CORN STOVER REMOVAL AND SOIL FERTILITY

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Introduction

With cellulosic ethanol production on its way to becoming a reality, the effects of stover removal on the landscape have not been fully examined and efficient agricultural management practices for biofuel production systems have not been developed. The current UW recommendations (e.g., UWEX A2809) do not recommend changes to nutrient management plans based on biomass removal (i.e., when corn is grown for silage). Data sets which evaluate the short- or long-term effects of biomass removal on optimum N fertilization rates for continuous corn in Wisconsin do not exist. Long-term field research (30+ years) in Wisconsin has shown that continuous corn rotations maintain and often increase corn yields and NUE over time when N is fertilized at UW recommended rates (Bundy et al., 2011); SOC and soil N supplying capability also have been shown to increase. These results indicate that with proper N fertilization and stover additions to the soil, the capacity of the soil to supply N for crop production can be maintained. An increase in biomass removal may jeopardize the sustainability of these agricultural systems. Future research in this area should focus how stover removal affects optimum N fertilization rates. However, the quantity of studies which evaluate the value of crop residue related to N fertilization rates are lacking.

Management of crop residue has been studied over the past several decades, although the effects on SOC and corn yield have not been consistent. Blanco-Canqui and Lal (2007) determined that biomass removal did not result in a decrease in SOC or corn yield after three years. Barber (1979) also reported that stover removal did not affect the corn yields, but did report a significant decrease in SOC after 11 years of stover removal. In contrast, Wilhelm et al. (1986) reported that continual removal of corn stover lead to a significant reduction in corn yields after only 3 years. Moebius-Clune et al. (2008) determined that after 32-years of annual stover removal from no-till, continuous corn systems, SOC was significantly reduced, but potentially mineralizable N pools remained unchanged. Although the authors did not report yields, they concluded that stover removal from the systems can be a sustainable management practice. It is clear that the short-term and long-term effects of stover removal need to be considered across different soils and climates, as well as in conjunction with other management practices.

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Materials and Methods

A three-year study was conducted on three Experiment Stations in Wisconsin: Arlington, Lancaster, and Marshfield. The experimental design was a randomized complete block, split-plot design. The main plot factor was stover removal rate and the treatments included: (i) no removal, (ii) a low rate of removal, and (iii) a high rate of removal. The system evaluated here is a two-pass system. Corn was harvested and then a flail chopper was used to cut and collect corn stover. The rates of stover removal were determined by the capacity of the flail chopper. When the blades on the flail chopper were set as low to the ground as possible, the amount of stover removed was determined to be ~50% on a dry weight basis (high rate). The low rate of removal was ~25% and was collected by setting the blade on the flail chopper to its highest setting. The split plot factor was N rate and the treatments were 0, 50, 100, 150, 200, and 250 lb/ac of N applied pre-plant as urea. The urea was lightly incorporated into the soil prior to planting.

Starter fertilizer containing of P and K will be applied 0.05 m (2 inches) below and 0.05 m (2 inches) to the side of the seed. Tillage operations will be consistent across all treatments and sites and will include fall chisel and disk after stover removal. Soil samples (8 inches) were taken in the fall of each year and analyzed for pH, organic matter, soil test P, and soil test K by the UW Soil and Plant Analysis Laboratory.

Preliminary Results

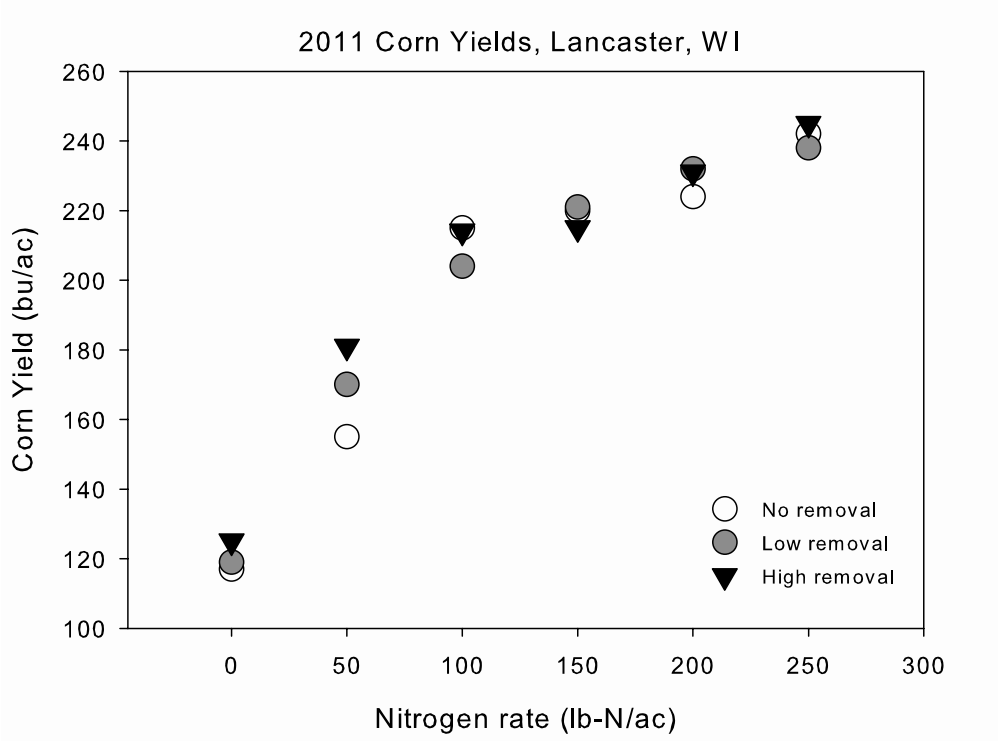

Figure 1. 2011 corn yields in Lancaster, WI for three removal rates of stover.

Preliminary analysis of yield results indicates that there was not a clear effect of stover removal across all sites and across years. For example, at Lancaster in 2011, there was no difference between stover removal rates (Fig. 1). But in 2012, no removal had higher N rates compared to the low removal rate at 200 and 250 lb/ac N rates. However, the high removal rate had a similar to the no removal at the 250 lb/ac N rate, confounding our interpretation. No clear effects of stover removal were determined at Arlington or Marshfield.

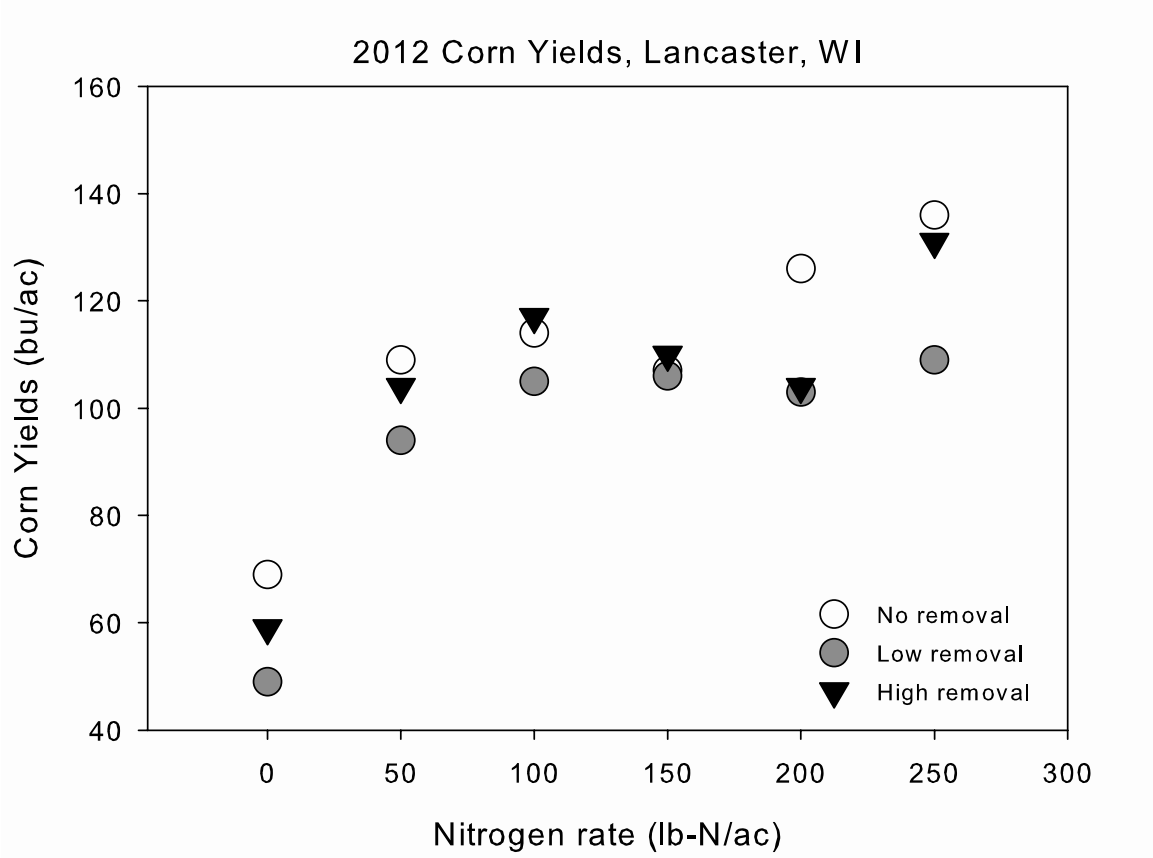

Figure 2. 2012 corn yields in Lancaster, WI for three removal rates of stover.

Table 1. Routine soil analyses from selected N rate plots from each stover removal treatment. Soil samples were collected at the end of 3 years of stover removal in fall of 2012.

Site†	Stover treatment	N rate	pH	OM	P	K
		lb/ac		%	ppm	ppm
ARL	No removal	0	6.9	3.3	73	144
		150	6.8	3.6	82	157
	Low removal	0	7.2	3.4	78	138
		150	7.0	3.8	102	132
	High removal	0	7.1	3.6	97	129
		150	7.0	3.1	72	140
LAN	No removal	0	7.2	2.2	25	91
		150	7.1	2.2	20	89
	Low removal	0	7.2	2.1	18	82
		150	7.0	2.1	20	90
	High removal	0	7.3	2.1	18	86
		150	7.0	2.1	20	87
MAR	No removal	0	6.6	2.9	53	106
		150	6.5	3.0	43	94
	Low removal	0	6.7	2.8	45	102
		150	6.7	2.9	40	104
	High removal	0	6.7	2.8	45	90
		150	6.3	2.9	48	83

† ARL = Arlington; LAN = Lancaster; MAR = Marshfield.

Preliminary Conclusions

- There is no clear effect of stover removal on corn yield at Arlington, Lancaster, or Marshfield after three consecutive years of stover removal.
- No clear negative effects of some stover removal on pH, OM, soil test P or soil test K.
- Further analysis must be conducted to evaluate trends in production and soil fertility over time.
- Short-term removal of stover, in amounts not exceeding 50% of stover biomass will not result in reductions in productivity or meaningful reductions in soil fertility on these Wisconsin soils.

References

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