Azinphosmethyl Transition Strategy for Washington State Apple Production

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The azinphosmethyl (AZM) transition strategy outlined in this document focuses on the production of fresh market apples in Washington State but could be relevant to apple production in other states within the western region, especially the Pacific Northwest.

Currently the only pest targeted for control by AZM is the codling moth, *Cydia pomonella* (L.). Codling moth is the key pest in western apple production, meaning that pest control programs in apple are centered on its control. While some other pests are suppressed by use of AZM, e.g. San Jose scale, *Quadraspidiotus perniciosus* (Comstock) and leafrollers, *Choristoneura rosaceana* (Harris) and *Pandemis pyrusana* Kearfott, their control does not rely upon AZM. AZM does not control other apple pests because, in general, they have developed high levels of resistance to organophosphate insecticides. Table 1 gives a list of pests of apple along with organophosphate insecticides recommended as controls and a list of alternatives. It is clear from this table that there are alternatives to organophosphate insecticides for codling moth control and a list of althernatives.

Table 1. Organophosphate products use to control codling moth and in Washington and available alternatives.

Apple Pest Control Comparisons		
Pest name	**OP control tools**	**Alternative control tools**
Codling moth	Guthion, Imidan	Esteem, Rimon, Horticultural oil, Assail, Calypso, Intrepid, CM virus (Virosoft, Cyd-X, Carpovirusine), Entrust (organic only), pheromone products, ***Altacor, Delegate***

A strategy of managing codling moth without use of AZM cannot logically be separated from the management of leafrollers since there are AZM alternatives that will provide coincidental control of both pests.

Pheromone technology

Pheromone technology has been adopted as a standard practice in codling moth management in Washington. It is estimated that roughly 70% of apple acreage is treated with pheromone technology as part of a codling moth management program. This technology is considered foundational for a sustainable pest management program in apple and is regularly supplemented with insecticide applications to keep codling moth damage at acceptable levels. Pheromone technology is not considered a "stand alone" control for codling moth as a replacement for AZM but is considered a key element in a codling moth management program using alternatives to AZM.

There are no known technical or regulatory barriers to using pheromone technology since it is an accepted practice worldwide for codling moth control.

A significant barrier to a fuller adoption of pheromone technology for codling moth control lies in the technologies cost, which is approximately $100 per acre for a full rate.

Alternative Insecticides

There are 8 alternatives recommended for control of codling moth, either directly or as supplements to pheromones, in Washington (WSU EB-0419). In addition, at least two additional products, Altacor and Delegate, will be registered for use in 2008. Not all of these products provide equal levels of codling moth control and some like virus require multiple applications as supplements to a pheromone treatment. In addition, not all insecticides registered for use against codling moth are recommended by WSU either because they do not fit our IPM program or they are not considered efficacious under our conditions and requirements of producing high quality fruit. This is especially true for synthetic pyrethroids, which while effective against codling moth are disruptive of integrated mite control by killing predatory mites.

In Table 2 the AZM alternatives are listed along with some insecticides (in italics), which are solely used for leafroller control. This table shows the chemical class and a code indicating a mode of action classification developed by IRAC.

Table 2. OP alternative insecticides and their classification by mode of

Trade name	MOA code[2]	Class	Activity
Assail	4A	neonicotinyl	disrupt never transmission
Calypso	4A		
Rimon	15	Insect growth regulator	chitin inhibitor
Intrepid	18		molt accelerator
Esteem	7C		juvenile hormone mimic
Delegate[1]	5	spinosyn	disrupt nerve transmission
Success	5		
Proclaim	6	avermectin	disrupt nerve transmission
Altacor[1]	28	anthranilamide	disrupt muscle action
HMO	NC3	biologicals	asphyxiant
virus	NC2		viral infection
Bt	11		disrupt midgut function

[1] Delegate and Altacor are expected to be registered in 2008

[2] Different number and letter codes designate different modes of action. NC# means these products are not classified but should have different modes of action than other products.

All of the non-italicized products listed in Table 2 are efficacious against codling moth but affect different life stages therefore making timing considerations more complex than when AZM was the primary control tool. The life stages of codling moth and leafroller affected by different AZM alternatives are shown in Table 3. The

insect growth regulators (IGR), Rimon, Intrepid and Esteem, have activity against both codling moth eggs and leafroller larvae and since these life stages occur at the same time in the spring coincidental control of both pests can be obtained with one application. The use of IGR products in an AZM transition strategy is important not only because growers can receive coincidental control of both pests with a single application but also because this group of insecticides offers three modes of action, which are evidently independent, and can be used with other alternatives to develop a sound resistance management strategy designed to conserve the efficacy of newly registered products for as long as possible.

Table 3. OP alternative insecticide activity against CM and LR.

Trade name	CM eggs	CM larvae	LR larvae
Assail	x	X	
Calypso	x	X	
Rimon	X		X
Intrepid	X	X	X
Esteem	X		X
Delegate*		X	X
Success			X
Proclaim			X
Altacor*		X	X
HMO	X		
virus		X	
Bt			X

* products to be registered in 2008.

One barrier to the adoption of new technology by apple growers is cost. AZM has been around for a long time and is inexpensive on a per application basis, about $25 per acre, relative to most new alternatives. The relative cost of AZM and alternatives is shown in Table 4. A relative cost of 1.0 is given to AZM with alternatives represented as some factor more or less expensive. These values were calculated assuming maximum field rates per application of the alternative products and prices based on average retail cost obtained from agricultural chemical distributors.

Added value from AZM alternatives comes in the form of safety for farm workers and the environment and in management of farm labor. The safety factor of AZM alternatives will play an important part of a transition strategy as safer insecticides provide Washington growers options to avoid cholinesterase testing requirements imposed by the state. The short re-entry period (REI, Table 3) for all AZM alternatives is crucial for modern high-density apple production system where hand labor for numerous activities is required throughout the growing season. The added cost of AZM alternatives can be mitigated by achieving control of more than one pest with a single application, such as spring applications of IGRs that kill codling moth eggs and leafroller larvae. There are other ways of reducing costs of AZM

alternatives by strategies that use tank-mixes of ovicides (IGRs) and larvicides to save a trip through the orchard.

Table 4. Relative cost, safety category and re-entry intervals for different AZM alternatives.

Trade name	Relative $	Tox. category	REI
Guthion (AZM)	1.0	I	14 days
Assail	2.1	III	12 hours
Calypso	1.7	II	12 hours
Rimon	2.2	II	12 hours
Intrepid	1.6	IV	4 hours
Esteem	2.1	IV	12 hours
Delegate*	??	IV	*12 hours*
Success	1.4	IV	4 hours
Proclaim	1.8	III	48 hours
Altacor*	??	IV	*12 hours*
HMO	0.2	III	12 hours
virus	1.2	IV	4 hours
Bt	0.7	IV	4 hours
* products to be registered in 2008.			

A biological barrier to the transition to AZM alternatives comes in the form of disruption of integrated (chemical plus biological) control systems that have been stable in Washington apple orchards for decades. Some of the AZM alternatives have been shown to disrupt integrated mite management (IMM), which relies upon biological control of spider mites while maintaining chemical control of key pests like codling moth and leafrollers. The neonicotinyl insecticides, Assail and Calypso, have been specifically implicated in the disruption of IMM. There is increasing evidence that the Rimon is also contributing the disruption of IMM. This is important because if growers switch to AZM alternatives and then have to apply specific miticides for spider mite control their pest management costs can increase significantly. While there is on-going research investigating ways to minimize the negative effects of AZM alternatives on IMM and other biological control systems in apple orchards, the negative effect of certain AZM alternatives on IMM is a good example of increased risks associated with an AZM transition effort. If growers opt to not use certain AZM alternatives because of the negative impact on programs like IMM they will use the remaining AZM alternatives more often increasing the probability of codling moth developing resistance to these alternatives faster than might otherwise have occurred.

Probably the greatest immediate barrier to the adoption of AZM alternatives is concerns over access to export markets. Washington exports approximately 35% of it apple crop annually. The export market is crucial to maintaining good prices. Most AZM alternatives that are, or soon will be registered, do not have tolerances or MRLs

established in foreign countries. Without these tolerances it is possible that fruit containing residues of AZM alternatives would not be allowed access into certain countries. The Northwest Horticulture Council is working hard on this issue with registrants but the EPA or other government agency should also see this as a high priority if they desire to encourage AZM transition efforts.

Various approaches for transitioning apple pest management programs have been developed based on research conducted at the Washington State University Tree Fruit Research and Extension Center. These approaches have been summarized at a web site - http://entomology.tfrec.wsu.edu/op-alternative/. This material can also be downloaded as a pfd. In addition, Vince Jones has led a team effort to develop a new web-based Decision Aid System (DAS) for pest management (http://das.wsu.edu/). This system uses real time weather provided by the Washington Sate University Ag Weather Net (http://weather.wsu.edu/). DAS provides growers the opportunity to automatically run predictive models and interfaces the model output with management recommendations and then provides access to the pesticide recommendations for a pest. The DAS provides the user with a non-organophosphate filter option for pesticide choices, making it easier to implement an AZM transition plan.

Proposed AZM Transition Plan

This proposal recognizes barriers to the adoption of new pest control technologies but offers a program of education, implementation and assessment (documentation) that can overcome these barriers and move the apple industry towards a pest management system that reduces reliance on AZM. The technology to move forward with a replacement of AZM in apple is currently available and will become even more robust with the registration of new insecticides. Leadership in the Washington apple industry recognizes the need to move proactively to help growers adopt new technologies for pest control. Adoption of AZM replacement technologies is already occurring within a segment of the apple industry, and understanding the benefits and problems faced by these growers will help others in the adoption process. Promoting change in practices based on adoption of any new technology is a challenge, and it becomes even more daunting when the end user does not fully understand and therefore trust the new technology. Thus, **education** to address the reasons why and how to best use new pest control technologies needs to expand and reach the appropriate target audiences with a depth that builds understanding and trust. The experience in the adoption of mating disruption (MD) for codling moth control demonstrated the value of large and well-coordinated **implementation** efforts where growers learned from their peers and visited locations where programs are actually being used. Sustainability of a pest management system based on new pest control technology will depend in large part on understanding its value. Therefore the transition plan proposes a significant **assessment** component that will focus not only on pesticide use but also on changes in practices and attitudes. While technical leadership is in place, the existing capacity within WSU (TFREC and CSANR) cannot meet the demands of an effort to fully implement the proposed transition plan. Providing a relevant administrative structure will increase the success of a project seeking to implement changes in practice that are in many respects profound and complex. Therefore an **administrative** structure

comprised of a broad range of partners is anticipated as being part of an AZM transition plan.

Elements of a Pest Management Transition Plan:

1. **Administration** – provides a structure for project management and supervision.
2. **Education/Communication** – transmit knowledge of tools and their proper use.
3. **Implementation** – identify the strategies to be used in the apple cropping system, including alternatives for pest targets.
4. **Assessment** – identify risks and social and economic benefits, justification of provisos for continued limited access to AZM.
5. **Research** – continued development of new control tools and other related activities already being actively pursued or proposed for funding.
6. **Funding** - $550,000 has been obtained from the Washington state legislature to support a two-year project to assist growers in this transition plan.

Administration: An Executive Committee will be formed of key leaders and charged with project oversight. The Executive Committee will provide project oversight including hiring of personnel, establishing policies and ensuring that the objectives of the project are met. Technical Partners, apple industry representatives and representatives of appropriate environmental and farm worker representatives will comprise an advisory board, which will actively interact with the Executive Committee and Project Manager on project direction.

Education/Communication: A concerted educational effort will be needed to expand the knowledge and understanding of new pest control technologies, specifically how to use them in a program to transition away from reliance on AZM. This effort will include directed workshops where new technologies and their proper use are taught in depth using effective teaching methods. Educational materials will accompany the workshops as take-home reminders and references. Part of the education effort will extend into the field season with field study tours focusing on management/technology, implementation and assessment. A newsletter (paper and electronic) highlighting new developments, experiences of growers, and notices of educational opportunities in different areas will be published on a regular basis. Information will also be made available on the web and through the newly developed internet-based Pest Management Decision Aids System. The educational effort will be directed at orchard owner/operators (small and large scale), orchard management staff, and private sector technical consultants. Each of these target audiences will require a specific educational approach. Additionally, to maximize the educational impact, program and educational materials will be prepared to fully engage Spanish-speaking audiences. Most of the technical information is available, and some of the educational materials that would be needed are currently available or could be developed with additional capacity and effort. Communications with all stakeholders will be a part of the educational effort. Understanding the complexity of changing pest control programs and barriers that growers face with implementation of the new technologies will help build a culture of trust and respect.

Implementation: A specific plan for transitioning pest control programs away from AZM will be developed in conjunction with the apple industry and technical partners. Implementation units (made up of volunteers and recruited growers) will be identified to initiate the project. These units will consist of growers/managers in all apple production areas of the state. Strategies for managing different pest situations will be developed and workshops will be held with the implementation units prior to and following each field season. Additionally, there will be in-season communication with members of the implementation units and regular in-field meetings to go over strategic direction at key points in the season. Goals will be established for reducing dependence on AZM with each implementation unit based on their knowledge, pest problems and trust level. New implementation units, or the expansion of original units, will be added to the project in years two and three. The implementation sites used in the first years of the project will serve as education/demonstration sites for field days where growers within different regions of the state can meet to discuss successes and how to deal with failures of the transition programs.

Assessment: The impact of implementing new pest control technologies will be based on measuring 1) crop protection (efficacy of pest control), 2) conservation of beneficial insects, 3) economics of production practices, 4) perceptions of farm workers and growers, and 5) reduction of economic and environmental risk. This part of the project would document all elements of the pest control program, including products used, timing, rates, efficacy (field assessment of injury and packouts), pest monitoring, cost of programs, and social aspects such as labor management, ease of use of products, and overall satisfaction or lack thereof associated with the transition program.

Research: There will be a continuing need to pursue research in areas directly related to the implementation of an AZM transition effort, however, research topics are not identified in this document.

Funding: The anticipated length of an AZM project is 3 to 3.5 years. A budget has been prepared anticipating the major elements of an AZM transition effort for apple production in Washington (Table 5).

Table 5. Proposed funding for an AZM transition project for apple production in Washington.

Draft Budget (July 2007-December 2010)	Annual	Total
Personnel		
Project Coordinator for Education and Communication (3.5 years)	65,000	227,500
Implementation Specialist (3 years)	50,000	150,000
Implementation Specialist (3 years)	50,000	150,000
Clerical (3 years)	35,000	105,000
Temporary labor (3 years)	40,000	120,000
Economist (3 years)	32,000	96,000
Graduate student (PhD) (3 years)	25,000	75,000
Employee Benefits		
Project Coordinator for Education and Communication	19,800	69,300
Implementation Specialist	18,000	54,000
Implementation Specialist	18,000	54,000
Clerical	12,600	37,800
Temporary labor	4,400	13,200
Economist	10,880	32,640
Graduate student	2,000	6,000
Operations		
Educational materials production	10,000	30,000
Educational workshops	10,000	30,000
Field educational events	2,000	6,000
Monitoring supplies	7,000	21,000
Vehicle rental, maintenance and fuel	20,000	60,000
Cell phone service	3,600	10,800
Equipment		
Computers & printers (3), GPS (2), Phones (3), etc.	6,000	6,000
ATVs (2)	8,000	8,000
Digital cameras (3)	1,200	1,200
Total	$452,080	$1,363,440

Activities and Timing: Table 6 provides a rough schedule of proposed activities that are envisioned to occur in this project.

Table 6. Proposed activities associated with an AZM transition effort in apple production in Washington.

Activity	Time Line
Form Advisory Board: Individuals from stakeholder groups will be identified by the Executive Committee and Project Manager and asked to serve on an advisory board.	Summer of 2007 and active through next four years.
Establish a baseline: Conduct a survey of insecticide use for the 2006 season to be used as baseline data to document change and for help in establishing realistic targets of an AZM transition effort in apple.	Winter of 2007 and spring of 2008.
Adoption working group: Establish a working group of people already implementing a pest management program using AZM alternatives. Help to identify successful activities, pros, cons and future needs to sustain such programs.	Winter of 2006 and continuing through 2009, building in new participants as adoption increases.
Education effort workshops: Conduct intensive and focused educational workshops on tools and methods for implementing AZM transition pest management programs in Washington tree fruit crops.	Winter of 2007-09 and continuing in off-season as needed.
Education effort delivery: Develop educational materials (manuals, web-based products, etc.) that support the implementation of AZM transition programs for all Washington fruit crops.	Initial efforts in winter of 2007-08 with revisions updated and new information added as it becomes available in next two years.
Implementation: Carry out an action plan for the transition of apple pest management programs to alternatives.	Establish implementation units in fall of 2007 and form new units each production season until transition goals are achieved.
Assessment: Document change in practices, costs and risks associated with the AZM transition effort in each tree fruit crop.	2008 production season and each production season until transition goals are achieved.
Reporting: Produce annual report of the AZM transition effort to the apple industry and state and federal partners providing funding.	At the end of each production season with final report at the end of the project.