

On-farm Practices to Manage Resistance to Neonicotinoid Insecticides in the Colorado Potato Beetle

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Colorado Potato Beetle

- Most severe insect pest of potatoes in northeastern and north central U.S. and Canada, Europe, former U.S.S.R., eastern China, Turkey, and Iran
- Resistant to > 40 insecticides world-wide
- Including organochlorines, organophosphates, carbamates, pyrethroids, neonicotinoids, and arsenicals

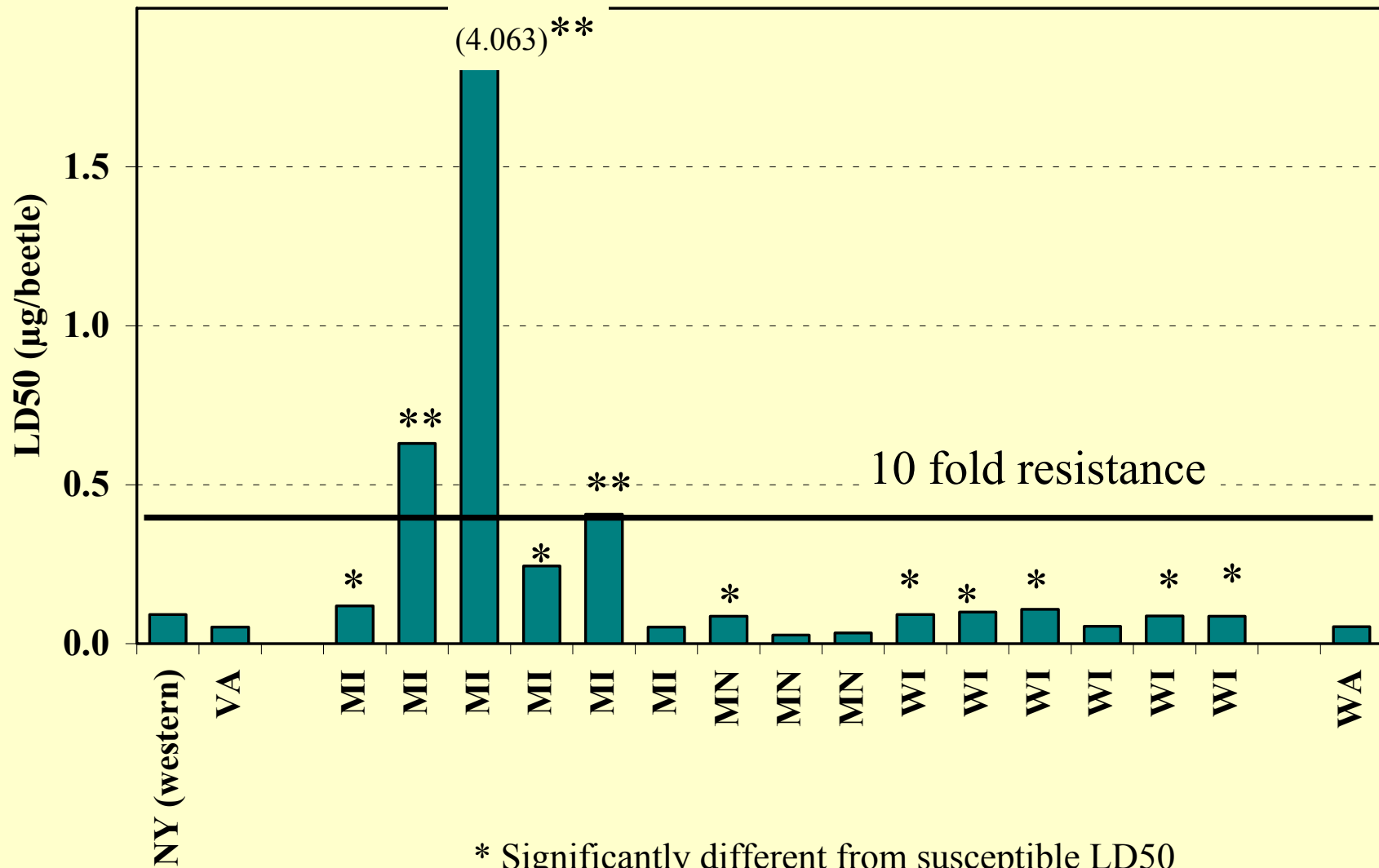


Colorado Potato Beetle

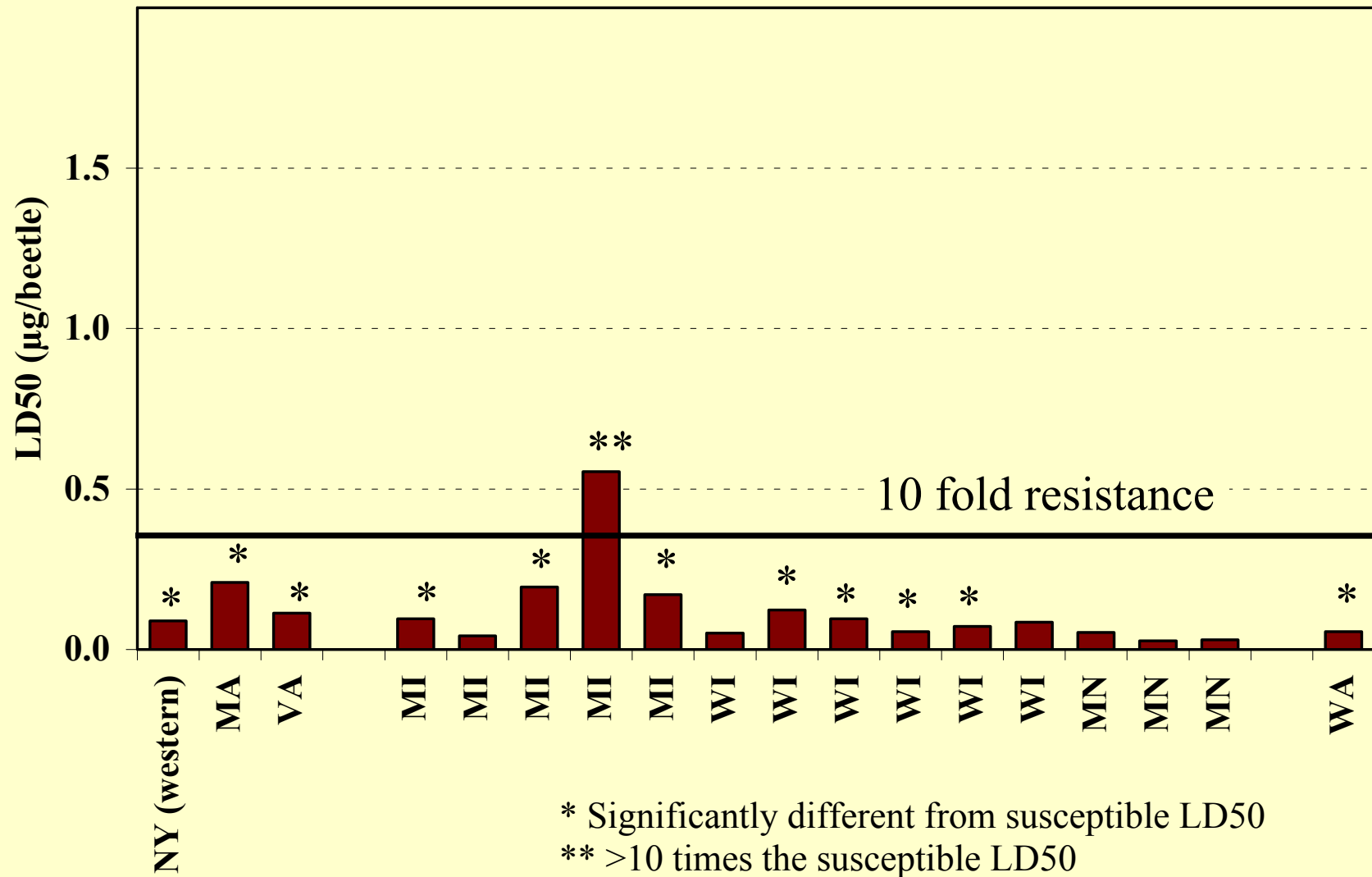
- One of the first insects with resistance to imidacloprid in the field (1997)
- One of the first insects with resistance to thiamethoxam in the field (2003)
- Broad cross resistance within neonicotinoids



Imidacloprid Resistance 2005



Thiamethoxam Resistance 2005



On-farm Tools for Resistance Management

- The Insecticide Resistance Action Committee Neonicotinoid Subcommittee and the National Potato Council recommend:
 - Use of neonicotinoids within an IPM framework, including cultural controls
 - If a neonicotinoid is used at planting, use a different mode of action for subsequent foliar treatments

www.iraac-online.org/

www.nationalpotatocouncil.org/

On-farm Tools for Resistance Management

- Non-chemical controls
- Chemical management

On-farm Tools for Resistance Management

- Non-chemical controls
 - Resistant varieties
 - Biological control
 - Crop rotation
 - Trap crops
 - Mechanical controls (trenches, flammers)

On-farm Tools for Resistance Management

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On-farm Tools for Resistance Management

- Crop rotation

- The single most important practice for resistance management of Colorado potato beetle

It may be impossible to manage Colorado potato beetle and insecticide resistance in a continuous potato crop system

On-farm Tools for Resistance Management

- Crop rotation
 - Colorado potato beetles overwinter as adults in the field or in field borders and fence lines
 - Adults walk or fly to new fields in the spring

On-farm Tools for Resistance Management

- Crop rotation
 - Distance $>$ 400 m, forces dispersal by flight
 - » A major mortality factor - most beetles don't find the new potato field
 - » Delays arrival by ca. 2-3 weeks
 - » Increases genetic mixing

On-farm Tools for Resistance Management

- Crop rotation

- Gene flow may aid in resistance management

but,

- gene flow may not be desirable, if there is an initial pocket of resistance

- » May cause spread of resistance

- » Especially if resistance is a dominant trait

On-farm Tools for Resistance Management

- Crop rotation combined with trap crop
 - Reduces beetle movement
 - » Can be helpful if there is an initial pocket of resistance
 - Provides a small area for control
 - » Chemical
 - » Mechanical

Using a Trap Crop to Manage Colorado Potato Beetle and Spread of Resistance

- 2005 trap crop research/demonstration
 - Initial resistance pocket in central Michigan
 - 2004 problem field (75 A)
 - » Potatoes in 2004
 - » Corn in 2005
 - 6-row trap crop around the field in 2005

Using a Trap Crop to Manage Colorado Potato Beetle and the Spread of Resistance



2004 potato
2005 corn

6-row trap crop

Using a Trap Crop to Manage Colorado Potato Beetle and the Spread of Resistance

- 40,000 plants
- 100,000 beetles
- Treated with
 - Agri-Mek
 - Rimon
- Destroyed by discing before larvae matured



Using a Trap Crop to Manage Colorado Potato Beetle and the Spread of Resistance

July 5



2005 potatoes

Tilled trap crop

Trap Crop Results

- Little extra cost
 - 1 application each, Agri-Mek, Rimon
 - » Trap crop (2 acres) = \$120
 - » Entire 75 acre field = \$4,500
 - Potato seed, fertilizer, herbicide

Trap Crop Results

- Little movement to adjacent potatoes
- Long distance movement to other fields - unknown
- [Ideal potential for use of flamer]
 - Kill adults and larvae
 - Destroy the trap crop

On-farm Tools for Resistance Management

- Chemical management
 - Scouting and economic thresholds
 - Chemical alternations, mixes
 - High dose/refuge strategy
 - Resistance monitoring

On-farm Tools for Resistance Management

- Chemical management
 - Scouting and economic thresholds
 - » Minimize applications and selection for resistance
 - » Don't treat everything with a neonicotinoid at planting

On-farm Tools for Resistance Management

- Growers should identify some fields to manage without a neonicotinoid at planting
 - Target fields where beetle pressure will be low and the grower can manage the situation closely

On-farm Tools for Resistance Management

- Chemical management
 - Chemical alternations have not been effective with Colorado potato beetle in the past
 - Mixes should be used only in desperation

On-farm Tools for Resistance Management

- Chemical management
 - Chemical alternations
 - » Assumes unstable resistance, limited capacity for the pest to maintain more than one resistance mechanism
 - » Few effective non-neonicotinoid insecticides are available
 - SpinTor, Rimon, Agri-Mek

On-farm Tools for Resistance Management

- Chemical management
 - High dose/refuge strategy
 - » Often required for GMO crops
 - Assumes
 1. Recessive inheritance of resistance
 2. Very low initial number of resistant individuals
 3. Large number of susceptible individuals in the refuge
 4. High level of gene flow between treated crop and refuge

On-farm Tools for Resistance Management

■ Chemical management

- High dose/refuge strategy

 - » Often required for GMO crops

- Assumes

1. Recessive inheritance of resistance

2. Very low initial number of resistant individuals

3. Large number of susceptible individuals in the refuge??

4. High level of gene flow between treated crop and refuge??

On-farm Tools for Resistance Management

- Chemical management
 - Resistance monitoring
 - » Can we detect resistance at an early stage?
 - » Does resistance increase gradually?
 - » If we find resistance, can we do something about it?
 - Are growers willing to change?
 - Is resistance unstable?

Conclusions - Managing Resistance in Colorado Potato Beetle

- We have failed repeatedly to manage insecticide resistance in Colorado potato beetle

Colorado potato beetles	41*
Entomologists	0

*Numbers of insecticides: Whalon et al. 2005.

The database of arthropods resistance to pesticides.

www.pesticideresistance.org/DB/index.html

Conclusions - Managing Resistance in Colorado Potato Beetle

- We have failed repeatedly to manage insecticide resistance in Colorado potato beetle
- It's going to take a special effort to manage resistance to neonicotinoids in Colorado potato beetle

Conclusions - Managing Resistance in Colorado Potato Beetle

- What do we need to do differently?
 1. Act before resistance appears
 - » Crop rotation
 - » Alternation of insecticides
 - » Resistance monitoring

Conclusions - Managing Resistance in Colorado Potato Beetle

- What do we need to do differently?
 1. Act before resistance appears
 2. Act decisively as soon as resistance appears
 - » Crop rotation + trap crops
 - » Alternative insecticides
 - » Education and implementation support for growers

Conclusions - Managing Resistance in Colorado Potato Beetle

- What do we need to do differently?
 1. Act before resistance appears
 2. Act decisively as soon as resistance appears
 3. Develop a diversity of controls
 - » New insecticide modes of action
 - » Biological control?
 - » Resistant varieties (GMOs)