Effects of climate-smart practices and a drought-tolerant *Bradyrhizobium* isolate across the Mid-South region

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Abstract

No-till farming is an agricultural practice that involves cultivating crops without disturbing soils and offers numerous benefits such as reduced soil erosion, increased microbial activity, and elevated soil organic carbon levels, which ultimately promotes carbon sequestration. Incorporating inoculants such as a N-fixing soil bacterium *Bradyrhizobium japonicum* into this practice can further enhance its advantages by fostering a symbiotic relationship with the soybean plant (*Glycine max*). The additional benefits include attracting other beneficial soil microorganisms to the soybean rhizosphere and minimizing reliance on chemical fertilizers. Consequently, the integration of this inoculant and no-till farming holds promise for mitigating greenhouse gas (GHG) emissions, while ensuring sustainable soybean productions. This research aimed to understand the soybean plant's nutrient uptake when planted under no-till practices. The conventional tillage was included for comparisons. In addition, soybeans were inoculated with the drought-tolerant *B. japonicum* spp. TXVA to provide additional benefit by nitrogen fixation. Through the analysis of N-P-K nutrients in leaf tissues, physiochemical properties in soils, and soybean yields from Colt, AR, Winnsboro, LA, and Norborne, MO, we offer insights into our understanding of nutrient acquisition and overall plant vitality across various tillage practices and inoculation treatments.

Introduction

Biofertilizers offer several advantages, including mitigating the overconsumption of chemical fertilizers while promoting plant growth, increased yield, and nutrient mobilization (Singh et al. 2021). Among these biofertilizers, nitrogen-fixing bacteria, such as *Bradyrhizobium* strain TXVA, hold particular promise for soil rejuvenation and reducing reliance on chemical fertilizers. In conjunction with biofertilizers, implementing climate-smart agricultural practices, such as no-till farming, further promotes sustainable agricultural practices (Dang et al., 2020). No-till farming, characterized by minimal soil disturbance during planting, prevents soil erosion and enhances soil health. The combined application of these techniques represents a promising avenue for fostering climate-smart and sustainable agriculture. This study investigates the efficacy of no-till practices and nutrient uptake in soybean plants, particularly in the mid-south region, where the integration of climate-smart practices is of critical importance for agricultural resilience and sustainability.

Methods

In May 2023, all fields in Colt, AR and Winnsboro, LA were planted either under conventional or no-tillage conditions (**Fig. 1**). A randomized complete block design (RCBD) was employed to manage variation and minimize error across three treatments: a drought-tolerant inoculant (TXVA), a commercial treatment, TagTeam (TAG), and a control with no treatment. The fields in Norborne, MO were planted by local farmers. Metrics monitored encompassed taproot and total root nodulation, plant height and biomass, and soil physiochemical analysis. Leaf samples were collected at the R1 stage.

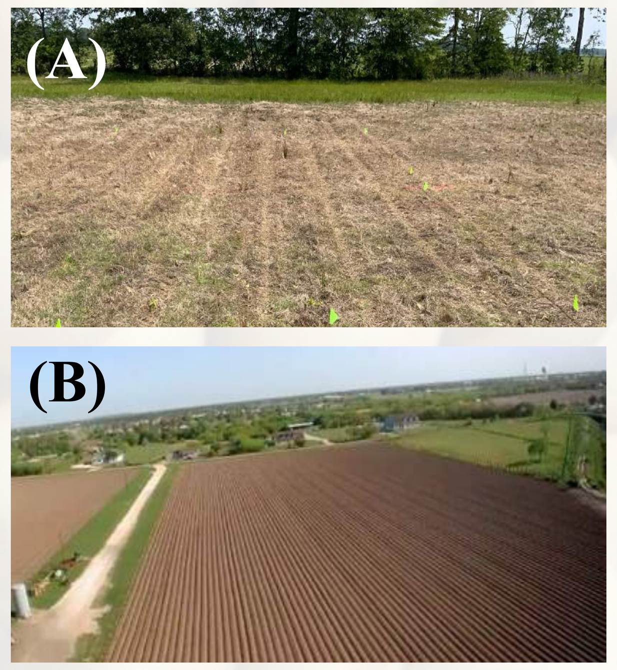

Figure 1. Examples of no-till field (A) and conventional tillage soybean fields (B).

Results

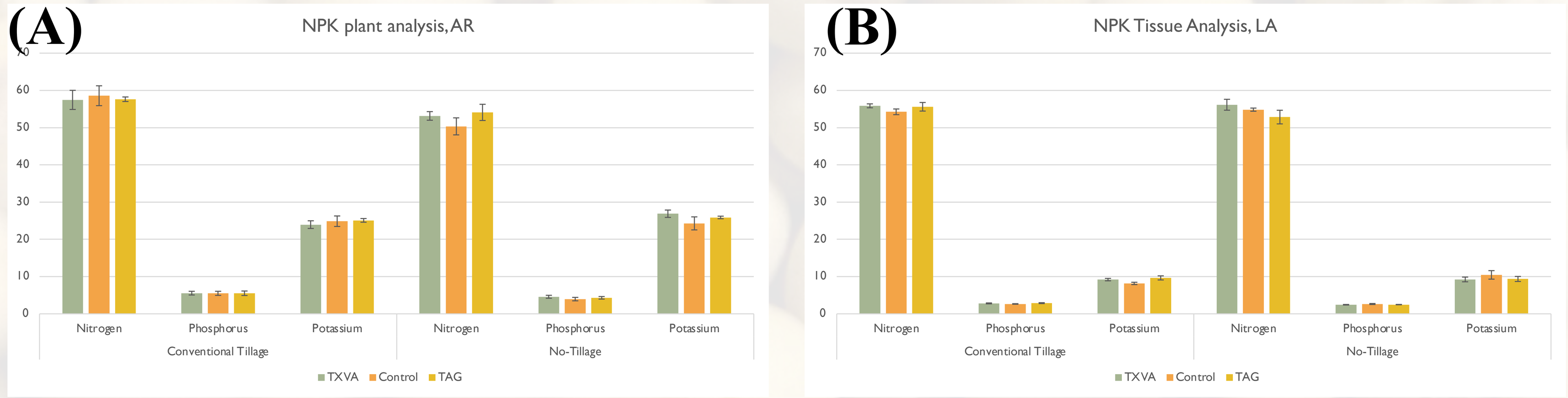

Figure 2. N-P-K concentrations (g)/kg of plant leaf tissue from the soybean fields in Colt, AR (A) and Winnsboro, LA (B). TXVA, a drought-tolerant inoculant; Control, no treatment; TAG, commercial inoculant TagTeam.

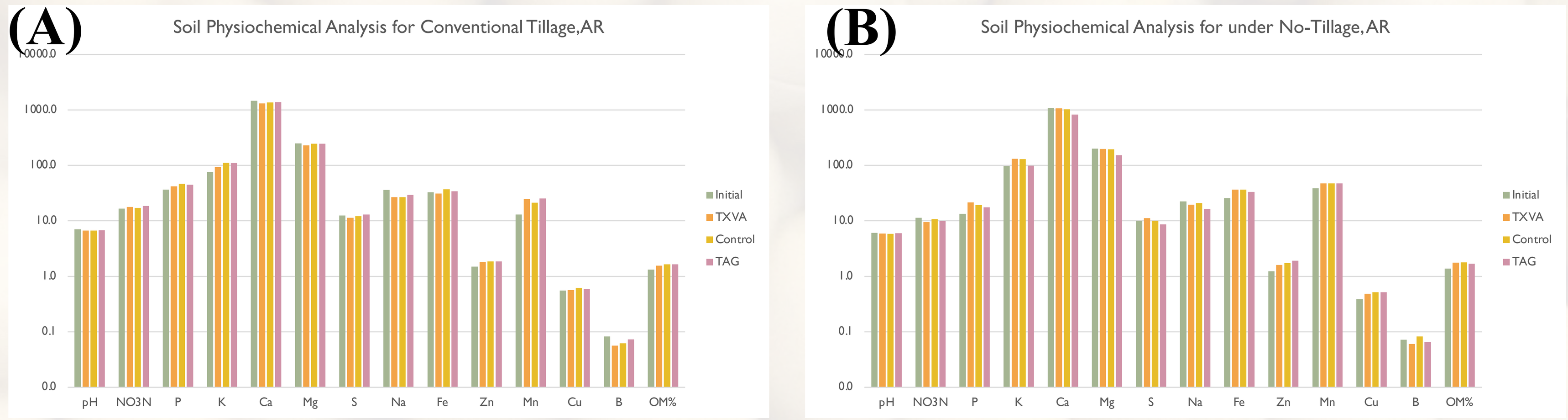

Figure 3. Soil physiochemical properties in conventional tillage (A) vs. no-till fields (B) in Colt, AR. The initial sample indicates soil physiochemical properties before applying any inoculant treatment. Organic matter (OM%) is measured as a percent, and all nutrients are measured as parts per million (ppm).

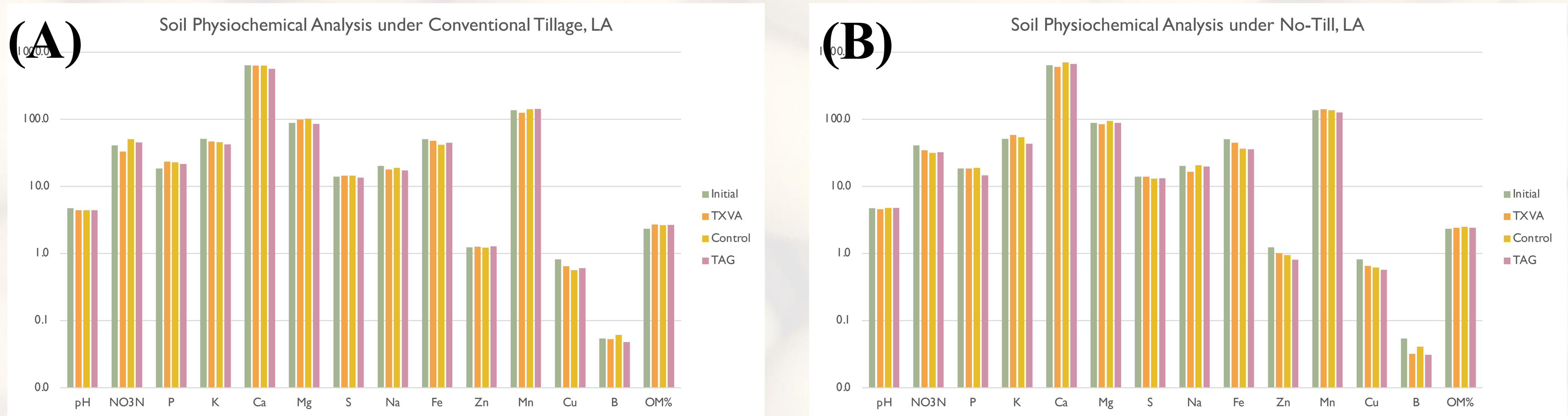

Figure 4. Soil physiochemical properties in conventional tillage (A) vs. no-till fields (B) in Winnsboro, LA. The initial sample indicates soil physiochemical properties before applying any inoculant treatment. Organic matter (OM%) is measured as a percent, and all nutrients are measured as parts per million (ppm).

Results cont'd

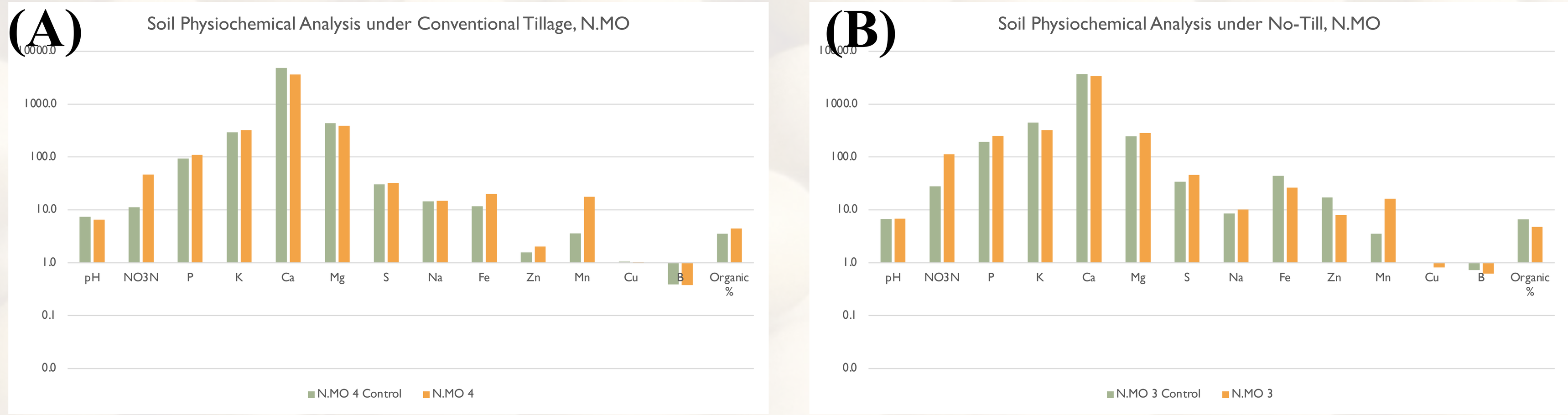

Figure 5. Soil physiochemical properties in conventional tillage (A) vs. no-till fields (B) in Norborne, MO. Organic matter (OM%) is measured as a percent, and all nutrients are measured as parts per million (ppm).

Conclusion

- There was an increase in potassium concentrations under no-till conditions in Colt, AR.
- There was an increase in potassium and nitrogen levels within the soybean fields located in Winnsboro, LA.
- Overall, there was no statistical difference between conventional tillage and no-till in soybean fields. However, further examination of greenhouse gases (GHG) such as CO_2, CH_4, and N_2O will provide deeper insight into GHG mitigation efforts.

Future Work

- Conduct more field trials in different states while optimizing sampling protocols to ensure standardization across all states.
- Perform a microbiome analysis to gain insight into the microbial activity to reduce GHG emissions.
- Measure changes in GHG emissions between conventional tillage and no-till practices.
- Expand to include more climate-smart practices.

References

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