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Pivot Bio Proven Inoculant as a Source of Nitrogen in Corn

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Pivot Bio Proven Inoculant as a Source of Nitrogen in Corn

Abstract

Nitrogen (N) fertilizer represents a significant annual cost for farmers. Additionally, N losses pose environmental concerns and represent loss of resources. Proven, an N fixing bacterial inoculant for corn developed by Pivot Bio (Berkeley, CA) is expected to fix between 20 and 30 lb N/a over a growing season. The use of bacterial inoculants to fix N for corn reduces the risk of N loss through leaching and volatilization by reducing the amount of inorganic fertilizers required to maximize yield. To evaluate the efficacy of Proven, a field trial was established in Manhattan, KS, on a Kennebec silt loam that had been under continuous no-till corn production for 5 years. The experiment was arranged in a split-plot design with four replications. The main treatment was N fertilizer rate at 0, 50, 100, and 150 lb N/a applied as urea directly before planting. The subplot factor was with and without Proven. Soil samples were taken before planting (0–36 in.), at V6 (0–12 in.), R1 (0–12 in.), and harvest (0–36 in.) for inorganic N. Plant measurements included vigor at V4 and V8-V10; NDVI at V5-V8; SPAD readings at R1-R3; and green leaf counts during grain fill. Whole plant biomass and N content were determined at R6. At harvest, grain moisture, test weight, and yield were measured. Nitrogen rate significantly affected grain yield and plant N uptake. The effect of Proven was not significant nor was the interaction between N rate and Proven.

Keywords

bacteria, nitrogen fixation, cereal crop

Cover Page Footnote

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Summary

Nitrogen (N) fertilizer represents a significant annual cost for farmers. Additionally, N losses pose environmental concerns and represent loss of resources. Proven, an N fixing bacterial inoculant for corn developed by Pivot Bio (Berkeley, CA) is expected to fix between 20 and 30 lb N/a over a growing season. The use of bacterial inoculants to fix N for corn reduces the risk of N loss through leaching and volatilization by reducing the amount of inorganic fertilizers required to maximize yield. To evaluate the efficacy of Proven, a field trial was established in Manhattan, KS, on a Kennebec silt loam that had been under continuous no-till corn production for 5 years. The experiment was arranged in a split-plot design with four replications. The main treatment was N fertilizer rate at 0, 50, 100, and 150 lb N/a applied as urea directly before planting. The subplot factor was with and without Proven. Soil samples were taken before planting (0–36 in.), at V6 (0–12 in.), R1 (0–12 in.), and harvest (0–36 in.) for inorganic N. Plant measurements included vigor at V4 and V8-V10; NDVI at V5-V8; SPAD readings at R1-R3; and green leaf counts during grain fill. Whole plant biomass and N content were determined at R6. At harvest, grain moisture, test weight, and yield were measured. Nitrogen rate significantly affected grain yield and plant N uptake. The effect of Proven was not significant nor was the interaction between N rate and Proven.

Introduction

Historically, N fixing microbes have had little to no role in agronomy outside of those in symbiotic association with legumes. The ability to use N fixing microbes as a source of N in crops provides great benefits, including decreased N losses and increased available N later in the growing season without additional synthetic fertilizers. Pivot Bio has recently released Proven, a bacterial inoculant intended to fix N in corn. Proven is applied in-furrow at seeding and forms a mutualistic relationship with the corn, growing on its roots and consuming plant exudates while fixing atmospheric N, even in the presence of high soil N. This N fixed by Proven is then available for plant uptake. Pivot Bio claims that Proven can be used as a source of approximately 20–30 lb N/a over a growing season. The objective of this study was to determine the contribution of Proven as an N source for corn. The hypothesis was that Proven would contribute 20–30 lb N/a for corn production.

Procedures

A replicated split-plot design experiment was established at the Kansas State University Department of Agronomy North Farm in the spring of 2019. The local mean annual precipitation and potential evapotranspiration were 31.5 and 51.2 in., respectively, with a mean annual temperature of 52.52°F. The soil at the experimental site is classified as Kennebec silt loam (fine-silty, Hapludoll). The main treatment was N rate at 0, 50, 100, and 150 lb N/a applied by hand as urea immediately before planting, and the subplot factor was the presence or absence of Proven. The experiment had four replicates. Each plot was composed of four 47-ft rows with 30-inch row spacing seeded at 28,000 plants/a.

Extensive soil sampling characterized nutrient status before, during, and after the growing season. Soil samples were collected and homogenized within each plot before planting (0–36 in), at V6 (0–12 in.), R1 (0–12), and after harvest (0–36). Inorganic soil N content was determined for each sampling by KCl extraction. Additionally, subsamples from each plot from the baseline soil sampling were tested for P, K, and pH analysis (0–12 in.). Based on these P, K, and pH results, an application of 30 lb/a of P was applied to the entire experiment in the form of triple superphosphate.

Corn growth and N uptake were documented in several ways. Stand counts were taken at R6 for the center two rows of each plot to determine the plant population in plants/a. Whole plant samples were also taken at R6 by cutting five representative plants from each of the center two rows of each plot at ground level. The plant biomass for each plot was separated from the ears and weighed separately. Subsamples of the biomass were coarse ground and dried. After drying and grinding using a 2-mm sieve, carbon and nitrogen analysis was performed. The biomass N and mass were used to calculate total biomass N content/plant, which with the stand counts was used to determine biomass N content/a.

Harvest took place when grain moisture content was less than 20%. Ears were collected by hand from each of the center two rows of a representative 10-ft area, totaling 20 ft of yield row. Ears were shelled with a stationary sheller, and the mass of the collected grain from each plot was used to estimate grain yield. A subsample of the grain was submitted to the Kansas State University Soil Testing Lab for carbon and nitrogen analysis. Grain N, along with the grain mass were used to calculate total grain N uptake/plant. The total grain N and total biomass N for each plot were summed to determine total N uptake/plant. The plant population was then multiplied by the total N uptake/plant to determine the total plant N uptake in lb/a.

Once total plant N uptake (lb/a) was determined for each plot, the amount of mineralized N (lb/a) was determined by summing the harvest soil N and total plant N and subtracting the preplant soil N. The difference in N uptake between plots with Proven and plots without Proven was calculated by subtracting the total plant N without Proven from the total N uptake with Proven. Plant N uptake with and without Proven was characterized by plotting N uptake vs. fertilizer N rate. Analysis of Variance (ANOVA) was conducted on all data using Sisvar with an alpha of 0.05 to assess the effects of N rate, Proven, and their interaction.

Results

There was no statistically significant effect of Proven (P = 0.1965) or a Proven by N rate interaction (P = 0.6209) on grain yield (Figure 1). However, increasing the rate of N fertilizer significantly increased grain yield (P = 0.0001) from 0 to 100 lb N/a with no additional increase at 150 lb N/a.

The rate of N fertilizer significantly affected total plant N uptake (P = 0.0000). The effect of Proven on total plant N uptake was not significant (P = 0.3093) nor was the interaction of Proven and N rate (P = 0.9916). However, total plant N uptake tended to be higher with Proven at all N rates (Figure 2).

Soil N mineralization without Proven produced 68 lb N/a, those treated with Proven produced 84 lb N/a, although this difference was not significant (P = 0.3358). Although there was a tendency for a positive effect of Proven on N mineralization, it was not significant.

Preliminary Conclusions

Although there was some evidence that Proven resulted in greater N mineralization, yield, and plant N uptake, the effects were not significant. These preliminary results suggest that Proven may be acting as an N source, but the amount of N provided by Proven may not be significant, or may not be enough to produce a significant increase in yield and total plant N in the conditions present in this experiment. It is important to emphasize that these results and conclusions are based on one site and one year, so generalizations that can be made about Proven based on these results are limited.

Acknowledgments

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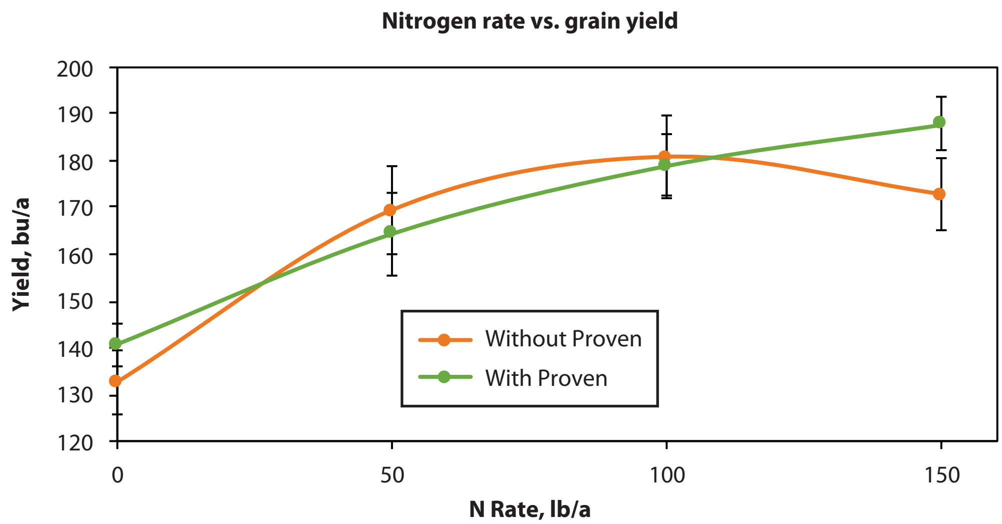

Figure 1. Grain yield and nitrogen (N) applied with and without Proven.

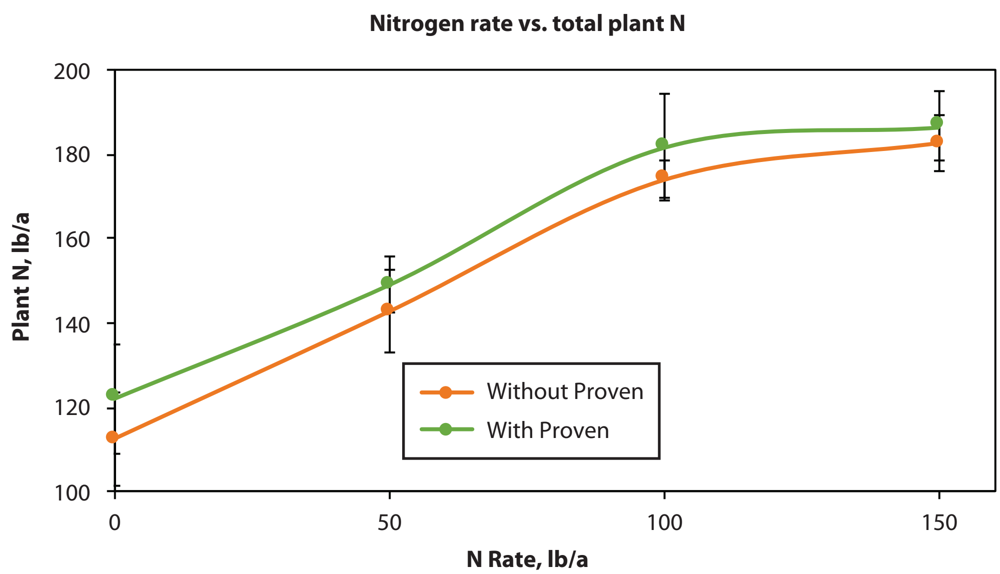

Figure 2. Total nitrogen (N) uptake with and without Proven.