Dec 2nd, 12:00 AM

Do We Really Need to Inoculate Our Fields?

Palle Pedersen
Iowa State University

DO WE REALLY NEED TO INOCULATE OUR FIELDS?

Palle Pedersen
Assistant Professor, Soybean Extension Agronomist
Department of Agronomy
Iowa State University

Abstract

Currently, there is a lot of interest in soybean seed inoculation. Several new products have entered the market and created a renewed interest in seed inoculation even on fields that have a history of soybean production. As a result of this renewed interest and the lack of information from Iowa, a soybean inoculant evaluation trial was initiated this year in Iowa to evaluate these products. Our objective was to determine if we need to adjust our current recommendations when using inoculants. Twelve different inoculants were tested at two locations (Ames and Vincent) in Iowa. Averaged across locations, none of the inoculants resulted in a significant yield increase over the non-inoculated plots. Two of the inoculants (BYEXP5 and TagTeam), however, yielded greater that the non-inoculated plots at Ames. Currently, none of the inoculants look to give us a consistently higher yield in the corn-soybean rotation. More data is needed before final conclusions can be drawn.

Introduction

Nitrogen fixation is the process of converting atmospheric nitrogen into a usable form for the plant and is critical for producing higher yields in soybean without large amounts of available nitrogen (Cooper and Jeffers, 1984). For nitrogen-fixation to occur, the nitrogen-fixing bacteria known as *Bradyrhizobia japonicum* need to be readily available in the soil. The relationship between the soybean plant and *B. japonicum* has mutual benefits. The soybean plant gets nitrogen and in turn provides the bacteria's carbohydrate supply. *Bradyrhizobia japonicum* is not native to the United States and acts in symbiosis only with soybean. Establishing *B. japonicum* through inoculation in a field where soybean has never been grown is therefore necessary to ensure nitrogen fixation.

When the seed germinates, the bacteria invade the root hairs of the seedling and begin to multiply. Nodules, which house the bacteria, form on the roots. Under field conditions, the first nodules form within 1 week after seedling emergence and become visible as they increase in size. Soybean can obtain up to 75% of its nitrogen requirements from the air when nitrogen fixing *B. japonicum* bacteria are present in the soil, have infected the roots of soybean, and functioning nodules are present on those roots (Varco, 1999). Active fixation, however, does not begin until about the V2 to V3 stage (Pedersen, 2004). After this, the number of nodules formed and the amount of nitrogen fixed increase with time.

Soybean utilizes nitrogen from several sources, including mineralized soil organic matter, symbiotically fixed nitrogen, and nitrogen incorporated into plant tissue. Demand for nitrogen is highest from the R5 to R8 (Pedersen, 2004). During this period, the plant utilizes nitrogen from all sources, but in the early to mid-pod fill stages, fixation by *B. japonicum* decreases rapidly (Harper, 1987). The soybean plant compensates for this reduction in fixed nitrogen by utilizing

nitrogen already incorporated in plant tissue, beginning in the R6 growth stage (Harper, 1987). As nitrogen is remobilized from older plant tissue to the developing seeds, senescence of plant tissue begins.

If soils do not already contain a high population of *B. japonicum*, these bacteria can be added either as a liquid or granular peat inoculant, or as a peat-based powder. The different forms can be seed-applied or used in-furrow. Most recommendations in the Midwest have been to inoculate the seed if: 1) fields have never been planted to soybean or nodulated soybean has not been grown in a field in the past three to five years, 2) soil pH has not been maintained above 6.0, 3) field with sandy soil, or 4) the field has been flooded for more than a week and the level of *B. japonicum* has been reduced because of anaerobic conditions. Our objective was to determine if we need to change our current recommendations using inoculant when growing soybean in a corn-soybean rotation.

Evaluation of soybean inoculants.

Field research was conducted this year at two locations (Ames and Vincent) in Iowa. The experiment was a complete randomized block design with 4 replications and consisted of twelve different inoculants and a noninoculated control. Plots were planted in 15-inch rows at 175 000 seeds acre^{-1} on April 23 and April 24. The soybean variety NK S24-K4 was used at both locations. Both locations had a history of soybean and are in corn-soybean rotation.

Table 1. Soybean yield as influenced by inoculants at Ames and Vincent, IA. 2004.

Inoculant		Ames	Vincent	Combined Sites
Company	**Product**	----------bu/acre----------		
Non-inoculated control		68.7	73.5	71.5
Becker Underwood	NOD+	72.1	69.0	70.3
Becker Underwood	BU-LQ†	67.6	72.5	70.0
Becker Underwood	NOD+ W/Extender	72.6	72.8	72.7
Becker Underwood	BU-LQX†	67.6	72.3	69.9
Becker Underwood	NOD+ W/Subtilex	71.3	68.8	70.2
Becker Underwood	BU-KQBS(D) †	68.2	72.1	70.4
Nitragin	Nitragin CellTech SCI	70.1	73.3	71.7
Nitragin	Nitragin Optimize	66.4	71.9	69.1
Brett-Young Seeds	BYEXP5†	75.0	71.9	73.4
Philom Bios	TagTeam Soybean	76.1	75.6	75.9
ABM	American Best (Liquid)	68.0	72.0	70.0
ABM	American Best (Conc.)	69.6	74.9	72.2
Means		70.3	72.4	71.4
LSD (0.10)		5.4	NS	NS
CV (%)		6	7	7

†Experimental products

‡NS, not significant

When yield results of the experiments were combined across sites, none of the inoculants studied in these trials resulted in a significant soybean yield increase when compared to the

non-inoculated control (Table 1). However, results were not consistent across locations. No differences were found among inoculants at Vincent. However, two inoculants (BYEXP5 and TagTeam) yielded greater than the control indicating that some of these new inoculants may result in higher yield despite soybean being planted in an area with a recent history of a corn-soybean rotation.

Summary and Conclusion

The decision on whether or not to inoculate is still dependent on whether the site has a recent history of healthy-looking soybeans. Iowa has a good population of *B. japonicum* in most soils, if soybean has been grown in recent years on the field. Because most cultivated fields include a rotation with soybean, the need to inoculate with more bacteria rarely exists. The practice of inoculating fields that have been out of soybeans for more than three to five years may still be a good insurance practice due to the inexpensive nature of the inoculant. This year's data is inconclusive as to whether any of the new inoculations will consistently provide a higher yield in a corn-soybean rotation. However, more than a single year's data is needed before we can draw final conclusions. The evaluation of soybean seed inoculants will therefore continue in 2005.

Acknowledgement

The author would like to thank Dr. Antonio Mallarino and Dr. John Sawyer for constructive comments and Jodee Roland, Jason DeBruin, Vladimir Costa, and Adriana Murillo-Williams for their technical assistance. Thanks are also expressed to the participating inoculant companies for partial support of the evaluation.

References

Cooper, R.L., and D.L. Jeffers. 1984. Use of nitrogen stress to demonstrate the effect of yield limiting factors on the yield response of soybean to narrow row systems. Agron. J. 76:257-259.

Harper, J.E. 1987. Nitrogen metabolism. p. 497-533. *In* J.R. Wilcox (ed.) Soybeans: Improvement, production, and uses. 2nd ed. Agron. Monogr. 16. ASA, CSSA, and SSSA, Madison, WI.

Pedersen, P. 2004. Soybean growth and development. Iowa State University, University Extension, Ames, Iowa 50011. PM 1945. 28 pp.

Varco, J.J. 1999. Nutrition and fertility requirements. p. 53-70. *In* L.G. Heatherly and H.F. Hodges (ed.) Soybean production in the mid-south. CRC Press, Boca Raton, FL.