Do Crop Rotation and Tillage Influence Seed-applied Inoculant Decisions?

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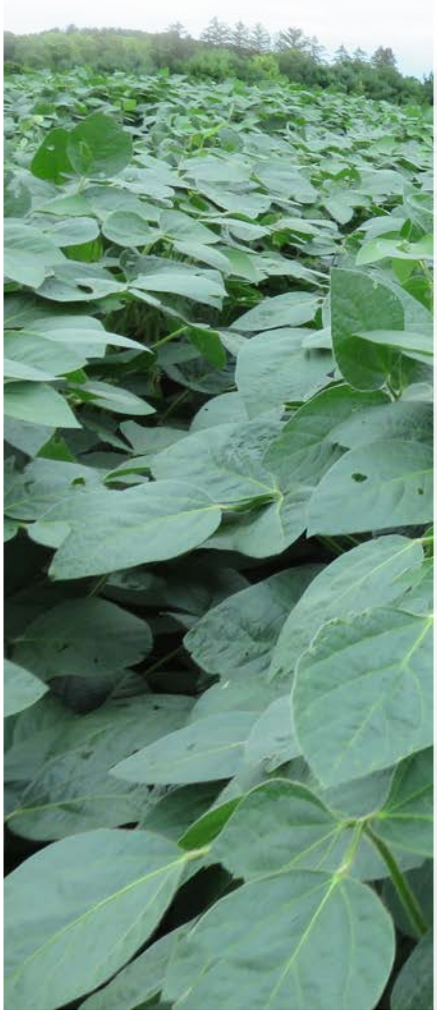
IN A BEAN POD…

- ☑ Conventional tillage and no-till did not impact soybean response to inoculant use.
- ☑ Soybean yield did not respond to inoculant use in first-year soybean after 5 years of continuous corn.
- ☑ One of the inoculant products used, Optimize, increased soybean yield by 1.9 bu/a (4%) on average compared to the non-treated control.



INTRODUCTION

Soybean has the unique ability to form a symbiotic relationship with a soil bacterium, *Bradyrhizobium japonicum*. This relationship results in biological nitrogen fixation, a process in which atmospheric nitrogen (N) is converted to plant-available N in exchange for photosynthetically derived carbon. Because of this symbiotic relationship, soybean growers typically do not apply N fertilizer, but will apply inoculants containing *B. japonicum* on or near the seed to ensure that adequate bacterial infection and subsequent biological nitrogen fixation can occur (Schulz and Thelen, 2008). Current university recommendations suggest using inoculants when planting in fields with no previous history of soybean, where soybean has not been planted in the last 3 to 5 years, for soils with pH <6.0, and for sandy texture soils (i.e., low organic matter soils) (Pedersen, 2004; Abendroth et al., 2006). Although much work has examined soybean yield response to inoculant use in fields with or without a previous history of soybean, there is a general lack of information examining inoculant use under different crop rotations and tillage systems. Our objective was to measure soybean yield response to seed-applied inoculants as influenced by crop rotation and tillage system.

Field trials were conducted from 2009 through 2011 within a long-term corn-soybean rotation study established in 1983 near Arlington, WI. This study contains two tillage systems: conventional and no-till. Conventional tillage was accomplished with one pass of a chisel plow in the fall and two passes with a field cultivator in the spring before planting. Within each tillage system, there are seven crop rotations containing soybean: continuous soybean (SS); soybean rotated annually with corn (SC); first-year soybean after 5 consecutive years of corn (1S); and two (2S), three (3S), four (4S), and 5 years (5S) of continuous soybean after 5 years of corn. Finally, within each crop rotation, there were three seed-applied rhizobia inoculant treatments: a non-treated control; Optimize Soybean (contains *B. japonicum*); and Excalibre (contains *B. japonicum* and *B. elkanii*).

Nodules on soybean roots (top picture). A healthy soybean nodule that is actively fixing nitrogen will have a red to pink color when split open (bottom picture). Nodules not actively fixing nitrogen will have a grayish color.

RESULTS AND DISCUSSION

Our results showed inoculant use did not interact with the tillage systems to influence yield. Because we did not did not observe a tillage x inoculant use interaction, we hypothesize that other tillage methods with intermediate intensity would also not interact with inoculant use to influence soybean yield.

For the crop rotation results, we would expect our best chance for observing a yield response with inoculant use would be in the 1S rotation (first-year of soybean after 5 years of continuous corn), but this was not observed (Fig. 1). Inoculant use actually increased yield within the 3S and 4S rotations by 8-10% and 7-9%, respectively. However, this yield increase was not observed where soybean was planted more frequently (i.e., the 5S and SS rotations) or less frequently (i.e., the SC, 1S, and 2S rotations). We hypothesize the addition of inoculant within the 3S and 4S rotations may have compensated for the 'rotation effect' as soybean was planted more frequently. This compensation was not observed in the SS rotation, potentially because of the lower inherent yield potential of this rotation. However, the biological explanation for this observation remains unknown.

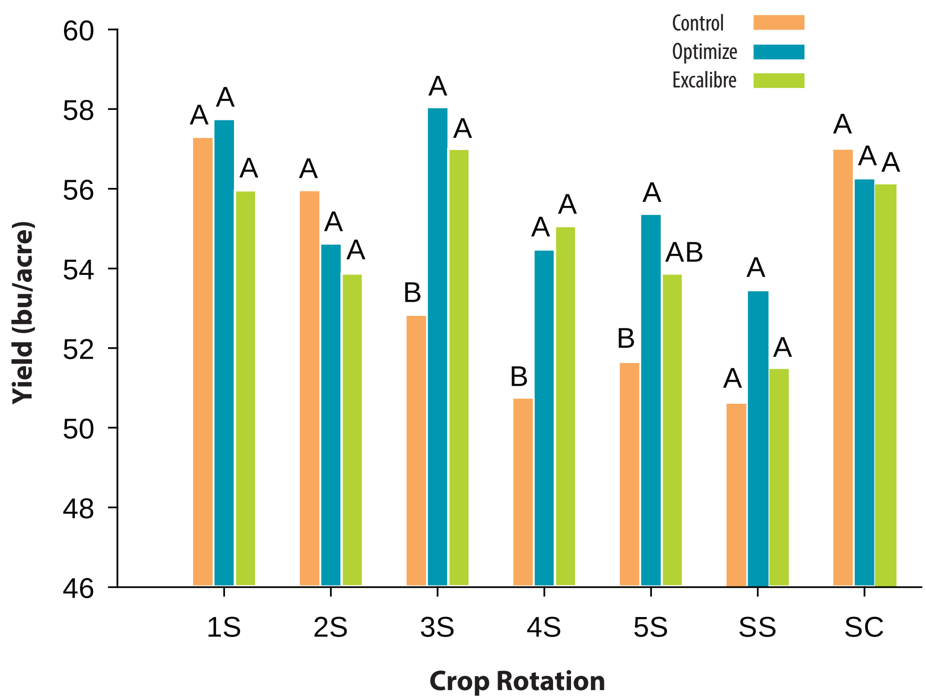


Figure 1. Results for the crop rotation and inoculant use interaction.

Columns with the same letter within each crop rotation are not statistically different.

Common university recommendations warrant inoculant use if soybean has not previously been grown in a field or has not been grown in a field for at least 3 to 5 years (Pedersen, 2004; Abendroth et al., 2006). Because we saw no yield advantage to inoculant use with first-year soybean after 5 years of continuous corn (i.e., the 1S rotation), our results showed it could take longer than 5 years in order to warrant inoculant use. Elkins et al. (1976) suggested that incorporating soybean into the rotation once every 8 years was enough for maintaining soil rhizobia populations for adequate nodulation. While we did not measure the amount of rhizobia in the current study, another study conducted in the late 1980s within this same long-term crop rotation experiment at Arlington found that *B. japonicum* populations did not significantly differ among any of the crop rotations containing soybean (Triplett et al., 1993). Based on this previous study, we suspect that the *B. japonicum* populations were adequate to help maximize yield during our experiment and thus explain our lack of finding a yield response to inoculant used within the 1S rotation.

We did observe that the Optimize inoculant treatment increased soybean yield by 1.9 bu/a (4%) on average compared to the non-treated control (Fig. 2). No statistical difference was found between Optimize and Excalibre nor Excalibre and the non-treated control. Optimize contains *B. japonicum* and lipo-chitooligosaccharides (LCOs); whereas, Excalibre contains two species of rhizobia bacteria: *B. japonicum* and *B. elkanii*. Lipo-chitooligosaccharides are signal molecules released by the rhizobia bacteria in order to facilitate the symbiotic relationship mentioned earlier. Studies have shown LCOs promote plant growth, and this may explain our results. However, this aspect was not formally tested. In addition, other studies evaluating yield response to Optimize and other inoculant products have produced inconsistent results (De Bruin et al., 2010; Furseth et al., 2012).

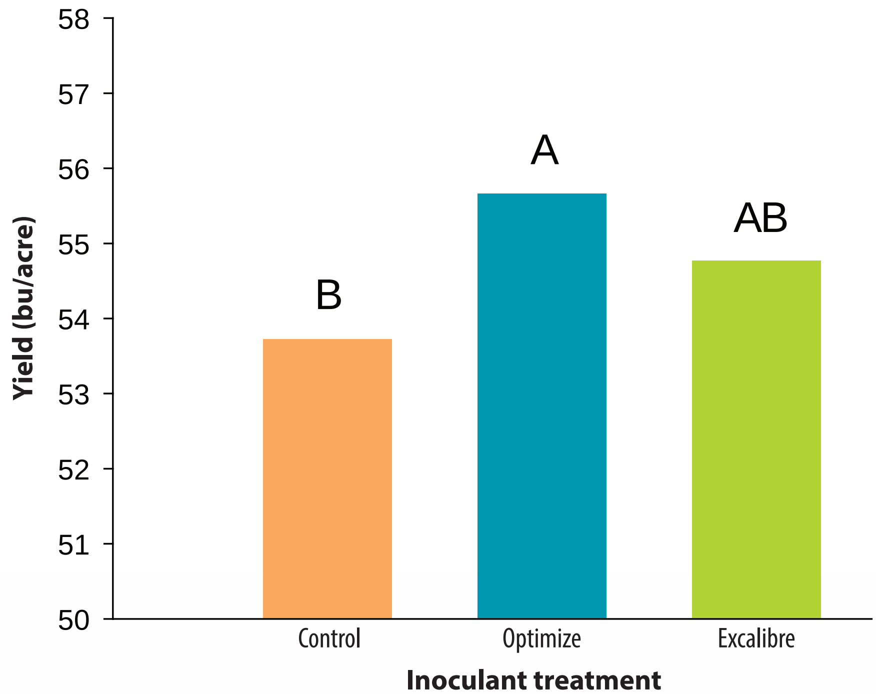


Figure 2. Inoculant use results for soybean yield.

Columns with the same letter are not statistically different.

CONCLUSIONS AND RECOMMENDATIONS

Our results showed that inoculant use did not interact with tillage system to affect soybean yield. Therefore, soybean growers can allow tillage and inoculant use decisions to remain separate. For crop rotation, we did not find that inoculant use increased yield within the 1S rotation (first-year soybean after 5 years of continuous corn). Based on this result, inoculant use would not be needed if soybean has been planted in a field within the past five years. Although we found inoculant use increased yield within the 3S and 4S rotations, we do not recommend planting 3 and 4 years of continuous soybean. We did observe that the Optimize inoculant product increased yield by 1.9 bu/a (4%) on average compared to the non-treated control, but the reasoning for this observation remains unanswered. Annual or biennial inoculant applications will certainly not inhibit soybean production, but they also would not be warranted based on our results. Given the results of this and previously published research, growers should consider product cost, efficacy, the probability of return on investment, and individual risk factors associated with potential profit or loss when making inoculant use decisions for soybean in Wisconsin.

Data from: Marburger, D.A., S. Mourtzinis, J.M. Gaska, and S.P. Conley. 2016. Do crop rotation and tillage influence seed-applied inoculant decisions? Agronomy Journal 108:402-406.

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