Co-Application of the Diamide Insecticides in Processing Snap Beans

January 15, 2015

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Wisconsin Crop Management Conference and Agri-Industry Showcase

Building Market Foundations for Sustainable Vegetable Production and Processing: A Consumer and Metrics-Based Approach

B. Bland, A. Bussan, J. Colquhoun, H. Dillard, A. J. Gevens, R. Groves, W. Hutchison, J. Kikkert, P. Mitchell, B. Nault, P. Nowak, F. Pierce, M. Ruark, T. Waters, C. Wohleb, C. Yue, and P. Zedler

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Goal. ***"Enhanced potential for improved efficiency, productivity, and profitability for the vegetable production and processing industry based on an improved understanding of the role of consumer markets"***

Approach. ***"Beginning with the market, work with growers, processors, and distributors to explore how to generate market rewards through science-based sustainability that is measurable and profitable"***

Specialty Crop Research Initiative
UW-Madison

http://ipcm.wisc.edu/scri/

USDA United States Department of Agriculture
National Institute of Food and Agriculture

Project Objectives

Objective 1. Identify consumer preferences and willingness to pay for sustainably produced and processed vegetables and quantify market segments

Objective 2: Create and test sustainability assessment tools and sustainability metrics for commercial vegetable growers

Objective 3: Validate and improve the relationship between practice-based sustainability assessments and environmental and economic outcomes at the farm scale in each region

- Implement sustainable practices to identify opportunities for improved water, nitrogen, and pesticide use efficiency at the field and farm level (Bland, Colquhoun, Mitchell, Ruark)
- Refine sustainable production practices to reduce environmental and economic risk (Bland, Colquhuon, Hutchison, Groves, Gevens, Nault, Ruark)

Objective 4: Build critical mass of support for sustainably grown and processed vegetables.

Factors Influencing Insect Pest Management
'Food Safety and Residues'

– **Major food retailers are setting acceptable residue levels below those set by government regulatory agencies.**

"No detectable residues" will be a competitive advantage for food retailers.

– **Older insecticides that do not meet these requirements are not being re-registered, resulting in increased use of novel insecticides** ***(reduced-risk & bio-pesticides).***

Neonicotinoid Insecticides in the News


U.S. ENVIRONMENTAL PROTECTION AGENCY

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Colony Collapse Disorder: European Bans on Neonicotinoid Pesticides

Several European countries have suspended the use of certain pesticides in response to incidents involving acute poisoning of honey bees. To EPA's knowledge, none of the incidents that led to suspensions have been associated with Colony Collapse Disorder. The following are the countries in which pesticides have been suspended, the pesticides in question, and the current registration status for the pesticide:

France - Sunflower and corn seed treatments of the active ingredient imidacloprid are suspended in France; other imidacloprid seed treatments, such as for sugar beets and cereals, are allowed, as are foliar uses.

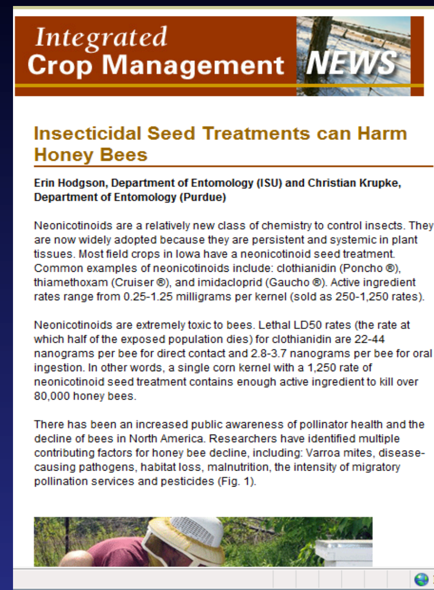
Germany - The use of a number of seed treatment pesticides was temporarily suspended following an incident in May 2008 in which many bees were inadvertently poisoned. However, after investigating the factors contributing to the situation, Germany lifted the suspensions with the exception of the neonicotinoid clothianidin, which remains suspended as a seed treatment for corn.

Italy - Certain imidacloprid and other neonicotinoid seed treatment uses were suspended temporarily, but foliar uses are allowed. This action was taken based on preliminary monitoring studies in northern and southern regions of Italy showing that bee losses were correlated with the application of seeds treated with these compounds; Italy also based its decision on the known acute toxicity of these compounds to pollinators.

Slovenia - Neonicotinoid seed treatments for maize and oil seed rape (canola) were temporarily suspended. The suspension was based on poor seed treatment methods resulting in release of dust during the seed sowing process. In August 2008, the suspension for oil seed rape seed treatments was lifted due to improved seed treatment methods and seed sowing equipment.

Quick Resources
- Honeybee Colony Collapse Disorder
- Pollinator Protection

For more information
- Find out more about colony collapse disorder from the USDA Agricultural Research Service
- Learn about EPA's Pollinator Protection efforts
- EPA Responds to NRDC's 2008 Freedom of Information Act complaint


Integrated Crop Management NEWS

Insecticidal Seed Treatments can Harm Honey Bees

Erin Hodgson, Department of Entomology (ISU) and Christian Krupke, Department of Entomology (Purdue)

Neonicotinoids are a relatively new class of chemistry to control insects. They are now widely adopted because they are persistent and systemic in plant tissues. Most field crops in Iowa have a neonicotinoid seed treatment. Common examples of neonicotinoids include: clothianidin (Poncho ®), thiamethoxam (Cruiser ®), and imidacloprid (Gaucho ®). Active ingredient rates range from 0.25-1.25 milligrams per kernel (sold as 250-1,250 rates).

Neonicotinoids are extremely toxic to bees. Lethal LD50 rates (the rate at which half of the exposed population dies) for clothianidin are 22-44 nanograms per bee for direct contact and 2.8-3.7 nanograms per bee for oral ingestion. In other words, a single corn kernel with a 1,250 rate of neonicotinoid seed treatment contains enough active ingredient to kill over 80,000 honey bees.

There has been an increased public awareness of pollinator health and the decline of bees in North America. Researchers have identified multiple contributing factors for honey bee decline, including: Varroa mites, disease-causing pathogens, habitat loss, malnutrition, the intensity of migratory pollination services and pesticides (Fig. 1).


FARM CHEMICALS INTERNATIONAL

Rainbow Basic Agrochemical Producer Biggest Exporter in China

Glyphosate, 2,4-D, 2,4-DB, Glufosinate, Dicamba, Pick Isoxaflutole, Mesotrione,

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France Plans Ban on Seed Treatment, Escalating Bee Issue

Syngenta: 'Dark day for French and European agriculture.'

June 5, 2012
By Jaclyn Sindrich

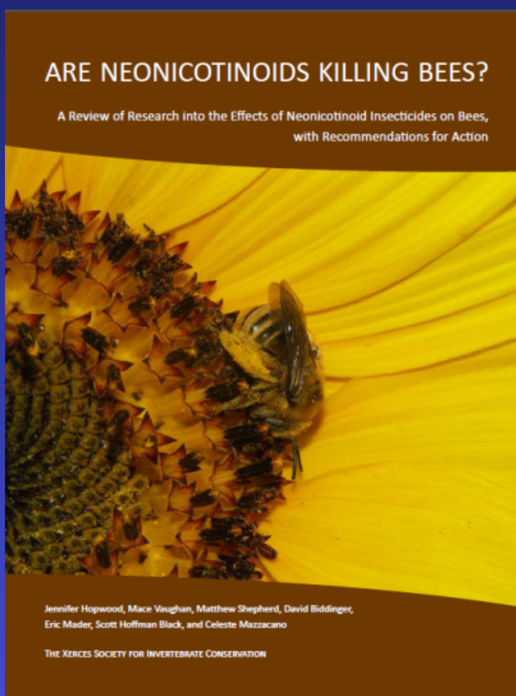
Syngenta's Cruiser OSR seed treatment for oilseed rape faces suspension in France.

According to reports, the French government is set to ban the product on the recommendation of ANSES, the French agency for food, environmental and occupational health and safety. ANSES says it based its decision on one study, published in the journal *Science*, which highlights sub-lethal doses of the active ingredient thiamethoxam on the ability of forager bees to return to the hive.

Thiamethoxam is a neonicotinoid-class insecticide – the type increasingly blamed for the bee malady called Colony Collapse Disorder. However, the underlying causes of CCD are still unclear and most likely manifold, according to most published scientific research.

Syngenta, in an email to *Farm Chemicals International*, called it "a dark day for French and European agriculture and in particular those in the Oil Seed Rape chain … The intention to suspend has been taken on the basis of one experimental study which has not been validated by expert panels and is at odds with the reality in the field."

Related
- Bayer CropScience To Study Colony Collapse Disorder
- BASF, Nunhems Enter Onion Seed Treatment Agreement
- Monsanto, Plant Health Care Partner on Seed Treatment


ARE NEONICOTINOIDS KILLING BEES?

A Review of Research into the Effects of Neonicotinoid Insecticides on Bees, with Recommendations for Action

Jennifer Hopwood, Mace Vaughan, Matthew Shepherd, David Biddinger, Eric Mader, Scott Hoffman Black, and Celeste Mazzacano

The Xerces Society for Invertebrate Conservation


BAYER

Our Commitment to Bee Health

Providing Innovative Solutions for Agriculture Today and Tomorrow

- As a company dedicated to crop production, Bayer is committed to environmental stewardship and sustainable agricultural practices, including protection of beneficial insects and honey bees.
- Scientists are seeking the causes of declining bee health, including a phenomenon described as Colony Collapse Disorder that is affecting colony health predominantly in the United States. Most scientists accept that parasitic mites, diseases, and bee husbandry practices are major factors. We firmly support further research into the role of various pressures on bee health – including insecticides – by working with many stakeholders.
- Bayer is actively involved in finding solutions to enhance honey bee health, including development of a product designed to control the varroa mite. The varroa mite – a relatively new parasite of the honey bee – has spread to most areas of the world within a short time period and is considered a significant factor in losses of honey bees in Europe and North America. At the same time, these mites are rapidly becoming resistant to available treatments.

NEONICOTINOIDS – An Important Class of Insecticides to Help Farmers Manage Harmful Pests That Limit Crop Production and Quality
- A total of 147 million U.S. acres are planted with neonicotinoid-treated seeds.
- Clothianidin is approved by EPA for use on corn, cotton, sorghum, soybean and sugar beets. It is the active ingredient in Poncho® seed treatments, the leading seed-applied insecticide on corn in the United States, increasing corn yields by 6 to 14 bushels an acre. Over 90% of U.S. corn is treated with neonicotinoids (clothianidin and thiamethoxam).

NEONICOTINOIDS NOT LINKED TO COLONY LOSS
- There has been no demonstrated effect on bee health associated with use of clothianidin or other neonicotinoid-based insecticides. In fact, the United States Environmental Protection Agency (EPA) commented recently (February 18, 2011) on clothianidin, affirming that the Agency is "not aware of any data that reasonably demonstrates that bee colonies are subject to elevated losses due to chronic exposure to this pesticide."
- In addition to its use on crops in the U.S., clothianidin is widely used on canola seed crops in Canada, where Bayer retains commercial beekeepers to bring large numbers of bees to the canola fields each year for pollination. No effect on bee colony health has been reported by these beekeepers during their extensive involvement with pollinating clothianidin-treated canola seed.

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Bee Health Home

Neonicotinoid Seed Treatments and Honey Bee Health

Last Updated: August 16, 2012

Have a question? Try asking one of our Experts

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This resource area was created by the Bee Health community

by Greg Hunt and Christian Krupke, Purdue University

CAP Updates: 28

- Jointly published in the American Bee Journal and in Bee Culture, September 2012.

In the last 10-15 years, the EPA has gradually eliminated many uses of several "older" classes of pesticides. These include the widely used organophosphates, a staple of many agricultural systems. This left farmers and chemical companies looking for alternatives. A new class of pesticides called neonicotinoids, or neonics for short, were initially developed in the 1970's. The chemical structure of these is derived from nicotine (also an insecticide, keeps tobacco plants safe from caterpillars) and they are relatively non-toxic to most vertebrates. Most are water-soluble and

Managed Pollinator Coordinated Agriculture Program (CAP) Updates

A National Research and Extension Initiative to Reverse Pollinator Decline

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Honey Bee Health

Accidental and Inappropriate Uses, (Wilsonville, OR, June 2013)

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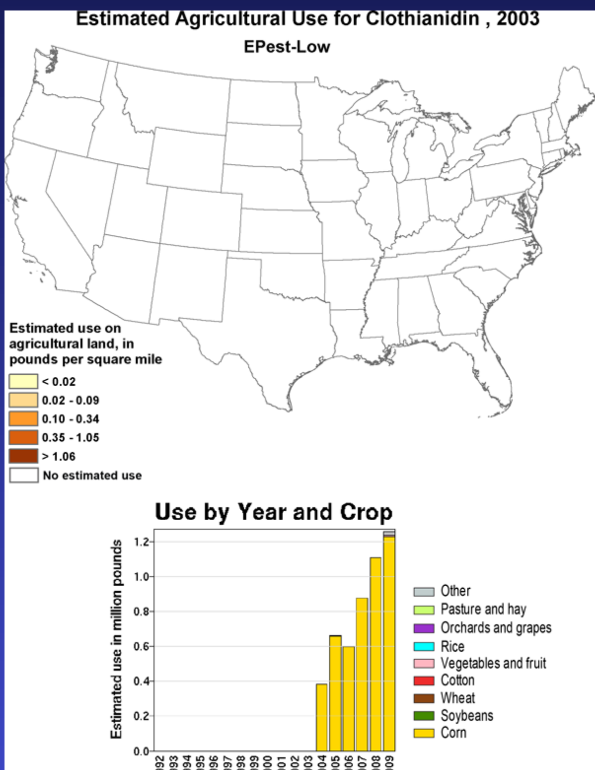
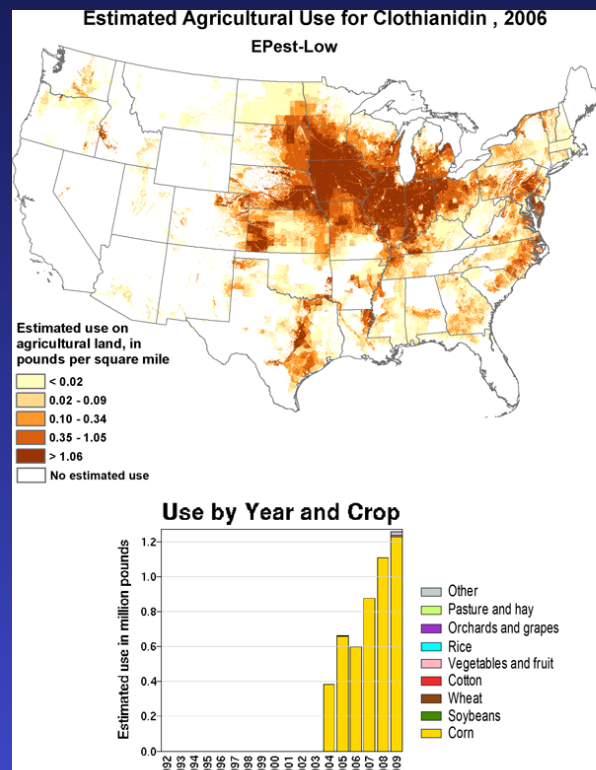
Bumblebee memorial scheduled for Sunday at Wilsonville Target

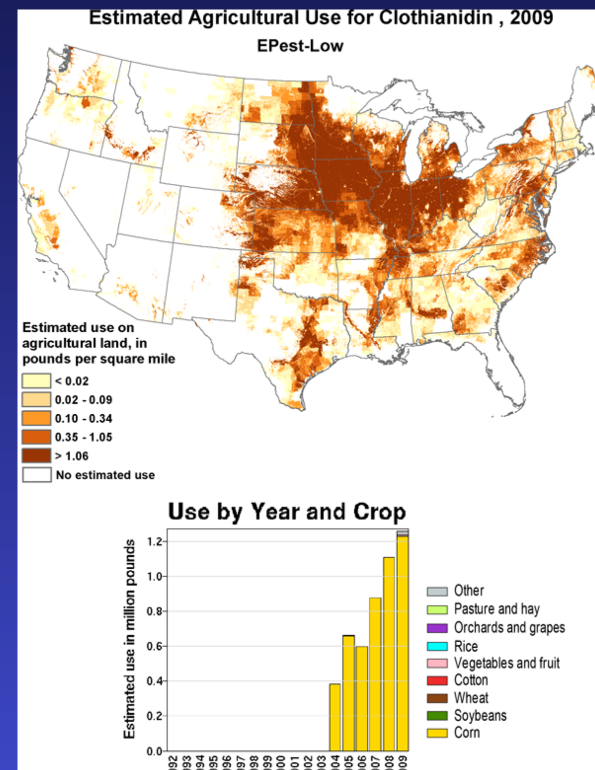
Rich Hatfield, a biologist with the Xerces Society, estimates that over 50,000 bumble bees were killed, likely representing more than 300 wild colonies. "Each of those colonies could have produced multiple new queens that would have gone on to establish new colonies next year. This makes the event particularly catastrophic."

Annual Changes in Crop Uses in the U.S.

Clothianadin: 2003 – 2006 - 2009



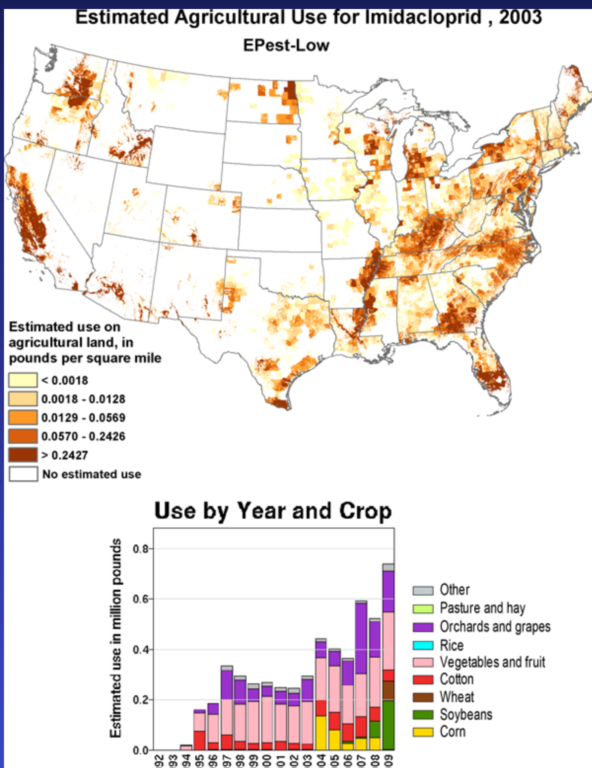


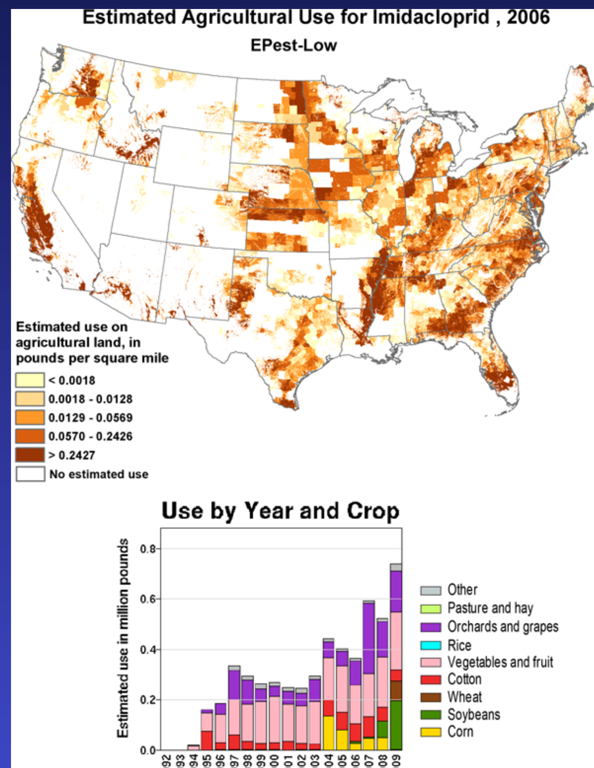


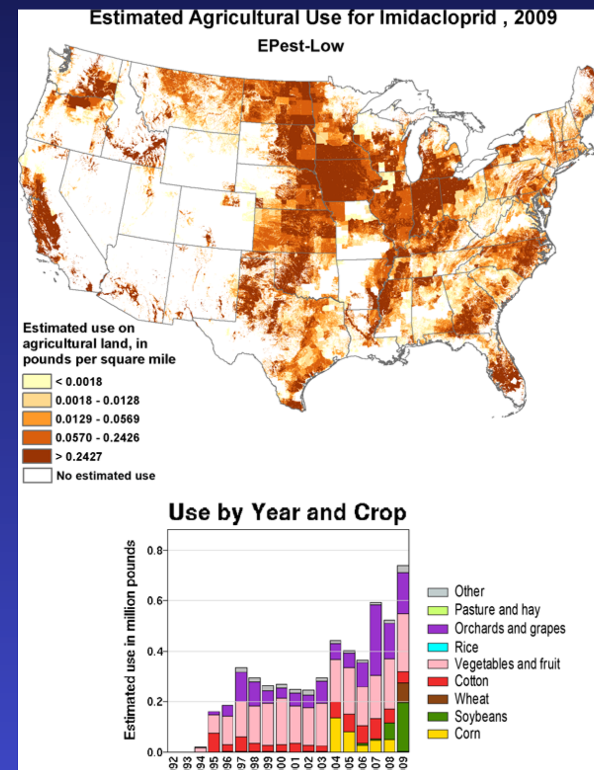
https://water.usgs.gov/nawqa/pnsp/usage/maps/compound_listing.php

Annual Changes in Crop Uses in the U.S.

Imidacloprid: 2003 – 2006 - 2009







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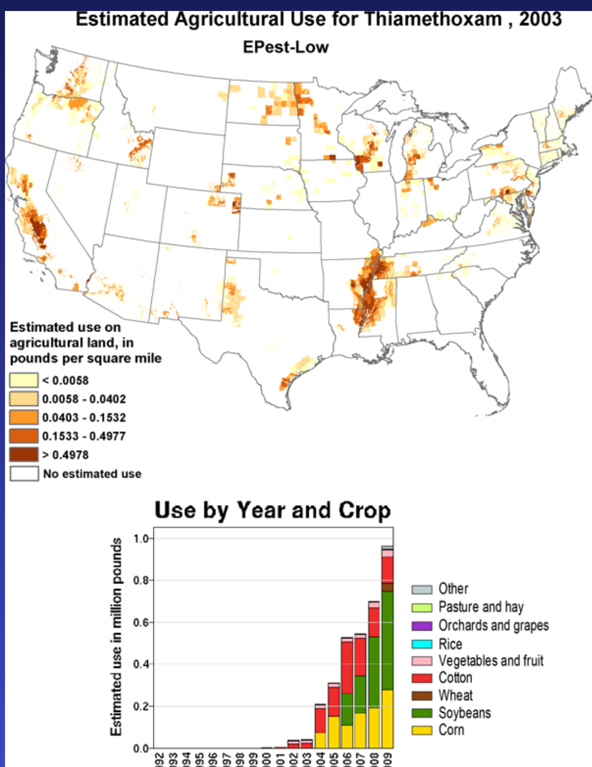
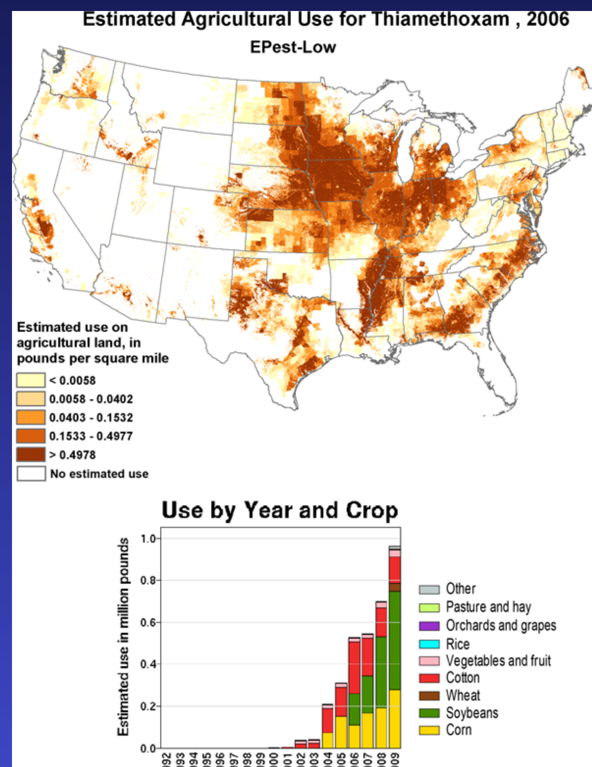
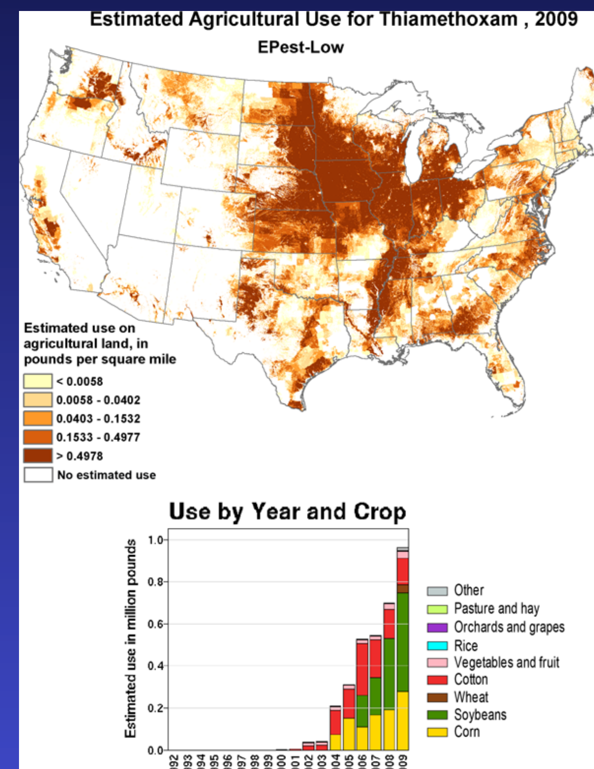
Annual Changes in Crop Uses in the U.S.

Thiamethoxam: 2003 – 2006 - 2009







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USDA and EPA Release New Report on Honey Bee Health - 2 May 2013

Key findings include:

Parasites and Disease Present Risks to Honey Bees:

The parasitic Varroa mite and new virus species have been found in the U.S. and several of these have been associated with Colony Collapse Disorder (CCD).

Increased Genetic Diversity is Needed:

Genetic variation improves bees thermoregulation, disease resistance and worker productivity.

Poor Nutrition Among Honey Bee Colonies:

Bees need better forage and a variety of plants to support colony health.

Need for Improved Collaboration and Information Sharing:

Best Management Practices associated with bees and pesticide use, exist, but are not widely or systematically followed by members of the crop-producing industry.

Additional Research is Needed to Determine Risks Presented by Pesticides:

The most pressing pesticide research questions relate to determining actual pesticide exposures and effects of pesticides to bees in the field.

Major Snap Bean Pests in Midwest

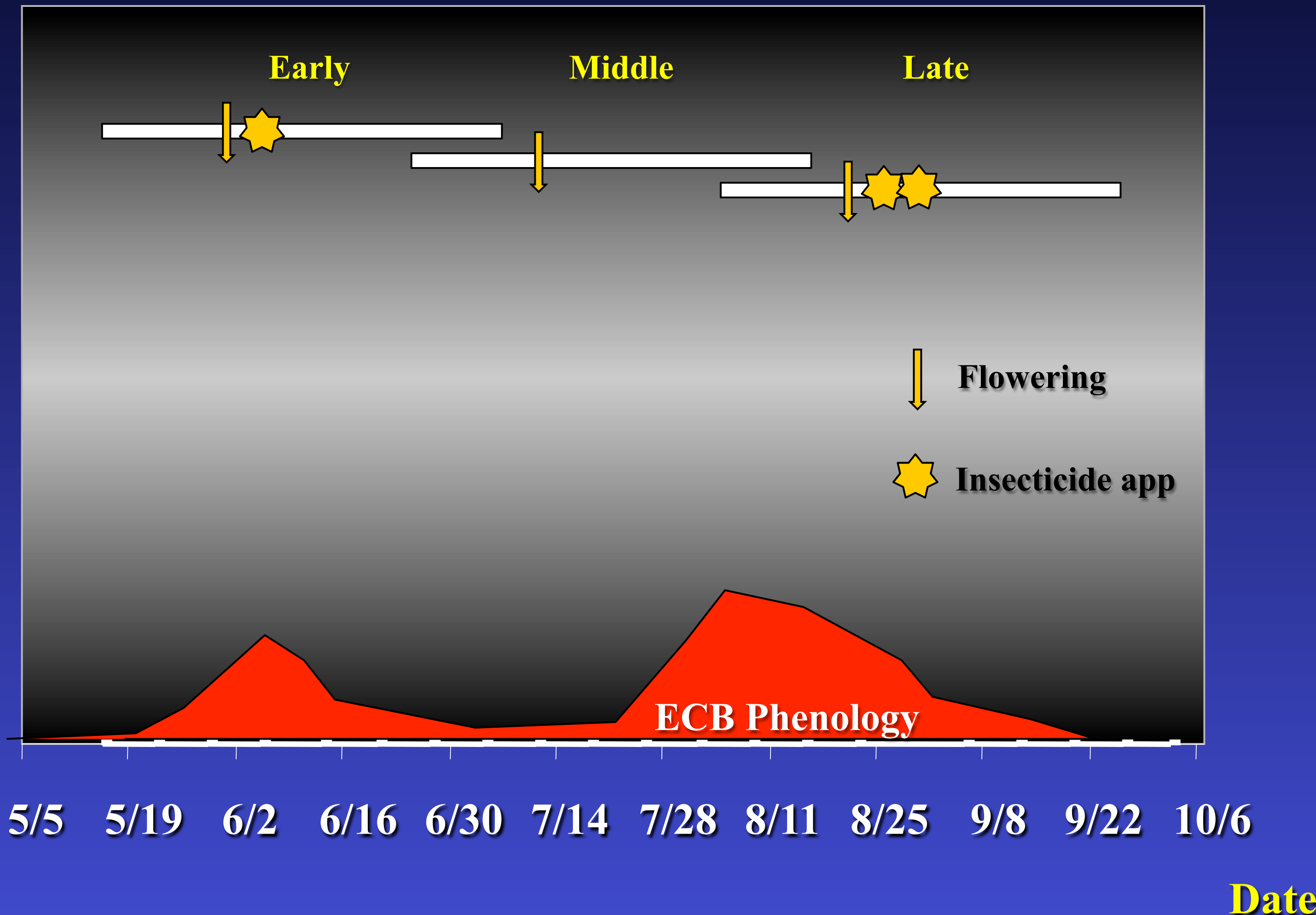
Seedcorn Maggot (SCM)

Cruiser®

Potato Leafhopper (PLH)

European corn borer (ECB)

Processing Snap Bean: European Corn Borer, Pest Phenology



Redrawn with permission, Brian Flood Del Monte Foods

Insecticides for Managing Snap Bean Pests

Recently Labeled in Wisconsin:

- Radiant SC (spinetoram)
- Coragen 1.67 SC (chlorantraniliprole) – foliar
- Blackhawk (spinosad) – foliar
- Beseige (chlorantraniliprole + lambda-cyhalothrin) (aka. Voliam Xpress)
- Belt SC (flubendiamide) – foliar
- Entrust SC (spinosad) – foliar
- Movento (spirotetramat) – foliar
- Transform WG (sulfoxaflor) – foliar

In the Pipeline or in Review:

- Exirel, Verimark (cyantraniliprole) – 2015/16

European Corn Borer Lifecycle

Eggs

- *Laid in masses (20-50)*
- *Black dots at hatch, 5-7 days*

Larva

- *Overwinter in corn stalks*
- *5 instars (2-4 weeks)\1st and 2nd external.*

ECB SEASONAL LIFECYCLE

Pupa

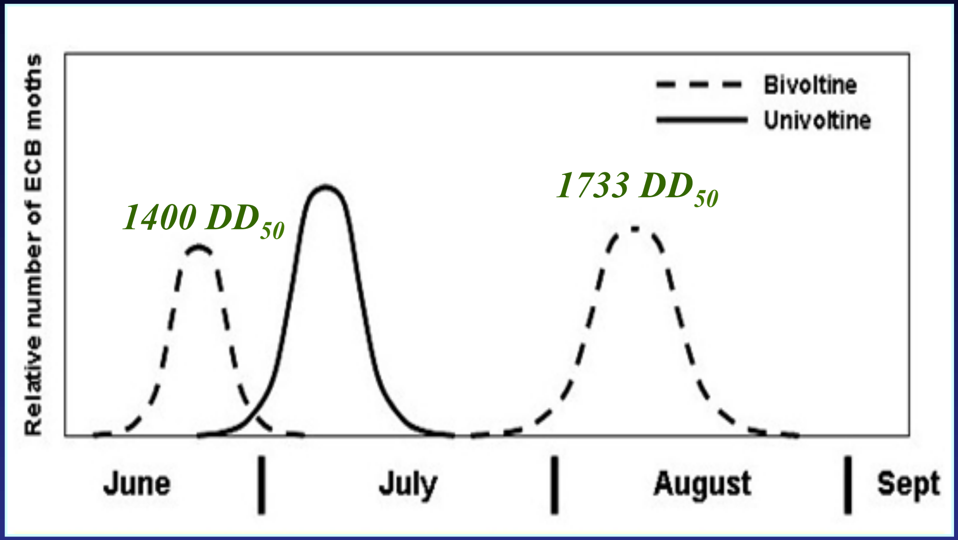
- *Inside stems 10-14 days*

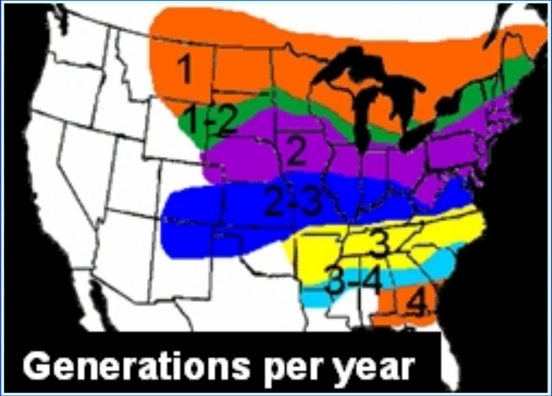
Adult

- *2 normal flight peaks June-Aug (1400 DD_{50} and 1733 DD_{50})*

European Corn Borer: Snap bean damage

European Corn Borer Management





1. Predict flight with degree days:

❖ 1^{st} = 375 DD_{50}, 2^{nd} 1400 DD_{50} and 3^{rd} 1733 DD_{50}

2. Monitor flights:

❖ Network of blacklight traps (DATCP)

3. Treat plants @ early bloom / pin bean stage:

(15 & 100 moths/night, 1^{st} and 2^{nd} generation)

Objectives

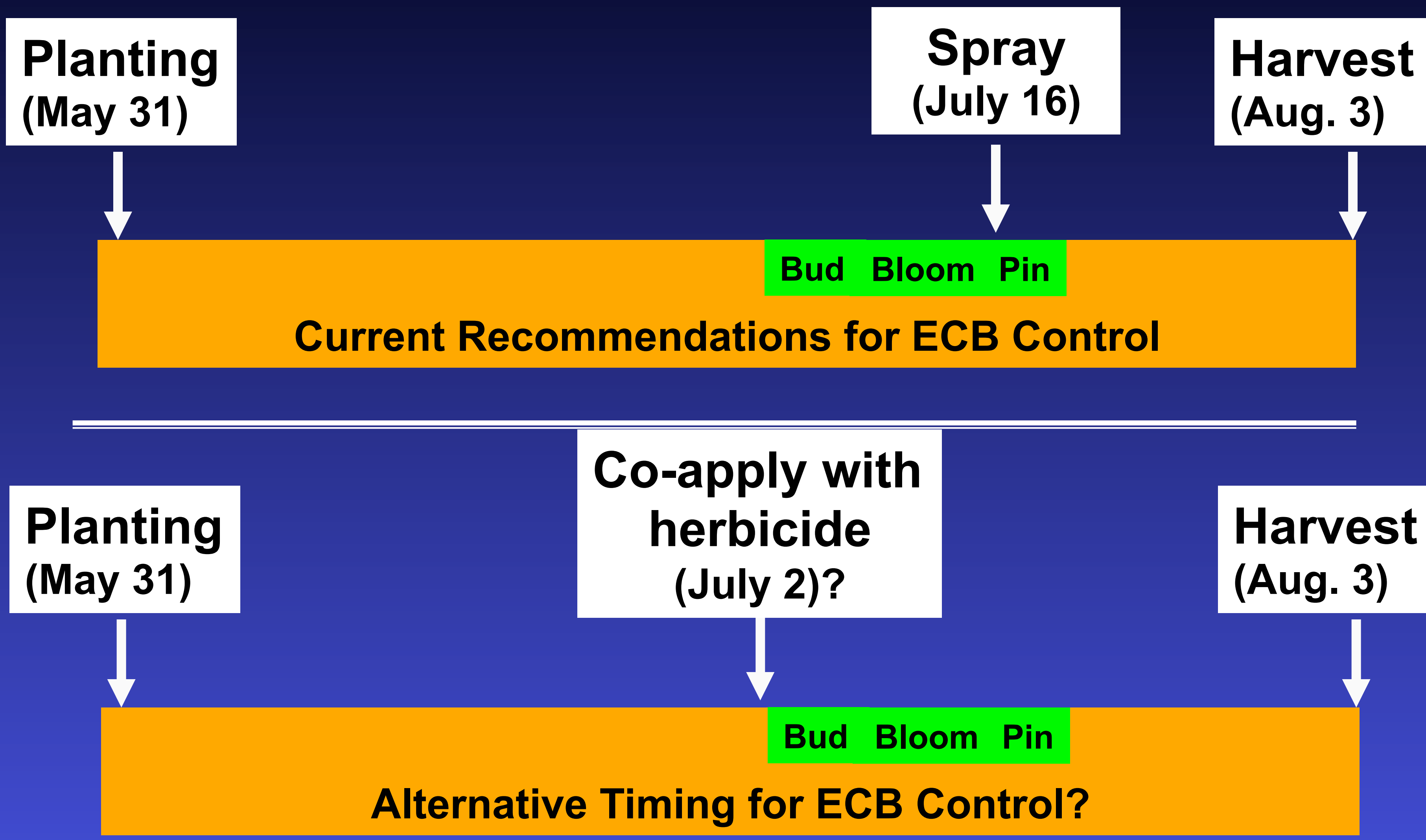
- Compared ECB control with chlorantraniliprole, cyantraniliprole, and bifenthrin at three different phenological stages of snap bean development (i.e., bud, bloom, pod formation) to determine the duration of residual activity for each insecticide under field conditions in snap bean.

- Co-applied cyantraniliprole and bifenthrin insecticides with either herbicides or fungicides at similar crop stages to determine if tank mixing cyantraniliprole and bifenthrin with common agrochemicals would reduce ECB control

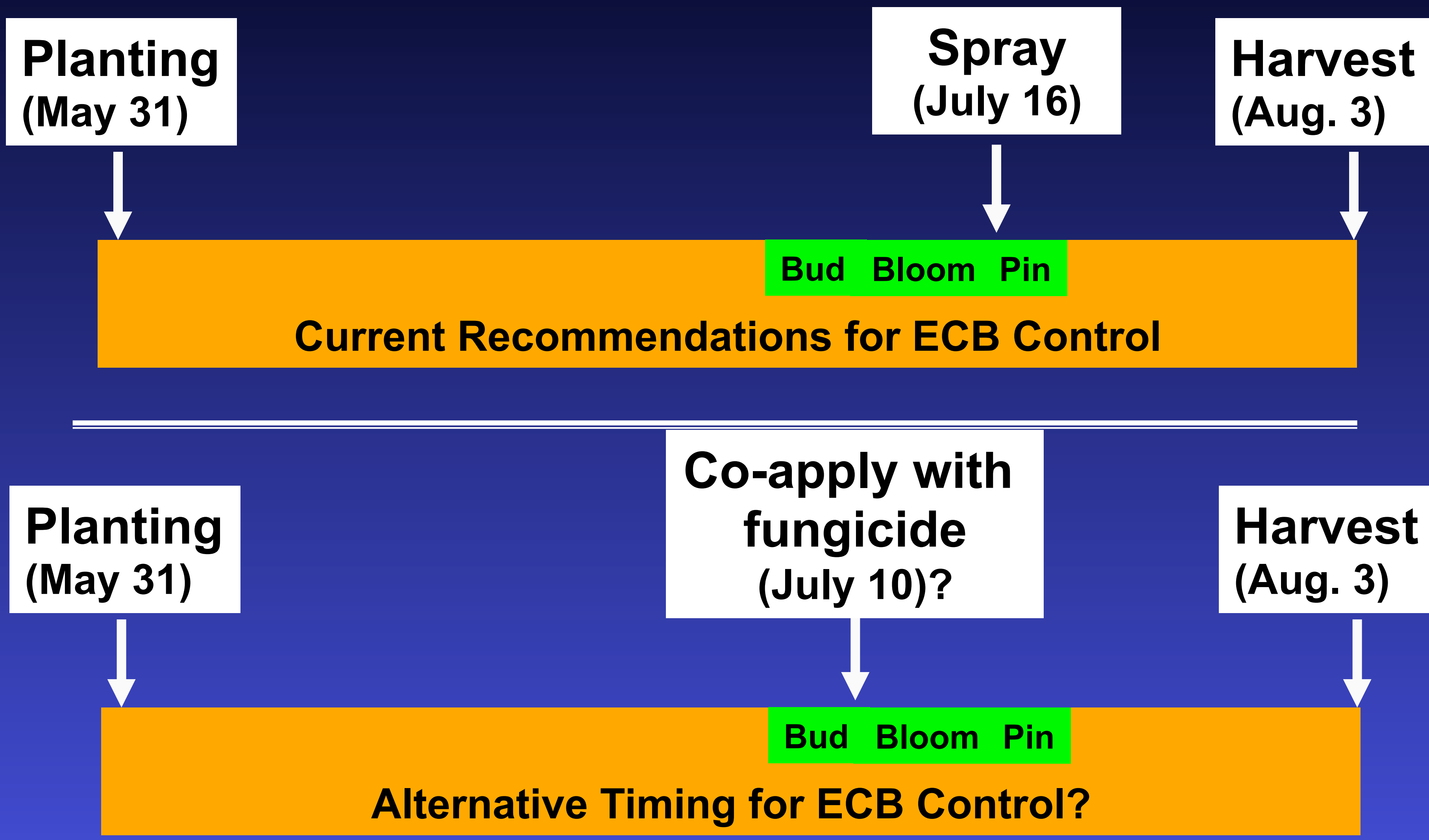
Anthranillic Diamide Insecticides

- Active ingredients: rynaxypyr (aka chlorantraniliprole) and cyazypyr (aka cyantraniliprole).
- Class: anthranilic diamide (IRAC MoA Class 28)
- Mode of action: ryanodine receptor modulator
  - Systemic activity
  - Most effective through ingestion
  - Insects stop feeding, become paralyzed and die within 1 to 3 days
  - Applied to soil at planting, drip chemigation and foliar spray (*seed treatment*)
  - Exceptionally long residual control – xylem mobile
  - Active against Lepidopterans, Coleoptera, and Hemiptera

Can Timing of Insecticide Application be Improved for ECB Control



Can Timing of Insecticide Application be Improved for ECB Control



Can Timing of Insecticide Application be Improved for ECB Control

Planting (May 31)

Spray (July 16)

Harvest (Aug. 3)

Bud Bloom Pin

Current Recommendations for ECB Control

Planting (co-application) side-dress (May 31)

Harvest (Aug. 3)

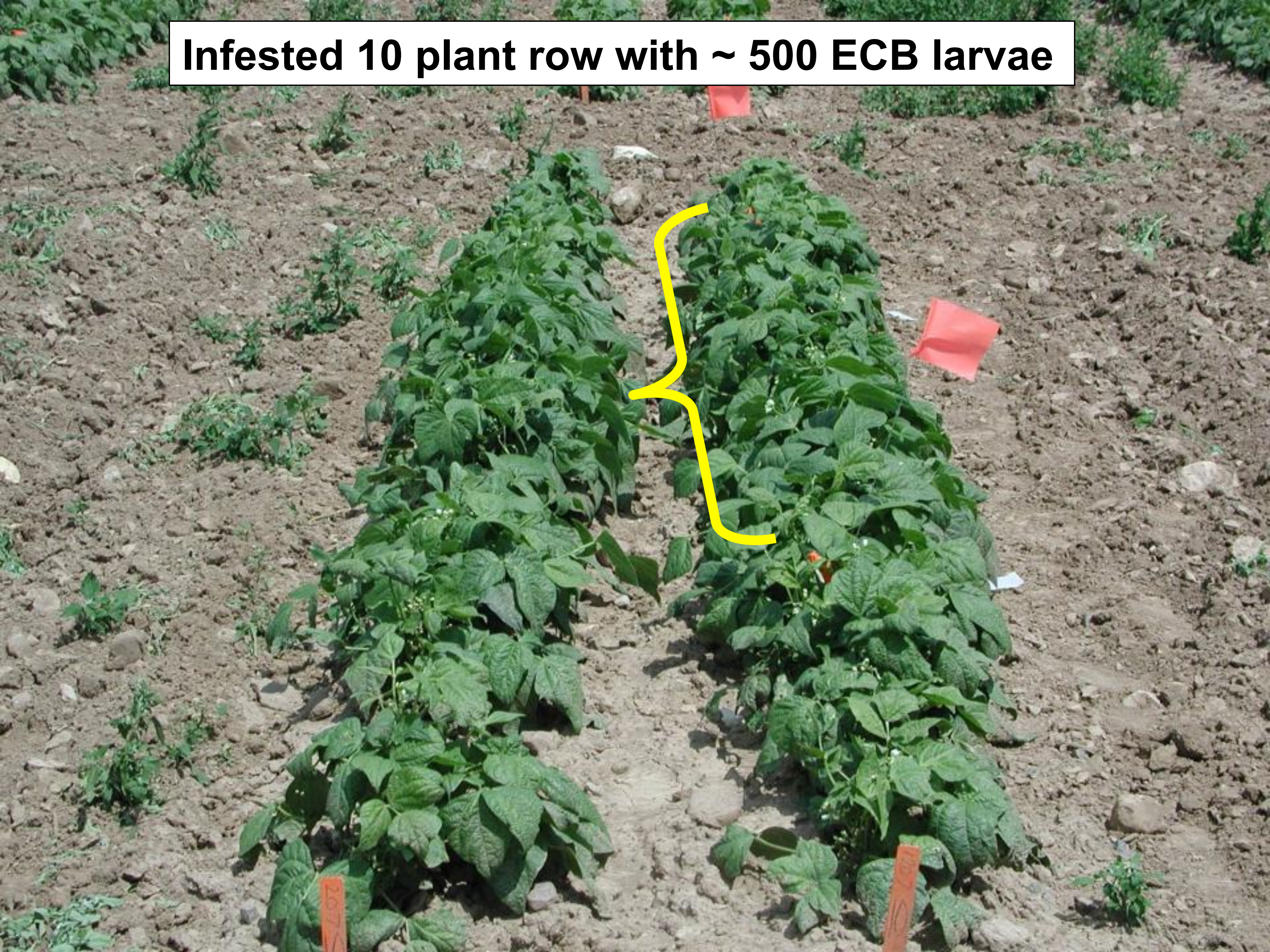
Bud Bloom Pin

Alternative Timing for ECB Control?

Agro-Chemicals Evaluated in Field Experiments 2012-2014, Plover, WI and Geneva, NY

Type	Study years[a]	Application timing[b]	Trade name	Active ingredient (AI)	Chemical group	Rate (ac^{-1})
Insecticides	2012, 2013, 2014	bud (R5), bloom (R6), pod formation (R7)	Brigade® 2EC	bifenthrin	pyrethroid	6.4 fl oz
	2012	bud (R5), bloom (R6), pod formation (R7)	Coragen®	chlorantraniliprole rynaxypyr	diamide	5.0 fl oz
	2012, 2013, 2014	bud (R5), bloom (R6), pod formation (R7)	Exirel®	cyantraniliprole cyazypyr	diamide	10.2 fl oz
	2012, 2013, 2014	bud (R5), bloom (R6), pod formation (R7)	Exirel®	cyantraniliprole	diamide	13.5 fl oz
Herbicides	2013, 2014	bud (R5)	Basagran®	bentazon	benzothiadiazinone	1.5 pts
	2013, 2014	bud (R5)	Reflex®	fomesafen	diphenylether	1.0 pt
Fungicides	2013, 2014	bloom (R6)	Topsin® M WSB	thiophanate-methyl	thiophanate	1.5 lb
	2013, 2014	pod formation (R7)	Bravo Weather Stik®	chlorothalonil	chloronitrile	2.5 pt

a Chlorantraniliprole was only included in the 2012 small plot study. Co-applications were only tested in 2013 and 2014.
b Applications were timed at specific phenological stages of bean maturation.


Infested 10 plant row with ~ 500 ECB larvae

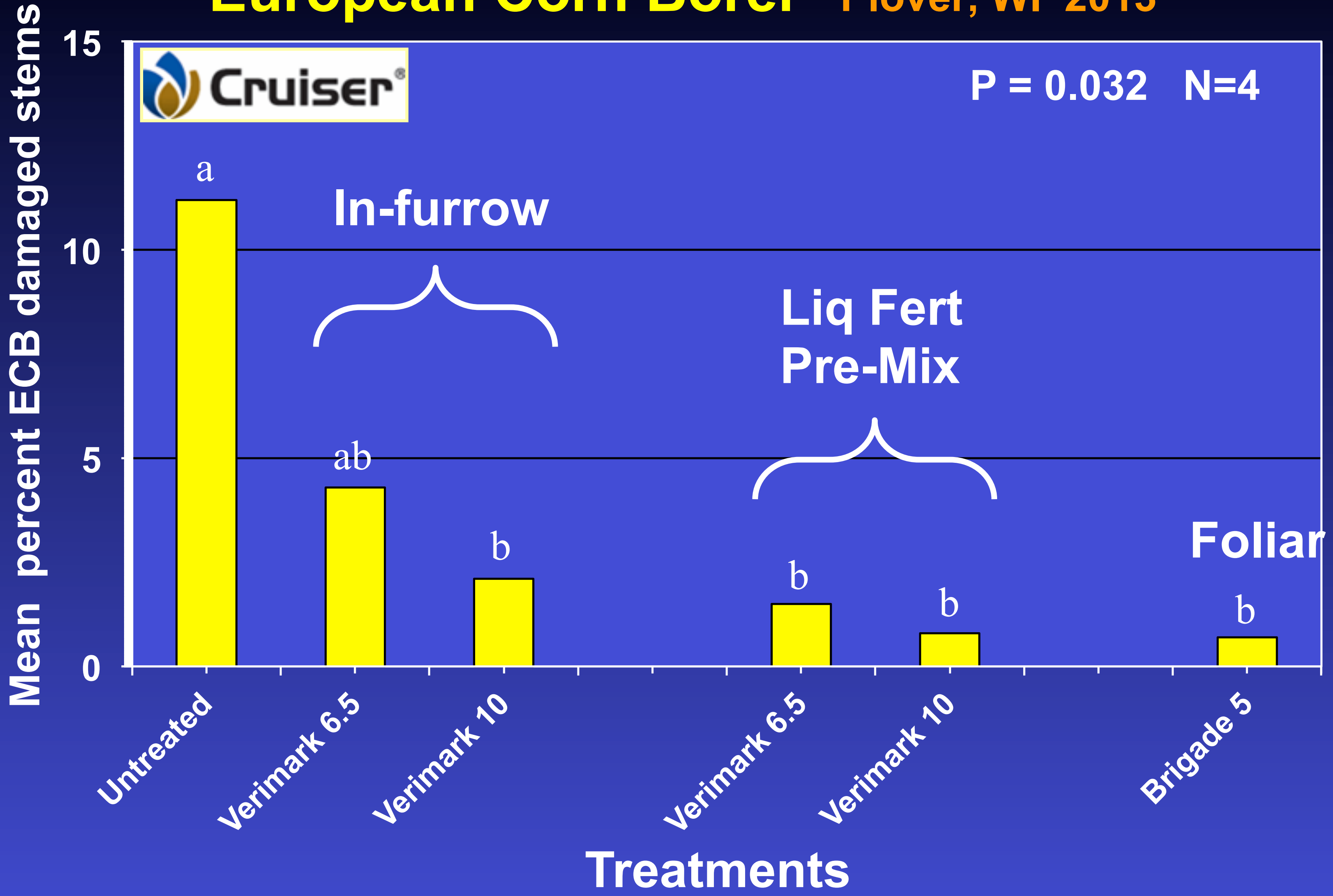
Mean Percent Plant and Pod Damage, 2012
Treated at 3 crop development stages, Plover, WI

Phenological stage	Insecticide	Plant damage		Pod damage
untreated	-	18.5±5.2 a		8.7±2.5a
bud	bifenthrin (6.4 fl oz/ac)	9.0±6.4 b		2.6±1.2 bc
	chlorantraniliprole (5.0 fl oz/ac) (aka. rynaxypyr) - Coragen 1.67SC	4.1±3.3 bc		1.9±1.1 bc
	cyantraniliprole (10.2 fl oz/ac) (aka. cyazypyr) – Exirel 10OD	1.0±0.7 c		0.7±0.3 bc
	cyantraniliprole (13.5 fl oz/ac) (aka. cyazypyr) – Exirel 10 OD	0.8±0.5 c		0.6±0.2 c
bloom	bifenthrin (6.4 fl oz/ac)	0.7±0.4 c		1.4±0.4 bc
	chlorantraniliprole (5.0 fl oz/ac) (aka. rynaxypyr) - Coragen 1.67SC	0.0±0.0 c		0.0±0.0 c
	cyantraniliprole (10.2 fl oz/ac) (aka. cyazypyr) – Exirel 10OD	0.1±0.1 c		0.2±0.1 c
	cyantraniliprole (13.5 fl oz/ac) (aka. cyazypyr) – Exirel 10 OD	0.0±0.0 c		0.1±0.1 c
pod formation	bifenthrin (6.4 fl oz/ac)	0.0±0.0 c		0.0±0.0 c
	chlorantraniliprole (5.0 fl oz/ac) (aka. rynaxypyr) - Coragen 1.67SC	0.0±0.0 c		0.3±0.1 c
	cyantraniliprole (10.2 fl oz/ac) (aka. cyazypyr) – Exirel 10OD	0.0±0.0 c		0.0±0.0 c
	cyantraniliprole (13.5 fl oz/ac) (aka. cyazypyr) – Exirel 10 OD	0.0±0.0 c		0.0±0.0 c

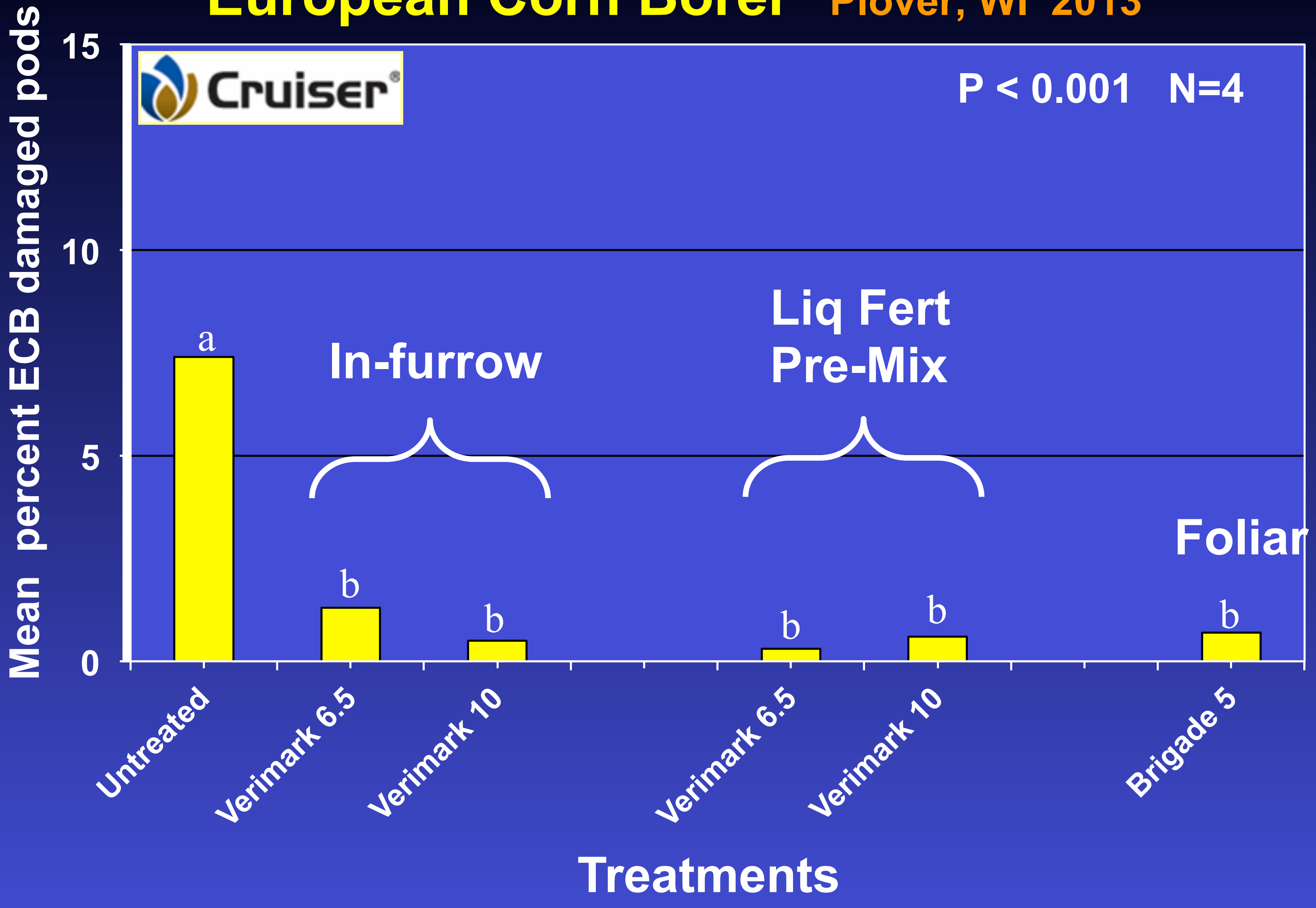
Mean Percent Plant and Pod Damage, 2013-14 Tank Mixes at 2 development stages, NY

Vegetative stage	Insecticide	Plant damage		Pod damage	
		2013[b]	2014[c]	2013	2014
untreated[a]	-	63.5±9.8 a	13.3±3.8 a	14.8±4.6 a	6.0±1.4 a
bud	bifenthrin (6.4 fl oz/ac)	22.1±10.1 ab	11.3±3.5 a	5.0±2.7 ab	4.4±1.5 ab
(herbicide)	cyantraniliprole (10.2 fl oz/ac) (aka. cyazypyr) – Exirel 10OD	19.4±7.5 ab	6.9±2.2 ab	3.7±1.2 b	2.8±1.0 ab
	cyantraniliprole (13.5 fl oz/ac) (aka. cyazypyr) – Exirel 10 OD	20.5±2.0 ab	9.6±6.4 a	2.4±0.5 bc	2.4±1.5 ab
bloom	bifenthrin (6.4 fl oz/ac)	12.5±3.9 bc	1.2±1.2 bc	3.7±2.0 b	0.4±0.2 b
(fungicide)	cyantraniliprole (10.2 fl oz/ac) (aka. cyazypyr) – Exirel 10OD	1.5±1.1 c	1.4±0.7 bc	0.2±0.1 c	0.8±0.4 b
	cyantraniliprole (13.5 fl oz/ac) (aka. cyazypyr) – Exirel 10 OD	1.7±1.3 c	1.0±0.7 bc	0.1±0.1 c	0.8±0.3 b
pod formation	bifenthrin (6.4 fl oz/ac)	7.7±3.4 bc	0.0±0.0 c	0.2±0.2 c	0.7±0.5 b
(insecticide)	cyantraniliprole (10.2 fl oz/ac) (aka. cyazypyr) – Exirel 10OD	0.8±0.8 c	3.8±2.2 b	0.2±0.1 c	0.6±0.3 b
	cyantraniliprole (13.5 fl oz/ac) (aka. cyazypyr) – Exirel 10 OD	0.5±0.5c	1.1±1.1 bc	0.0±0.0 c	0.5±0.2 b

Percent Snap Bean Stems Damaged by European Corn Borer Plover, WI 2013



Percent Snap Bean Pods Damaged by European Corn Borer Plover, WI 2013



Advantages of Reduced Risk Technologies

- Limit impacts on pollinators
- Reduced risk to environment and farm workers
  - Drift to non-target areas is eliminated
  - Farm workers do not come into contact with residues on exterior of plant
  - Beneficial organisms not directly exposed
- Longer residual activity
  - Not subject to loss from rain and UV light
  - Not subject to plant growth dilution effects
- More cost-effective??

Summary

- Diamide insecticides (e.g. Coragen & Exirel) appear to have very good activity against ECB when applied as a foliar.
- Co-application of diamides with fungicides (bloom) had no antagonistic effects and were similar in performance to current foliar recommendations (pod-formation)
- Cyantraniliprole (aka. cyazypyr) was effective against ECB when applied as a in- furrow and as a liquid fertilizer pre-mix applications.

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