Kansas Agricultural Experiment Station Research Reports

Volume 3
Issue 6 *Kansas Field Research*

Article 20

2017

Soybean: Evaluation of Inoculation

T. M. Albuquerque
Kansas State University, thaisalb@ksu.edu

O. Ortez
Kansas State University, oaortez@ksu.edu

G. I. Carmona
Kansas State University, gabicarmona@ksu.edu

See next page for additional authors

Recommended Citation

Albuquerque, T. M.; Ortez, O.; Carmona, G. I.; and Ciampitti, I. A. (2017) "Soybean: Evaluation of Inoculation," *Kansas Agricultural Experiment Station Research Reports*: Vol. 3: Iss. 6. https://doi.org/10.4148/2378-5977.7437

Soybean: Evaluation of Inoculation

Abstract

Most of the nitrogen (N) required by a soybean plant is supplied via biological nitrogen fixation (BNF). When BNF is adequately established in the soil, soybean can obtain up to 50 to 75% of its N from the air. This project aims to quantify the response to inoculation for soybean in its second year in a field without previous history of this crop. Due to this objective, a field study was conducted during the 2015 and 2016 growing seasons at Ottawa, KS (East Central experiment field location). The treatments consisted of five different N-management approaches: non-inoculated (NI), inoculated ×1 (I×1), inoculated ×2 (I×2), inoculated ×3 (I×3), and non-inoculated but fertilized with 300 lb N/a (NF) as the main N source. In 2015, yields among treatments did not differ significantly from one another. In 2016, yields ranged from 36 to 59 bushels per acre. Greater yields were recorded when fertilized with 300 lb N/a, while lowest yield was related to the non-inoculated scenario. Treatments presented significant yield difference; however, the scenario with 300 lb N/a did not differ from the inoculated ×3; while the inoculated treatments were not different for the yield factor. In summary, further research should be pursued to be more conclusive as to the best management approach for N in soybeans in an area without history of this crop.

Keywords

inoculation, soybean, nitrogen, N fertilizer, yields

Authors

T. M. Albuquerque, O. Ortez, G. I. Carmona, and I. A. Ciampitti

Soybean: Evaluation of Inoculation

T.M. Albuquerque, O.A. Ortez, G.I. Carmona, and I.A. Ciampitti

Summary

Most of the nitrogen (N) required by a soybean plant is supplied via biological nitrogen fixation (BNF). When BNF is adequately established in the soil, soybean can obtain up to 50 to 75% of its N from the air. This project aims to quantify the response to inoculation for soybean in its second year in a field without previous history of this crop. Due to this objective, a field study was conducted during the 2015 and 2016 growing seasons at Ottawa, KS (East Central experiment field location). The treatments consisted of five different N-management approaches: non-inoculated (NI), inoculated ×1 (I×1), inoculated ×2 (I×2), inoculated ×3 (I×3), and non-inoculated but fertilized with 300 lb N/a (NF) as the main N source. In 2015, yields among treatments did not differ significantly from one another. In 2016, yields ranged from 36 to 59 bushels per acre. Greater yields were recorded when fertilized with 300 lb N/a, while lowest yield was related to the non-inoculated scenario. Treatments presented significant yield difference; however, the scenario with 300 lb N/a did not differ from the inoculated ×3; while the inoculated treatments were not different for the yield factor. In summary, further research should be pursued to be more conclusive as to the best management approach for N in soybeans in an area without history of this crop.

Introduction

Soybean crop, as a legume species, has the characteristic of N fixation or can convert from the atmosphere when the proper symbiotic relationship with specific bacteria is established. The success of an effective symbiotic process depends on the existence of the bacteria in the soil. Thus, if the bacteria are not present in the soil, the "inoculation" practice can establish the specific rhizobia in the field, providing a successful N fixation. Based on previous information, inoculation is usually effective when: 1) soybean was never planted before or in the past 3 to 5 years; 2) soil pH is below 6.0 units; 3) soil has a high sand content; 4) in anaerobic conditions, field has been flooded for more than a week when nodulation was supposed to become established; and 5) early-season stress conditions (e.g. heat) affects plant-bacteria establishment. The inoculation has become a standard practice in soybean fields due to the critical supply of N coming from BNF and the high soybean N demand. Additionally, inoculation practice is relatively inexpensive as compared with other input costs. Nonetheless, it is still valid to properly assess agronomic yield advantage of the inoculation practice in fields where soybean was never grown before. The main objective of this study was to quantify the response to inoculation for soybean in a second year in a field without previous history of this crop.

Site Characteristics

Soil type at the Ottawa location was a Woodson silt loam (Mollisols). Soil samples were taken before planting to a total depth of 6 inches. Soil chemical parameters analyzed were pH, Mehlich P, cation exchange capacity (CEC), organic matter (OM), calcium (Ca), magnesium (Mg), and potassium (K) availability (Table 1).

Procedures

The study was arranged in a randomized complete block design with six replications. Plot size was 10-ft wide by 50-ft long. The soybean variety utilized was soybean P34T43R2 (RR-2 released 2014 yr; maturity group (MG) = 3.4). Five treatment combinations were evaluated for the same genotype by N management approaches: 1) non-inoculated (NI), 2) inoculated ×1 (I×1, single-rate), 3) inoculated ×2 (I×2, double-rate), 4) inoculated ×3 (I×3, triple-rate), and 5) non-inoculated but fertilized with 300 lb N/a (NF, liquid UAN, 32-0-0 split in three equal applications at planting, flowering, and pod formation) as the main N source. The inoculant used was VAULT® HP plus integral® (BASF company). Herbicides and hand weeding were used to maintain no weed interference for the entire season, and soil nutrient concentrations (other than N) were maintained above the recommended critical levels (through inorganic P/K applications). Seeding rate target was 110,000 seeds/a (see Table 2 for final stand counts).

Stand counts were performed (measuring two 17.5-ft sections per plot) immediately after emergence (VE), in the six replications. Yield information is expressed in bushels per acre adjusted to 13.5% moisture content. Yield was collected from the central two rows (5 × 50 ft). Seed harvest index was estimated as the ratio between the grain yield and the whole-plant biomass collected at R5 stage.

Weather Information

Temperature maximum and minimum normal (30 years) variations followed a similar trend as the seasonal temperature for 2016 growing season. Seasonal precipitation distribution, expressed in inches, was documented throughout the entire growing season (Figure 2). For 2016, seasonal precipitation was higher relative to the historical average, with exception of the month of June.

Results

Yields

Overall yields for this site averaged 47 bu/a (ranging from 36 to 60 bu/a). Statistically, soybean yields differed among all evaluated treatments (Figure 3). High yields were recorded when 300 lb of N were added to soybeans, while lowest yield was found when no inoculant was applied.

Seed Harvest Index

Seed harvest index (HI) is the ratio between seed biomass and the whole plant biomass (including seeds), expressed in relative terms. Seed HI was comparable across all treatments, averaging 29%. Highest yielding treatment, 300 lb N/a, presented the lowest seed HI, 27%; while the treatment that did not receive any inoculant achieved the maximum seed HI, 31% (Figure 4).

Total Biomass

Plant biomass was also determined at the end of the season, reaching overall values for this site higher than 10,000 lb/a (Figure 4). Lowest biomass value was recorded in the non-inoculated treatment, while maximum biomass was obtained when 300 lb N/a were applied to soybeans. In this study, superior biomass was not related to high seed HI, but these plant traits presented an opposite direction (Figure 4). Therefore, maximum yields were attained with biomass playing a major role.

Conclusions

Maximum agronomical yield was documented for the soybean variety when 300 lb of N/a were applied. Conversely, the lowest yield was recorded for the variety that did not receive inoculation.

For the yield factor, treatments differed statistically, with yield ranging from 36 to 59 bushels per acre. Final soybean yields presented the following trend from high to low: 300 lb N/a > inoculated 3× > inoculated 2× = inoculated 1× = non-inoculated treatments.

In summary, further evaluation and research is needed in order to properly inform our farmers about the best nitrogen management approach in soybeans grown in an area without history of this crop.

Table 1. Pre-plant soil characterization at 0- 6-inch depth at Ottawa location

Soil parameters, units	Ottawa
pH	5.8
Mehlich P (ppm)	16.3
Cation exchange capacity (meq/100 g)	18.7
Organic matter (%)	4.3
Potassium (ppm)	83.7
Calcium (ppm)	2716
Magnesium (ppm)	379

Table 2. Final stand counts per treatment at Ottawa location, 2016 growing season

	Treatments (× 1,000 plants/a)				
Field sites	Non-Inoc	Inoc × 1	Inoc × 2	Inoc × 3	Fertilizer-N
Ottawa	98	100	98	104	103

Inoc = inoculation.
N = nitrogen.

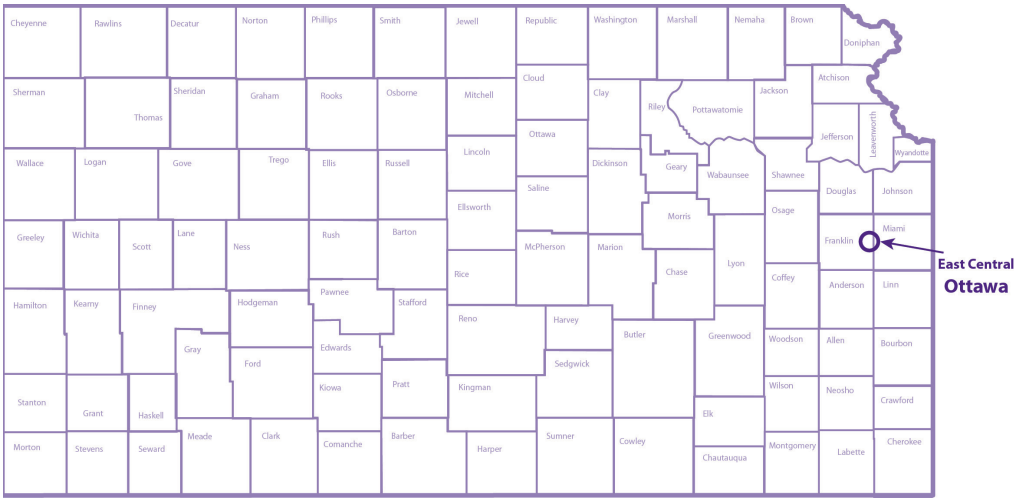

Figure 1. Field location for the soybean inoculation project during the 2015 and 2016 growing seasons (Ottawa, KS).

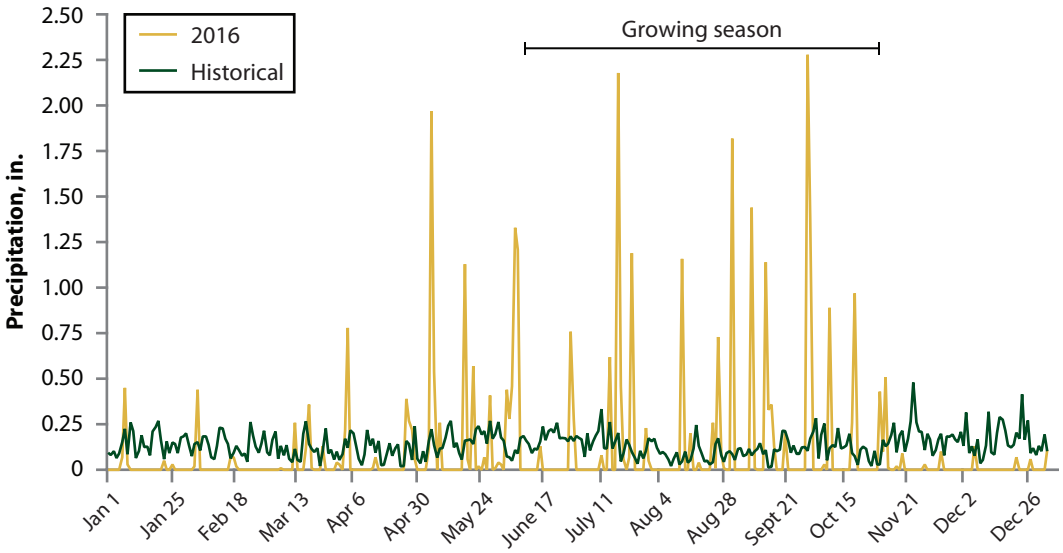

Figure 2. Monthly precipitation (green line, darker) for the historical average (1985-2016 period) and 2016 growing season (yellow line, lighter) at Ottawa, KS. Data from Kansas Mesonet (Historical Weather, http://mesonet.k-state.edu/).

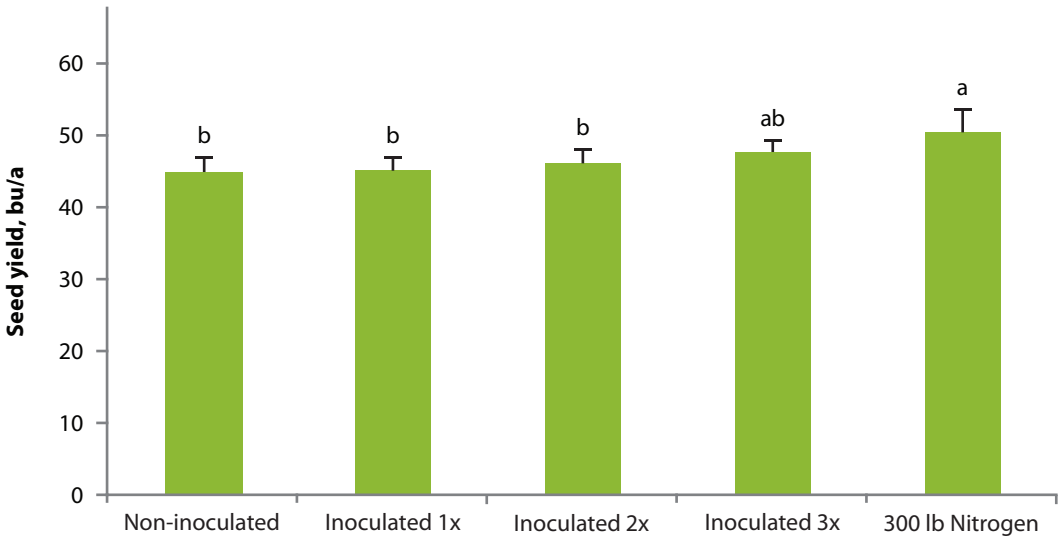

Figure 3. Soybean yield (13.5% moisture) at Ottawa, KS, during the 2016 season. Error bars represent the standard error for each treatment.

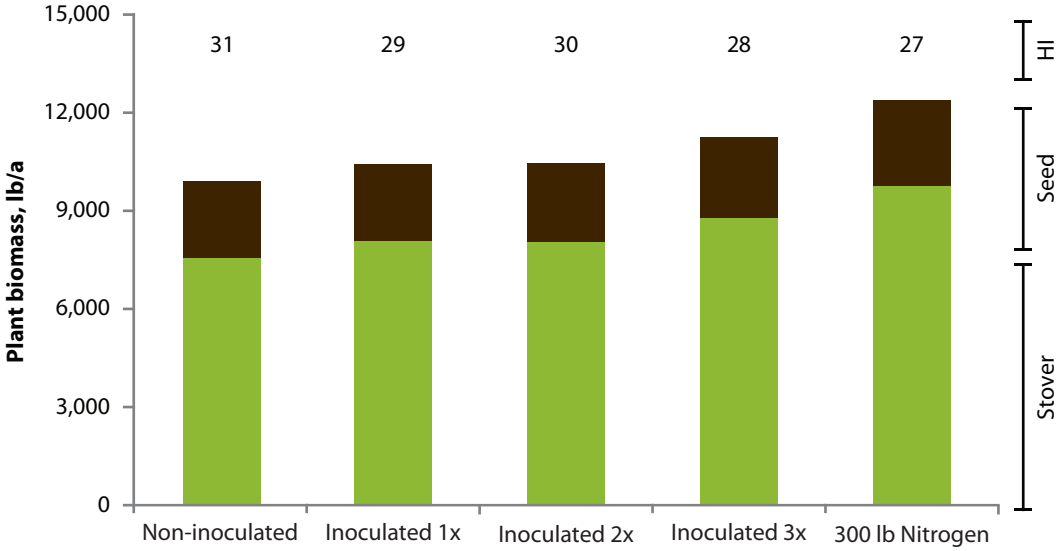

Figure 4. Seed harvest index, at the Ottawa, KS, site during the 2016 season. HI = harvest index.