallons of water per acre and by air in 5-10 gallons of water per acre. Aerial application is common for growers who do not have their own tractors, and in situations when fields are too wet to drive a tractor through.

Azinphosmethyl is primarily used to prevent infestation of fruit by cranberry fruitworm, *Acrobasis vaccinii* and by cherry fruitworm *Grapholitha packardii*. These two blueberry pests have greater economic impact in Michigan than in any other production region. The larvae of these moth species bore into fruit immediately after bloom, and grow inside the developing fruit. In unmanaged fields, we have witnessed up to 80% fruit infestation by cranberry fruitworm, indicating the high potential for infestation by this pest. As a concrete example of the potential for economic damage by these pests, one Michigan blueberry farm that had transitioned to using IGRs for fruitworm control experienced extreme infestation of cherry fruitworm during 2007. The grower's estimate of the loss was between 7 and 14% of fruit by weight that was lost or had to be rejected. That equates to 1500 pounds at $1.60 per pound, or $2,400 per acre. This loss is due to infested fruit that dropped from the bush and fruit that had to be removed during processing. If one larva had escaped detection and reached the final product, economic loss would have been far greater.

In early-harvested blueberry varieties, mature larvae can be present during harvest, creating a potential for rejection of the fruit if detected by inspectors. There is zero tolerance for such infestation in blueberries by the consuming public and the food processing industry. In addition to the fruitworm pests that are key drivers of azinphosmethyl use in this crop, azinphosmethyl is one of the most effective insecticides used to prevent infestation of the crop by blueberry maggot, plum curculio, tip borer, leafrollers, and thrips. These insects require control in the post-bloom period of the growing season. Although azinphosmethyl is active on some later-season insect pests such as Japanese beetle, the 7 day PHI of Guthion 50WP restricts its use for control of pests near to harvest relative to some other available options.

As demonstrated above, unless growers employ a management program for fruitworms, some level of infestation is likely in most Michigan blueberry farms. We estimate that 20-25% of fields face high pressure from these pests, requiring multiple insecticide applications to minimize contamination. The first application may be made during bloom to target the early egglaying by these pests, and so bee safety is an important consideration for fruitworm sprays (Table 1). Although AZM is not allowed during bloom, as growers have access to more selective insecticides, targeting the egg stage may become more important, thus making bee safety an increasingly important issue.

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[1] USDA-National Agricultural Statistics Service (2005). Agricultural Chemical Usage, 2005 Fruit Summary. United States Department of Agriculture.

Potential alternative insecticides
Blueberry is a minor crop that would not receive many registrations of new insecticides without the efforts of the IR-4 Program. Active engagement in the priority-setting process of IR-4 by a team of blueberry extension entomologists and industry representatives has led to registration of some potential alternatives to AZM for use against the fruitworm complex. Despite these efforts, this industry has only recently (early 2008) received registration of Intrepid (methoxyfenozide) so there has been no commercial scale testing of one of this alternative insecticide for fruitworm control. Other insecticides are in the registration pipeline through IR-4 studies or EPA review and are expected to be registered during the azinphosmethyl phase-out period. There is currently some adoption of alternative insecticides for control of fruitworms in Michigan, including Confirm during bloom and Asana after bloom. However, this industry is still dependent on Guthion 50WP, with it being applied to almost 60% of the acreage.

Table 1. Insecticides used to control fruitworms in Michigan blueberries and the available alternatives and pipeline alternatives.

Timing	Currently used insecticides	Registered alternatives	Pipeline alternatives
In bloom (bees present)	B.t.	Confirm Esteem	Intrepid
Post bloom	Guthion	Asana Danitol Mustang Max SpinTor Entrust Delegate Sevin Lannate Imidan	Altacor Assail Avaunt Calypso Intrepid Rimon

Labeled alternatives
Esteem, Asana, Danitol, Mustang Max, Sevin, Lannate, Imidan, B.t., SpinTor, Entrust, Delegate and Confirm are currently registered for blueberry but each of these products has their limitations and do not together provide an economical or sustainable alternative to azinphosmethyl. Some of these have been registered only recently at the end of 2007 and have had no full scale field testing.

<u>Esteem</u> has shown variable and medium efficacy against fruitworms, it is expensive, and is not recommended for this use due to the difficulty of timing and the long period of egglaying by fruitworms that would require multiple applications.

Asana and Danitol have good activity against fruitworms, and Mustang Max is expected to be active (not yet tested). Asana has been registered for five years and has increasing adoption for use against fruitworms after bloom. There is concern regarding the level of adoption of this chemical class because pyrethroids with shoret PHIs are expected to be used later in the season for fruit flies and Japanese beetle control. For these reasons, pyrethroid insecticides should be used with caution in the context of a resistance management strategy.

Sevin and Lannate are carbamates with activity against fruitworms. Sevin has only half the length of activity of azinphosmethyl and would therefore not be a replacement for this insecticide. It is also very hard on beneficial insects. Lannate has a shorter residual, with high activity on fruitworms. It is also very broad spectrum in its activity.

B.t. was the standard in-bloom insecticide used by growers before registration of Confirm. Use of this is very low due to the very short residual control afforded, the sensitivity to temperature, and the susceptibility to wash-off.

SpinTor and Entrust (the organic formulation) are active on eggs and larvae of cranberry fruitworm, but have short residual activity. During the period after petal fall, when egglaying by these pests can extend for a few weeks, this property makes this a relatively ineffective option for growers and this is not ranked highly. This is also easily washed off plants, and since most Michigan highbush blueberries receive regular rain events and are irrigated by overhead sprinklers, SpinTor and Entrust are not effective alternatives to azinphosmethyl for fruitworm control. Delegate is in the same chemical class and is expected to be more active than SpinTor.

Confirm has been registered for a few years in this crop and has received some adoption by growers. A recently-completed USDA-RAMP project demonstrated commercial-scale efficacy of Confirm for fruitworm control but the higher price and more complicated timing and application needed for optimal performance have resulted in this being used primarily during bloom when the bee safety of this product tips the balance towards its use. It is more expensive than Guthion, Asana, or Danitol and so has not been used after bloom once there are more options available.

There is an urgent need for cost-effective alternatives to azinphosmethyl, to provide growers with tools to use for fruitworm control in their IPM programs. Some potential alternatives are in development and are expected to be registered during the phase-out period.

Pipeline alternatives
The insecticides listed below have shown promise for fruitworm control in research trials conducted by John Wise and Rufus Isaacs at the Trevor Nichols Research Complex in the past 5-10 years. Based in part on these findings, applications for registration have been requested by the manufacturers and IR-4. Assail, Avaunt, and Intrepid are expected to be registered in 2008 or 2009. The others are expected later and will have less time for commercial testing prior to the 2012 deadline for the complete phase-out.

Table 2. Names and characteristics of potential new reduced-risk AZM alternatives

Trade name	Chemical	Class	Mode of action
Assail*	acetamiprid	neonicotinoid	over-stimulates nerves
Altacor	rynaxypyr	anthranilamide	inhibits muscle activity
Alverde	metaflumizone	semicarbazone	blocks sodium channel
Avaunt*	indoxacarb	oxadiazine	blocks nerve signals
Belt	flubendiamide	pthalic acid diamides	disrupts calcium transport
Calypso	thiacloprid	neonicotinoid	over-stimulate insect nerve
Delegate	spinetoram	spinosad	over-stimulate insect nerve
Intrepid*	methoxyfenozide	insect growth regulator	disrupts molting
Proclaim	emamectin benzoate	avermectin	activates GABA receptor
Rimon	novaluron	insect growth regulator	disrupts molting

*Registration expected during 2008 season

Efficacy and economics
For any of these insecticides to be a replacement for azinphosmethyl, growers will first need to perceive that they are effective within the reality of their blueberry production system. Efficacy is not enough, however, as the likelihood of transition is diminished if the cost is high. There may be value to transition away from organophosphates and toward selective insecticides with improved environmental profiles as third party auditing and public scrutiny of agriculture increases. Value from the reduced human health risk can also be a deciding factor, but most applications for fruitworm control occur after bloom which is over a month before harvest of this crop, and much of the harvest is conducted with over the row harvesters.

Our challenge is to find the most effective *and* least expensive alternatives to azinphosmethyl, and to have those alternatives tested under commercial farm conditions, *and* to educate the end-users (growers, consultants, scouts) on how to optimally integrate these alternatives into their blueberry farm management.

Export market and MRLs
Michigan blueberries are sold throughout the world, in markets with stringent pesticide residue testing protocols. Access to these export markets is essential to the long-term success of this industry, yet these markets do not have tolerances or MRLs for almost all of the alternatives to azinphosmethyl discussed above (Table 3). For example, our two most important export markets for fresh and frozen highbush blueberries are Canada (#1)

and the UK (#2). Very few insecticides used in highbush blueberries have existing MRL's in these countries. If azinphosmethyl is restricted by EPA as predicted in the phase out plan without tolerances or MRLs in place for effective alternatives, then sales contracts are likely to be lost by Michigan growers and processors or they will have to withstand high levels of fruitworm damage in their crop, risking complete load rejections. Neither of these alternatives is acceptable.

To provide an understanding of the scale of this market, 18.3 million pounds of fresh highbush blueberries were exported from the US to Canada in 2006. Sales of frozen blueberries to Canada accounted for 45% of the total frozen blueberry export tonnage. Overall exports to Canada accounted for 72% of all U.S. highbush blueberry export tonnage. In this critical Canadian market, azinphosmethyl has an import tolerance. This is very important since few other insecticides have an established MRL in that country, and consequently, the industry cannot switch to an alternative (non-OP or carbamate) chemistry.

The United Kingdom (UK) is the second most important export market for our fruit. While no UK MRL exists for azinphosmethyl, the country's regulators defer to and accept the Codex MRL value. As is evident from Table 3, there are very few Codex MRL's and no UK MRL's for reduced risk insecticides that may be used to control fruitworms.

Table 1. MRL's for blueberry insecticides in primary export markets. Values collated by D. Trinka with some values from EPA draft alternatives AZM matrix file.

Insecticide	US	Canada	UK	Japan	Australia	Codex
Guthion (azinphosmethyl)	5.00	2.00	-		-	5.00
Asana (esfenvalerate)	3.00	-	-	-	-	1.0 for fenvalerate
Confirm (tebufenozide)	3.00	-	-	3.00	-	3.00
Danitol (fenpropathrin)	3.00	-	-		-	-
Delegate (spinetoram)	0.25	-	-		-	-
Diazinon (diazinon)	0.50	-	-		-	-
Esteem (pyriproxifen)	1.00	-	-		-	-
Imidan (phosmet)	10.00	5.00	-	10.0	-	10.00
Lannate (methomyl)	6.00	6.00	-		-	-
Sevin (carbaryl)	10.00	7.00	-		-	-

Non-insecticidal alternatives

There are no commercial products for mating disruption of either cranberry fruitworm or cherry fruitworm and none in development. This is due to the small size of the potential market, and the difficulty in manufacturing the pheromones of cranberry fruitworm which are 16 carbon doubly-unsaturated aldehydes, making them intractable to economical large scale synthesis.

Cultural controls such as mulching and/or tillage have the potential to help reduce pest pressure from fruitworms, but there is only anecdotal evidence for this. More research is needed to determine the level of pest suppression possible from these cultural controls.

An additional approach is the removal of wild host plants from the land surrounding blueberry fields, although since blueberry is native to the Great Lakes region, this is practical only in certain farms that do not have high populations of non-commericial blueberry.

Biological control agents include *Trichogramma* wasps that kill fruitworm eggs. These are not economically viable as a commercial product to apply to the crop, but conservation of their populations through use of selective insecticides and habitat manipulation may be used by growers as part of an integrated pest management strategy to suppress fruitworm populations. This topic requires additional research.

There are no virus products for control of these two fruitworm species.

There are no nematode approaches for control of these fruitworm species.

Blueberry Azinphosmethyl Transition Plan
The phase-out of AZM from blueberry production will have high economic impact if alternatives are not registered soon, evaluated in commercial blueberry farms, integrated into current IPM programs, and the most effective approach transmitted effectively to blueberry growers. A team of private and land-grant university cooperators are ready to tackle these issues, and evaluate the potential for transition away from azinphosmethyl. We can also provide input to EPA on the issues related to MRLs, but have no control over the setting of these tolerances. We propose to build on the already close working relationships between the MSU blueberry research and extension team, the Trevor Nichols Research Complex, and both MBG Marketing and the recently-formed Michigan Blueberry Advisory Committee to follow the following steps toward transition.

1. Establish Transition Team
During winter 2007-8 a transition team was formed including one or more representatives from each of the following organizations. The Blueberry Guthion Transition Task Force is comprised of the following organizations:

MSU Blueberry Entomology Program
MSU IPM Program
Trevor Nichols Research Complex
MSU Extension
Michigan Blueberry Growers Association
Michigan Blueberry Advisory Committee
Michigan Integrated Food and Farming Systems
Wilbur-Ellis Company
United Ag Products
Royster Clark
Robertson's Crop Dusting
Michigan Department of Agriculture
Michigan Farm Bureau

This group met in early 2008 to review the current status of the phase-out timeline, the alternatives to azinphosmethyl available, their efficacy, and to fine-tune the approach to learning more about the efficacy and sustainability of alternative programs. The Task Force will develop Best Management Transition Practices to test each year in the implementation plots (see below). Using the priorities identified by this group (see below), we applied for funding during winter 2007-8 to support the education and implementation program described below.

AZM Transition Task Force Priorities, from meeting on 2-11-08

Research priorities

1. Degree day model for CFW and CBFW
2. Efficacy of newer chemicals for CFW and CBFW (aerial as well as ground)
3. Importance of coverage for efficacy
4. Effectiveness of Delegate applied pre-bloom for CFW and CBFW control
5. Ensure studies address cherry fruitworm control in addition to CBFW
6. Testing programs on farm to see which is most effective
7. Performance of Intrepid against CFW and CBFW on-farm
8. Aerial Guthion versus aerial Asana
9. Secondary pests, which programs have a greater risk of secondary pests becoming a problem?
10. Concentration of compounds vs. control (related to aerial application)

Education/extension priorities

1. Degree days and how to use them for insect management
2. Update the Blueberry Pest Management Strategic Plan
3. June on-farm IPM meetings to update growers on insect management options

Regulatory priorities

1. Need MRLs for other (newer) compounds
2. EUP for most promising insecticides to learn about performance
3. Survey of current Guthion use patterns in Michigan blueberries (used by many small growers, so number of acres doesn't tell the whole story)
4. Expedited labeling of Intrepid for 2008 season

2. Education and Implementation Program

Michigan blueberry growers will require a coordinated program of education in the next 4 years to enable transition to registered alternatives while maintaining efficacy, and without reliance on azinphosmethyl. To achieve this, we will deliver a hands-on training program that combines classroom style meetings during the spring with on-farm training workshops during the period of fruitworm pest activity later in the season. The training meetings will be held at MSU's Trevor Nichols Research Complex and at public meeting rooms in the three primary blueberry-producing counties in the state. We will also hold evening dinner-and-discussion meetings at farms in the main production regions where growers, researchers, and extension personnel can discuss the alternative management approaches and reinforce the appropriate deployment of IPM tactics. This approach has been very successful in recent IPM implementation programs in Michigan vineyards.

The project team will prepare a bulletin on fruitworm IPM, and this will be available online at www.blueberries.msu.edu and will be distributed at the meetings, and will be mailed through the MSU Extension statewide list of blueberry growers. This bulletin will be updated annually to ensure that the most recent information is available.

The target audience for our information will include large commercial blueberry growers as well as smaller U-pick farms, crop consultants, blueberry scouts, and extension personnel. MSU has graduated over 40 Spanish-speaking blueberry growers through a bilingual training program in the past five years, and Spanish information materials will be mailed to these ex-students. We will also work through this project to translate our newly-developed blueberry fruitworm fact sheets into Spanish, and to deliver information about the phase-out and transition strategy to this audience.

A critical component of the education and implementation program will be the field testing of blueberry IPM programs that do not use azinphosmethyl. For these to have the maximum visibility and impact, implementation sites will be distributed in five regions of Michigan at the farms of influential growers who currently rely on azinphosmethyl. Fields will be selected in collaboration with the Transition Team, and the cooperating grower will select a field that has a history of pest pressure. These fields will be managed by the grower using annually-updated Best Management Transition Practices as developed by the Transition Team. At the start and end of each season, the transition team members will meet with the cooperating growers to review progress and chart the future transition course for implementation on these plots.

Measurement of pest management success will be made on the transition plots as well as on a nearby field managed under the grower's typical management regime. We will follow methods developed and refined during the recent Blueberry RAMP project, to determine the effectiveness of the Best Management Transition Practices in terms of pest control. The cost, ease of implementation, and environmental impact of the programs will also be measured and compared among programs.

3. Continued Testing of Alternatives

The MSU Entomology Department scientists conduct multiple research trials each year in small plots of blueberry at the Trevor Nichols Research Complex. This work is supported by the Agricultural Chemical Industry and by the Michigan Blueberry Growers Association. We will continue to evaluate and identify promising candidates for control of fruitworms and other insect pests. We will also continue to apply for research funding to test IPM components including further refinement of a degree-day model for optimal pesticide application timing, cultural controls, and biological controls.

4. Feedback to EPA on Transition Progress

At the annual meeting of the Transition Task Force, and at other times as necessary, a progress report will be prepared for EPA that will describe the current level of production challenges being experienced by the blueberry industry as significant milestones in the phase-out are reached. These will focus on the impacts on blueberry growers as the first restrictions come into force during 2008, and as each successive reduction in allowable AI is reached, and when aerial application is banned. Anonymous surveys of blueberry growers will be conducted at the end of the season when each of these major changes occurs and the results will be made available during the winter to the Transition Team and to the EPA. We consider this feedback to be an essential component of the phase out so that the full impacts of the transition on grower perception of pest management capability can be understood by regulators as they are happening.

5. Funding for Transition

The Northcentral IPM Center has committed to support the initiation of this transition. This important seed funding will help to get the transition team formed, arrange meetings to analyze the current role of azinphosmethyl in this system, and prioritize our future direction. We will work this winter to identify additional funding to enable the full transition plan described above to move forward. We are investigating potential sources of commodity, state, regional, and national funding to put this plan in motion but time is not on our side. The phase-out of azinphosmethyl will have its first impacts on blueberry producers in late May 2008 when fruitworms begin to infest blueberries.