Residue and Agronomic Management to Lessen the Continuous Corn Yield Penalty

Crop Physiology

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Question: ***Can the continuous corn yield penalty be mitigated with residue and agronomic management?***

Objective: ***Identify residue and agronomic management practices that lessen yield losses due to high crop residue environments.***

Introduction:

- Accelerated residue degradation and nutrient cycling will be necessary to maximize yield potential in corn (*Zea mays* L.) grown continuously, in addition to other high volume residue situations such as increased planting density and crops that annually produce much greater than average yields.
- Residue accumulation, along with soil nitrogen availability or immobilization, and the weather are the primary agents of the continuous corn yield penalty (CCYP).
- Potential candidates to increase corn yields and reduce the causative factors of the CCYP are mechanical residue management and enhanced agronomic systems.

Research approach:

The field experiment was conducted at Champaign, Illinois on a Drummer Flanagan silty clay loam, planted on April 28th, 2016 over 4 replicated blocks of 13th year continuous corn and 1st year corn in a corn-soybean rotation (Figure 1A and 1B) using two commercial hybrids.

The factors evaluated were:

1) **Residue Management:**

Mechanical residue treatments were implemented during the previous harvest by a combine head equipped with:

- Calmer's BT Choppers® (residue sized 3-4 cm in length; Figure 2A), vs.
- Standard Stalk Rollers (residue not sized; Figure 2B).

2) **Agronomic Input Level:**

Standard

- One week prior to planting, nitrogen was applied at 202 kg N ha^{-1} as UAN.
- Soil test values for P and K were in the optimal range and no additional fertility was applied.
- Plots were planted to achieve a final stand of 79,100 plants ha^{-1} (32,000 plants ac^{-1}; to simulate a standard producer practice).
- No fungicide was applied.

High Input

- A base rate of 202 kg N ha^{-1} as UAN was applied preplant with an additional sidedress of 67 kg N ha^{-1} as urea (46-0-0) at V5 (269 kg N ha^{-1} total).
- Phosphorus was banded preplant at 112 kg P_2O_5 ha^{-1} as Mosaic's MicroEssentials® SZ™ (12-40-0-10S-1Zn) and potassium was broadcast at 84 kg K_2O ha^{-1} as Mosaic's Aspire® (0-0-58-0.5B).
- Planted to achieve a final stand of 111,200 plants ha^{-1} (45,000 plants ac^{-1}; as an intensive practice).
- Plots received a foliar fungicide application of BASF's Headline AMP® at plant growth stage VT/R1.

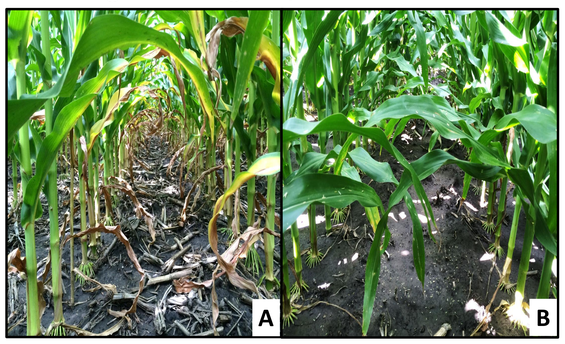

Figure 1. Late-season differences between 13th year continuously grown corn (A) and 1st year corn in a corn-soybean rotation (B).

Results and Discussion:

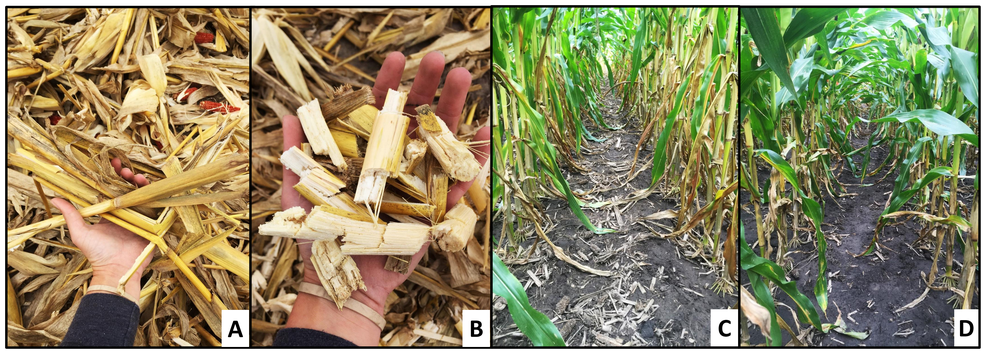

Figure 2. Mechanical residue management in corn on corn the previous fall (A and B) and at the R3 growth stage the following growing season (C and D): Standard stalk rollers (A and C) and Calmer's BT choppers (B and D) .

- **Mechanical residue management showed visual differences after harvest (Figure 2A and 2B), and in-season (Figure 2C and 2D).**
- **On average, residue decay was increased by sizing the residue (50% reduction in residue when chopped compared to a 43% reduction with the standard stalk rollers) (Figure 3).**
- **Seedling emergence in continuous corn was significantly delayed during the first 5 days of emergence (3-26% delay across harvest method; *P* = 0.007) compared to corn in rotation with soybean. Stand establishment was reduced in corn on corn vs. corn following soybean (94% vs. 97%, respectively) (Figure 4).**
- **Visual growth differences between continuous corn and rotated corn (Figure 1A, and 1B), translated into a CCYP of 0.6 Mg ha^{-1} across treatments (Table 1); the greatest yields were achieved in the corn-soybean rotation with the enhanced agronomic system (i.e., additional plants, added fertility, sidedressed nitrogen, and a foliar fungicide application).**
- **The high input level improved plant growth (Figure 5) and grain yield across rotations by 2.1 Mg ha^{-1} (Table 1; *P* = < 0.001). Across harvest method, the CCYP was lessened by 56% with the high input level (penalty of 0.4 Mg ha^{-1}) vs. the standard input level (penalty of 0.7 Mg ha^{-1}), suggesting enhanced agronomic management as a method to alleviate the CCYP.**

Figure 5. Early-season differences between standard (left) and high input (right) agronomic systems.

- **Across agronomic input level, chopped residue harvest increased continuous corn yields by 0.5 Mg ha^{-1} compared to standard harvest and reduced the CCYP (0.8 Mg ha^{-1} with the standard stalk rollers vs. 0.3 Mg ha^{-1} with sized residue) (Table 1).**

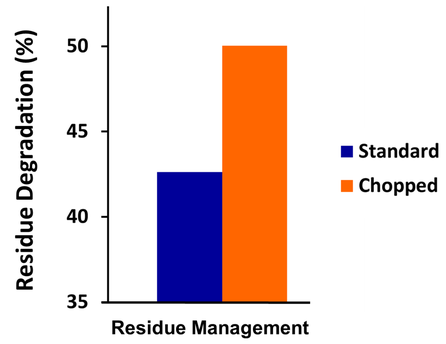

Figure 3. Effect of mechanical residue management on percent overwinter residue degradation across rotations. Data represents dry matter weight reduction of residue subsamples from the initial previous season post harvest vs. remaining preplant in field-located mesh bags.

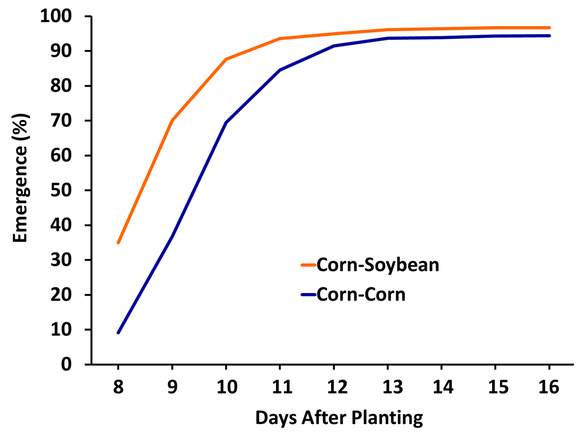

Figure 4. Effect of rotation on corn seedling emergence. Values are averaged across all other treatments. Data was obtained daily from a 3 m row section and compared to the known planting density.

Table 1. Effect of rotation, harvest, and agronomic management on final grain yield at Champaign, IL during 2016. Values represent the average of 2 hybrids, expressed on a dry weight (0% moisture) basis.

	Continuous Corn		Corn-Soybean
Input Level	**Standard**	**Chopped**	**Standard**
	Mg ha^{-1}		
High Input	13.6 a	13.9 a	14.2 a
Standard	11.3 b	11.8 b	12.3 b
Mean	12.4 C	12.9 B	13.2 A

Ŧ Mean separation tests were conducted using an LSD calculation with the Tukey adjustment. Lowercase letters compare agronomic management within a rotation by harvest treatment combination. Upper case letters compare the main effect of rotation and mechanical management. Similar letters are not significantly different at $P \leq 0.10$.

Conclusions:

1. Does residue management reduce the CCYP?

✓ **Yes, mechanically sizing the previous crop residue increased degradation and significantly reduced the continuous corn yield penalty.**

2. Can a high input system mitigate the yield penalty associated with continuous corn?

✓ **Yes, intensified agronomic management increased yields regardless of cropping rotation or harvest method. The CCYP was significantly lessened with high input management.**