Review of New Insecticides Under Field Development For Desert Vegetable and Melon Production

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Abstract

The efficacy and field performance of new insecticides for control of insects on vegetables and melons under desert growing conditions has been investigated in small plot trials for the past several years at the Yuma Agricultural Center. Our objective has been to determine how new chemistries will fit into the growers management programs in Arizona. Thus, our research programs have been focused on studies to determine how to integrate these new chemicals into our local management programs in the most cost/effective way possible. This document was created to provide you with an overview of new insecticide chemistries being developed by the Agrichemical Industry for use in vegetables. The first part of this report concisely describes the new types of chemistries being developed. The tabular information presented is a summary of the efficacy and activity of the new compounds based on research we have conducted at the Yuma Agricultural Center.

Introduction

The number of effective insecticides currently available to growers for insect control in melons and vegetables is relatively small compared with other crops. Furthermore, with the uncertainty surrounding the recent passage of the Food Quality Protection Act, as well as increasing environmental concerns, the vegetable industry in the western U.S. could potentially be facing the loss of a number of important insecticides. Consequently, there is speculation that some of the more broadly toxic compounds may be removed from the market in the next few years, and the organophosphate and carbamate insecticides are being targeted as prime candidates for reduced usage. As these older chemicals are lost, the introduction of replacement products that can live up to both regulatory and grower standards will be critical. Fortunately, there are several new insecticides currently being tested under experimental conditions, that offer excellent activity on many of the key pests that infest desert vegetables and melons.

Over the past several years, whiteflies and aphids have not been a significant problem to growers largely because of the development of Admire under our desert growing conditions. Similarly, the new insecticides now being developed by the Agrichemical industry have demonstrated good activity on the lepidopterous pests (*beet armyworms, cabbage looper)* and leafminers. Most recently, new products are being developed for control of *thrips and aphids* with demonstrable efficacy. In most cases, these insecticides are only a few years away from registration on leafy vegetables and melons.

The performance of these products on vegetables under desert growing conditions has not been thoroughly investigated. In addition, we as researchers are not certain how they will fit into the growers management programs in Yuma. Thus, our research programs have been focused on studies to determine how to integrate these new chemicals into our local management programs in the most cost/effective way possible. This document was created to provide you with an overview of new insecticide chemistries being developed by the Agrochemical Industry for use in vegetables. The tabular information presented below is a summary of the efficacy and activity of the new compounds based on research we have conducted over the past several years.

The first part of this report concisely describes the new types of chemistries being developed by Industry. The descriptions list the new and existing chemistries (in bold) based on the most current information available to the public. Under each category are listed the individual compound that have been tested. All insecticide compounds listed in this review are identified by their Common name (italicized and lower case), Trade name (if available shown in Upper case) or Code Letter/Number which identifies a compound in early development.

I. Conventional Chemistries

Carbamates (APHISTAR, *triazimate*; MESUROL, *methiocarb*). These products belong to the carbamate chemistry which has been developed for over 40 years. They are neurotoxic and similar to organophosphates in that they inhibit cholinesterase. *Methiocarb* is best known for slug and snail control in ornamentals, as well as for bird repellency. It has a federal label for control of aphids and mites in ornamentals. *Triazimate* is a potent systemic aphicide that is highly selective and relatively fast acting. It is mobile within the plant and is safe towards beneficial insects.

II. Novel Insecticide Chemistries

Chloronicotinyls (AMIRE, PROVADO, *imidacloprid;* NI-25, *acetamiprid; CGA 293343*): This class of neurotoxic compounds have a mode of action similar to nicotine, and are highly effective systemically against sucking pests. *Imidacloprid* is most effective on aphids and whiteflies through root uptake, but does have translaminar and contact activity as a foliar spray. *Acetamiprid* is a new insecticide being developed by Rhone-Poulenc that is more broad spectrum with both contact and systemic activity via foliar application. *CGA 293343* is a new insecticide being developed by Novartis that is systemic in the plant by root uptake and transport in the xylem. It is supposedly more mobile in the soil than imidacloprid.

Pyrroles (ALERT, *chlorfenapyr*): The pyrroles are compounds that act as metabolic toxins and work by uncoupling oxidative phosphorylation in the mitochondria. They have translaminar activity, and are toxic both by contact and ingestion to chewing and sucking arthropods. A Section 3 label on cotton is presently pending.

Pyridazinone (SANMITE, *pyridaben*): This compound is a non-systemic acaricide and insecticide that is a metabolic toxin acting as a Mitochondrial Site I uncoupler. It is relatively selective on mites, aphids and whiteflies. It presently is registered for use on apples and citrus.

Phenyl pyrazoles (REGENT, *fipronil*): A a broad spectrum neurotoxin that works as a GABA agonist. It has contact active on both chewing and sucking insects. It has shown excellent potential for lygus bug on cotton and thrips in vegetables. It is currently registered for use in the Ag/Vet market.

Amino triazinones (FULFILL, *pymetrozine*): A highly selective, anti-feeding compound with a unique mode of action, acting specifically on the salivary pump of sucking insects causing rapid cessation of feeding. It is slow acting, but has both contact and systemic activity on aphids and whiteflies.

III. Insect Growth Regulators (IGR)

Non-traditional IGRs *(*APPLAUD, *buprofezin):* A thiadizine like compound with long residual activity that acts as a chitin synthesis inhibitor. The product has both contact and vapor activity and primarily active against some sucking insects. It currently has a Section 18 registration in Arizona on cotton.

Hormone Analog IGRs (CONFIRM, *tebufenizode;* NEEMIX; *azadirachtin*, STERLING; *fenoxycarb*, KNACK; *pyriproxyfen*): These compounds are active through the disruption of insect hormonal systems, such as the ecdysone, and juvenile hormone mediated processes that govern metamorphosis in insects. They are very selective and are generally slow acting. *Tebufenozide* is an ecdysone agonist that inhibits molting with selective activity against lepidopterous larvae. It is easy on beneficial insects and recently received a Section 18 registration in Arizona on lettuce. *Azadirachtin* is a naturally occurring botanical that acts as an analog of ecdysone with some activity against

a wide range of pests. It is currently registered as NEEMIX for use on vegetables. *Fenoxycarb* is a non-neurotoxic carbamate which affects the molting process. It is being developed as a companion with *pymetrozine* and will be labeled as STERLING for whitefly control in the US. *Pyriproxyfen* is a selective juvenile hormone analog active by suppressing embryogenesis of females and interrupting normal metamorphosis of whiteflies. It currently has a Section 18 registration for California and Arizona on cotton.

IV. Biological Pesticides

Bacterial insecticides (Bt's): New strains of Bt are still being discovered that have activity against key vegetable pests. New toxin genes such as Cry IH, Cry IJ and Cry IK are being developed by several companies. A new strain of *B.t. aizawai* (Serotype H7) was recently released as XENTARI with increased activity against *Spodoptera*. Most recently, a new Bt active against armyworm and looper, CRYMAX, was developed from genetically recombined strains of *Bt kurstaki*.

Fungal insecticides (*Beauveria bassiana*): There are several species of fungi that are pathogenic against insects that have been investigated in vegetable crops. Many of them are still years away from commercial development. MYCOTROL (*Beauveria bassiana*) is a product recently registered on vegetables that has selective activity on aphids and whiteflies. The fungal spores need to come in direct contact with the target pest and require moderate-high levels of relative humidify to be efficacious in the field.

V. Natural Products

Botanicals (NEEMIX; *azadirachtin*): This IGR (see above) is derived from seed of the neem tree.

Fermentation Products (SUCCESS; *spinosad*, PROCLAIM; *emamectin* benzoate): *Spinosad* is a neurotoxic compound produced through a fermentation process by the naturally occurring soil bacterium *Saccaroplyspora spinosa*. It has translaminar activity on lepidopterous larvae and leafminers on vegetables. *Emamectin* is an avermectin (Agrimek) analogue that is derived from the naturally occurring soil microorganism, *Streptomyces avermitilis*. It is also a neurotoxin that has translaminar activity primarily against lepidopterous larvae.

VI. Transgenic Crops

Advances have been made to develop genetically altered vegetable crops with resistance to pests (eg. Bt potato, Bt sweet corn). However, varieties specific for Arizona cropping systems have not been released for field evaluation. We do expect to see transgenic Bt crops such as cabbage and lettuce to be field developed in the next several years. Other transgenic toxins are also being developed by the seed industry.

Table 1. Insecticides Being Developed for Management of Beet Armyworm and Cabbage Looper in Lettuce and Cole Crops.

Product	Active ingredient	Formulation tested	Mode of Action	Primary activity	Rates tested[a]	Field efficacy[b]	Registration status
Alert	chlofenapyr	2 SC	metabolic	translaminar	0.10-0.15	BAW: excellent CL: excellent	1996 EUP, no AZ label
Success	spinosad	NAF 295, 1.6 DE	neurotoxic	translaminar	0.09	BAW: excellent CL: excellent	1995 EUP, no AZ label
Proclaim	emamectin	0.16 EC 5 G	neurotoxic	translaminar	0.0075	BAW: excellent CL: excellent	1996 EUP no AZ label
Confirm	tebufenozide	70 WSP 2 F	Hormone agonist	ingestion	0.06-0.125	BAW: excellent CL: moderate	1997 Sec 18 in AZ
DPX-MP062	?	30 WDG	neurotoxic	ingestion	0.025-0.090	BAW: excellent CL: excellent	no AZ label
Crymax	*Bt 'kurstaki'*	WDG	Infection, septicemia	ingestion	1.0 lb. product	BAW: moderate CL: excellent	Labeled for use in AZ
Neemix	azadirachtin	4.5EC	Hormone agonist	ingestion, contact	1.0 pt. product	BAW: fair CL: fair	Labeled for use in AZ
Lannate	methomyl	90S	neurotoxic	contact	0.6- 0.75	Commercial standard	Labeled for use in AZ
Larvin	thiodicarb	80DG, 3.2EC	neurotoxic	ingestion	0.75	Commercial standard	Labeled for use in AZ

[a] rate/acre expressed as lbs. AI unless otherwise noted.

[b] efficacy compared to commercial standards; Excellent, >90% control after 5 days exposure in field; Moderate, 50-85% ; Fair, <50%.

Table 2. Temporal Mortality ("knockdown") of Beet Armyworm and Cabbage Looper to New Insecticides Being Developed in Lettuce.

		Days to achieve > 90% larval mortality[a]					
		Beet armyworm larvae		Cabbage looper larvae		Cabbage looper larvae (10 mm)	
Product	Rate	small (<5 mm)	large (10-15 mm)	small (<10 mm)	large (>15 mm)	small plants (thinning)	large plants (heading)
Alert	0.15	1	1	1-2	1-2	1	3
Success	0.09	1-2	2	1-2	1-2	2	3
Proclaim	0.0075	1-2	1-2	1-2	1-2	1	3
Confirm	0.125	3-4	5	3-5	5>	4	--
DPX-MP062	0.065	3	2-3	2	3	2	[redacted]
Crymax	1 lb. prod	--[b]	--	5	5>	5	--
Neemix	1 pt. prod	--	--	--	--	--	--
Lannate	0.75	1-2	--	--	--	--	--
Larvin	0.75	2-3	2-3	3-4	5	3-4	4

[a] mortality was recorded for a 5 day period following treatment.

[b] >90% control was not achieved at 5 days after treatment; see Palumbo, J.C. and D.L. Kerns. 1996. Temporal activity of new insectcides chemistries against beet armyworm in lettuce,143-146. *In* N.F. Oebker (ed) 1996 Vegetable Report. University of Arizona, College of Agriculture Series P-104.

Table 3. New Insecticides Being Developed for Whitefly in Vegetables and Melons

Product	AI	Formul. tested	Mode of action	Primary activity	Rates tested/ application	Lifestage activity	General Efficacy
Admire	imidacloprid	2F	neurotoxic	systemic-ingestion	0.25-0.32 Soil incorp.	Adults, nymphs	Commercial standard; prevents colonization for up to 50 days
NI 25	acetamiprid	80 WP	neurotoxic	systemic-ingestion	0.5-0.075 foliar	Adults, nymphs	good on melons and cole crops with repeated application
Sterling	fenoxycarb+ pymetrozine	40 WP 50 WP	IGR anti-feedant	contact, systemic	0.09 + 0.06 foliar	adults, nymphs	good on melons with repeated application
Knack	pyriproxyfen	0.83 EC	IGR, Juvenoid	translaminar	0.5-0.66 foliar	nymphs, egg	good on melons, cole crops; 14-21 d residual
Applaud	buprofezin	70 WP	IGR, chitin synthesis	contact, vapor	0.25-0.38 foliar	nymphs	good on melons; 14-21 d residual
SanMite	pyridaben	75 WP	metabolic	unknown	0.15-0.30 foliar	unknown	good on melons with repeated application
Mycotrol	*Beauvaria bassiana*	WP	fungal infection	contact	1.0 lb prod. foliar	nymphs	fair on melons; requires high humidity and good coverage

Table 4. Insecticides Being Developed for Leafminer in Vegetables and Melons.

Product	AI	Formul. tested	Mode of action	Primary activity	Rates tested/	Lifestage activity	General Efficacy
Agrimek	abamectin	0.15 EC	neurotoxic	translaminar	0.009 (8 oz)	larvae, adult suppression	Commercial standard; labeled for use in AZ
Trigard	cyromazine	WSP	IGR	systemic	0.125	larvae	Comparable to Agrimek; labeled for use in AZ
Neemix	azadirachtin	4.5EC	Hormone agonist	ingestion, contact	1.0 pt. product	Larvae-pupae	Fair control, slow, prevents adult emergence; AZ Label
Success	spinosad	NAF 295, 1.6 DE	neurotoxic	translaminar	0.09	Larvae, adult suppression	Comparable to Agrimek on *L. sativa*; no AZ label
Proclaim	emamectin	0.16 EC 5 G	neurotoxic	translaminar	0.0075	Adult	marginal suppression; no AZ label
Alert	chlofenapyr	2 SC	metabolic	translaminar	0.10-0.15	Adult	marginal suppression; no AZ label

Table 5. New Insecticides Being Developed for Aphids in lettuce, cole crops, and spinach.

Product	AI	Formul. tested	Mode of action	Primary activity	Rates tested/ application	General Efficacy
Admire	imidacloprid	2F	neurotoxic	systemic-ingestion	0.25-0.32 Soil incorp.	Commercial standard; prevents season-long colonization and head contamination
Provado	imidacloprid	1.6 F	neurotoxic	translaminar	0.05(3.75) oz foliar	Comparable to Admire; control depends on spray timing (7-14 d residual activity)
NI 25	acetamiprid	80 WP	neurotoxic	systemic-ingestion	0.5-0.075 foliar	Control comparable to Admire in lettuce with repeated applications
Fulfill	pymetrozine	40 WP 50 WP	anti-feedant	contact, systemic	0.06 foliar	Control comparable to Admire in lettuce with repeated applications
Aphistar	RH-7988	50 WP	neurotoxic		0.10 foliar	Control comparable to Admire on lettuce with repeated applications

Table 6. Insecticides Being Developed for Potential control of Western Flower Thrips on lettuce (Preliminary findings; spring 1997)

Product	AI	Formul. tested	Mode of action	Primary activity	Rates tested/ application	General Efficacy
Lannate+ Ammo	methomyl+ cypermethrin	90S 2.5EC	neurotoxic	Contact	0.75+0.1 Foliar	Commercial standard; provides >80 % control of adult and nymphs for 5-7 days
Fiprinil	phenyl pyrazole	80 WDG	neurotoxic	contact, ingestion	0.05 foliar	Comparable to Lannate/Ammo at 7 days
Success	spinosad	NAF 295,	neurotoxic	translaminar	0.07-0.13 Foliar	High rates comparable to Lannate/Ammo at 7 days
Alert	chlofenapyr	2 SC	metabolic	translaminar	0.10-0.15 Foliar	Moderate control (60%) of adults at 7 days; poor control of nymphs.