RESIDUE HARVEST EFFECTS ON IRRIGATED, NO-TILL CORN YIELD AND NITROGEN RESPONSE

Charles S. Wortmann[1], Charles A. Shapiro[1], and Marty R. Schmer[2]
[1]Department of Agronomy and Horticulture, University of Nebraska-Lincoln;
[2]ARS-USDA
cwortmann2@unl.edu

INTRODUCTION

Immobilization of applied N is expected when much high C:N crop residue remains in the field as is typical following corn grain harvest. Immobilization of N is expected to be less if crop residue is less. The effect of reduced immobilization on N availability may more than compensate for N removed in residue harvest. Therefore, applied N requirement for a following corn crop may be less if crop residue is reduced through harvest. Residue removal decreased the economically optimal N rate (EONR) by >11 and >17 lb/ac for no-till and strip till, respectively, in southern Minnesota (Sindelar et al., 2013).

Crop residue harvest often affects the yield of the following crop but the direction of the effect depends on production conditions. When soil water deficits are likely to occur, residue removal may cause reduced yield of the following crop (Wilhelm et al., 2004). Residue removal effects on soil temperature, and thereby on rate of crop development, have been well documented (Sindelar et al., 2013). The interactions between tillage practice, N requirement, and residue removal can be important. In Sindelar et al. (2013) crop residue removal resulted in corn yield increases of 6.5 and 9% for tillage and no-till, respectively. Averaged over 10 cropping seasons, irrigated corn grain yields were 7.5 to 8.6% higher for no-till when corn residue was removed compared with no residue removal, while grain yields were similar under tillage in all residue removal treatments (Schmer et al., 2014). In an analysis of 239 site-years across 36 research sites that were primarily in the US Corn Belt, Karlen et al. (2014) found mean corn yields of 156, 161, and 161 bu/ac with no, moderate and high rates of residue removal. This amounted to a 3% average yield increase with corn residue harvest compared with no corn residue harvest. Corn yield was on average 20% more with no residue removal for tilled compared with no-till management, but there was no tillage effect on grain yield with residue removal.

Therefore, when water is not limiting, crop residue harvest may result in increased yield and less immobilization of applied N. Research was conducted to determine the combined effect of these factors on crop yield and the economically optimal N rate (EONR) for the following corn crop under irrigated, no-till conditions.

MATERIALS AND METHODS

Field research was conducted in 2013 and 2014, with continuous irrigated no-till corn from 2012, at two locations of the Agricultural Research and Development Center (ARDC) and one of the Haskell Agricultural Laboratory (HAL). Residue removal rates were 0 and >75%. Sub-plot treatments were six N rates of 0 to 224 lb/ac at ARDC and 0 to 180 lb/ac at HAL.

Observations included canopy reflection at V9-10 for normalized difference red edge (NDRE; NDRE = (780 nm – 730 nm)/(780 nm + 730 nm)) and normalized difference vegetative index (NDVI; NDVI = (780 nm – 670 nm)/(780 nm + 670 nm)) with a hand carried Rapid Scan (Holland Scientific, Lincoln NE). Grain yield and N uptake were determined.

RESULTS AND DISCUSSION

More N availability at V9-10 with residue removal compared with no removal was indicated by generally higher NDRE and NDVI. Plant N uptake was 22% and applied N recovery was 43% more with residue removal compared with no removal.

Table 1. Crop residue effects on crop canopy reflectance (NDVI and NDRE), N uptake and applied N recovery.

	NDVI	NDRE	N uptake	%N recovery
No removal	0.77	0.32	119	21
Residue removed	0.81	0.35	147	31

Grain yield averaged 160 bu/ac and was on average 20% more with residue removed (Fig. 1). Yield increases varied by site-year from 2.7 to 71% and were greater following the second compared with the first year of residue removal. Responses included linear and curvilinear responses and the yield peak was often not reached. The EONR was determined to be 7 to 21 lb/ac, with a mean of 16 lb/ac, less with residue removal compared with no removal.

The results indicate that applied N immobilization was reduced by corn residue removal as N uptake at V9-10 and at physiological maturing were greater with residual removal. The 20% yield increases due to crop residue removal were greater than the average of 3% increase determined from Karlen et al. (2014). The greater effects on yield in this study may be attributed to lack of soil water deficits with irrigation while in many non-irrigated studies, water deficits with residue removal compared to no removal may have caused more yield reduction (Wilhelm et al. 1986; Varvel et al., 2008). The mean reduction in EONR was only 16 lb/ac N and similar to 12 lb/ac mean reduction in EONR with residue removal determined by Sindelar et al. (2013). However, the effect of residual removal on EONR varied greatly by trial and cannot be well predicted pre-plant. To fully capitalize on this potential to reduce N rates likely will require sidedress N application in response to crop canopy color. Higher corn yield with lower N rates associated with residue removal may not be sustainable in the long term due to total soil N decline.

CONCLUSION

Significant grain yield increase can be expected for irrigated no-till corn following corn by removal of some crop residue. While average applied N recovery and crop N uptake are greater with residue removal and mean EONR is less, there is little justification to adjust the pre-plant N rate due to inadequate predictability of EONR. However, if a significant proportion of N is sidedress applied based on canopy reflectance, mean N application will be reduced by residue removal.

REFERENCES

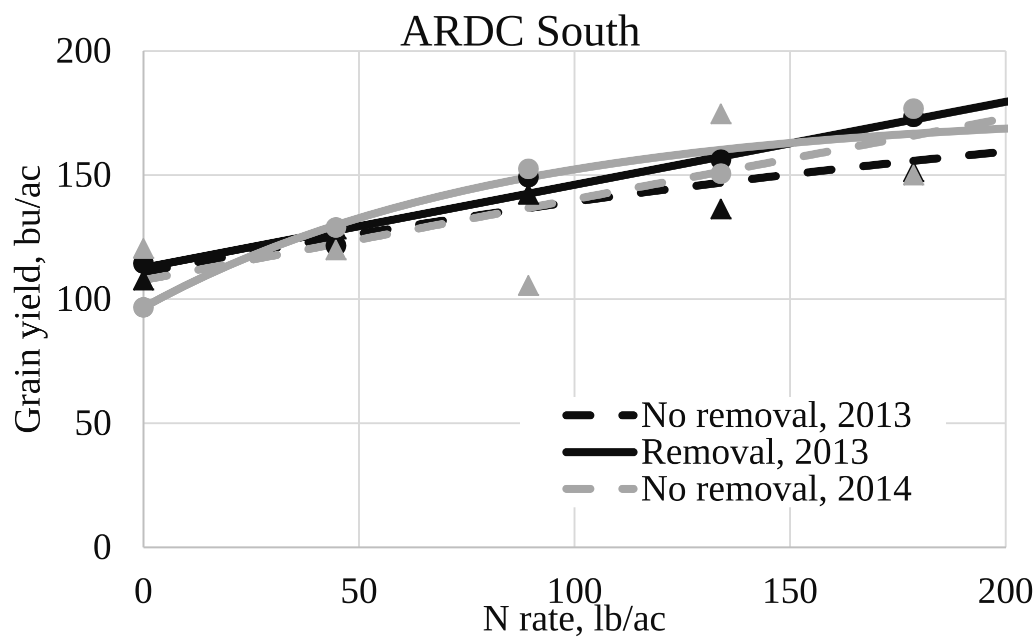
Karlen et al. 2014. Multilocation corn stover harvest effects on crop yields and nutrient removal. Bioenerg. Res. 7:528-539.

Schmer et al. 2014. Tillage and residue management effects on soil carbon and nitrogen under irrigated continuous corn. Soil Sci. Soc. Amer. J. 78:1987-1996.

Sindelar et al. 2013. Agronomic responses of continuous corn to stover, tillage, and nitrogen management. Agron. J. 105:1498-1506.

Varvel et al. 2008. Comparison of corn and switchgrass on marginal soils for bioenergy. Biomass and Bioenergy 32:18–21.
Wilhelm et al. 2004. Crop and soil productivity response to corn residue removal: A literature review. Agron. J. 96:1–17.

Figure 1. Corn grain yield response to applied N, with and without residue removal, at UNL-ARD south and north and Haskell Ag Lab over two years in eastern Nebraska. Residue removal by N rate interaction effects were not significant.



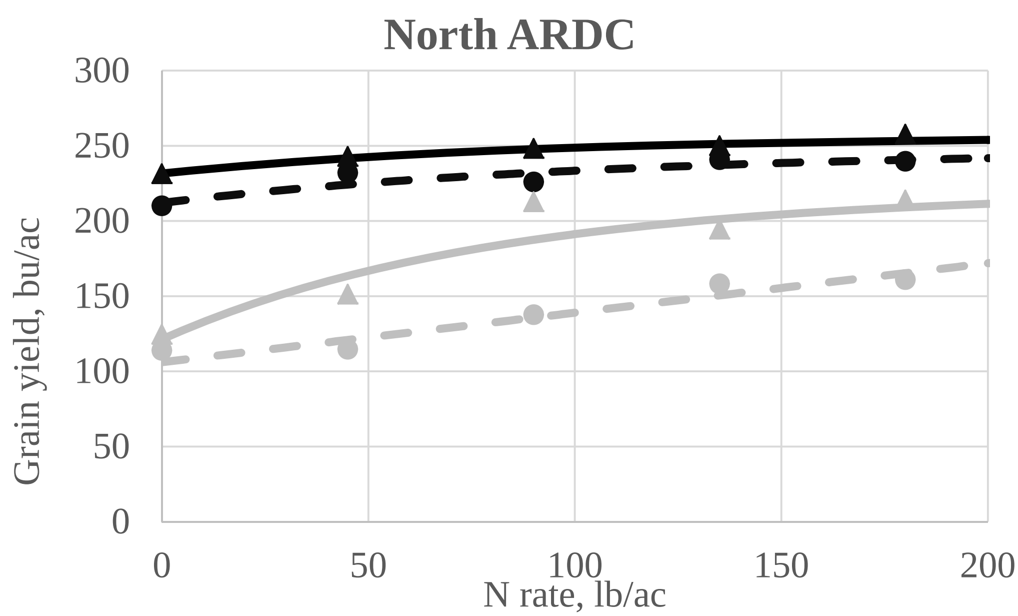
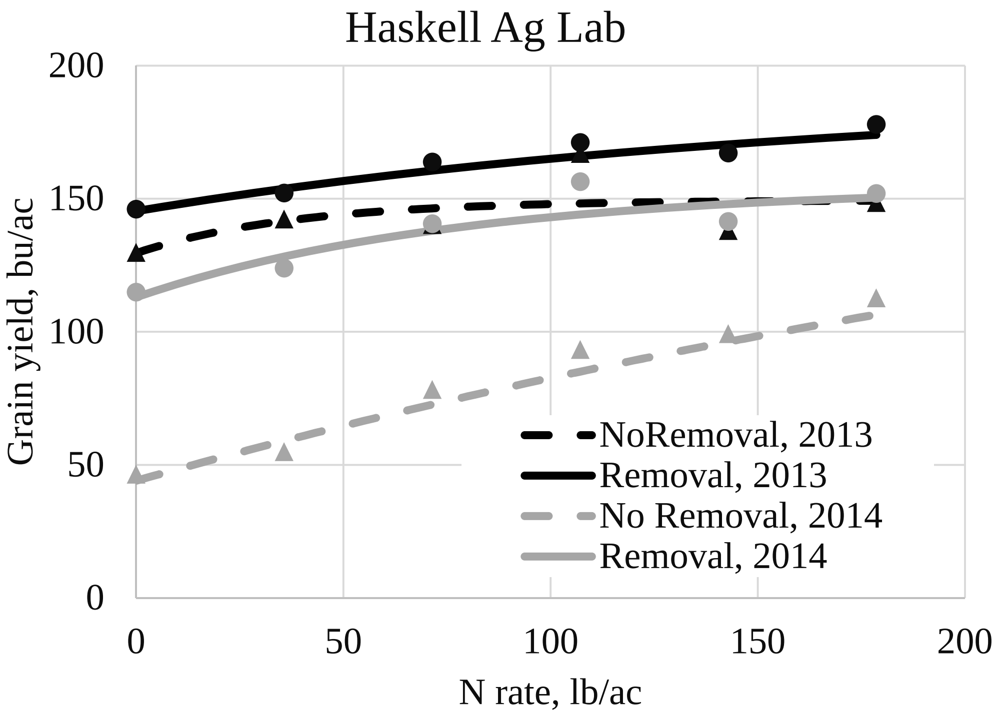


Fig. 1. Continued.



PROCEEDINGS OF THE

45^{th}

NORTH CENTRAL
EXTENSION-INDUSTRY
SOIL FERTILITY CONFERENCE

Volume 31

November 4-5, 2015
Holiday Inn Airport
Des Moines, IA

PROGRAM CHAIR:

John E. Sawyer
Iowa State Univ
Ames, IA 50011
(515) 294-7078
jsawyer@iastate.edu

PUBLISHED BY:

International Plant Nutrition Institute
2301 Research Park Way, Suite 126
Brookings, SD 57006
(605) 692-6280
Web page**: www.IPNI.net**

ON-LINE PROCEEDINGS:

http://extension.agron.iastate.edu/NCE/