Managing the Corn Microbiome for Sustainable Nutrient Retention in Illinois Agricultural Soils

Crop Physiology

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OBJECTIVE: ***Determine the effects of biological nitrification inhibition traits on corn inbred growth and physiology, and if the presence of these traits affects corn hybrid grain yield.***

INTRODUCTION

- Nitrogen (N) management is one of the most important factors in corn production as deficiencies can result in extensive yield reduction. To increase plant-available N nutrition, growers often apply N fertilizer; however, environmental N losses need to be addressed by researchers.
- In recent years, a number of N-fixing bacterial products have been brought to the market and have shown the potential to provide supplemental fixed-N from the atmosphere for corn utilization.
- Biological nitrification inhibition (BNI) traits have been introduced in corn inbred lines, presenting an opportunity to improve N retention in corn production systems.
- However, little is known about the potential synergies of combining both N-fixing bacteria and corn genetic material with BNI traits to further improve N utilization, which was the basis of this research.

MATERIALS AND METHODS

Two field experiments were conducted at Champaign, Illinois during the 2022 growing season to determine the effects of BNI traits in corn inbred and hybrid production systems. All trials were planted following soybean under conventional tillage. Experimental units were plots, four rows wide and either 17.5 or 37.5 feet in length with 30 inch row spacing, arranged in a randomized complete block experimental design with six replications.

Trial 1

- **Experimental Treatments:** This study was conducted in a full factorial design with three N fertilizer rates, three corn inbreds, and two in-furrow treatments for a total of 18 experimental treatments.
- **Nitrogen:** Urea was applied pre-plant broadcast and lightly incorporated at 0, 30, and 60 lbs N acre^{-1}.
- **Inbred:** B73 or 2 B73 BNI near-isogenic lines (NILs) were planted at a seeding rate of 32,000 plants acre^{-1} on May 12th.
- **In-Furrow:** A N-fixing bacterial inoculant (*Klebsiella variicola* & *Kosakonia sacchari*) was applied with a Sure-Fire in-furrow system (Figures 1 & 2).

Trial 2

- **Experimental Treatments:** This study was conducted in a full factorial design with 12 corn hybrids developed from the same B73 and 2 B73 BNI NILs from the previous study. The three B73 inbreds were crossed with Mo17, PH207, PHG47, and PHZ51.
- **Nitrogen Fertility:** All 12 hybrids were seeded at 34,000 plants acre^{-1} and supplied 160 lbs N acre^{-1} as urea applied pre-plant broadcast and lightly incorporated.

Figure 1. Applying a N-fixing inoculant in-furrow at planting.

Figure 2. Planter-mounted Sure-Fire in-furrow system.

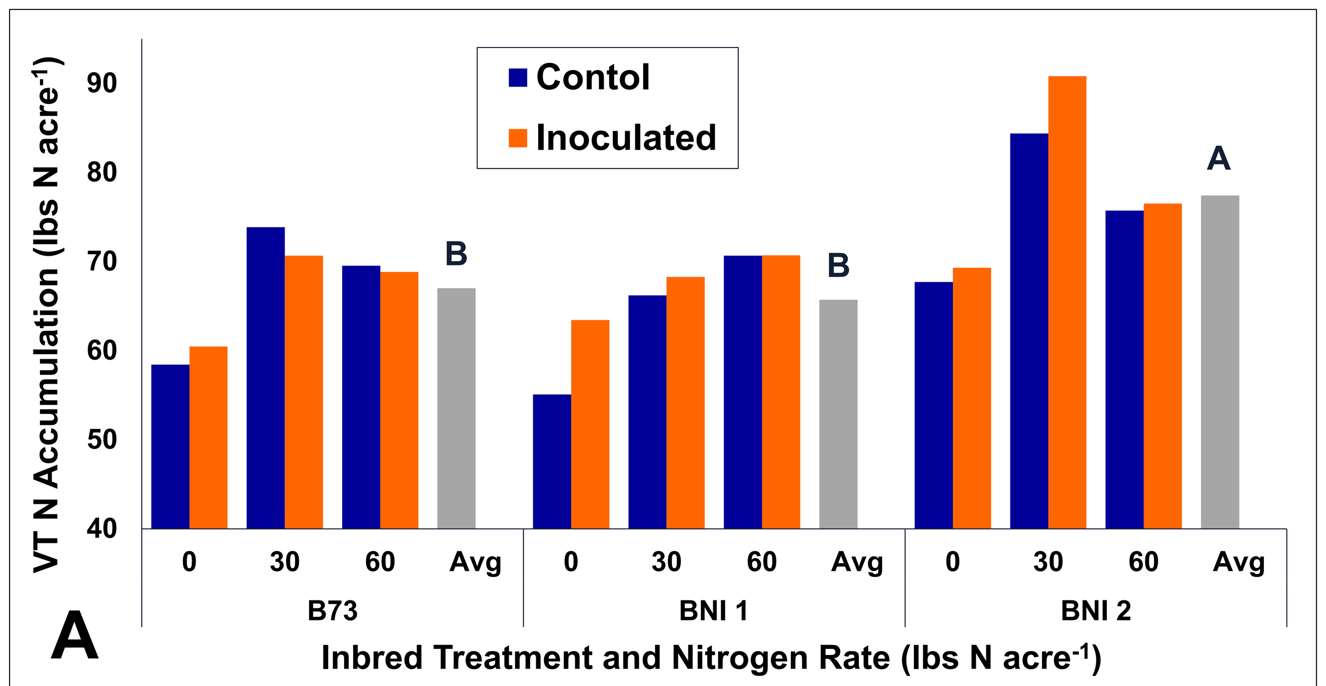
RESULTS AND DISCUSSION

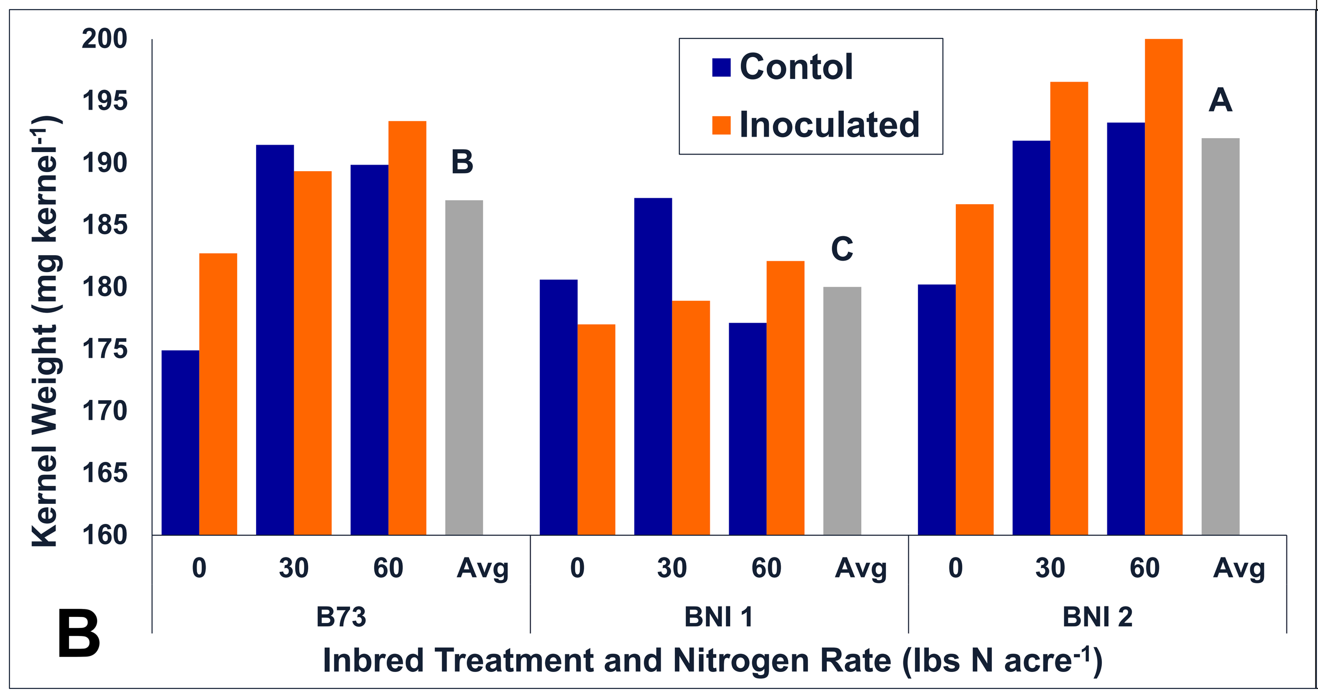
Effects of BNI and Nitrogen-Fixing Bacteria on Corn Inbred Physiology

The main effect of BNI trait had a significant response on VT plant N accumulation. When averaged across N rate and in-furrow treatment, BNI 2 inbreds accumulated greater levels of N compared to B73 and BNI 1 inbreds (Figure 3.A). Also, application of N-fixing bacteria tended to increase plant N accumulation when treated to inbreds with both BNI traits at most N rates (Figure 3.A).

When averaged across N rate and in-furrow treatment, BNI NIL 2 inbreds had a greater kernel weight compared to B73 (Figure 3.B). This response was mainly driven by increases in kernel weight due to applying N-fixing bacteria with BNI 2 inbred (Figure 3.B).

Also, BNI 2 led to an increase in grain protein concentration compared to B73 (Figure 3.C). With an increase in both kernel weight and grain protein concentration, BNI 2 may improve grain feeding quality.





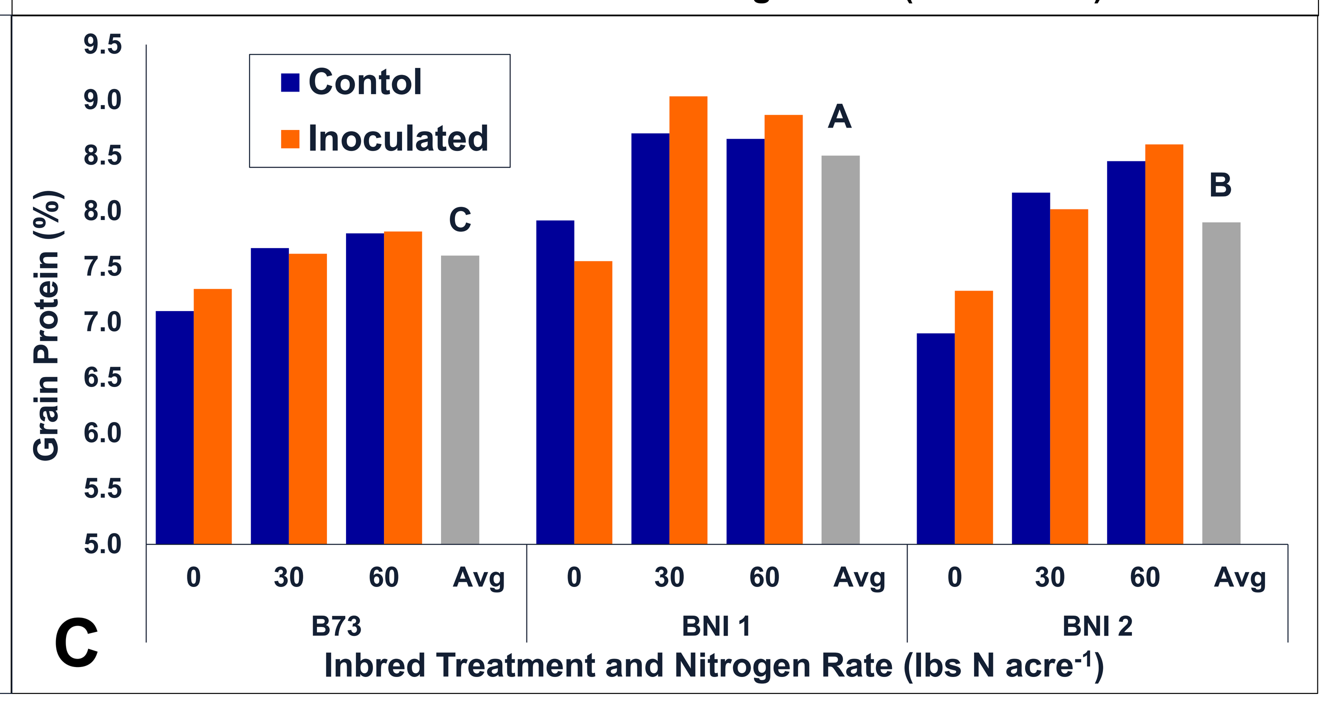


Figure 3. VT corn inbred N accumulation (**A**), kernel weight (**B**), and grain protein concentration (**C**) as influenced by corn inbred, N-fixing bacteria, and N rate at Champaign, Illinois in 2022. Uppercase letters that differ indicate treatment mean significant differences at $P < 0.01$.

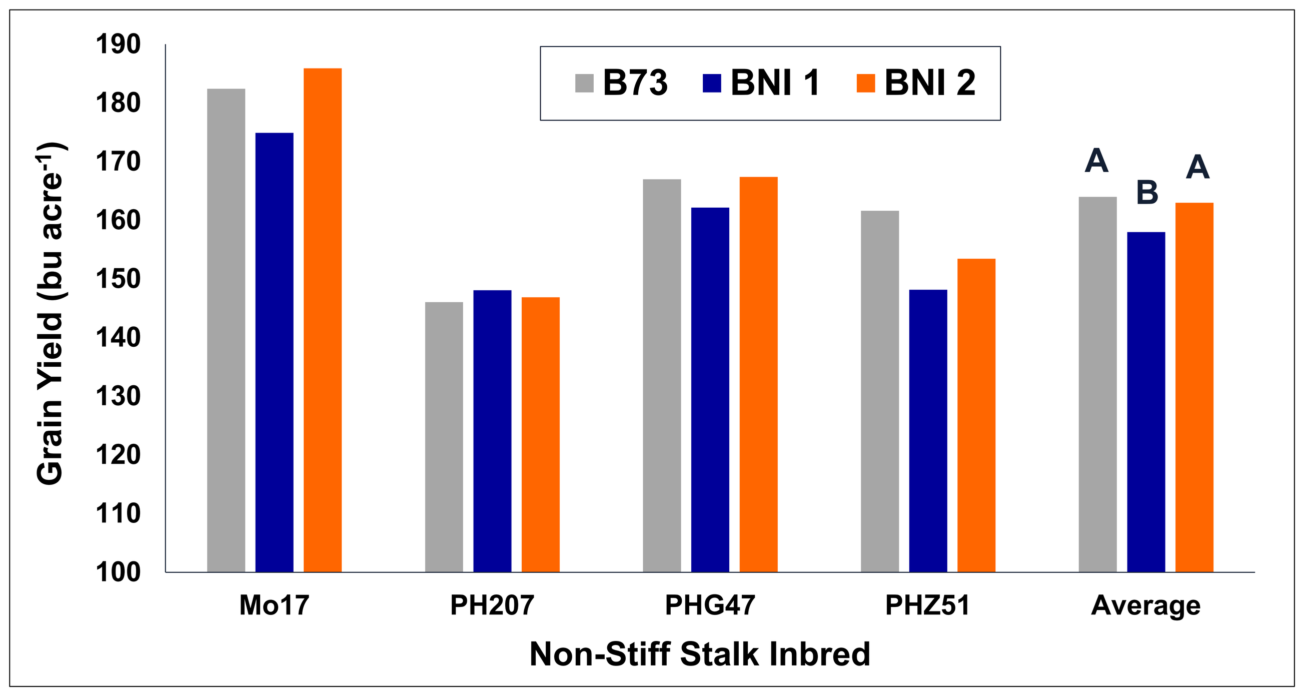


Figure 4. Hybrid corn grain yield as influenced by BNI trait at Champaign, Illinois, in 2022. Uppercase letters that differ indicate treatment mean significant differences at $P < 0.05$.

Effects of BNI on Corn Hybrid Productivity

Grain yields largely depended on the various non-stiff stalk inbreds that were crossed with B73. Hybrid crosses with Mo17 led to the greatest grain yield production (Figure 4).

When averaged across non-stiff stalk inbred, BNI 1 trait significantly reduced grain yield compared to B73. However, the presence of BNI 2 resulted in similar grain yields compared to B73 with all hybrid crosses, except PHZ51 (Figure 4). These results suggest that there is no grain yield fitness cost due to the presence of BNI trait 2.

CONCLUSIONS

- ***BNI 2 trait can improve inbred corn physiological parameters and further benefits were observed when applying a N-fixing bacterial inoculant to inbreds with BNI traits.***
- ***There was no fitness cost of the presence of the BNI 2 trait in hybrid corn.***
- ***BNI may be an option to improve N use and yields of hybrid corn.***