Enhancing Wheat Straw Decomposition to Improve Soybean Double Cropping

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OBJECTIVE: ***Determine if living microbial blends, alone or with adjuvants, enhance wheat straw decomposition, nutrient release, and subsequent double crop soybean grain yields.***

INTRODUCTION

Within the central and southern Midwest, double crop production is a common rotation of winter wheat (*Triticum aestivum* L.) followed by soybean [*Glycine max* (L.) Merr.] in the late spring.

The production of two crops within the same year greatly increases total grain production, as well as the amount of crop residue remaining in a field. There are nutrients tied up in this residue that will slowly release over time as the native soil microbial colonies decompose the organic material. However, the use of biological products has been proposed to increase the rate of decomposition and nutrient release of the residues, which can provide additional nutrition for the next crop.

RESEARCH APPROACH

Location and Weather: Over two years at Champaign, IL wheat was harvested in bulk, and the studies were implemented during the soybean phase of the double crop rotation (Figure 1). Experimental units (plots) were four rows wide and 11 m long, arranged in a randomized complete block design with five (2023) or six (2024) replications. From June to September in 2023 and 2024, plots received 73% and 111% of the 30-year average precipitation, respectively (Figure 2).

Treatments: Directly after wheat harvest, nine different broadcast sprayer treatments were supplied to remaining residues. Treatments consisted of a factorial of three levels of living microbial blends of no microbes, Microbial Blend 1 **(**Residue Complete; 0.94 L ha^{-1}), and Microbial Blend 2 (Residue WS; 112.1 g ha^{-1}) by three levels of adjuvants as no adjuvant, spray-grade ammonium sulfate (AMS, 21-0-0-24; 19.0 kg ha^{-1}) or a combination of AMS + non-ionic surfactant (NIS; 0.25% v v^{-1}) (Table 1).

Measurements: Decomposition of the wheat residue was measured by collecting two subsamples of the treated straw from a 60.96 cm^2 area 24 hours after treatment application. One sample to measure initial residue dry weight and the other to document decomposition from soybean planting through harvest. The soybean was harvested at physiological maturity and measured for grain yield.

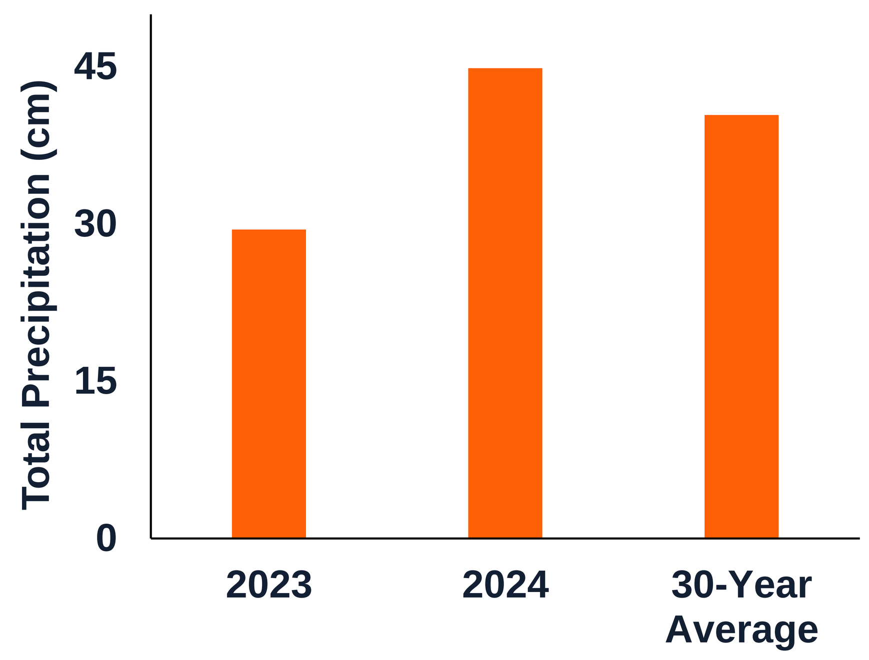

Figure 2. Total precipitation from June to September in 2023 and 2024 compared to the 30-year average at Champaign, IL.

RESULTS

Wheat Straw Decomposition: Averaged over 2023 and 2024, wheat straw decomposition tended to be enhanced by all treatments when compared to the untreated control. Using a paired t-test, the application of Microbial Blend 1 and AMS + NIS or their combination increased the season-long decomposition of wheat straw compared to the untreated control (Figure 3).

Grain Yield: In 2023, soybean grain yield tended to be enhanced by every treatment when compared to the untreated control, with the AMS-containing treatments having the greatest effect (Table 1), but only the Microbial Blend 2 + AMS application statistically increased yield over the untreated control. In 2024 and the two-year average, soybean grain yield only tended to be enhanced by the three treatments using just the AMS level of adjuvant. All other applications tended to have minimal effect on grain yield or slightly decreased grain yield, with no statistical improvements (Table 1).

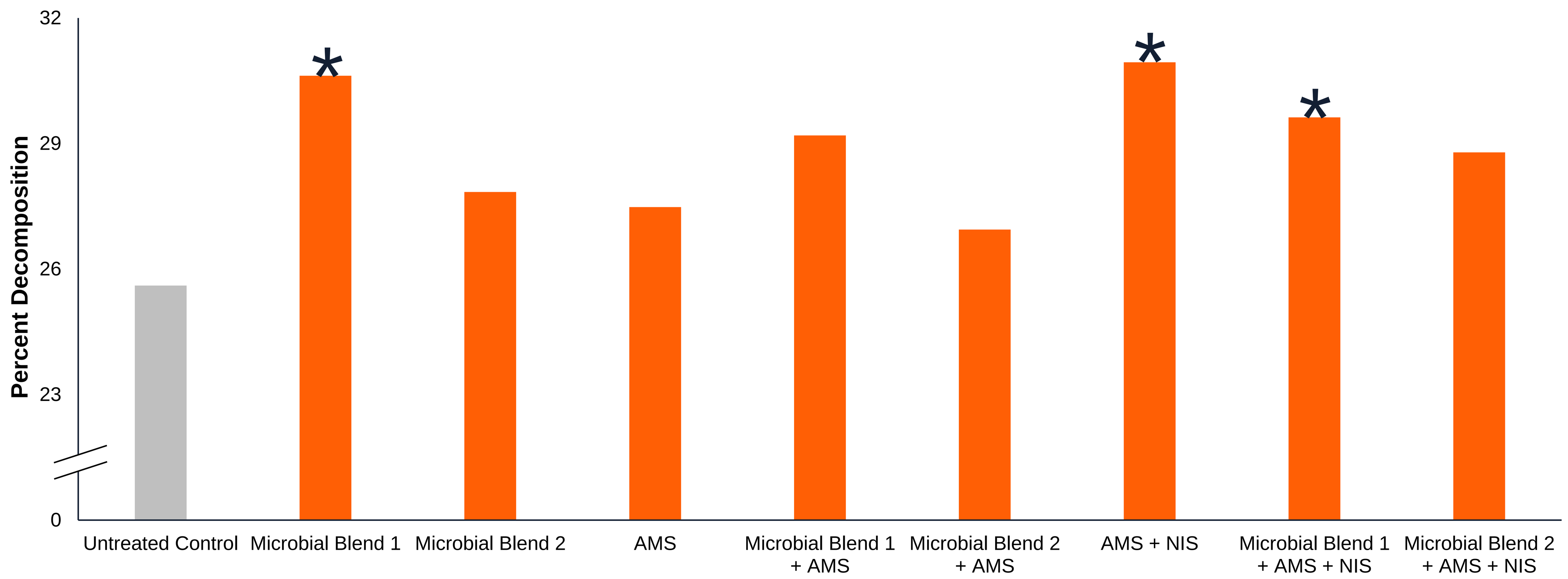

Figure 3. Effect of biological and adjuvant treatments on wheat straw decomposition (from soybean planting to soybean harvest, average time of 125 days for the two years) at Champaign, IL averaged over the 2023 and 2024 growing seasons. There was no significance at $P \leq 0.05$ using Fisher's LSD separation test for multiple pairwise comparisons (p=0.11).
* A statistical difference at $P \leq 0.05$ using a paired T-test to the untreated control.

Table 1. Effect of biological and adjuvant treatments on soybean grain yield at Champaign, IL averaged over 2023 and 2024. Grain yield is expressed at 0% moisture. There was no significance at $P \leq 0.05$ using Fisher's LSD separation test for multiple pairwise comparisons.

Treatment Description	2023	2024	2 Year Average
	---------------------------- Mg ha^{-1}	----------------------------	
Untreated Control	**1.60**	**3.95**	**2.77**
Microbial Blend 1	**1.70**	**3.74**	**2.71**
Microbial Blend 2	**1.63**	**3.97**	**2.80**
AMS	**1.73**	**3.99**	**2.86**
Microbial Blend 1 + AMS	**1.71**	**4.05**	**2.88**
Microbial Blend 2 + AMS	**1.82***	**3.95**	**2.88**
AMS + NIS	**1.67**	**3.78**	**2.73**
Microbial Blend 1 + AMS + NIS	**1.63**	**3.71**	**2.68**
Microbial Blend 2 + AMS + NIS	**1.64**	**3.89**	**2.76**
P > F	0.37	0.30	0.12

* A statistical difference at $P \leq 0.05$ using a paired T-test to the untreated control

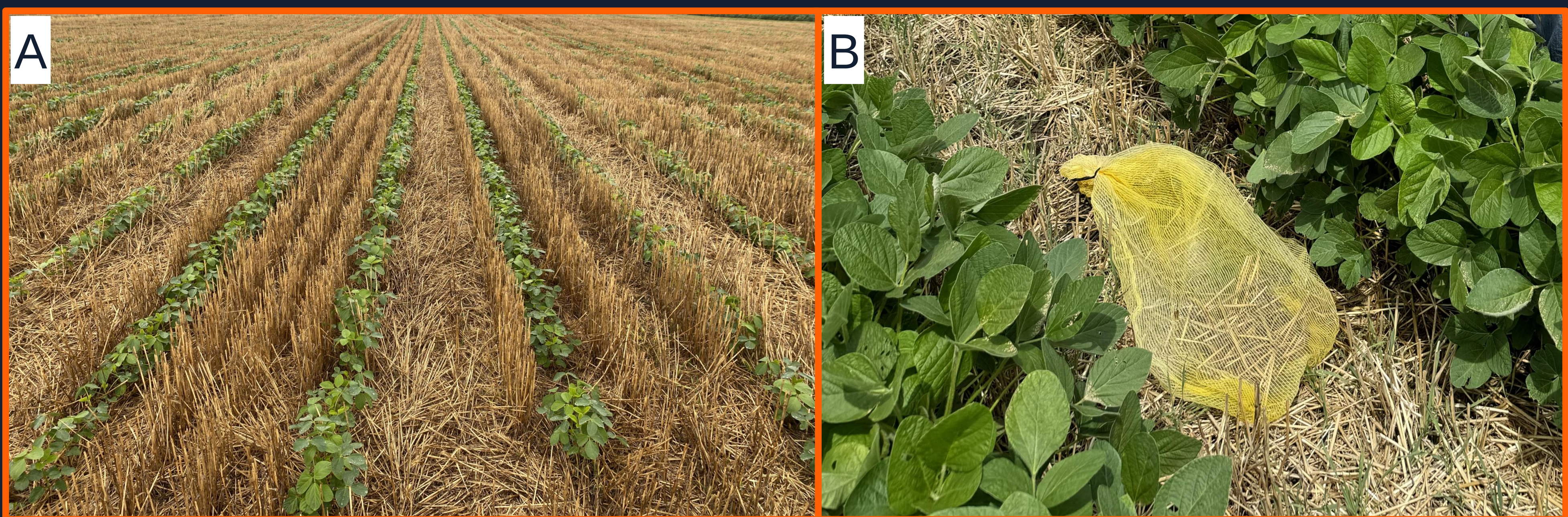

Figure 1. Soybean planted into wheat straw (A) showing the high residue environment of double crop systems along with a residue sample (B) allowing evaluation of season-long residue decomposition.

CONCLUSIONS

Wheat straw decomposition can be increased with post-harvest applications of living microbes and/or adjuvants.

On average, applications utilizing spray-grade AMS without NIS adjuvant tended to enhance soybean grain yield.

Application of microbial blends can improve wheat straw decomposition, and supplementation with an AMS adjuvant promotes the greatest numerical soybean yield response.

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