Managing Insecticide Resistance in Vegetable Crops



European Corn Borer Adults (ECB) ECB larval hatch

ECB Feeding on Green Pepper

ENY Cornell Cooperative Extension Vegetable School

Plattsburgh, NY February 25, 2014

Peter Jentsch Senior Extension Associate Entomology



THE JENTSCH LAB

INSECT BIOLOGY, ECOLOGY, AND MANAGEMENT IN HUDSON VALLEY AGRICULTURAL COMMODITIES OF NY



HOME ENTOMOLOGY PROGRAM ORGANIC AG RESEARCH TREE FRUIT VEGETABLE SWEET CORN SMALL FRUIT GRAPE

Plant Protection Presentations

Recent presentations:

Cornell Cooperative Extension Eastern NY Commercial Vegetable Program Invasive Insects: BMSB Management in Vegetable.

Cornell Cooperative Extension Eastern NY Commercial Fruit Program Upper Hudson / Champlain Commercial Tree Fruit School Insect Pest Management Overview

Empire Expo, On-Center, Syracuse, NY Jan. 21, 2014: <u>Status of BMSB and SWD in NY</u> <u>Late Season SWD Management.</u>

Blog.cornell.jentsch



Agriculturally Invasive Insect Pests in NY State: Update on BMSB Management in Vegetable



Brown Marmorated Stink Bug Tree of Heaven Ailanthus altissima

Lower Hudson Valley Commercial Vegetable Growers' School The Falcon, Marlboro, NY February 24, 2014 – 10:00AM

Peter Jentsch Senior Extension Associate – Entomology



Fundamentals of Lepidoptera (Pest) Resistance Mgt.

What is Insecticide Resistance?

Individuals (insects) in any given population differ in genetic, physical and biochemical traits. They will respond differently under varying environmental conditions.

When exposed to a specific insecticide class a 'selected' group of individual insects (variants) from the populations may survive.

This group expresses a greater tolerance to exposure to the insecticide class.

Repeated use of the same class of active ingredient will continue to increase the selection process as insects reproduce.

Fundamentals of Lepidoptera (Pest) <u>Resistance Mgt.</u> How Should We Manage Insecticide Resistance ?

I. Is the insect prone to insecticide resistance?

Migratory (regionally or from outside the field) Endemic (within the field year after year)

Does the insect have multiple generations? Single Multiple (mite 6-9, lep. Complex 2-3)

Previous resistance to earlier / older insecticides

Fundamentals of Lepidoptera (Pest) <u>Resistance Mgt.</u> Examples of Insect Dvelopment of Insecticide Resistance San Jose scale (Lead Arsenate early 1900's) Endemic / 2 gen.

Codling Moth (Lead Arsenate early 1920's) Endemic / 2 gen.

Colorado potato beetle (OP's Carbamates, Pyrethroids) Imidacloprid and newer classes Endemic / multiple generations

Oblique banded leaf roller (OP azinphosmethyl 1990's) Endemic / 2 gen.

Corn ear worm – reduced control

European Corn Borer – reduced control

Fundamentals of Lepidoptera (Pest) Resistance Mgt.

II. How Should We Manage Insecticide Resistance?

Theory: By rotating insecticide classes for each generation you reduce the potential for acquiring insecticide resistance

Example of class rotation

Class 1	Class 2	Class 3

ECB G1ECB G2ECB G3Overwintering

Pyrethroid Carbamate Spinosad

Warrior Lannate Radiant SC / Entrust

Fundamentals of Lepidoptera (Pest) Resistance Mgt.

- Know Your Chemical Classes
 - Biological
 - Bt, Fungal biocontrol
 - CNS (Central Nervous Sys.)
 - Contact, feeding
 - Pyrethroid, Carb, OP, Neonic
 - Spinosads
 - IGR (Insect Growth Reg.)
 - Egg, larva
 - Esteem
- Know How Best to Use Them











CDMS
ContentsIntegrated Crop & Pest Management GuidelinesContentsfor Commercial Vegetable Production
A Cornell Cooperative Extension Publication2014

PEPPERS: <u>Recommended Varieties</u> | <u>Planting Methods</u> | <u>Fertility</u> | <u>Harvesting</u> | <u>Disease</u> <u>Management</u> | <u>Insect Management</u> | <u>Weed Management</u>

Common name Trade Name	Rate/A Product	PHI (days)	REI (hours)	Field Use EIQ	Comments
acephate					
Orthene 97 or OLP 0.97 lb/lb	0.75-1 lb	7	24	18.1-24.2	For use on bell peppers only. Do not exceed 2 lpounds a.i. per acre per season.
bifentrhin + zeta-cyperme	thrin				
* <mark>Hero</mark> 1.24 lb/gal	4.0-10.3 fl oz	7	12	1.6-4.1	
chlorantraniliprole					
*†^ <u>Coragen</u> 1.67 lbs/gal	3.5-5.0 fl oz	1	4	0.7-1.1	In NYS do not apply by air and do not apply within 100 ft of a water body. Do not use in Nassau, Suffolk, Kings and Queens Counties. May only be applied as a foliar spray.

http://veg-guidelines.cce.cornell.edu



For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification.



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 - Esteem
- Know How Best to Use Them
- Know your insect complex
- Know The Number of Generations
 Per Season of Pest



Fundamentals of Lepidoptera (Pest) Biology

Know your insect complex

How does the pest overwinter ?
Migratory or regional

- Damaging life stage ?
 Adult, larva
- Threshold for management:
 scout for larva, traps for adults, models for emergence ?
- Most susceptible life stage to manage ?



Managing Lepidopteran in Vegetable Crops

Lep	bidopteran complex in vegetable production # of	<mark>f NYS Veg. Crops</mark>
	Armyworm Complex	
	Fall armyworm (FAW), Spodoptera frugiperda	1
	Common armyworm (CEW), Psuedaletia unipur	ncta 2
	Beat armyworm (BAW), Spodoptera exigua	1
	Cutworm Complex: Agrotis spp.	
	Imported Cutworm (ICW),	1
	Black Cutworm (BCW),	1
	Western Bean Cutworm (WBCW),	2
	Cabbage Looper (CL), Trichoplusia ni	4
	Corn earworm/ Fruit worm (CEW, FW), Helicoverpa zea	2
	Diamondback Moth (DBM), Plutella xylostella	1
	European corn borer (ECB), Ostrinia nubilalis	4

Field Vegetable Production in NYS

Asparagus **Beans (ECB)** Beets Cabbage Cabbage (DBM, ICW, CL) Broccoli, Cauliflower, **Brussels Sprouts** Carrots **Celery** (CL, BAW, FAW) **Cucurbits** (SVB, CL) Cucumber, Melon, Pumpkin, Squash, Watermelon

Onions Peas **Peppers** (ECB) Potatoes (ECB, VCW, CL) Spinach (CL) Sweet Corn (ECB,CEW, FAW, CAW, WBCW, BCW) Tomatoes (CEW, THW, CW, CL) **Turnips and Radishes**

Trapping Lepidopteran in Vegetable Crops

Lepidopteran complex in vegetable production Trap Type **Armyworm Complex** Fall armyworm (FAW), Spodoptera frugiperda Pheromone Common armyworm (CEW), Psuedaletia unipuncta Pheromone Beat armyworm (BAW), Spodoptera exigua Pheromone Cutworm Complex: Agrotis spp. Pheromone Imported Cutworm (ICW), **Black Cutworm (BCW)**, Pheromone Western Bean Cutworm (WBCW), Pheromone Cabbage Looper (CL), Trichoplusia ni Pheromone Corn earworm, Helicoverpa zea Pheromone Diamondback Moth, Plutella xylostella Pheromone European corn borer, Ostrinia nubilalis Pheromone Leak Moth, Acrolepiopsis assectella Pheromone



Due Diligence

Common Army Worm June 5, 2012

Observations

Common Army Worm June 5, 2012

Common Army Worm June 5, 2012

Scouting

ECB Trapping to Determine the Onset of Each Generation





ECB Trapping to Determine the Onset of Each Generation

= Larval hatch

Trigger for Insect Pest Management





Factors Affecting The Management Of Insects Using Insecticides: Temperature & Larval Emergence



Adult Flight of European Corn Borer, Corn Ear Worm and Fall Army Worm New Paltz, 2012



Fundamentals of Lepidoptera (Pest) Resistance Mgt.

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Example of class rotation

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Pyrethroid Carbamate Spinosad

Warrior Lannate Radiant SC / Entrust

- Insecticide Efficacy
 - Most effective
 - Residual activity



Evaluation of late season insect damage on sweet corn^{1,2}. N.Y.S.A.E.S., New Paltz, N.Y.-2010

				% infested ears	8	
	Treatment	Rate	FAW	CEW	Total	
1	Coragen SC	3.5 fl.oz/A	5.0 c	38.0 c	43.0 c	
2	Coragen SC	5.0 fl.oz/A	1.0 ab	35.0 bc	36.0 bc	
3	Voliam Xpress	7.0 fl.oz/A	0.0 a	5.0 a	5.0 a	
4	Belt	2.0 fl.oz/A	1.0 ab	26.0 b	27.0 b	
5	Radiant SC	8.0 fl.oz/A	0.0 a	42.0 c	42.0 c	
Gr	ower standard: Pounce Tombstone	8.0 fl.oz/A (#1,3) 2.5 fl.oz/A (#2,4)	1.0 ab	7.0 a	8.0 a	
Ur	ntreated	-	4.0 bc	85.0 d	89.0 d	
P	value for transform	ned data 0.0302	0.001	0.001		

'Mira 350 Bi-color' planted on 19 June, silk applications on 9, 13, 17, 21 August. Sampling date on 30 August of 25 ears per plot @ 4 replicates / treatment.

Coragen - chlorantraniliprole; Belt - flubendiamide; Radiant SC - spinetoram; Voliam Xpress - lambda-cyhalothrin + chlorantraniliprole

- Insecticide Efficacy
 - Most effective
 - Residual activity
 - Temperature dependent?



Environmental Temperature Plays A Role In Insecticide Efficacy (European Corn Borer)

The influence of post-exposure temperature on the toxicity of insecticides to Ostrinia nubilalis (Lepidoptera: Crambidae).

Musser,F.R., Shely, A.M. Pest Management Science. 2005 Volume 61, Issue 5, Pages 508 - 510



Examined the influence of post-treatment temperature on insecticide toxicities. Temp. change from 24 to 35 degrees C (75 - 95°F)

Pyrethroids	Warrior (lambda-cyhalothrin)	9.5 fold decrease
	Brigade (bifenthrin)	13.6 fold decrease
Carbamate	Lanate (methomyl)	no change
Spinosyn	SpinTor / Entrust (spinosad)	3.8 fold decrease

The results demonstrate that the most effective insecticide against a pest may vary with environmental conditions.

- Insecticide Efficacy
 - Most effective
 - Residual activity
 - Temperature dependent?
 - Label restrictions
 - PHI, ai/A & No. of apps per season



- Insecticide Efficacy
 - Most effective
 - Residual activity
 - Temperature dependent?
 - Label restrictions



Management

- Insect Complex
- Lepidopteran only
- Mixed Population (potato & flea beetle)
- Single or multiple active ingredients for narrow or broad spectrum activity



- Insecticide Efficacy is everything
- If the insecticide is ideal...then
 Timing is everything (life stage)!
- If you have the right insecticide...then Calibration is everything!!!





- If you have the calibration dead on ... then Coverage is everything!!!!
- Weather...(wind during application, rainfall post application, temperature pre-post application.....
- Next application window...how many apps are needed / generation?

Reduce the weak links by checking every variable !

SWD Management after 0.8" of Rainfall (R. Issacs, Univ. Mich)

		%	%
Material	Rate	Control	Control 0.8" rainfall
Mustang Max	4.0 oz./A	100	70-100
Assail 30SG	5.3 oz./A	60-100	20-45
Delegate 25WDG	4.5 oz./A	88-100	20-60
Malathion 8F	2.0 pts./A	70-100	8-45 .

Loss of SWD efficacy 1-3 days after rain

24 hrs. post application rain event.

Stresses the need for retreatment of most insecticides.





Factor that led to European corn borer outbreaks in New York in 2011?

• Insecticides 'challanged' by high populations leading to very high larva #'s.







European corn borer outbreaks in New England: 1926

U. S. DEPARTMENT OF AGRICULTURE FEDERAL HORTICULTURAL BOARD In Cooperation With BUREAU OF ENTOMOLOGY					
EUROPEAN CORN BORER QUARANTINE EFFECTIVE NOVEMBER 23, 1926					
WARNING					
Pointed and State Regulations prohibit the transportation of the following CUT FLOWERS, PLANTS, and FARM PRODUCTS from indexed areas in MANK, NEW HAMPSHIRE, MASSACHUSETTS, and PHODE IELNO to points audit the sree questions of the EUROPEAN CORN BORER, unless accembatiol for a Permit or Certificate of Inspection: CUT FLOWERS AND FLANTS Chrysanthemum Commos Hollyhock Corn Bronneern Caley Bests with togs Rhubarb All Serghums Shilled Care, and State Green Baas in Dablis Aster Zinnia Gladiolos Sudan Grass of Boonneern the pod Cast and Re States us such or When were a spacing					
CITIES AND TOWNS IN THE QUARANTINED AREA					
ADART STRATAGE STRATA					
NEW HAMPSHIRE Alumatia Bridewater Dambastan Centra Les Nachary Puterturo Sauth Normarkat					
Alleran Lander and Alleran Lande					
MASSACHUSETTS					
Ander Karten Sterner Straten Sterner Straten Sterner Staten State					
RHODE ISLAND Vesterly Berligten Constant Jonatorn Middletown North Kingdom Perturbat Smithhold Warea					
Build was Experience in the second processing and processing proce					
CORN ON COB WILL NOT BE CERTIFIED FOR SHIPMENT					
Maximum penalties of imprisonment for one year and a fine of \$500 are provided by law for violations of this quarantine.					
For inspection apply to: For further fulformation apply to L. H. WORTHLEY, Administrator in Corn Bover Control.					

U. S. DEPARTMENT OF AGRICULTURE	
In Cooperation With	
BUREAU OF ENTOMOLOGY	
EUROPEAN CORN BORER QUARANTINE	

EFFECTIVE NOVEMBER 23, 1926

ENFORCED IN COOPERATION WITH STATE QUARANTINES

WARNING

ation of CORN and BROOMCORN (including all parts of Federal and State Regulations Prohibit the tr estalk), all SHELLED CORN, SEED OF BROOMCORN, SORGHUNS and SUDONCOM CARAS, from quarantime areas a transmission of the state of the sta arantined, on account of the EUROPEAN CORN BORER, unless a

CITIES, TOWNSHIPS, AND COUNTIES IN THE QUARANTINED AREA

INDIANA

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NCH, CALHOUN, GENESEE, HILLSDALE, HURON, INCHAM, JACKSON, L INROE, OAKLAND, SANILAC, SAGINAW, SHIAWASSEE, ST. CLAIR, TU

WEST VIRGINIA

and all townships and all other ;

PENNSYLVANIA

ER. BLAIR. BRADFORD, BUTLER, CAMBRIA, CAMERON

VERMONT

BENNINGTON COUNTY. BET JEAST CITIES OF RECEIPT AND JEAST CITY CORN ON COB WILL NOT BE CERTIFIED FOR SHIPMENT

for one year and a fine of

Ens foother inf L. H. WORTHLEY,

Administrator in Corn Borer Conta 2336 East 226 St., Clewland, this.

- Corn
- Cut Flowers
- Plants •
- Vegetables







Factors that led to European corn borer outbreaks in New York in 2011?

- ECB overwinter as late instar larva
- Mild winter and moderating temperatures allow for high survival
- Temperature extremes and sudden changes in temperature reduce survival of ECB





Factor that led to European corn borer outbreaks in New York in 2011?

Mild winter







Factor that led to European corn borer outbreaks in New York in 2011?

- Overwintering refuge / no till for 2 years
 - Weed hosts and standing corn stalks provide winter habitat
 - Stalks left standing (Tillage of stalks reduces larval population)
 - Does no-till corn allow for higher winter survival of ECB?







Manage Insecticide Resistance

 Rotating insecticide classes for each generation to reduce the potential for acquiring insecticide resistance for insects with high resistance potential.

Scout throughout the season

Early observations for cutworm detection

Trap to determine seasonal fluctuations

ECB for peppers

Limit pyrethroid use

Cool temperature for highest efficacy



Thanks to the staff at the HVL for all their support:

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Summer Research Assistant
PT Summer Research Assistant
Summer Research Assistant
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Summer Intern

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Thank You...Questions??



