Fall Residue Management Reduces the Continuous Corn Yield Penalty

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Objective: ***Identify management practices for post-harvest residues to mitigate the yield penalty associated with continuous corn cropping systems.***

Introduction:

- Corn (*Zea mays* L.) produces twice the post-harvest residue as soybean, resulting in greater in-season carbon returned to the field.[1]
- While greater carbon sequestration is considered a positive, the higher levels of residue can lead to poorer seedling emergence and greater soil nitrogen immobilization, especially under continuous corn and conservation tillage practices.
- The use of mechanical, chemical, and biological management practices offers the potential to manage residue to optimize carbon return to the soil and mitigate the residue yield penalty associated with no-till continuous corn cropping.

Reference

1. Power, J.F; Doran, J.W; Wilhelm, W.W. Uptake of nitrogen from soil, fertilizer, and crop residues by no-till corn and soybean. *Soil Sci. Soc. Am. J.* **1986**, *50*, 137-142.

Research Approach:

Field experiments were conducted at Champaign, Illinois using two long-term cropping sites located within 4.5 km of each other. Each site consisted of eight replicated blocks of 17 or 19 years of continuous corn and corn/soybean rotations in 2020 and 2021, respectively. The study alternated between the two field sites, with one site pertaining to the current season's corn experiment and the other site serving as the setup to establish the no-till corn/soybean rotation for the following year's corn crop.

All residue treatments were applied after harvest as a complete factorial in the fall prior to spring planting.

The factors evaluated were:

1.) Mechanical Sizing of Residue (Figure 1)

- Standard Stalk Rollers (residue not sized)
- Sizing Knife Rollers (residue sized 2-3 cm in length)

2.) Chemical Application

- No fall fertility
- 224 kg ha^{-1} Ammonium Sulfate (AMS; 21-0-0-24S)

3.) Biological Sprays (Figure 2)

- Untreated Control
- Microbial Extract (Accomplish LM®; 18.8 L ha^{-1} to supply 1.3 kg N and 2.9 kg S ha^{-1})
- Humic Acid (Hydra-Hume®; 9.4 L ha^{-1} to provide 1.16 kg humic acid ha^{-1})
- Microbial Blend (SB5500®; 2.3 L ha^{-1})

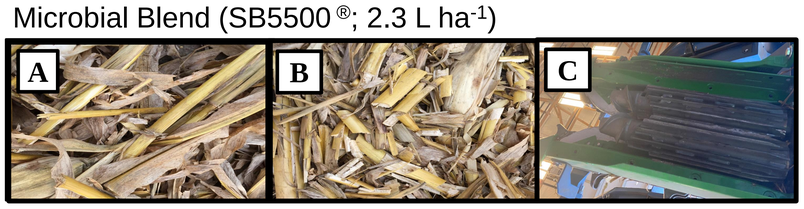

Figure 1. Mechanical sizing of corn residue. (**A**) Unsized residues. (**B**) Sized residues. (**C**) Sizing knife rollers on combine head.

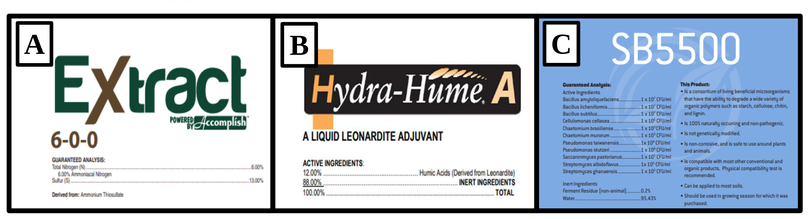

Figure 2. Biological products used for residue management. (**A**) Microbial Extract. (**B**) Humic Acid. (**C**) Microbial Blend.

Results:

Residue decomposition (Figure 3) was reduced with the humic acid and microbial extract treatments but tended to increase with addition of AMS (Table 1) or sizing residue (data not shown).

Figure 3. Post-harvest residue samples were collected from a 930 cm^2 area to evaluate treatment effect on overwinter decomposition.

Table 1. Residue decomposition as influenced by fall fertility and fall biological applications. Residue was sampled in the fall post-harvest for initial biomass, placed in the field to overwinter, and re-weighed prior to planting for final biomass.

Chemical Application	Fall Biological Application †				Chemical Average
	Untreated	Microbial Extract	Humic Acid	Microbial Blend	
	Decomposition (%)				
Untreated	16.5 ab	12.3 c	13.0 c	13.8 c	13.9 NS
AMS	14.7 bc	13.9 c	13.3 c	17.3 a	14.8 NS
Biological Average ‡	15.6 A	13.1 B	13.1 B	15.6 A	

† Chemical *x* Biological LSD (α ≤ 0.1) = 2.4; ‡ Biological LSD (α ≤ 0.05) = 1.7.

The continuous corn yield penalty (CCYP) was 2,561 kg ha^{-1} when no fall management was applied (standard stalk rollers only) (Figure 4A).

Sizing the residues or applying fall AMS significantly reduced the CCYP, with a combined reduction in the CCYP of 730 kg ha^{-1} (Figure 4 A/B/C).

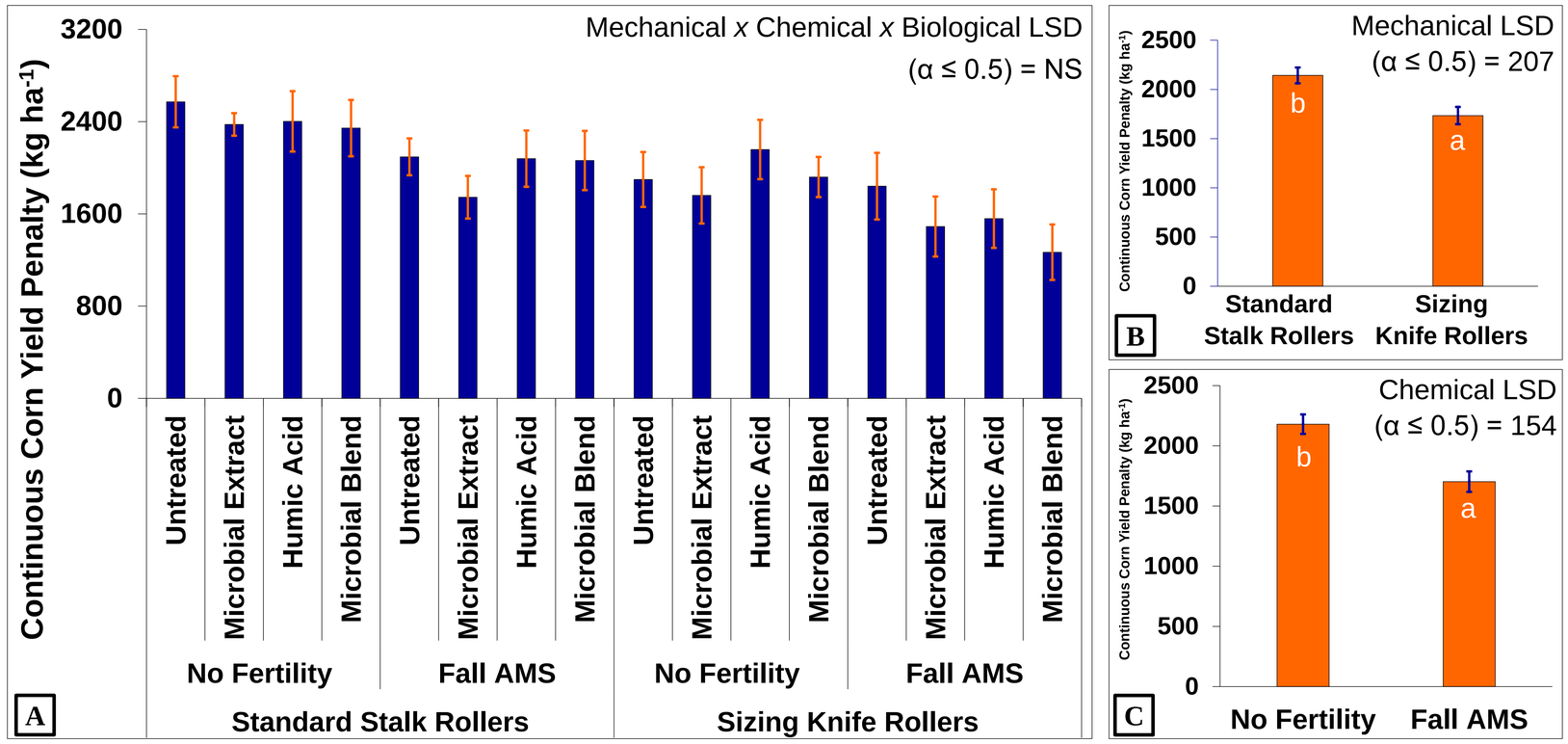

Figure 4. The continuous corn yield penalty (yield difference between corn-soybean rotation and continuous corn) as influenced by fall residue treatments pertaining to **A)** four levels of biological management **B)** two levels of mechanical harvest method, and **C)** two levels of fall fertility at Champaign, IL in 2020 and 2021.

Conclusions:

- Sizing residues and applying fall AMS tended to increase residue decomposition, while the addition of biologicals reduced overwinter decomposition. Biological activity may have increased post-planting, resulting in the observed higher yields.
- All three approaches of mechanical, chemical, or biological residue management individually reduced the CCYP, and the greatest reduction in the penalty occurred when all managements were applied together in an additive approach.

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