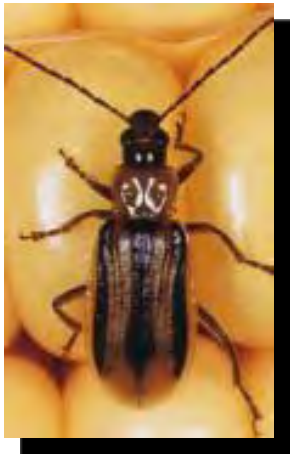
Force Insecticide Best Use Guidelines

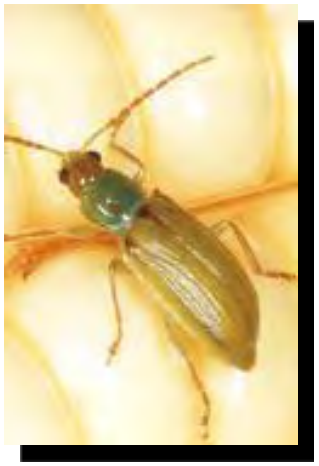
Classification: PUBLIC

Corn Rootworm

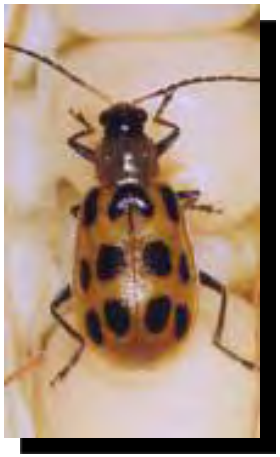
- Most destructive corn insect in the U.S.
- Costs corn producers $1+ billion per year
- Dynamic pest that is adapting and changing
- Three species:
  - Northern, Southern and Western



Western



Northern



Southern

Classification: PUBLIC

Corn Rootworm Biology

- All species have one generation per year
- Eggs are laid in mid-to late summer and overwinter (diapause) in top six inches of soil
- Eggs hatch from mid-May to early June
  - Hatch may last up to five weeks
- Rootworm larvae
  - Yellow/white color with wrinkled bodies
  - Larvae ½ - ¾ inches long
  - Generally need food within 3 – 4 hours of hatching
  - Can travel up to 20 inches to corn roots
  - Can survive 3 – 4 days without food
  - Development lasts about three weeks
    - Feeding can last longer due to extended hatching periods

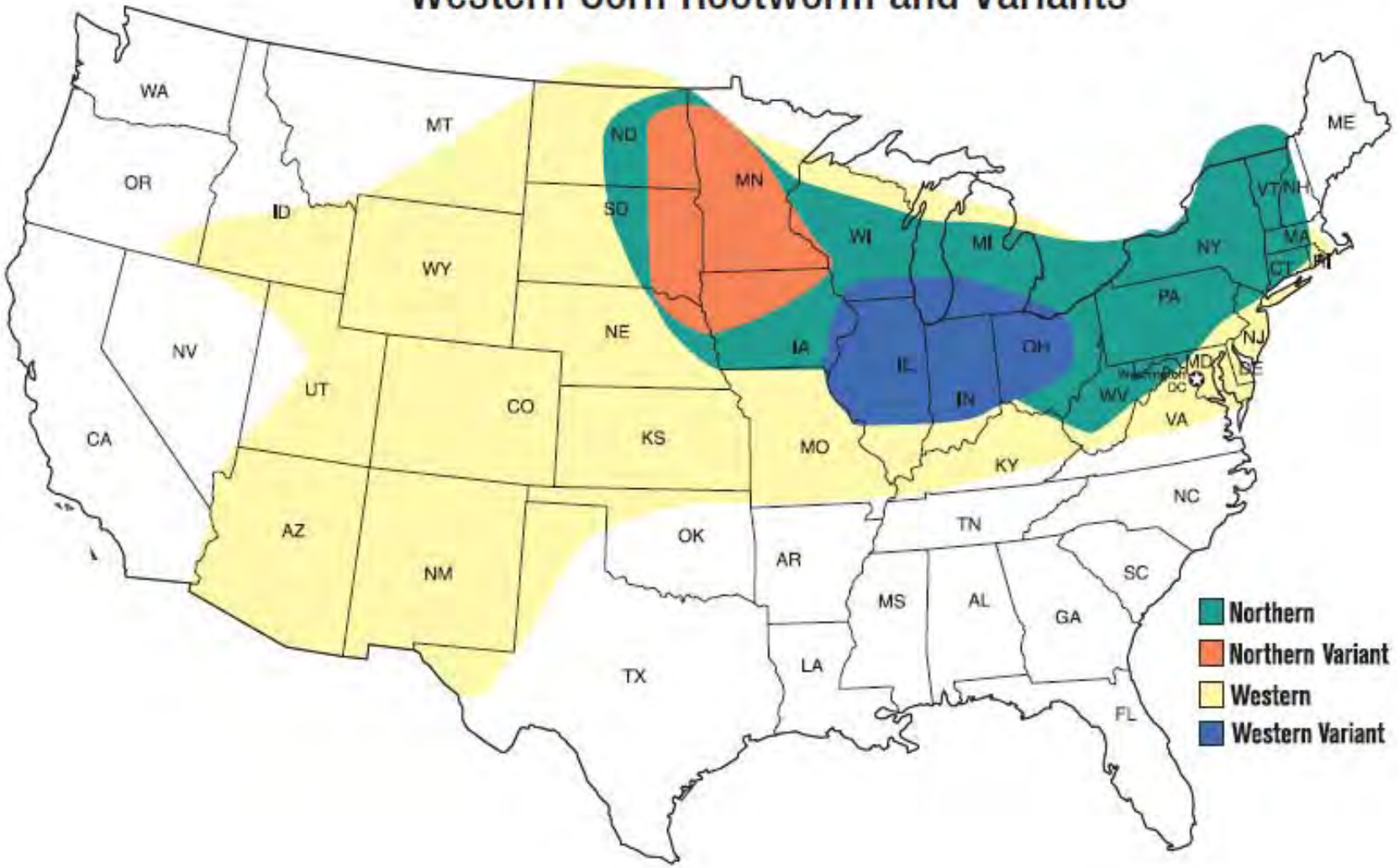
Classification: PUBLIC

Corn Rootworm Biology

- Adults emerge from mid-July – August
- Males tend to emerge one week earlier than females
- Females mate once and begin laying eggs in two weeks
  - Lay an average of 500 eggs but can exceed 1000
  - Can lay viable eggs for up to two months
- Beetles can travel up to one mile

Classification: PUBLIC

Geographic Distribution of Northern and Western Corn Rootworm and Variants



Classification: PUBLIC

Corn Rootworm Damage

- Larval root feeding
  - Primary grower concern
  - Scarred roots are more susceptible to disease
  - Reduces corn plant's ability to uptake water and nutrients, resulting in increased plant stresses
  - Inhibits formation of brace roots, resulting in lodged or goose-necked corn
    - Difficult harvest (slow)
    - Volunteer corn
- Adult beetles feed on pollen, silks and leaves
  - Foliar damage
  - Can interfere with pollination (poor ear fill)

Classification: PUBLIC

Corn Rootworm Damage

Corn Rootworm Larval Feeding

Classification: PUBLIC

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Other Early-Season Corn Insects

- Black Cutworm
- White Grubs
- Wireworms
- Seedcorn Maggot
- Seedcorn Beetle
- Lesser cornstalk borer

Classification: PUBLIC

Black Cutworm

- Larvae
  - Light gray to black color
  - Up to 1.5 inches long
  - Rough greasy appearance
  - Hatch and feed on corn leaves
  - Cut seedlings at or just below the soil surface
- Adults
  - Prefer fields with weeds or crop residues for egg laying
- Problem fields
  - Fields prone to cool, moist soils
  - Fields with heavy vegetation during early spring
  - Fields planted into sod or legume pastures

Classification: PUBLIC

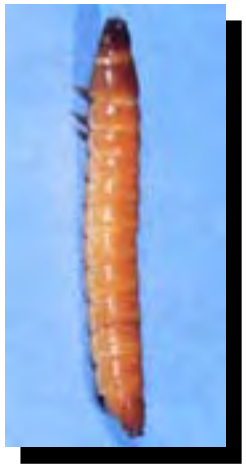
White Grubs

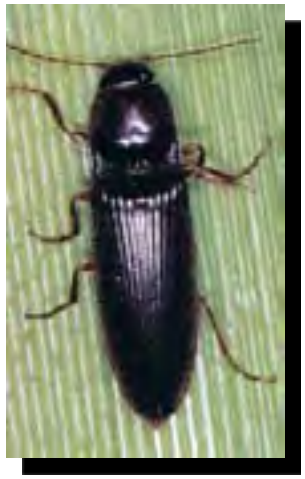
- Larvae
  - White, curved and up to one inch long
  - Brown heads with six prominent legs
  - Hind part of body smooth and dark
- Adults
  - Brown or brownish-black in color
  - Beetles emerge from May to June
- Symptoms of injury
  - Irregular plant emergence
  - Stunted or wilted plants
  - Injury spotted throughout field

Classification: PUBLIC

Wireworms

- Larvae
  - Yellowish or reddish-brown color
  - Wiry, hard shell
  - Up to 1.5 inches long
- Adults
  - Brownish or black color
  - Hard shell
  - Click beetles
- Attracted to grasses to deposit eggs
- Attack corn seed or drill into base of stem below ground
  - Damage the growing point





Classification: PUBLIC

Seedcorn Maggot

- Larvae
  - Yellowish-white in color
  - ¼ inch long
  - Sharp point at head's end
  - Legless and tough skin
- Adults
  - Grayish-brown fly
  - 1/3 inch long
- Eat seeds before emergence
  - Corn attacked by maggots fails to sprout
- Most common and severe in wet, cold springs and on land with high organic matter

Classification: PUBLIC

Controlling Corn Rootworm – Improving yields

Classification: PUBLIC

Rootworm control methods

- Syngenta recommends a combination of the following for optimal rootworm control:
  - Consistent refuge acre management (trait stewardship)
  - Crop rotation where possible and effective
  - Rotating or stacking traits
    - Agrisure® 3122 trait stack – dual modes of action against CRW
  - Seed treatments help provide early season protection
    - CruiserMaxx® Corn 1250
  - Soil-applied insecticides
    - Force® 3G or Force CS

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

Force®

- Superior corn rootworm control for more than 20 years
- Additional mode of action for rootworm control on CRW-traited acres
  - **Force on trait trials consistently demonstrate average yield increases of 10+ bu/a regardless of rootworm trait utilized**
- Effective in high rootworm pressure areas
- No adverse herbicide interactions
- Control of multiple early-season pests that traits alone may not control (wireworms, black cutworm, white grubs)

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

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Force®

- Protects corn roots
  - Preserves plant's ability to uptake water and nutrients
  - Healthier plant that is better prepared to fight stresses
  - Stronger stands at harvest (less downed corn)
    - Saves time
    - Helps prevent volunteer corn
    - Increases potential for maximum yields

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

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Force®

- Unique chemistry works on contact or through ingestion
- Can be applied to rootworm-traited (all traits), refuge or full-field conventional corn acres
- Low use rates compared to competitors
- Application flexibility
  - T-band or in-furrow
  - Multiple equipment options
- Available in granular or liquid formulation
  - Force 3G (granular)
  - Force CS (liquid)

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

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What growers need to know about resistance

- Multiple modes of action combined with consistent trait stewardship is key to managing resistance
- Iowa State researchers published a study[1] in 2011 citing resistance to Event MON88017 (Cry3Bb1 protein) among western corn rootworm in some fields in Iowa
  - sold commercially as YieldGard VT Rootworm/RR2™ in:
    - YieldGard VT Triple®; Genuity® VT Triple PRO™; Genuity® SmartStax®
- Susceptible and resistant rootworms were identified within each field where resistance was cited
- Western corn rootworm has ***not*** shown resistance to the Agrisure RW trait
- Syngenta does not use Event MON88017 in its corn hybrids

[1]Gassman AJ, Petzold-Maxwell JL, Keweshan RS, Dunbar MW (2011) Field-Evolved Resistance to Bt Maize by Western Corn Rootworm. PLoS ONE 6(7):e22629. doi:10.1371/journal.pone.0022629.

Classification: PUBLIC

What growers need to know about resistance

- Excessive feeding does not necessarily indicate resistance
  - Potential contributing factors to rootworm damage include:
    - High rootworm populations
    - Planting timing is not synched with protein expression
      - Early hatch & late planting -OR- early planting & late hatch
    - Alternative hosts present (weedy fields or volunteer corn)

Classification: PUBLIC

Force on CRW Trait

- Benefits of applying Force insecticide to rootworm-traited corn:
  - Enhanced yield potential
  - Additional mode of action for rootworm control
    - Piece of mind from exceptional rootworm control
  - Enhanced root protection in heavy rootworm pressure
  - Control of additional early-season pests
  - Improved standability of corn plant
    - Protects yield
    - Faster harvest
    - Less potential for volunteer corn

Force 3G and Force CS are Restricted Use Pesticides

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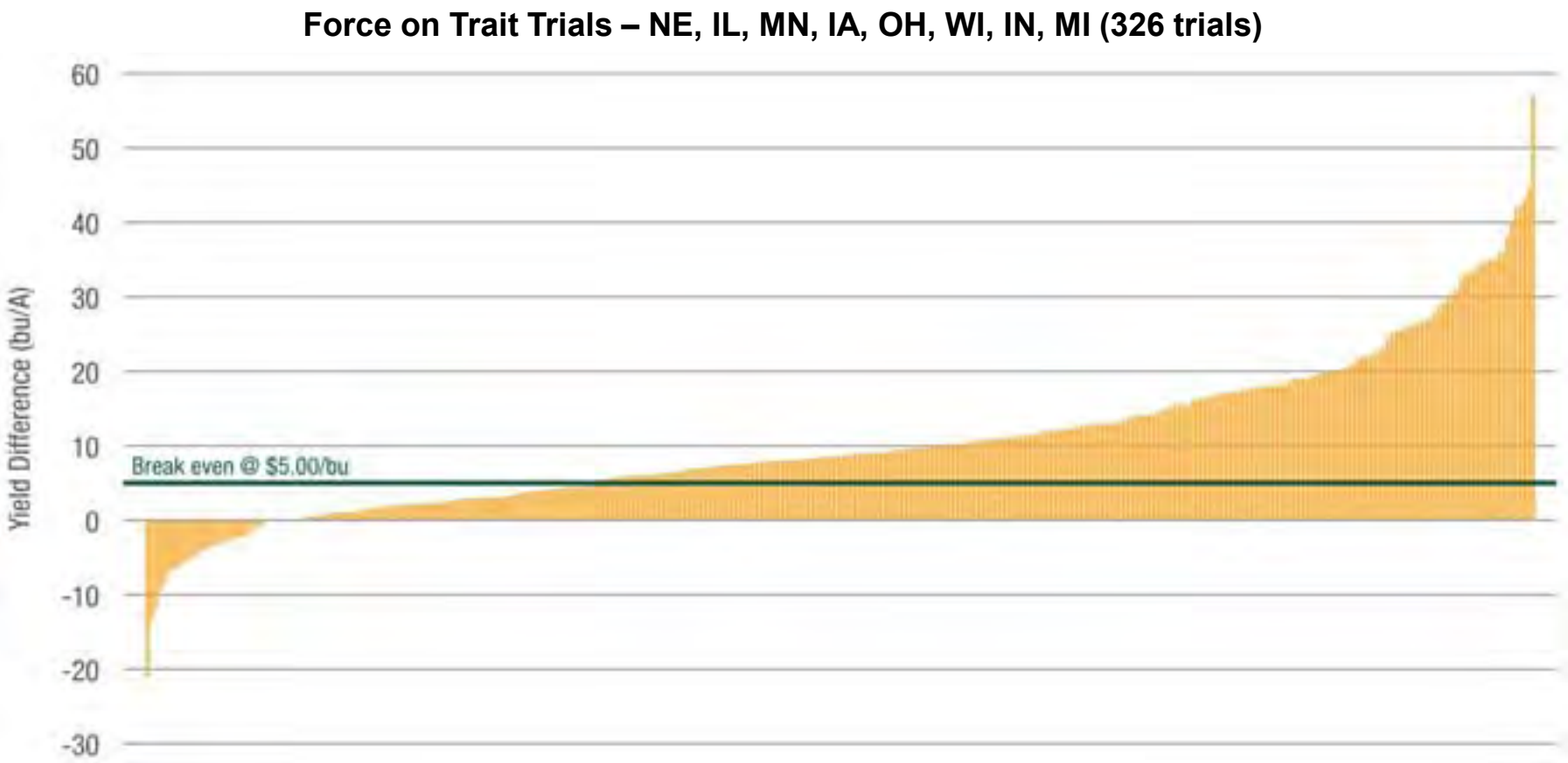
Force® insecticide on RW trait strip trial results Syngenta, 2007-2011 (various RW traits utilized)



10.42 Bushel Average Increase

70% of the trials = Economic return at $5/bu corn

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

Where does Force on CRW trait fit?

A check in one or more boxes may indicate a treatment of Force insecticide in addition to a rootworm trait will be beneficial.

- ❑ Do you plant early?
- ❑ Do you plant corn on corn?
- ❑ Is there heavy corn rootworm pressure?
- ❑ Are secondary pests a concern?
  - Cutworm
  - Wireworms
  - Grape colaspis
  - White grubs
- ❑ Is there potential for early-season weed competition?

(Pest population growth accelerates in early weed cover)

- ❑ Are you in an area where corn rootworm resistance to Bt is suspected?
- ❑ Do you need to manage insects with multiple modes of action?

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

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Herbicide interaction

- **Force does not increase the risk of crop injury** when used with popular corn herbicides, including:
  - HPPD herbicides such as: Halex® GT, Callisto®, Lumax®, Lexar® and others
  - Sulfonylurea (SU) herbicides such as Capreno®, Prequel®, Corvus®, SureStart®, Verdict™ and others
- Organophosphate (OP) soil insecticides can damage crops when used with certain HPPD or SU herbicides
- Examples of OP soil insecticides:
  - Counter®, Lorsban®

Callisto Xtra, Lumax, Lexar, Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

Recommended Force application methods

- **T-band**
  - Corn rootworm and cutworms are only concern
- **In-furrow**
  - Corn rootworm and cutworms, along with wireworms, grubs or seed corn maggot are a concern
  - Why? – A rescue treatment of Warrior II with Zeon Technology® insecticide can handle cutworm, but not the others

Force provides excellent control of corn rootworm regardless of the application method.

Force 3G, Force CS, and Warrior II with Zeon Technology are Restricted Use Pesticides

Warrior II with Zeon Technology is highly toxic to bees exposed to direct treatment on blooming crops and weeds. Do not apply this product or allow it to drift onto blooming plants while bees are foraging adjacent to the treatment area.

Classification: PUBLIC

Force Chemistry

- Pyrethroid
  - Force unique active ingredient: Tefluthrin
    - More volatile than other pyrethroids, allowing movement in soil spaces
  - Insect repellency properties
  - Residual activity
  - Binds to organic matter in soil
  - Unaffected by exposure to light

Force® 3G

- Consistent rootworm control for more than 20 years
- Low use rate compared to competitors
  - Treats approximately 68% more acres per 50-pound bag than Aztec®
- Applied pre-emergence using a T-band or In-furrow application
  - Can be applied via SmartBox® system
- Labeled rate: 3.0-5.0 oz./1000 ft. of row or 3.3-5.5 lbs./a (30-inch rows)
- Registered crops:
  - Field corn
  - Popcorn
  - Seed corn
  - Sweet corn

Recommended use rates – Force 3G

Force 3G	Pounds of Force 3G insecticide required per acre for various row spacing		
Row Spacing	30 in.	20 in.*	15 in.*
Linear ft./A	17,424 ft.	13,068 ft.	17,424 ft.
Ounces per 1,000 ft. of Row	**Force 3G - Pounds per Acre**		
3 oz.	3.3 lbs.	2.5 lbs.	3.3 lbs.
4 oz.	4.4 lbs.	3.3 lbs.	4.4 lbs.
5 oz.	5.5 lbs.	4.1 lbs.	5.5 lbs.

*Refuge treated rows only. Do not exceed more than ½ treated area.

See **current product label** for detailed product and application information.

Force 3G is a Restricted Use Pesticide

Classification: PUBLIC

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Force® CS

- Insect control equal to Force 3G with the convenience of a liquid
- Cost per acre comparable to Force 3G
- Low use rate compared to granular competitors
  - At average use rate, treats 160 acres with four, 23-pound boxes
  - Need 18, 50-pound bags of Aztec to treat the same amount of acres
- Applied pre-emergence using a T-band or In-furrow application
- Labeled rate: 0.46-0.57 fl. oz./1000 ft. of row or 8.0-10 fl. oz./a (30-inch rows)
- Packaged in 2.5 gallon box that weighs 23 lbs.
  - Easier to lift and load (saves time)
  - Reduced handling and product exposure

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

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Force® CS

- Delivered through a closed application system
  - John Deere Central Insecticide System™
    - Available for many John Deere planters through authorized John Deere retailers
  - Raven application system
    - Aftermarket option
    - Can be fitted to most planters
- Do not store containers where temperatures may go below freezing
- Registered crops:
  - Field corn
  - Popcorn
  - Seed corn
  - Sweet corn

Force CS is a Restricted Use Pesticide

Classification: PUBLIC

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Recommended use rates – Force CS

Force CS	Fluid ounces of Force CS insecticide required per acre for various row spacing		
Row Spacing	30 in.	20 in.*	15 in.*
Linear ft./A	17,424 ft.	13,068 ft.	17,424 ft.
Fluid Ounces per 1,000 ft. of Row	**Force CS - Fluid Ounces per Acre**		
0.46 fl. oz.	8 fl. oz.	6 fl. oz.	8 fl. oz.
0.57 fl. oz.	10 fl. oz.	7.5 fl. oz.	10 fl. oz.

*Refuge treated rows only. Do not exceed more than ½ treated area.

See **current product label** for detailed product and application information.

Force CS is a Restricted Use Pesticide

Classification: PUBLIC

Force CS equipment options

John Deere Central Insecticide System

- Available for many John Deere planters
- Installed and serviced by authorized John Deere retailers
- Closed-handling, closed calibration system
- Fully integrated with the planter

Raven

- After market option that can be fitted to most planter makes and models
- Installed and serviced by authorized Raven dealers
- Closed-handling, closed calibration system
- System design allows for integration with in-furrow liquid fertilizer systems

RAVEN

Force 3G vs. Force CS

Force 3G

- Granular
- Packaged in 50 lb. bag
- Applied T-band or In-furrow
- Delivered via planter box or SmartBox system
- Low use rate compared to other granular insecticides

Force CS

- Liquid
- Packaged in 2.5 gal, 23 lb. box
- Applied T-band or In-furrow
- Delivered via John Deere CIS or Raven application system
- Low use rate compared to all granular insecticides

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

Force 3G vs. Force CS

Force 3G®

- Pyrethroid chemistry
- No adverse herbicide interactions
- Can be used on rootworm-traited, refuge and full-field conventional acres

Loading Force CS boxes

Force CS®

- Pyrethroid chemistry
- No adverse herbicide interactions
- Can be used on rootworm-traited, refuge and full-field conventional acres
- Closed-handling system limits product exposure
- Easier to lift and load
- More convenient refuge acre management

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

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Force 3G vs. Force CS

When you should recommend…

- Grower has insecticide boxes for granular insecticide application
- Grower's planter is equipped with a SmartBox system

- Grower is considering investing in new planter or equipment
- Grower is interested in applying Force CS with liquid in-furrow fertilizer (i.e. via Raven application system)

Force vs. the competition

	Manufacturer	Chemistry	Formulation	CRW Control	Adverse Herbicide Interaction	Requires Proprietary Application Equipment
Force	Syngenta	Pyrethroid	Granular or Liquid	Excellent	Low	No
Counter®	AMVAC	OP	Granular	Excellent	High	Yes
Smart Choice™	AMVAC	OP & Pyrethroid	Granular	Excellent	High	Yes
Aztec	AMVAC	OP & Pyrethroid	Granular	Excellent	Medium	No
Capture® LFR	FMC	Pyrethroid	Liquid	Fair	Low	No

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

Key take-aways

- Force provides superior control of corn rootworm and a broad spectrum of early-season pests (wireworms, cutworm, white grubs)
  - Better root protection
  - Healthier plant able to fight off stresses
  - Improved standability for a better harvest
- Average yield increase of 10+ bu/a when applied over the top of a CRW trait
- No adverse herbicide interactions – fits any herbicide program
- Low use rate – less product to store and handle
- Available in a granular or liquid formulation
- Flexibility in application methods and equipment options

Force 3G and Force CS are Restricted Use Pesticides

Classification: PUBLIC

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Callisto Xtra, Lexar, Lumax, Force 3G, Force CS and Warrior II with Zeon Technology are Restricted Use Pesticides.

Crops or other material produced from Agrisure Corn Traits products can only be exported to, used, processed and/or sold in countries where all necessary regulatory approvals have been granted.

Warrior II with Zeon Technology is highly toxic to bees exposed to direct treatment on blooming crops and weeds. Do not apply this product or allow it to drift onto blooming plants while bees are foraging adjacent to the treatment area.

CruiserMaxx Corn 1250 is a application of separately registered products that deliver 1.25 mg a.i./seed of Cruiser 5FS seed treatment insecticide and Maxim Quattro seed applied fungicide.

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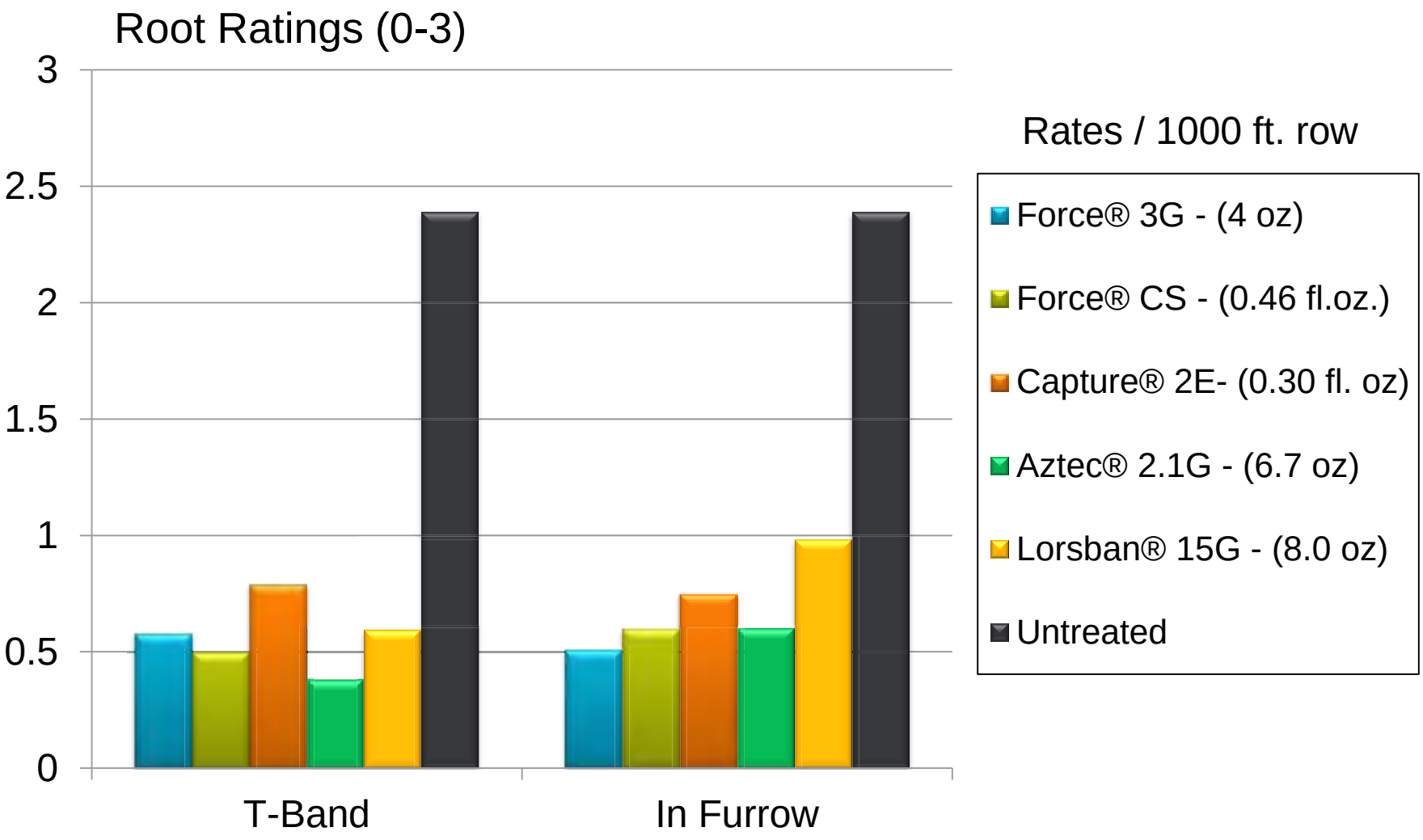
Appendices

Classification: PUBLIC

Corn Rootworm Control
High Pressure in Untreated



Force 3G and Force CS are Restricted Use Pesticides

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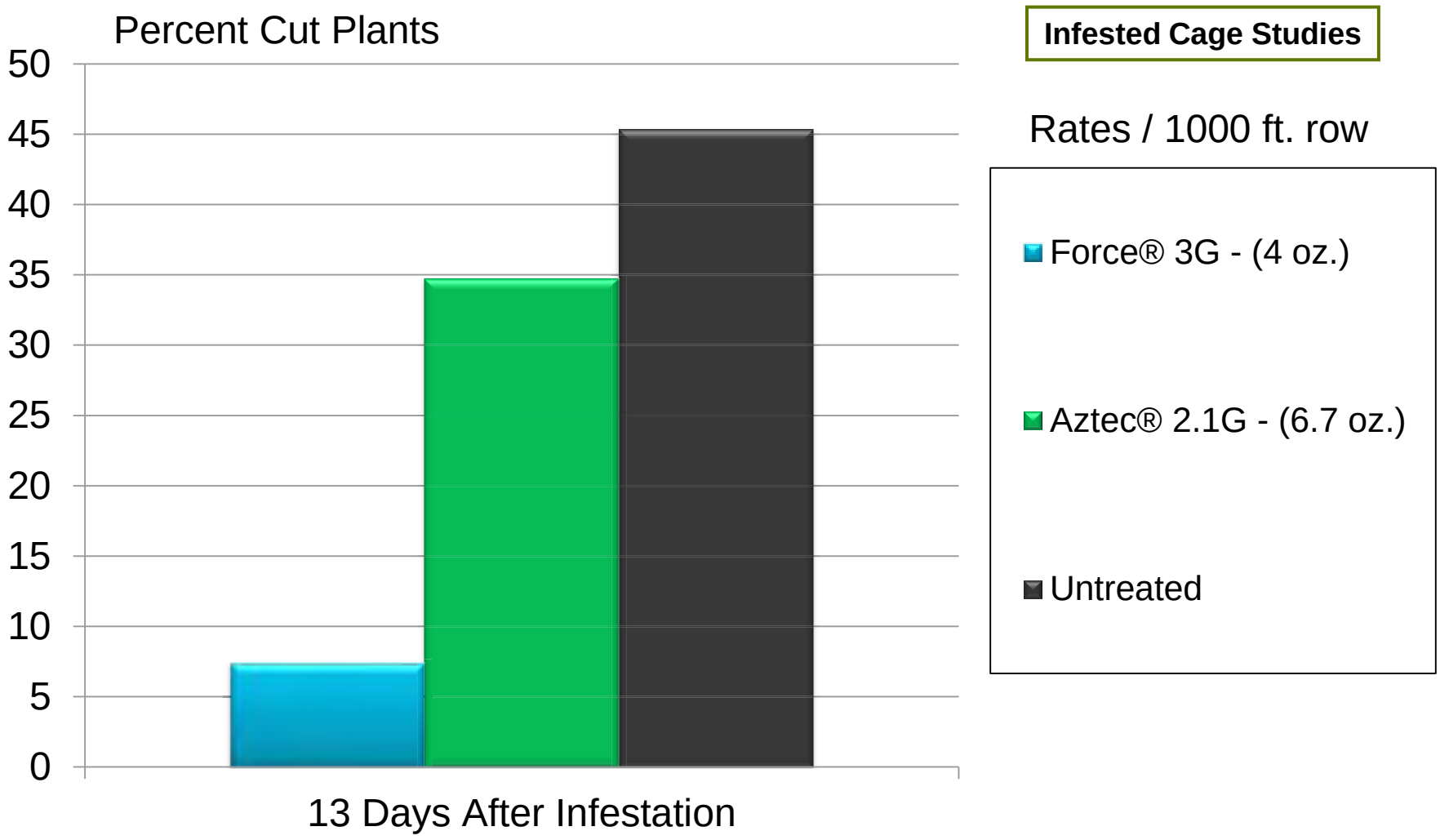
Black Cutworm Control – University of Missouri



Force 3G is a Restricted Use Pesticide

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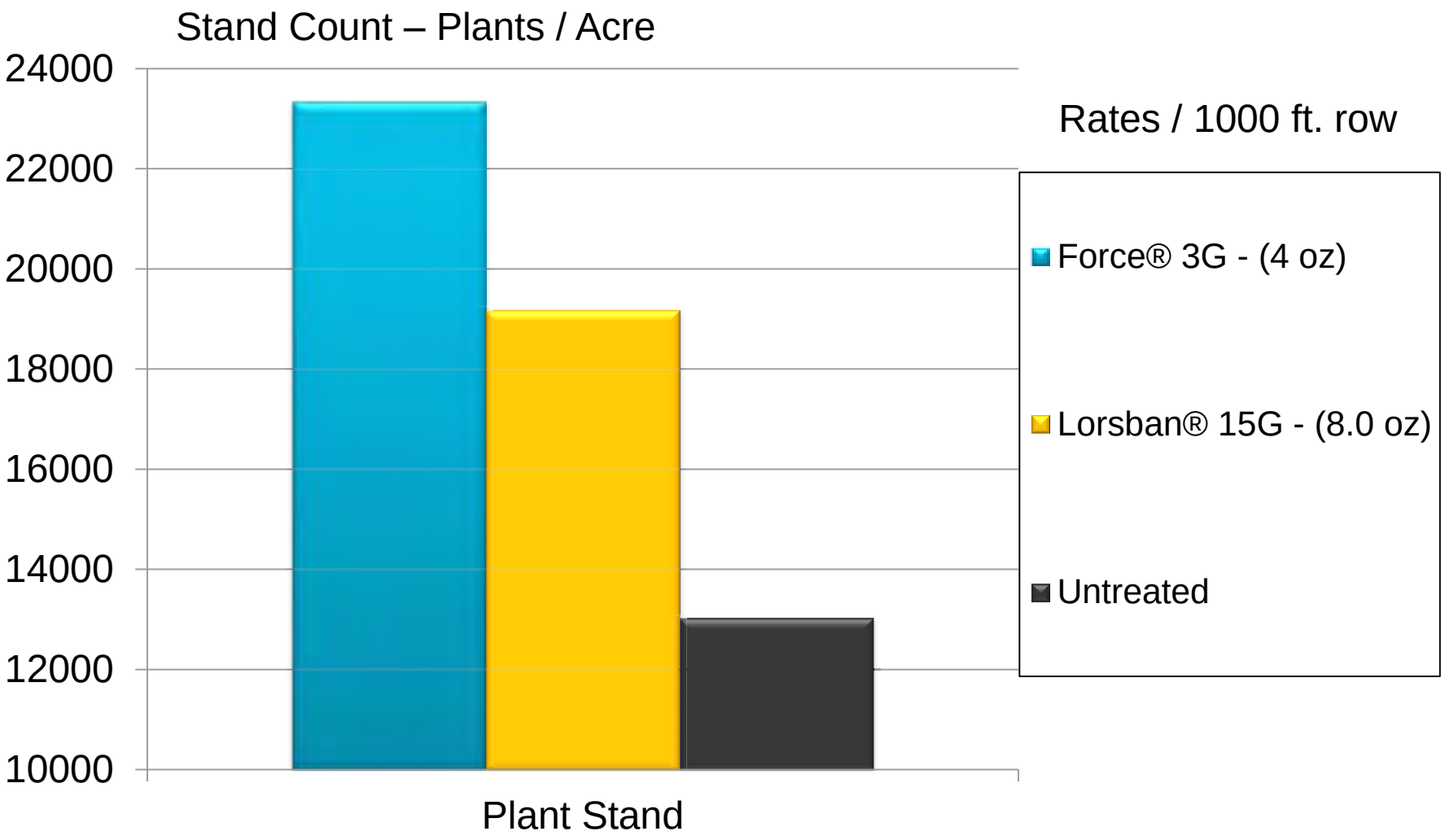
White Grub Stand Protection - – University of Minnesota



Force 3G is a Restricted Use Pesticide

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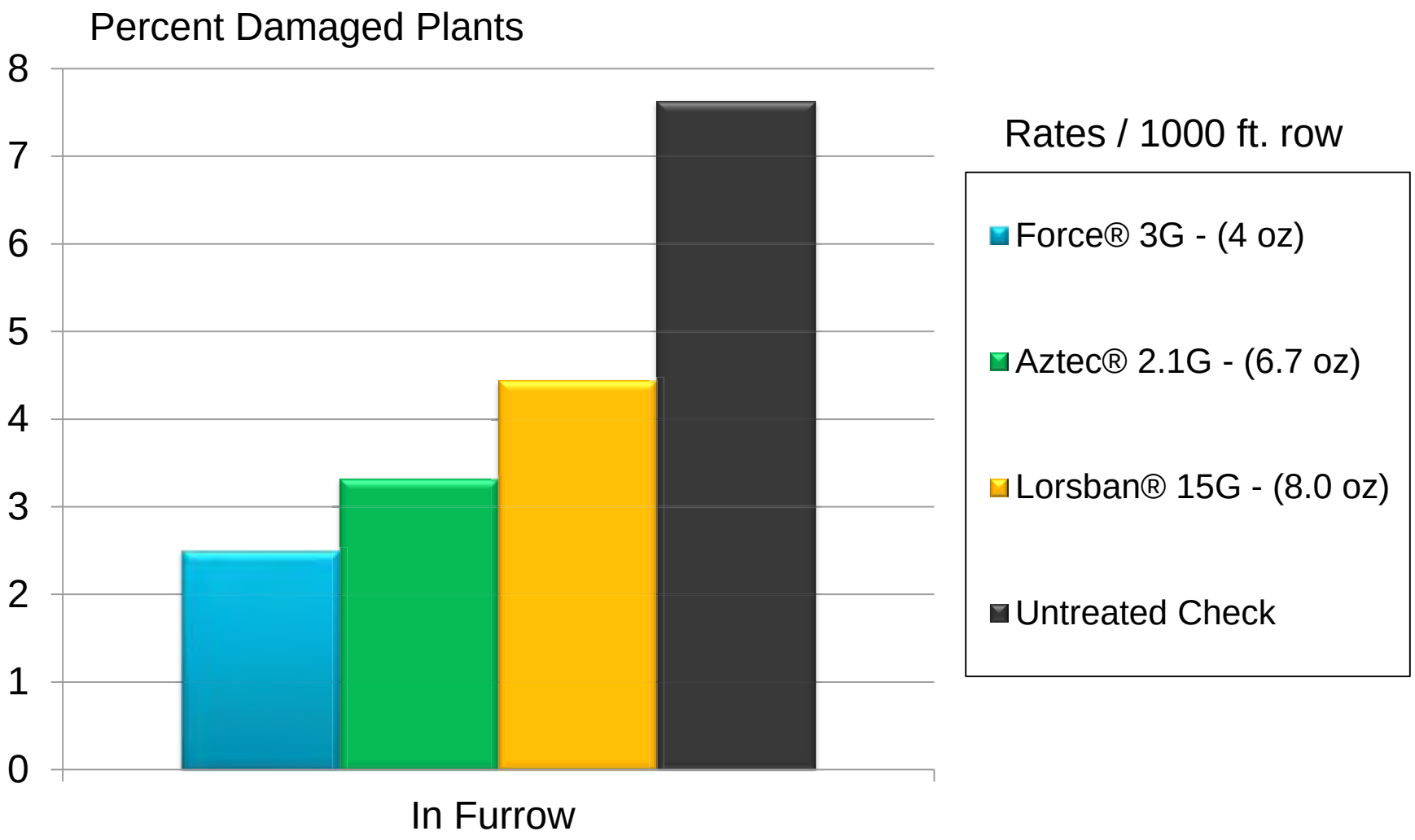
Wireworm Trials – University of Missouri (Average 2 Trials)



Force 3G is a Restricted Use Pesticide

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Iowa State node-injury scale

Visual Damage	Linear Scale
No Damage	0
	0.05
Feed scars evident, but none eaten to within 1.5 inch of plant	0.10
	0.20
Several roots eaten to within 1.5 inch, but total equivalent to 1 node	0.50
	0.75
One node destroyed	1.0
	1.75
Two nodes destroyed	2.0
	2.75
Three nodes destroyed	3.0

SLC 1130A 01-2012

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