Evaluation of Soybean Cyst Nematode Control with *Pasteuria nishizawae* and the Effect of Management Practices on Biocontrol Efficacy

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Introduction

Problem:

Soybean Cyst Nematode:

Heterodera glycines, soybean cyst nematode (SCN), is a soil borne pathogen of soybean (*Glycine max*) roots which causes over $1.5 billion[4] in damages to soybean in the United States annually. Once this pathogen is present in a field it will never be fully eradicated, it can just be suppressed down to levels where it does not negatively impact yield.

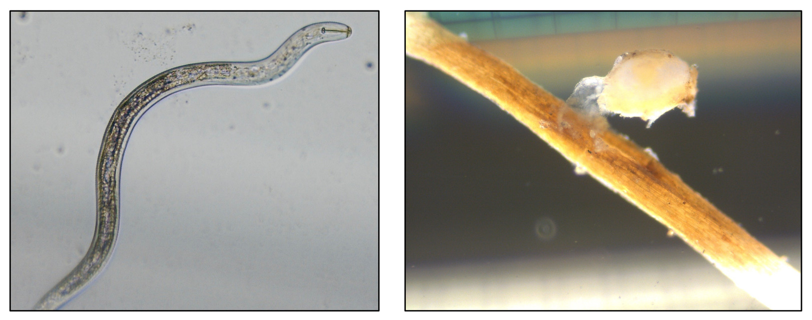

Figure 1. Left: Image of a juvenile soybean cyst nematode (*Heterodera glycines*). Right: Image of a egg-encumbered female soybean cyst nematode beginning to develop into a mature cyst on the root of soybean.

H. glycines Control:

The best way to reduce the negative impacts of *H. glycines* is through multiple integrated pest management strategies. Currently three main strategies are used; using resistant varieties (PI88788, Peking, and PI 437654), practicing crop rotation with non-host crops, and if necessary chemical control with fumigation. However, these practices are currently not sufficient to effectively reduce the effects of *H. glycines* . This is due to the fact that main source of genetic resistance (PI88788) is breaking down due to its overuse in the majority of soybean germplasm. In addition, crop rotation is not effective on its own due to the fact that the pathogen can remain viable in the soil for as many as 10 years. Finally, the chemical control is very expensive, yields inconsistent results and usually kills off the beneficial microbes in the soil as well.

Solution: *Pasteuria nishizawae*?

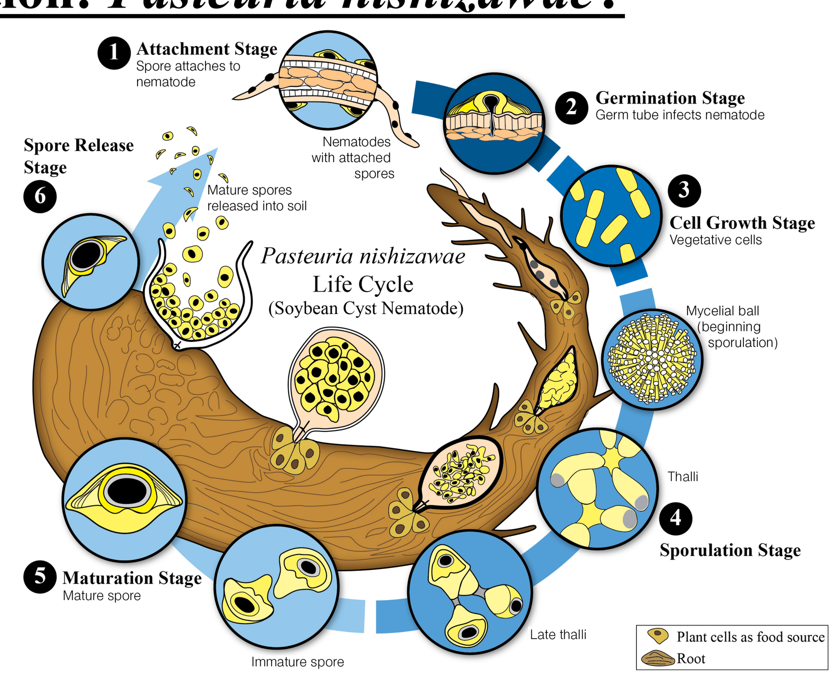

Figure 2. Interaction of the *Pasteuria nishizawae* and *Heterodera glycines* life cycles on the root of soybean. (photo source: © Debra Nehr)

Pasteuria nishizawae is a soil borne, gram-positive, and endospore-forming bacterium that is naturally found as an obligate parasite on *H. glycines* . This bacterium has the potential to serve as a sustainable biological control against *H. glycines* due to the fact that it has no known off-target effects and it would create more infectious units throughout the growing season. Due to endospore survival state of *P. nishizawae* , this bacterium could provide season long protection with one application. The use of *P. nishizawae* as a made available as seed treatment in Clariva Complete® by Syngenta™.

Objectives

1. **Determine the effects of agronomic management practices on the reproductive factor (Rf) of *Heterodera glycines* and soybean yield.**
2. **Determine the efficacy of *Pasteuria nishizawae* seed treatment as a biological control agent against *H. glycines* and yield loss.**

Results

1. Objective 1:

A. Agronomic management practices on yield: Results show that both row spacing and seeding rate significantly affect the yield.

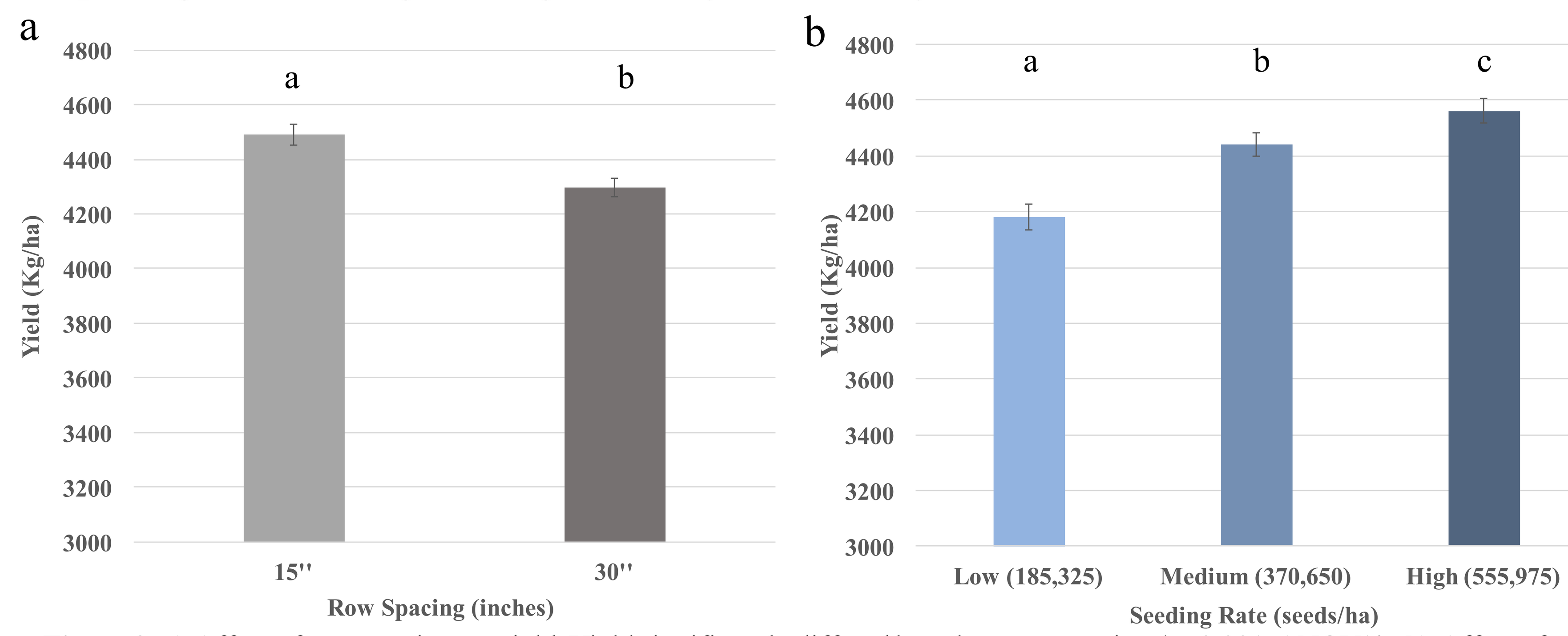

Figure 3. a) Affect of row spacing on yield. Yield significantly differed based on row spacing (p<0.001, ANOVA). **b)** Affect of seeding rate on yield. Yield significantly differed based on seeding rate (p<0.001, ANOVA).

B. Agronomic management practices on *H. glycines* reproductive factor: Results show that seeding rate had a significant role on reproductive factor of *H. glycines,* however, row spacing did not.

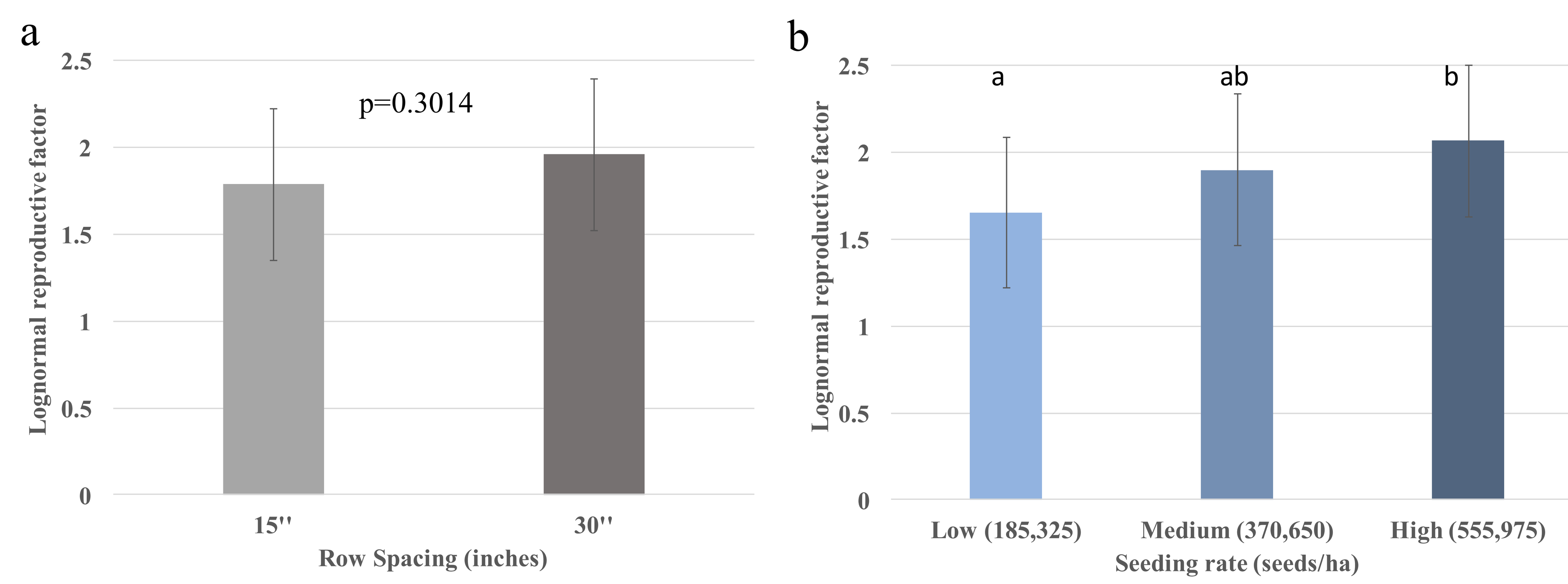

Figure 4. A) Affect of row spacing on reproductive factor of *H. glycines* under a lognormal distribution (Rf= Pf/Pi). Lognormal values show relative relationship between row spacing and Rf , but the arbitrary values correspond to the non-transformed Rf values of 15''= 9.482, 30''= 10. 047.) **b)** Affect of seeding rate on the reproductive factor of *H. glycines* under a lognormal distribution (Rf= Pf/Pi). Lognormal values for seeding rate corresponding to the non-transformed Rf values of, Low= 7.879, Med= 9.548 , High= 11.856.

Methods

Location: Experiments were carried out on research plots at Arlington Agricultural Research Center in Arlington, WI (silt/loam) and private farm land in East Troy, WI (Matherhorn silt/loam). Experimental data was collected for the 2014-2016 growing seasons for the East Troy site and 2015 -2016 for the Arlington site.

Experimental Design: The experimental design was a split-plot, randomized complete block with subsampling and six total replications. Row spacing was used as the split plot for the main blocks. Seeding rate and seed treatment were randomly assigned within each split plot. Plots were planted double wide to allow for two yield subsamples to be taken per plot.

Treatment Components

Seed Treatment	Seeding Rate (seeds/ha)	Row Spacing (inches)
Clariva® Complete	185,325	15"
CruiserMaxx® Vibrance®	370,650	30"
	555,975	

Data Collection: Soil samples were collected at planting, R1stage, and harvest for both field sites.. Soil samples were comprised of 5 soil cores at depths of 0-6" and 6-12". At R1, soil samples were taken at both soil depths within rows and between rows. SCN samples were collected at planting and harvest for the 2015 and 2016, but only collected at planting for the 2014 growing season. SCN soil samples processed by the University of Missouri Nematology Extension Lab.

Statistics: Statistical analysis was performed with SAS Version 9.4 (SAS Institute., Cary, NC) in which yield and reproductive factor were subjected to a GLMMIX model analysis. The fixed affects consisted of row spacing, seeding rate, seed treatment and their interactions, while the random effects consisted of the replication, year, experimental location and their interactions. For the analysis of the reproductive factor the data was fit to a lognormal distribution since the data did not fit a Gaussian distribution.

Results

2. Objective 2:

A. Effect of Clariva Complete® seed treatment on yield and *H. glycines* reproductive factor: The Clariva Complete seed treatment had no significant affect on the soybean yield (p=0.534, ANOVA)or H. glycines reproductive factor (p=0.4153 ANOVA).

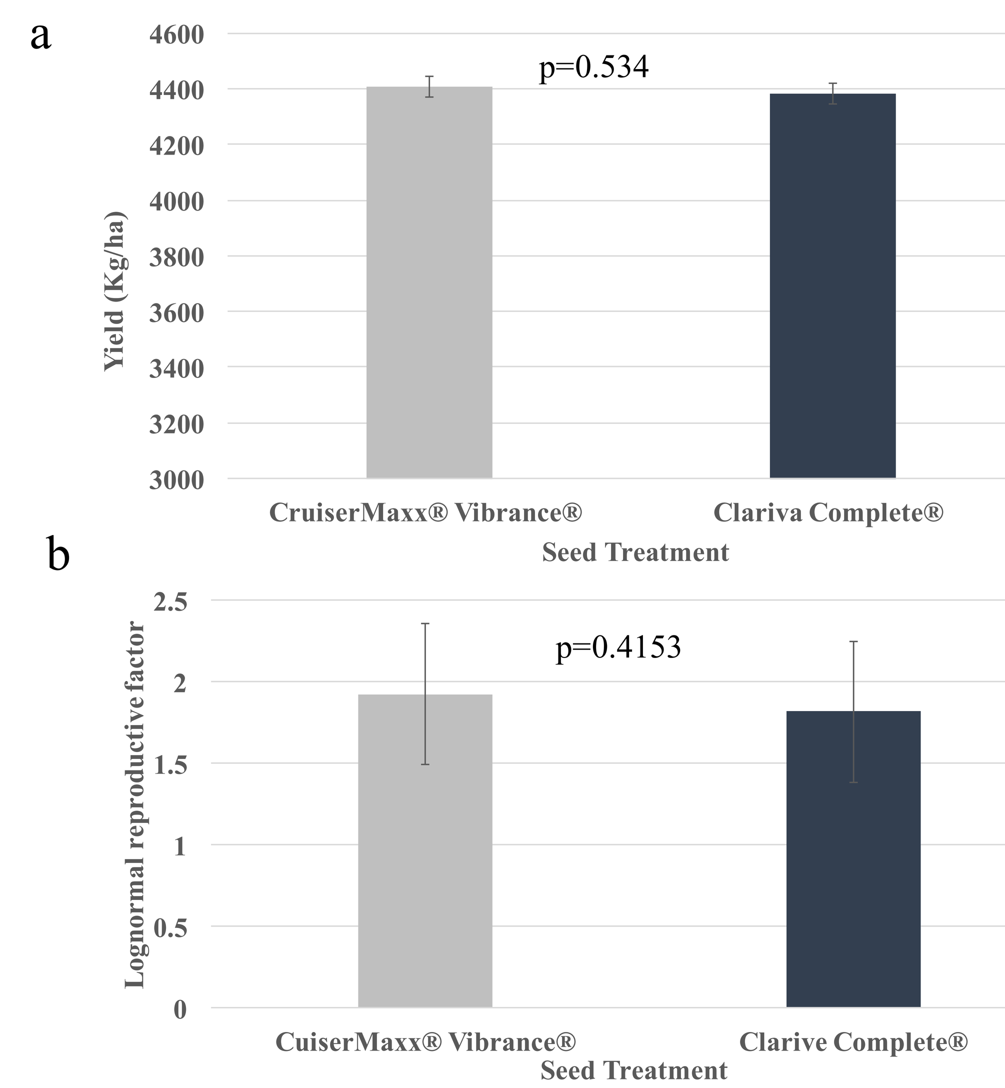

Figure 5. a) Affect Clariva Complete® seed treatment on soybean yield. No significant differences in yield were observed based on seed treatment (p=0.534, ANOVA).**b)** Affect Clariva Complete ® seed treatment on the reproductive factor of *H. glycines* under a lognormal distribution. The Gaussian reproductive factor values corresponding to the lognormal values are CC=9.285 CMV= 10.237.. No significant differences in reproductive factor (Rf= Pf/Pi). were observed based on seed treatment. (p=0.4153 ANOVA).

Conclusions

1) Seeding rate and row spacing had a significant effects on soybean yield (Figure 3 a,b).
2) Row spacing (figure 4a) had no effect on the reproductive factor of *H. glycines,* but seeding rate did lead to a significant impact on yield between the highest seeding rate (555,975 seeds/ha) and the lowest (185,325 seeds/ha) (Figure 4b).
3) Seed treatment had a no significant effect (Figure 5a) on the yield or the reproductive factor of *H. glycines* (figure 5a,b).
4) The overall lack of a seed treatment response may be an artifact of the source of genetic resistance used (PI88788) that was effective against a Hg 2.5.7. population

References

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