MANAGING DECOMPOSITION OF CEREAL RYE RESIDUES IN NO-TILL SOYBEAN FOR TIMELY NUTRIENT RELEASE

Crop Physiology

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OBJECTIVE: *Investigate the efficacy of residue-degrading applications to enhance cover crop decomposition and improve soybean grain yield.*

INTRODUCTION:

Cover cropping with cereal rye (*Secale cereale* L.) is a practice utilized for the retention of nutrients during a typically fallow period, which would otherwise be prone to loss through runoff or leaching. However, this benefit can become a drawback when nutrients required by the following row crop become immobilized within the cover crop residues, often resulting in a yield penalty.

Managing cover crop residues with applications of nitrogen and sulfur and/or biological products designed to enhance residue decomposition may increase row crop yields. However, the effectiveness of these treatments when administered with spring termination of the cover crop in a no-till system is unknown. Enhancing residue decomposition and subsequent mineralization of the retained nutrients is necessary to ensure adequate nutrient availability for the following row crop to mitigate the associated yield penalty.

MATERIALS AND METHODS:

Location: Champaign, Illinois on a Mollisol soil (Organic matter, 5.3%; CEC, 27.1; pH, 6.0) under no-till management.

Management: A cover crop was drilled at a population of 84 kg ha^{-1} in the fall of 2022 as cereal rye following corn harvest. In the spring of 2023, soybean [*Glycine max* (L.) Merr.] plots were established using the variety AG33XF3 at a population of 345,000 plants ha^{-1}.

Treatments: At the cereal rye tillering stage, on the same day as termination, foliar treatments of ammonium thiosulfate (**ATS**; 12-0-0-26S) were applied at a rate of 65.5 liters ha^{-1} with or without biological treatments of a living microbial blend (**MB**; Residuce Complete) at 0.9 liters ha^{-1} or a carbon mixture (**CM**) of sugar and humic acid (NeoVita 43 and Hydra-Hume), both applied at 9.4 liters ha^{-1} (Table 1).

Table 1. Seven treatment combinations of fall cover crop establishment, spring sulfur, and spring biologicals applied to the experimental field in 2023.

Cover Crop		Sulfur		Biological
None		None		None
Cereal Rye	X	None	X	None
		ATS		Microbial Blend
				Carbon Mixture

Parameters Evaluated: In each cover crop plot, three cereal rye biomass samples were collected post treatment application from a 930 cm^2 area (Fig. 1A & 1B), placed into mesh bags (Fig. 1C), and weighed to collect fresh weights. Two samples were returned to the field while the third was dried to calculate initial moisture. The two field samples were later collected at the R3 or R7 soybean growth stages, dried, and reweighed the determine the extent of residue decomposition.

Figure 1. Procedure for collecting cereal rye biomass samples

Grain Yield - The two inner rows of each plot were harvested for grain yield, which is presented at 0% moisture.

RESULTS AND DISCUSSION: GRAIN YIELD

Adding cereal rye decreased soybean grain yield by 0.53 Mg ha^{-1}, but all treatments with ATS mitigated this yield penalty.

- All treatments to cereal rye numerically increased soybean grain yield compared to unmanaged cereal rye (Figure 2).
- Foliar applications of ATS, ATS + MB, and ATS + CM mitigated the soybean yield penalty resulting from the presence of cereal rye by 0.38, 0.42, and 0.49 mg ha^{-1}, respectively (Figure 2).
- ATS and biological treatment effects on soybean grain yield exhibited an additive trend (Figure 2).

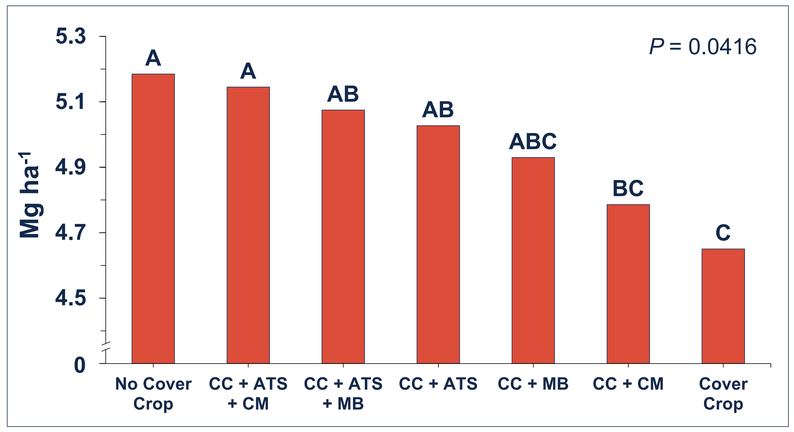

Figure 2. Soybean grain yield as affected by a cereal rye cover crop (CC) with or without foliar treatment combinations of ATS, a microbial blend (MB), and a carbon mixture (CM).

Figure 3. Untreated cereal rye (A) compared to cereal rye after receiving a foliar application of ATS resulting in a burndown effect (B)

RESULTS AND DISCUSSION: DECOMPOSITION

Applications of ATS resulted in an inconsistent effect on cereal rye residue decomposition.

- Foliar-applied ATS markedly enhanced burn down at termination (Figure 3) and significantly delayed residue decomposition (by 2.1 percentage points) at R3, but had no effect on residue decomposition at R7 (Table 2).
- Despite inconsistency in decomposition, there was a yield response to ATS applications, presumably as a result of nutrient supplementation to soybean (Table 2).

Table 2. Effect of sulfur treatment on cereal rye residue decomposition at soybean growth stages R3 and R7, and soybean grain yield at Champaign, IL in 2023. Data was averaged across biological treatments.

Sulfur Treatment	R3	R7	Grain Yield
	— % Decomposition —		Mg ha^{-1}
None	58.4	85.7	4.88
ATS	56.3	86.1	5.08
LSD ($\alpha = 0.1$)	2.0	NS	0.19

Biological applications to cereal rye residues did not increase cereal rye residue decomposition.

- Although the biological treatments differed from each other in the degree of residue degradation at soybean growth stage R3, by growth stage R7, there was no effect of the biological treatments on cereal rye residue decomposition (Table 3).
- Soybean grain yield was not affected by either of the biological treatments when averaged across the sulfur treatments (Table 3), but when ATS was omitted, both biological treatments resulted in a numerical increase in soybean grain yield (Figure 2).

Table 3. Effect of biological treatments on cereal rye residue decomposition at soybean growth stages R3 and R7, and soybean grain yield at Champaign, IL in 2023. Data was averaged across sulfur treatments.

Biological Treatment	R3	R7	Grain Yield
	— % Decomposition —		Mg ha^{-1}
None	57.9	85.4	4.97
Microbial Blend	55.0	86.0	5.00
Carbon Mixture	59.2	86.3	4.97
LSD ($\alpha = 0.1$)	2.5	NS	NS

CONCLUSIONS:

- **Foliar treatments with ATS at termination mitigated the soybean yield penalty resulting from a cereal rye cover crop.**
- **All treatments to cereal rye residue numerically increased soybean grain yield compared to unmanaged cereal rye.**
- **Increases in soybean grain yield from ATS and biological treatments were not consistent with the decomposition of cereal rye residue.**

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