Marrone® Bio Innovations

Applications of Biopesticides as Seed Treatments

Keith Pitts

Safe Harbor

This presentation contains forward-looking statements that involve substantial risks and uncertainties. All statements, other than statements of historical facts, included in this presentation regarding strategy, future operations and plans, including assumptions underlying such statements, are forward-looking statements, and should not be relied upon as representing the Company's views as of any subsequent date. Such forward-looking statements are based on information available to the Company as of the date of this presentation and involve a number of risks and uncertainties, some beyond the Company's control, that could cause actual results to differ materially from those anticipated by these forward-looking statements, including any difficulty in developing, manufacturing, marketing or selling the Company's products, any failure to maintain and further establish relationships with distributors, competition in the market for pest management products, lack of understanding of bio-based pest management products by customers and growers, adverse decisions by regulatory agencies, and the impact of negative publicity and perceptions around the company's financial restatement. Additional information that could lead to material changes in the Company's performance is contained in its filings with the SEC. The Company is under no obligation to, and expressly disclaims any responsibility to, update or alter forward-looking statements contained in this presentation, whether as a result of new information, future events or otherwise.

Potential Targets for Seed Treatments

Soil dwelling insects

Plant parasitic nematodes

Soil-borne pathogens

Soil Insect Pests of Corn, Soybeans and Wheat

Western Corn Rootworm

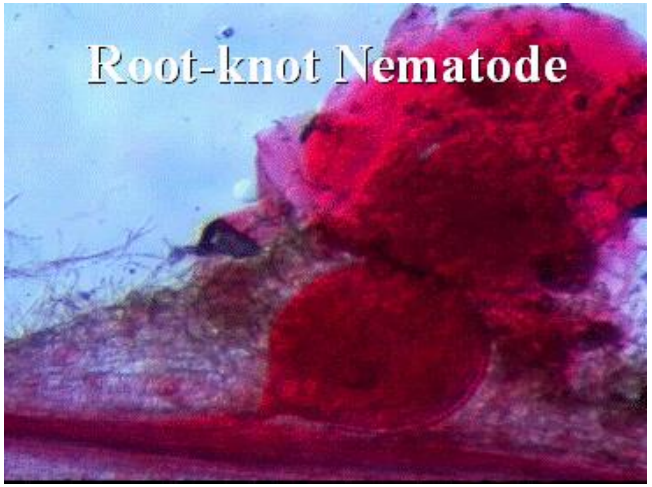
Wireworms

Seed Maggots

White grubs

In North America, control strategies include combinations of crop rotation, GMO hybrids, neonicotinoid seed treatments and soil-applied insecticides. Organic growers rely solely on crop rotation to minimize populations.

Key Plant Parasitic Nematodes



In North America, control strategies include nematicidal seed treatments, in-furrow nematicides and resistance cultivars. Organic growers rely solely on crop rotation to minimize populations.

MBI-206/305
Heat-killed *Burkholderia rinojensis* (strain A396)

- Discovered in MBI's discovery screen; isolated from soil
- Several active compounds found within the cell and in the whole cell broth active against certain insects, mites and nematodes
- Commercial product contains heat-killed cells and spent fermentation media
- First EPA registration 2014
- Product is a liquid formulation – 94.46% a.i., OMRI listed. Sold in the U.S. as Venerate® XC and Majestene® and in Mexico as Venerate
- Controls susceptible insects through exposure and ingestion by interfering with molting process and exoskeleton degradation
- Mode of action against nematodes is unknown but reduces egg-mass development, gall and cyst formation and number of J2's

Photos courtesy of: Bugwood.org;

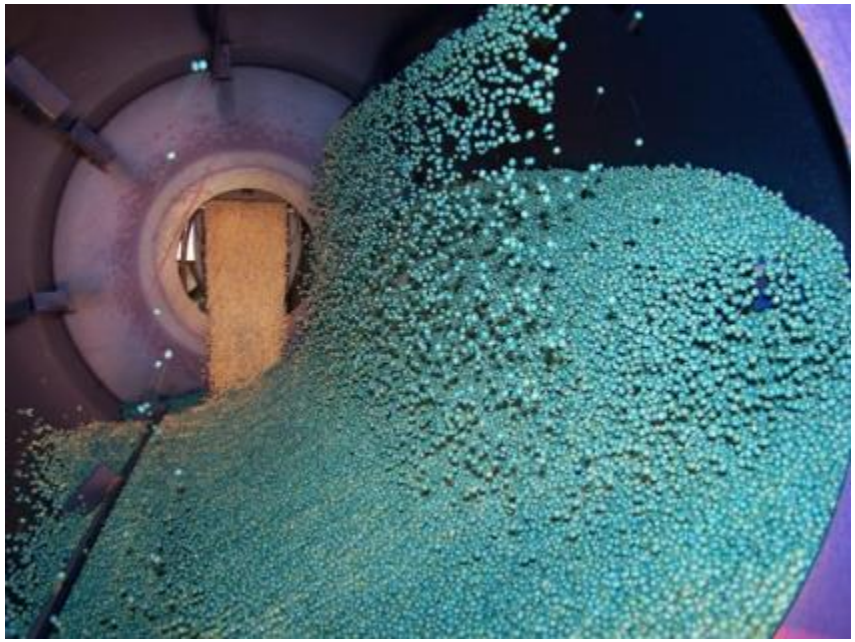
MBI-203/304
Chromobacterium subtsugae strain PRAA4-1^{T}

- Commercial product contains non-viable *Chromobacterium subtsugae* strain PRAA4-1^{T} cells and spent fermentation media
- Produces multiple metabolites within the cell during fermentation active against certain insects, mites and nematodes
- First EPA registration 2013
- Product is sold as a water dispersible granule (U.S.) and as a dry flowable (Mexico) containing 30% active ingredient, OMRI listed
- Reduces egg-laying in susceptible insects and functions as a stomach poison
- Mode of action against nematodes is unknown but reduces egg-laying, gall and cyst formation and number of J2's




Photos courtesy of: Bugwood.org;

Seed Treatments



Research Program

Evaluate candidate bioinsecticides/nematicides at multiple rates as both seed treatments and as soil applied in-furrow/T-band applications against key pests

Evaluate MBI bioinsecticides/nematicides with MBI biofungicides and with Rootella™ mycorrhizae from Groundwork Bioag

Small plot replicated trials in corn, soybean and cotton across several states in multiple years

Methodologies for Seed Treatments

Application rates and materials used varied from 2013 – 2017 beginning with Technical Grade Active Ingredients graduating to commercial formulations evaluated in 2016 and 2017.

In 2016 and 2017*, Chromobacterium subtsugae was* evaluated by applying a dry flowable formulation to seeds at rates of 390 and 780 gm/100 kg seed in corn and 195 and 390 gm/100 kg seed on soybeans.

Burkholderia rinojensis was evaluated by applying a liquid formulation to seeds at the rates of 390 and 780 ml/100 kg seed in corn and 195 and 390 ml/100 kg seed on soybeans.

Treatments were applied using a small scale seed treater and commercially available inerts commonly used in treating seeds.

Case Study – In-furrow and Seed Treatments on Corn and Soybeans

Both candidate active ingredients (*B. rinojensis* and *C. subtsugae*) provided commercially acceptable levels of control of key soil pests in corn and soybeans including:

Corn rootworm larvae
Seed corn maggot
Lesion and cyst nematodes

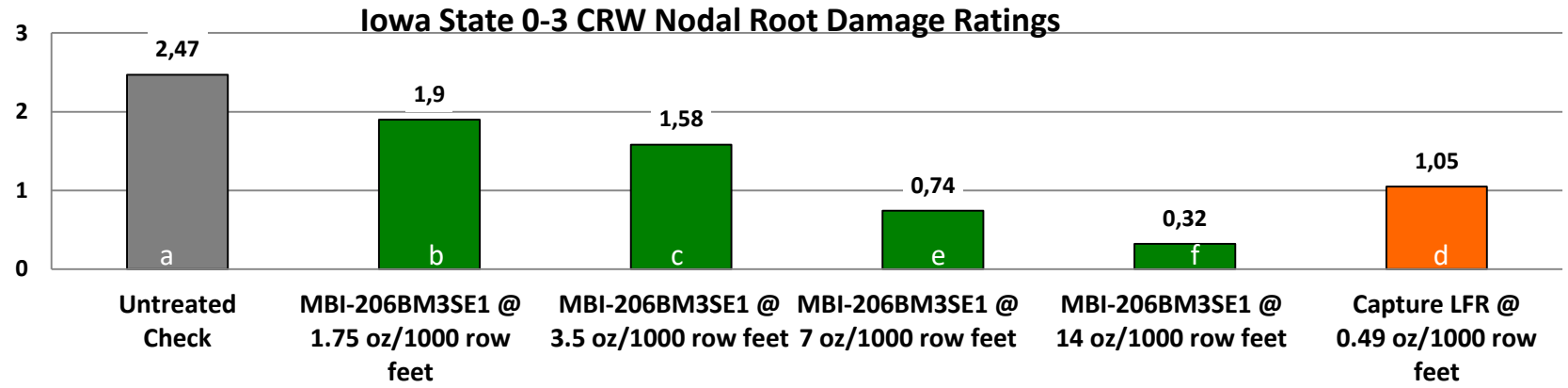
When applied in-furrow or as seed treatments and in combination with Rootella™ mycorrhizae

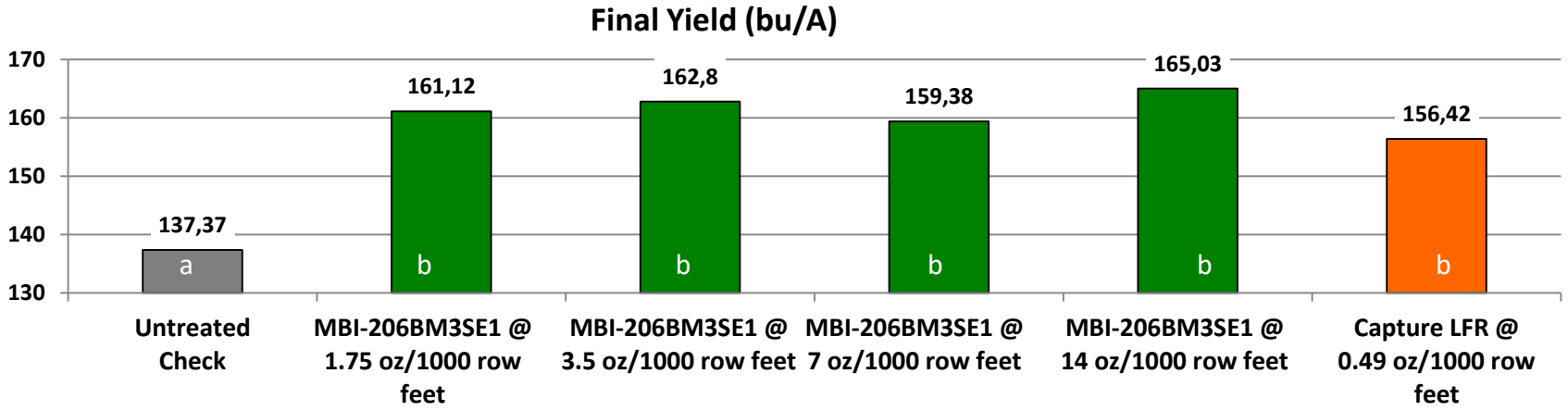
Iowa State University 0-3 CRW Root Damage Rating System

0 1 2 3

Corn rootworm Field Trial – MBI-206 In-furrow

Venerate (MBI-206) reduced rootworms & increased yields as well as or better than the chemical standard





Venerate (MBI-206) as low as 2.37 L/HA (1.75 fl. oz./1000 row feet) significantly increased yield

Marrone Bio Innovations

Corn Rootworm Seed Treatment Trials-Root Damage Ratings ISU 0-3 scale

Mean Root Damage Rating (2016)				
Treatment	Iowa	Ohio	Wisconsin	Mean rating
Untreated	2.78 a	0.87 a	1.64 a	1.76
Mycorrhizae only	1.01 b	0.88 a	1.48 ab	1.12
Myco + *C. subtsugae*	0.68 b	0.47 b	0.92 bc	0.69
Myco + *B. rinojensis*	0.71 b	1.07 a	1.02 abc	0.93
Avicta® Complete 1250 + Vibrance*	0.79 b	0.4 b	0.82 c	0.82
Treatment Prob (F)	0.0001	0.0001	0.0018	

Avicta Complete 1250 contains thiamethoxam + sedaxane
B. rinojensis applied at the rate of 780 ml/100 kg corn seed
C. subtsugae applied at the rate of 780 gm/100 kg corn seed
Rootella mycorrhizae applied at 1.5 gm/1000 seeds

Results from Corn Nematode Trials

Yield in bushels/acre (2016)			
Treatment	Iowa	Wisconsin	Mean yield
Untreated	185.0 c	242.3 c	213.65
Mycorrhize only	206.4 b	244.7 bc	225.55 + 11.9 bu.
Myco + *C. subtsugae*	219.5 ab	253.1 ab	236.3 + 22.7 bu.
Myco + *B. rinojensis*	215.2 ab	256.6 a	235.9 + 22.3 bu.
Avicta® Complete 1250 + Vibrance®	220.5 ab	256.6 a	238.55 + 24.9 bu.
Treatment Prob(F)	0.0001	0.0053	

Avicta Complete 1250 contains thiamethoxam + sedaxane
B. rinojensis applied at the rate of 780 ml/100 kg corn seed
C. subtsugae applied at the rate of 780 gm/100 kg corn seed
Rootella mycorrhizae applied at 1.5 gm/1000 seeds

Results from Corn Nematode Trials - 2017

Treatment	Iowa	Wisconsin Yield and Nematodes/100 cm soil			
	Yield BU/ac	Yield BU/ac	Lesion	Dagger	Spiral
Untreated	139 a	189 c	17.6	16.4	10.0
Mycorrhizae only	171 b	197 c	8.2	8.2	7.4
Myco + *C. subtsugae* 250 gm	169 b	216 b	9.6	6.8	6.4
Myco + *C. subtsugae* 500 gm	172 b	228 a	8.4	4.8	6.4
Avicta® Complete 1250 + Vibrance	161 b	231 a	6.2	5.6	5.2

Avicta® Complete 1250 contains thiamethoxam + sedaxane
C. subtsugae applied at the rate of 250 gm and 500 gm/100 kg corn seed (low and high rates)
Rootella mycorrhizae applied at 1.5 gm/1000 seeds

Corn In-Furrow Trial with *B. rinojensis* - Plant Health Response

Untreated

B. rinojensis @ 135 ml/100 m-row IF

B. rinojensis @ 270 ml/100 m-row IF

In-furrow Nematicide Trial – Lesion (*Pratylenchus*) nematodes

Marrone Bio Innovations

Soybean Cyst Nematode Trials

Yield in bushels/acre (2016)			
Treatment	Wisconsin	Iowa	Mean yield
Untreated	56.8 c	48.0 b	52.4
Mycorrhize only	56.9 c	56.8 ab	56.8 + 4.4 bu.
Myco + *C. subtsugae*	61.4 bc	58.9 ab	60.2 + 7.8 bu.
Myco + *B. rinojensis*	62.1 bc	59.2 ab	60.6 + 8.2 bu.
Clariva® Complete*	66.62 a	62.5 a	64.6 + 12.2 bu.
Treatment Prob (F)	0.0016	0.0435	

*Clariva® Complete contains *Pasteuria nishizawae*, sedaxane, thiamethoxam, fludioxanil, mefenoxam
B. rinojensis applied at the rate of 390 ml/100 kg soybean seed
C. subtsugae applied at the rate of 390 gm/100 kg soybean seed
Rootella mycorrhizae applied at 0.4 gm/1000 seeds

Seed Corn Maggot on Soybean

Treatment	Stand 28 DAP P=0.0001	Plant Height (in.) 14 DAP P=0.0001	Bu/Acre P=0.0001
Untreated	46 a	7.8 a	35
Clariva® Complete*	64 b	9.3 b	53 + 18 bu.
Myco + *C. subtsugae* low rate	63 b	9.0 b	51 + 16 bu.
Myco + *C. subtsugae* high rate	63 b	9.5 b	60 + 25 bu.
Treatment Prob (F)	0.0001	0.0001	0.0001

*Clariva Complete contains *Pasteuria nishizawae*, sedaxane, thiamethoxam, fludioxanil, mefenoxam
C. subtsugae applied at the rates of 125 gm and 250 gm/100 kg soybean seed (low and high rates)
Rootella mycorrhizae applied at 0.4 gm/1000 seeds

Burkholderia rinojensis A396 in Albaugh LLC Seed Treatment

SOY

Competitor

124 SCN Field Trials (bu/A)

BioST Nematicide 100 yields equal to or greater than Competitor 62% of the time (Soybeans)

COTTON

Reniform nematode; 25 pounds more lint with BIO*ST*

Rootknot nematode
Black Oak, AR USA

On millions of acres of large-acre crops (corn, soy, cotton, wheat)

Marrone Bio Innovations

Cotton Yield Across Trials in Six States with *B. rinojensis* Nematicide Seed Treatment

	Yield in lint yield per acre						
	AR	MS	AL	VA	GA	TX	AVG Yield
Base	1086	1100	520.3	1408.4	918	1168	1033.53
Base + BIOST Nematicide 100	1293	1028	737.5	1463	1006	1145	1112.08
Base + Abamectin @ 4 floz/cwt	1260	1096	808	1446	829	1061	1083.41

BioST Nematicide 100 seed treatment outperformed abamectin treatment by an average of 19 lbs./acre

Key Findings

Both candidate active ingredients (*B. rinojensis* and *C. subtsugae*) provided commercially acceptable levels of control of key soil pests in corn, cotton and soybeans when applied as seed treatments or in-furrow including:

Corn rootworm larvae
Seed corn maggot
Lesion, reniform, root knot and soybean cyst nematode

In the key broad acre crops of corn, soybean and cotton

And were compatible in conventional systems with chemical seed treatments and in biological stacked systems for organic production

Commercial Status

In 2016 *Burkholderia rinojensis* was introduced as a seed treatment on cotton and southern soybeans by Albaugh, LLC under the tradename BioST® Nematicide 100 as part of a comprehensive seed treatment package. In 2017 the market area increased to Midwestern corn and soybeans.

Excellent shelf-life and compatibility characteristics

In-furrow application is an alternate method of treatment

Commercial Status

In 2017, *Chromobacterium subtsugae* (Grandevo ST) was introduced as part of a Biological Stacked Seed Treatment with Rootella™ mycorrhizae and MBI-110 *Bacillus amyloliquifaciens* strain F727 (Amplitude ST) to Midwestern growers under a large plot evaluation program by Groundwork Bioag focused on both organic and conventional growers.

In 2018, regulatory approvals in the US and with targeted states have been been secured for all four BSST components. OMRI certification has also been secured for all BSST components. BSST set for a 2019 roll-out.

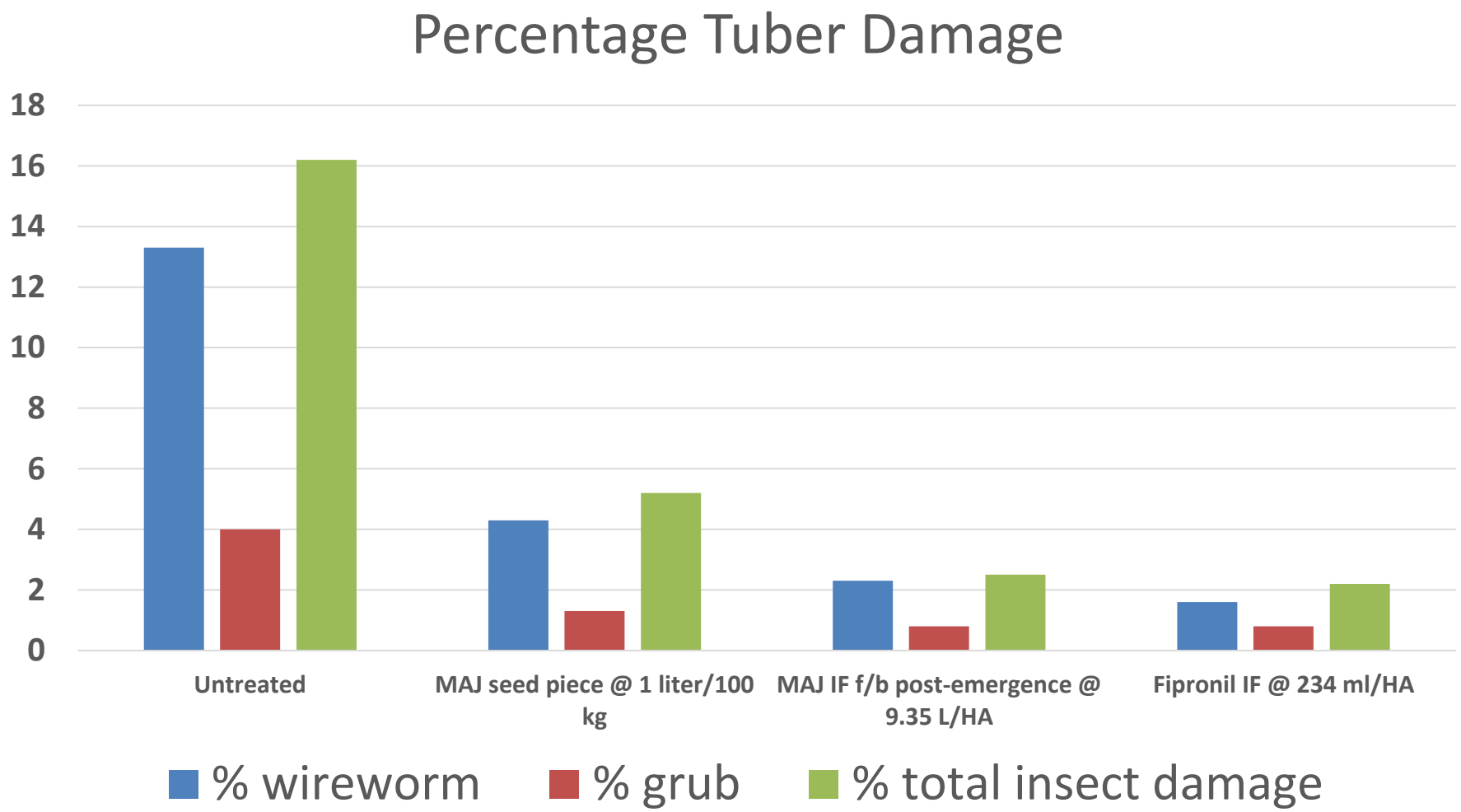
Next Steps

Commercialize in broad acre crops outside of U.S. with a focus on Latin America

Expand crops and pests to include wireworms and white grubs in potatoes and sweet potatoes and wireworms in wheat.

Expand into vegetable seeds

Control of Wireworms and White Grubs With Majestene (Heat-killed *Burkholderia rinojensis*) - 2018



Marrone Bio Innovations

QUESTIONS?