

# Bollworm (and Fall Armyworm) Issues in Bt Cotton

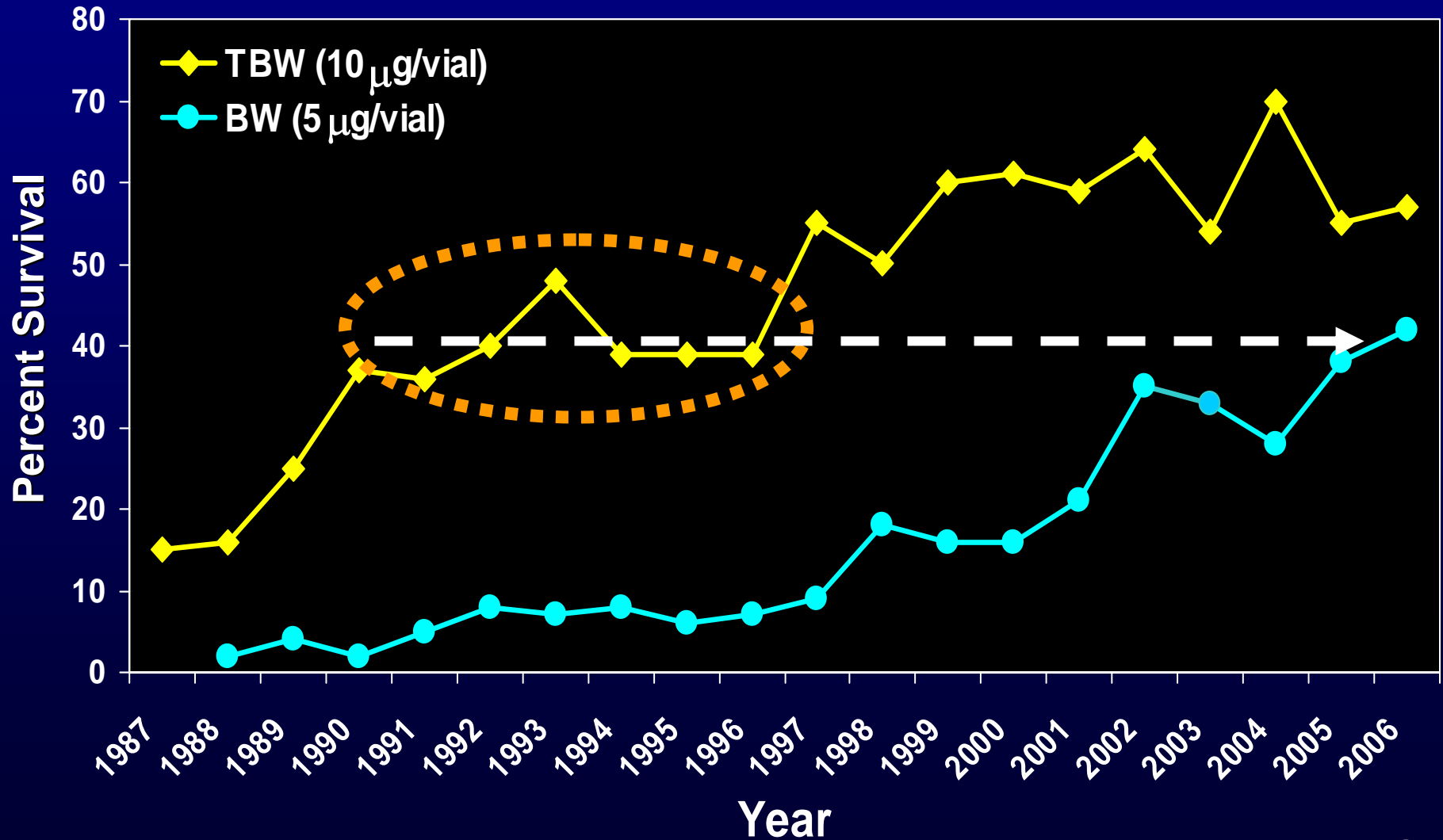
Walt Mullins  
Monsanto Company

# Bollworm/Fall Armyworm Issues with Bt Cotton

- Pyrethroid resistance
- Variability in Natural Tolerance to Bt
- Varietal Influence on Expression/Control
- Other Influences on Expression/Control
- Field to Field Variation

# Resistance Monitoring Survey

## Cypermethrin (May-Sep Mean Survival)



# Toxicity of Cry1Ac

(susceptible LAB colonies)

Insect	LC50	Bollgard® Plant Protein Expression Level*
Tobacco budworm	0.013	1.0
Pink bollworm	0.012	1.0
Beet Armyworm	>100	1.0
Bollworm	0.87	1.0
Fall Armyworm	>100	1.0

**\*Expression levels vary considerably due to many factors. Number represents an estimate of average fresh weight expression across tissue types and times.**

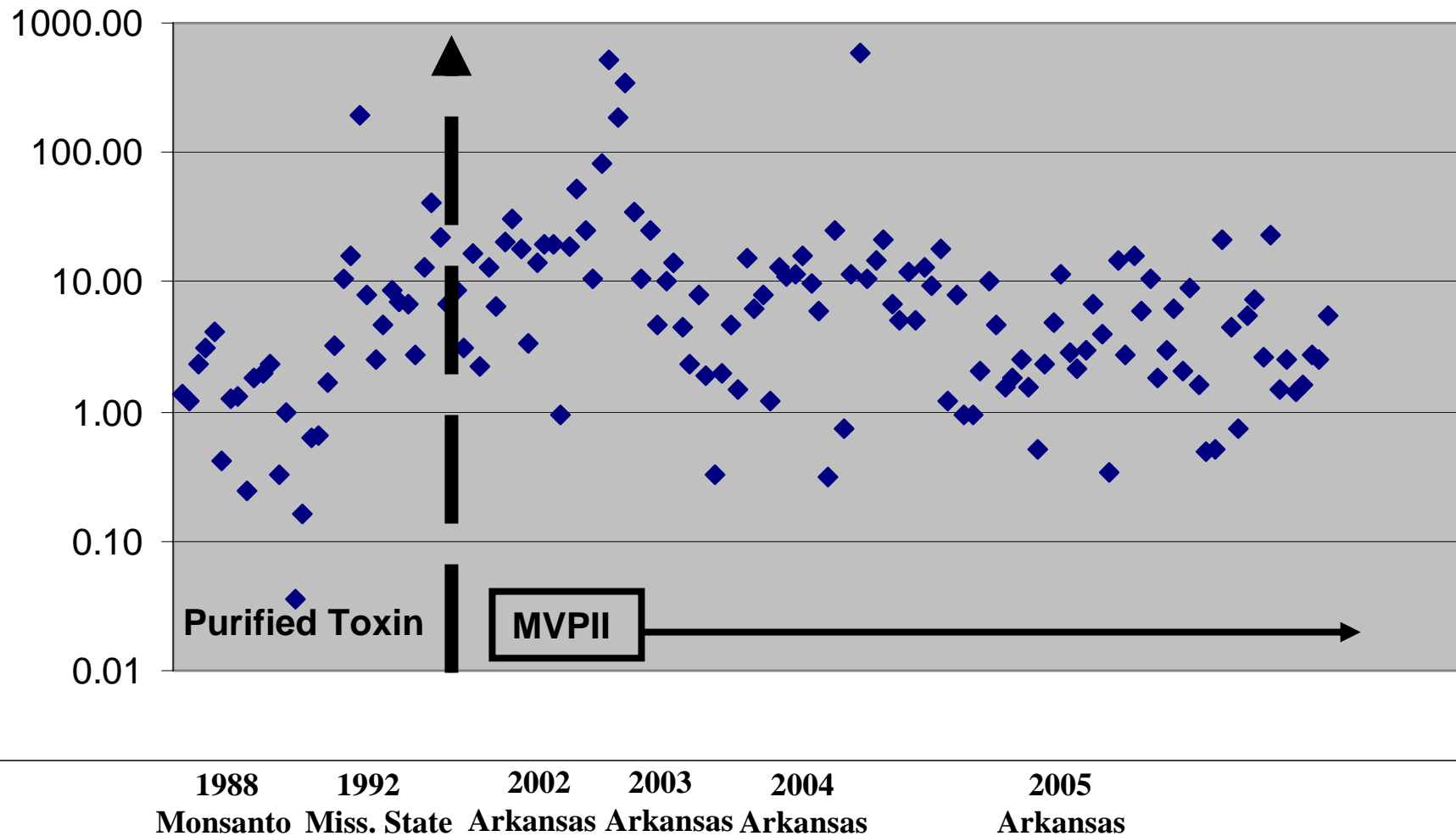
# Toxicity of Cry2Ab2

(susceptible LAB colonies)

Insect	LC50	Bollgard® II Plant Protein Expression Level*
Tobacco budworm	0.549	180
Pink bollworm	0.036	180
Beet Armyworm	16.72	180
Bollworm	17.48	180
Fall Armyworm	82	180

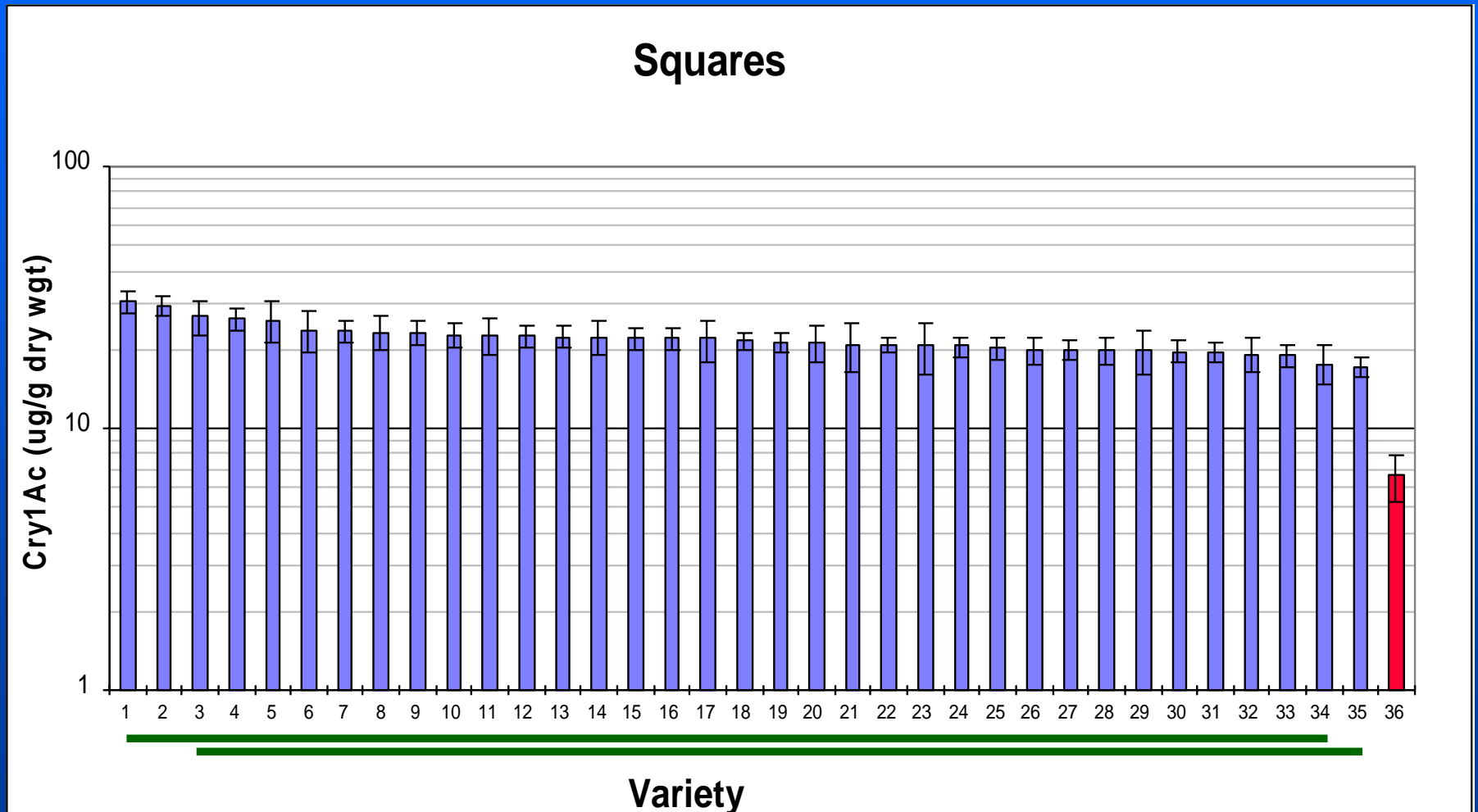
**\*Expression levels vary considerably due to many factors. Number represents an estimate of average fresh weight expression across tissue types and times.**

# Variation in LC50s (LC50 / LC50 Lab) for *H. zea* Exposed to Cry1Ac in Diet Incorporation Assays



# Varietal Influence on Expression? 1999 GE Expression Results

( — GE Requirement Level )

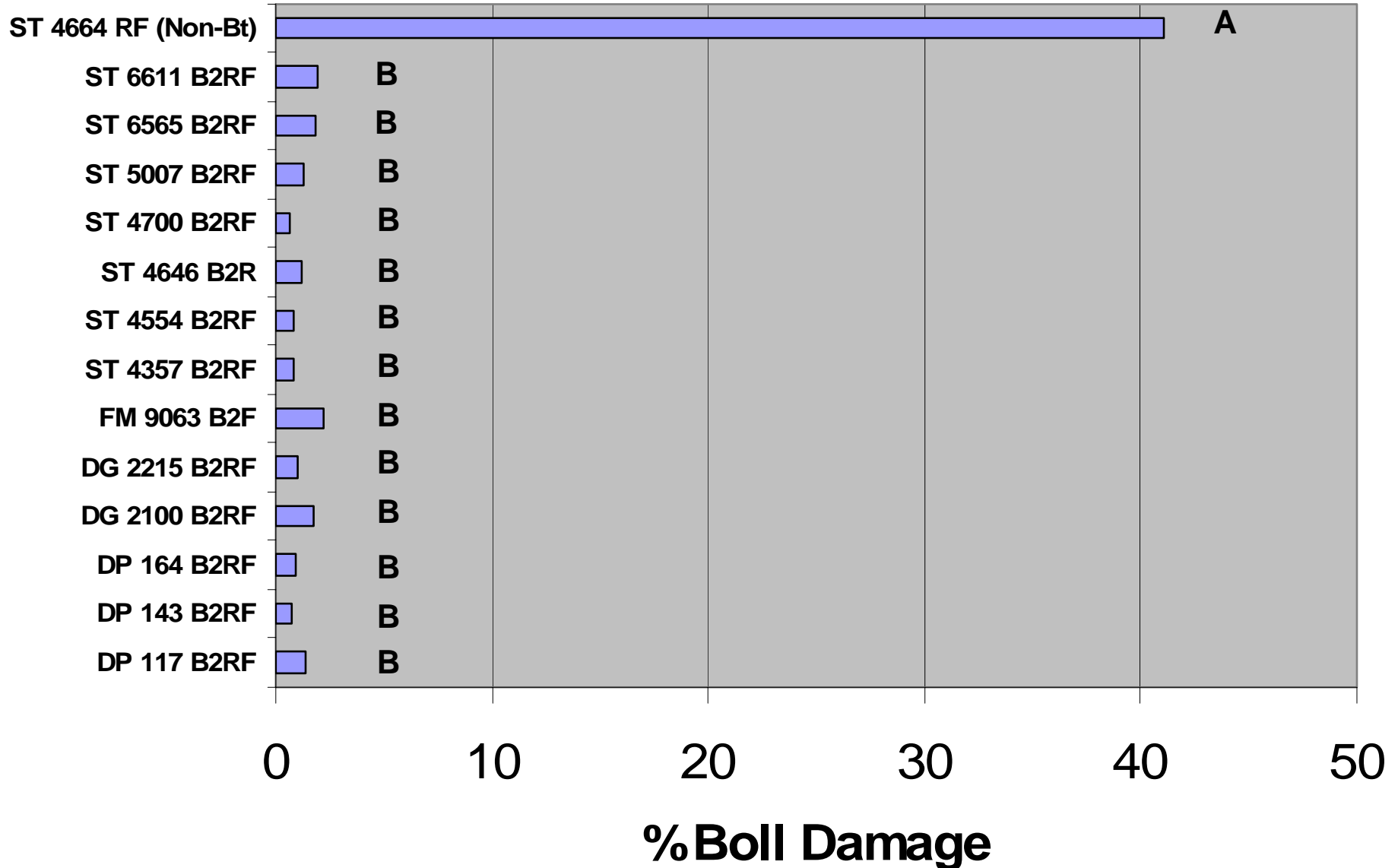


# Bollgard® II Varietal Effect on Bollworm Control?

- Tested in 6 high risk bollworm areas in 2006: 2-NC, 2-SC, SW GA, SE TX
- Disruptive sprays applied to remove beneficials
- Very High *H. zea* pressure at all sites except GA (moderate mid-season)
- Rated for % boll damage by examining harvestable bolls during peak infestation periods



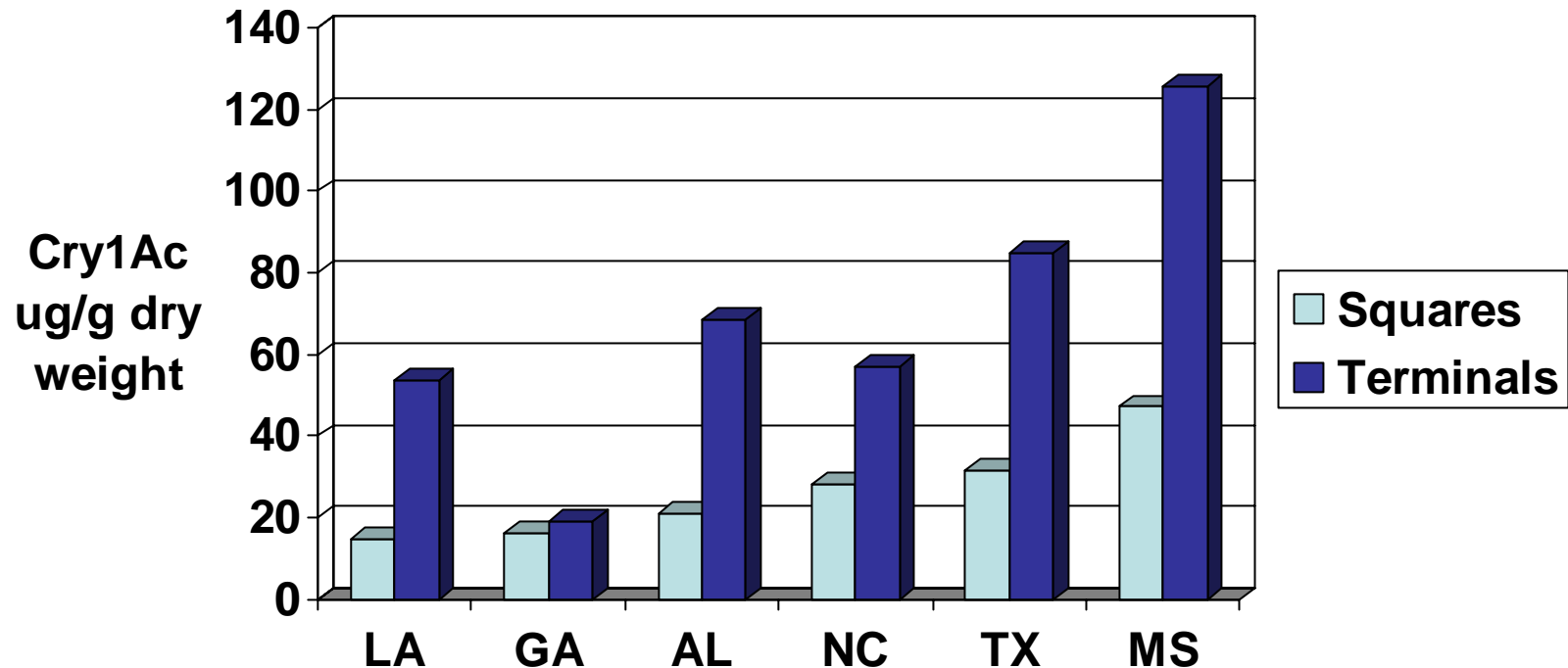
# Percent Boll Damage due to Bollworms



# Variety Comparison Conclusions

- No Statistically Significant Effect of Variety on Boll Damage across all sites/all rating dates
- No Statistically Significant Effect of Variety on Boll Damage across all sites at latest rating dates
- No Statistically Significant Effect of Variety at any one site or rating date when measuring % boll damage

# Impact of Location on Expression Square and Terminal Tissue (Bollgard®)



Greenplate, JEE, 1999

# Factors Influencing Expression

(Greenplate, JEE, 1999)

- **LOCATION (Environment)**
- Sampling time
- Tissue type or plant part
- Tissue location on the plant
- Plant to Plant variation

# Environmental Influences on Expression

- Waterlogging
- Drought
- Nitrogen Levels
- Shading
- In furrow Insecticides
- Heat
- Insect Attack
- Soil Type
- Foliar Treatments

**BUT, not necessarily in predictable ways!!**

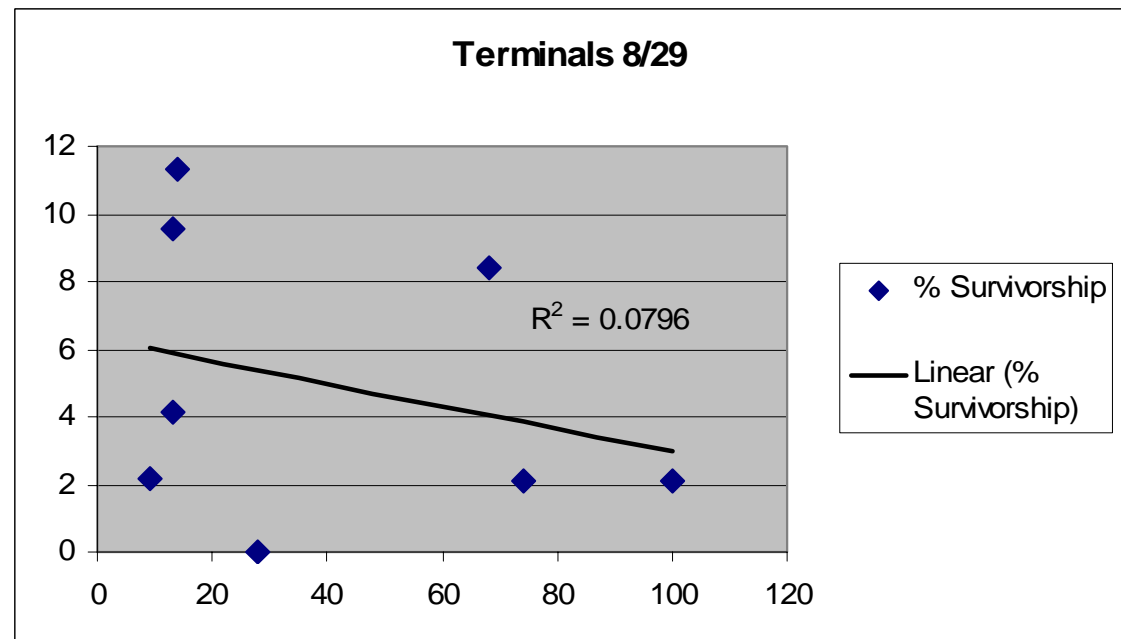
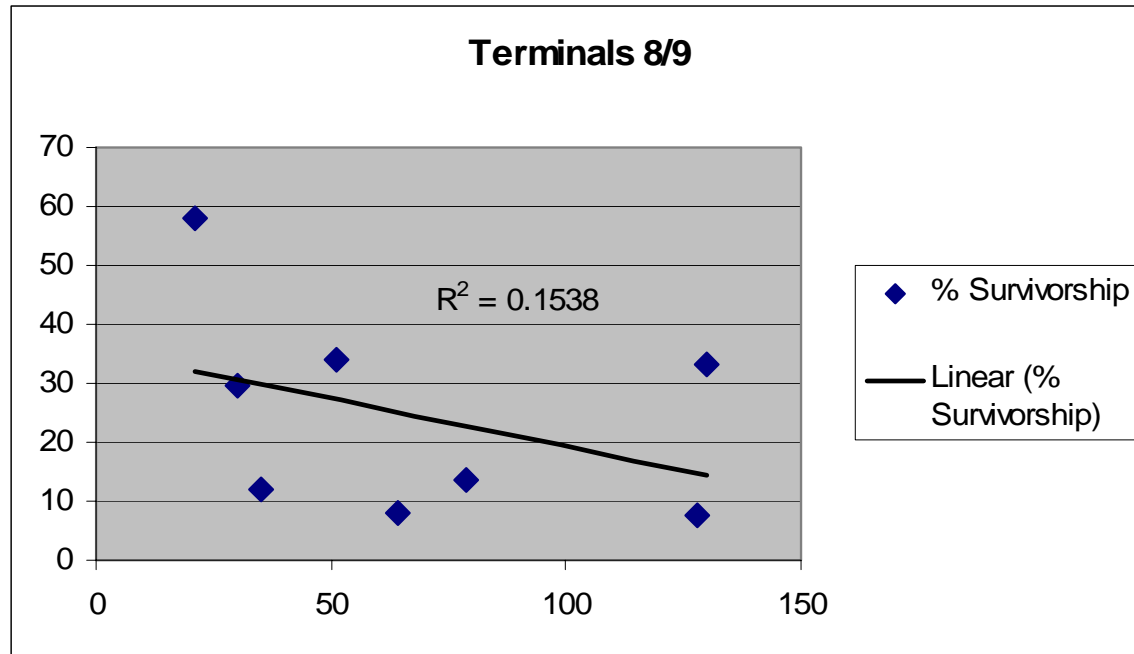
# Correlating Bollworm Survival to Expression

## (Cry1Ac equivalents Measured by Quantitative Bioassay)

Conducted at Leland  
Agronomy Center, 2001

- \*Lab bioassay
- \*Excised tissue
- \*Neonate bollworms
- \*48 hour survivorship

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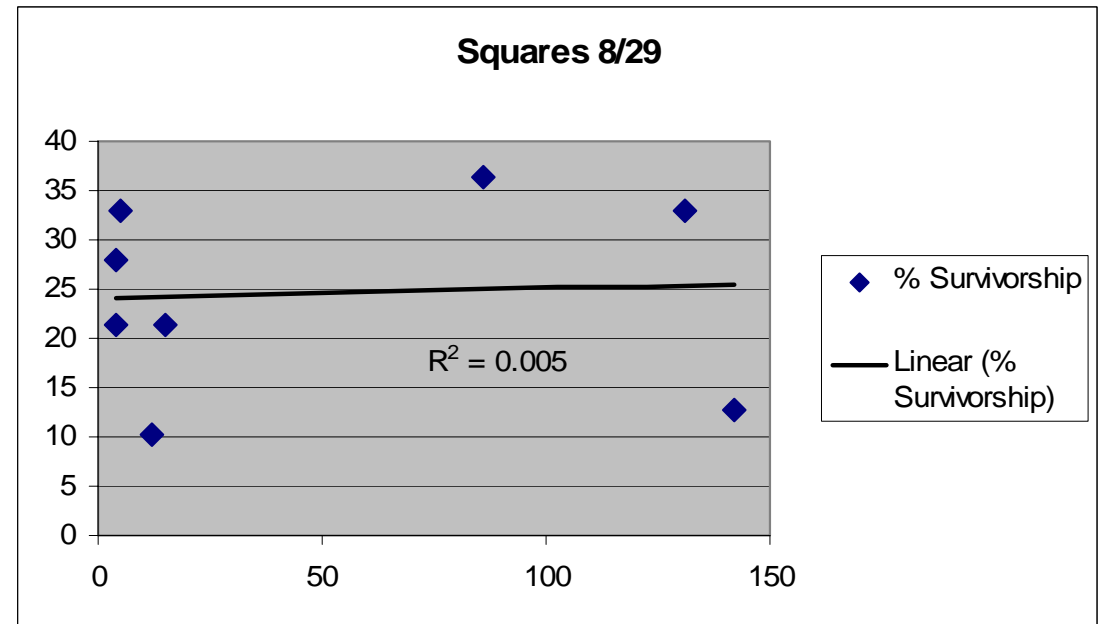
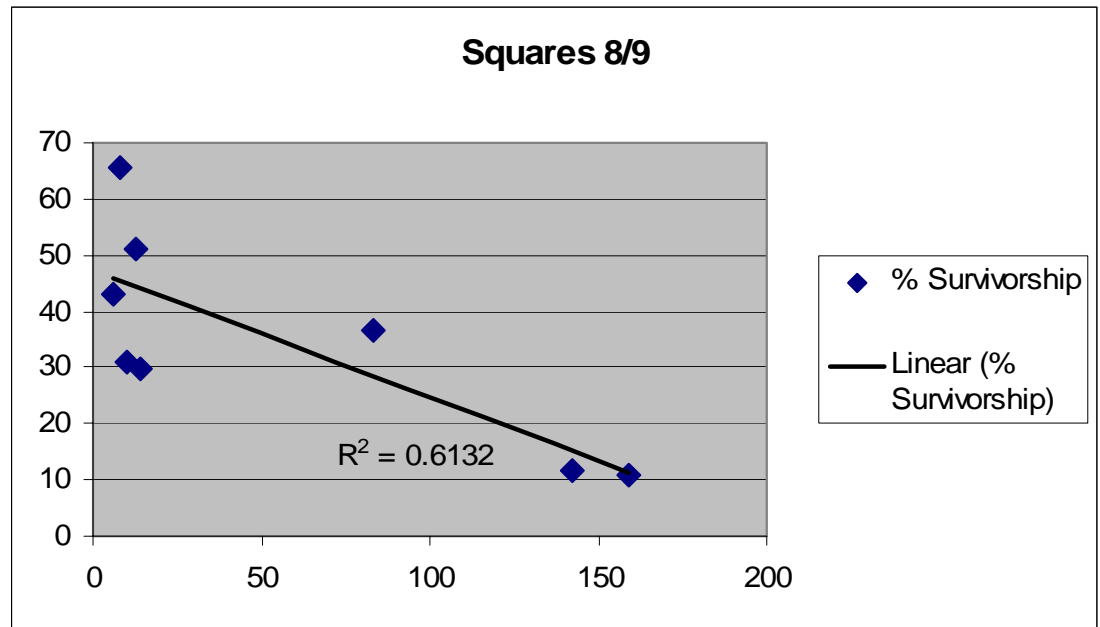
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**Plant-Toxin Interactions in Transgenic Bt Cotton  
and their Effect on  
Mortality of *Helicoverpa armigera* (Lepidoptera:  
Noctuidae)**

**K. M. OLSEN AND J. C. DALY**

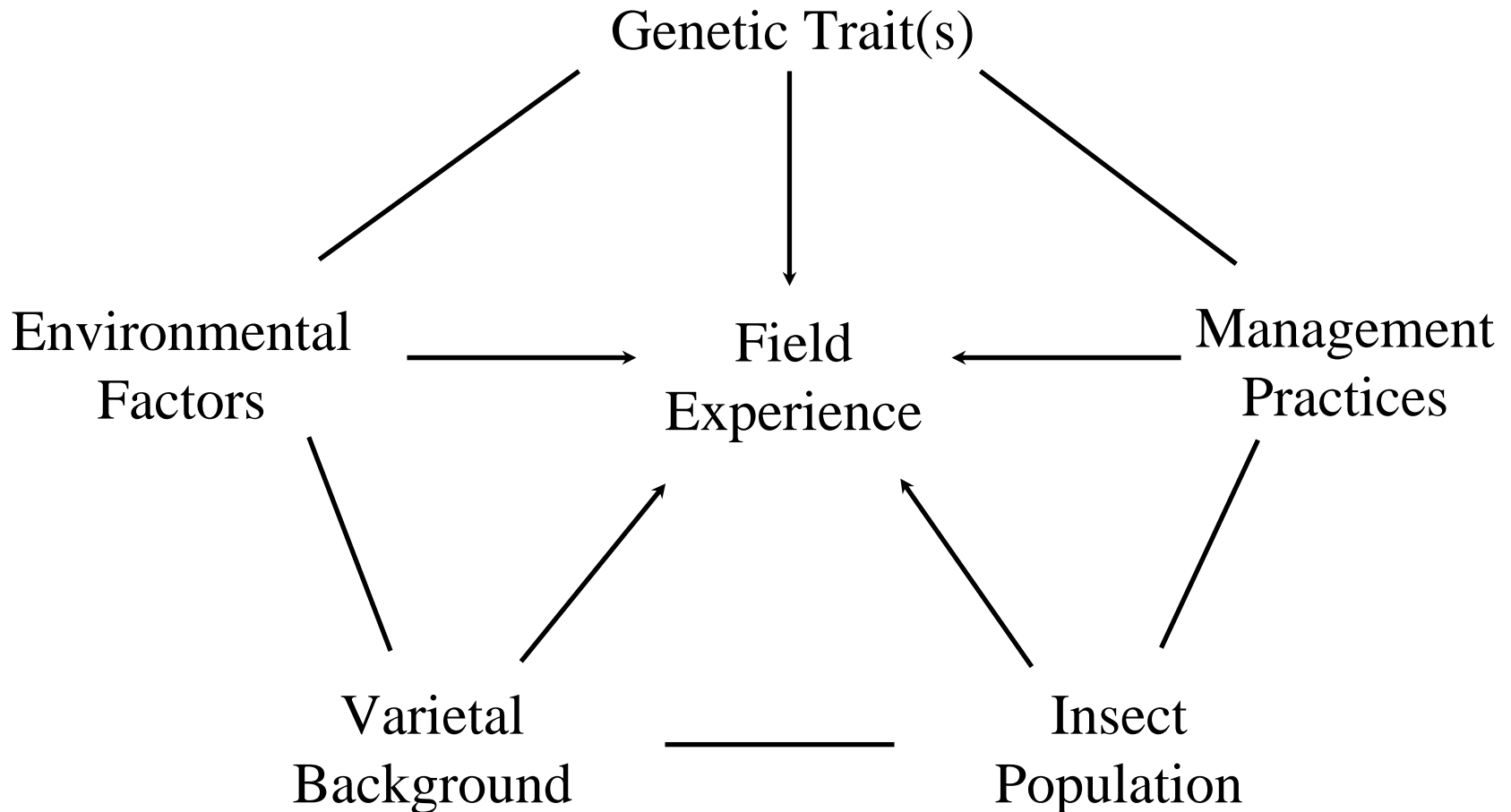
**Commonwealth Scientific and Industrial Research  
Organisation, Entomology and Australian Cotton CRC, GPO  
Box 1700,  
Canberra, ACT 2601, Australia  
J. Econ. Entomol. 93(4): 1293-1299 (2000)**

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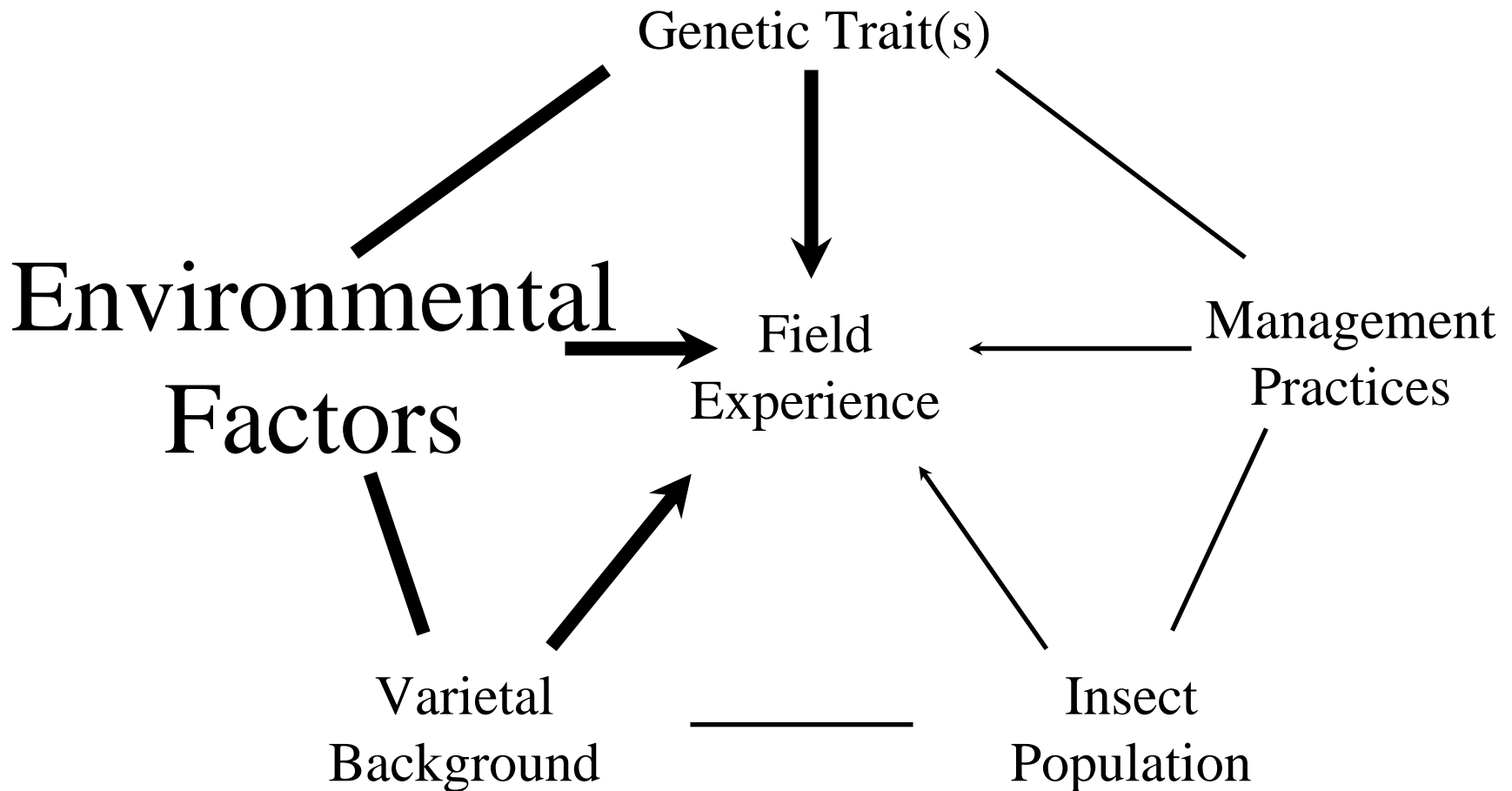
**“Changes in plant physiology,  
associated with the maturation of  
the cotton plant, were observed to  
contribute to changes in the efficacy  
of the Bt toxin.”**



# Why Field to Field Variations Occur With Transgenic Traits (1999)



# Why Field to Field Variations Occur With Transgenic Traits (2006)



# Ramifications of Biological Variation for Bollworm and Fall Armyworm Control in Bt Cotton

- Understanding a particular technology's range of effects requires multiple experiences across multiple environments, varietal backgrounds and pest populations
- Damage in one field rarely dictates or predicts that damage will occur in other adjacent fields, even given the same Bt technology in the same variety
- Every field of Bt cotton must be monitored for bollworm/fall armyworm damage and treated accordingly