HARVEST GRAIN AND CROP RESIDUE YIELD DIFFERENCES IN CROP ROTATION AND RESIDUE MANAGEMENT SYSTEMS IN TILLAGE TRANSITION IN EASTERN SOUTH DAKOTA

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ABSTRACT

A long-term field study was established in Brookings, SD to investigate the impact of crop rotation, tillage, and residue management on grain yield and crop residue production. These results were compiled when this field was undergoing a transition in the influence of two contrasting tillage systems in the first four years of the study. Initial soil test results indicated that the organic matter levels and pH as well as extractable K and orthophosphate-P (0-6") were high. Corn and wheat residue weights were not influenced by tillage, crop rotation, or residue management. Soybean residue was influence by all three main treatment effects, but it may have been due to the influence of the corn residue weight in the no-till plots that accumulated and were considered along with the soybean residue when it was weighed. The amount of corn residue production was much greater than either of the other crops. Soybean grain yield benefited from tillage. Delays in growth were observed in the early part of the growing season in the no-till plots and lack of tillage reduced final yield. Corn grain yield was greater in the corn-soybean-wheat rotation compared to the corn-soybean rotation. Final corn yields were probably influenced by the relatively higher soil moisture levels in corn plots following a 'short-season' crop like wheat compared to corn following a 'full-season' crop like soybean where the profile moisture was relatively more depleted. Under similar growing conditions, growers need not be concerned that the lack of tillage or residue removal may lower corn, wheat, or soybean grain yields or reduce residue production that could be a resource for the biofuels industry.

INTRODUCTION

Several federal and state government organizations are investigating the use of plant products as a renewable fuel source. Crop grains have been used for several years in this regard. There is one soybean crushing/processing plants to extract soybean oil and nine ethanol production plants currently in operation in South Dakota. There is also some interest in surrounding states to use crop residue as a biofuels resource. Farmers will often turn-out livestock to graze on corn stalks or bale crop residue for use as livestock bedding material and emergency feed. Growers would need to know how the impact of residue management, crop rotation, and tillage on the production of crop residue as well as the impact of these practices on grain yield should crop residue become a raw material for the biofuels industry in South Dakota.

MATERIALS AND METHODS

A field in which conventional tillage (chisel plow/disk) was applied for several decades was prepared for a small plot study by soil sampling at the 0-6" and 6-24" increments of depth by field section in 1998. The range in selected soil parameters are provided in Table 1.

Table 1. Mean soil parameters in the rotation study field at Brookings, SD in fall 1998.

Parameter (0-6")	Range
pH (1:1)	7.5 - 8.1
Organic Matter (dry combustion)	2.9 - 5.2 %
Extractable ortho.-P (Olsen P)	23 - 69 mg kg^{-1}
Extractable (NH_4OAc)	211 - 999 mg kg^{-1}

Selected field strips were chisel plowed and disked. The remainder of the field was left untilled. In 1999, spring wheat was planted in the entire field to draw soil N to a low level. In 2000, Corn, soybean and spring wheat was planted with adapted hybrids/varieties with appropriate production practices according to either a corn-soybean, spring wheat-soybean, or corn-soybean-spring wheat rotation scheme where every crop in the rotation was represented. Treatment plot dimensions were 30'x35'. Tillage was arranged in a strip plot format with crop in rotation randomized across tillage strips. All treatments were replicated four times. Grain was harvested after physiological maturity. The crop residue from a 5x30' area of the main treatment plot was raked, weighed, and subsampled for moisture. Residue was returned to half of the plots and the remainder was discarded to set up the residue management treatment for each crop in rotation and tillage treatment.

RESULTS AND DISCUSSION

Residue Weight

Mean soybean residue weights (2000-2003) were significantly affected by tillage, crop rotation and residue management (Table 2). Without tillage, residue accumulated on the soil surface and was not incorporated. The weight of soybean residue from the corn-soybean-wheat rotation was also greater than the corn-soybean or wheat-soybean and wheat-soybean rotation. This was probably more influenced from the weight of corn residue accumulating in the no-till treatment which was greater than the wheat or soybean residue by itself. Corn and wheat residue weights were not influenced by treatment. This is important since it indicates that neither grain or residue yield was impacted regardless of tillage system or when the crop residue was removed.

Table 2. Mean grain yield and crop residue dry weights and relative responses for the crop crotation study in Brookings, SD for 2000-2003.

Treatment Effect	Corn	Soybean	Wheat
	Residue Weight		
	---------------- lbs./a (% Rel. Weight) --------------		
Tillage			
no-till	6609 (80)	3812 (70)	2261 (64)
conv. till (chisel/disk)	6173 (75)	2843 (53)	2111 (63)
LSD $_{(.05)}$	N.S.	**329 (5)**	N.S.
Crop Rotation			
corn-soybean	6303 (77)	3302 (61)	-
wheat-soybean	-	3078 (58)	2068 (59)
corn-soybean-wheat	6484 (78)	3604 (66)	2305 (67)
LSD $_{(.05)}$	N.S.	**340 (6)**	N.S.
Residue Management			
removed	6324 (64)	2940 (55)	2132 (64)
retained	6461 (63)	3710 (68)	2204 (64)
LSD $_{(.05)}$	N.S.	**97 (1)**	N.S.
	Grain Yield		
	---------------- bu./a (% Rel. Yield) ---------------		
Tillage			
no-till	131 (82)	34.9 (76)	50.5 (64)
conv. till (chisel/disk)	129 (79)	36.1 (79)	50.5 (64)
LSD $_{(.05)}$	N.S.	**0.6 (2)**	N.S.
Crop Rotation			
corn-soybean	121 (76)	35.2 (77)	-
wheat-soybean	-	35.2 (77)	50.9 (87)
corn-soybean-wheat	138 (86)	36.3 (79)	50.0 (86)
LSD $_{(.05)}$	**13.9 (9)**	N.S.	N.S.
Residue Management			
removed	129 (81)	35.4 (77)	51.0 (87)
retained	129 (81)	35.6 (78)	50.0 (85)
LSD $_{(.05)}$	N.S.	N.S.	N.S.

- The comparison of crop grain yield or residue means are significant at the 5% level among treatment effect levels for a particular crop if the LSD level is exceeded. The LSD for significant means are bolded.
- N.S. = Not Significant

Grain Yield

The soybean grain yield was increased when tillage was applied compared to no-till. In the early part of the season, corn and soybean growth were accelerated somewhat (data not shown) in tilled plots. The effect of cooler soil temperatures in the spring was mitigated when the ground was tilled. Corn yield increased in the corn-soybean-wheat rotation compared to the corn-soybean rotation. Rainfall was often less than optimal for the month of August during the grain filling period (data not shown). The preceding wheat crop in the corn-soybean-wheat rotation reached physiological maturity in July. The preceding soybean crop in the corn-soybean rotation reached physiological maturity in September. There was probably a higher moisture savings for corn following a wheat crop in the corn-soybean-wheat rotation since there were two months in the summer where a crop was not extracting soil moisture. Higher stored moisture probably accounted for the higher yield in this rotation.

CONCLUSION

Under similar growing conditions and soil type, growers need not be concerned that lack of tillage or residue removal may lower corn or wheat grain yields or reduce residue production that may be used as a raw material in a future biofuels industry.

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