SOIL/WATER RESEARCH
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Crop rotation, tillage method, and crop residue management study at Brookings SD, in 2008. (29708)

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Objective

Compare and contrast nutrient cycling of crop rotations under no-till and conventional tillage systems with and without residue removal.

Materials and Methods

A site located on the "Old Larsen Farm" near Brookings was selected for the rotation study. The soil type at this site is the Divide series. Plots were established in Aug. 1999. Crop rotations established in 2000 were Corn/Soybean, Spring Wheat/Soybean and Corn/Soybean/Spring Wheat. No-till and Conventional tillage blocks were established for each crop rotation. Conventional tillage plots were tilled with a disk/chisel plow and leveled with a disk in November and April, respectively. Residue management plots were included in the plot design for each crop rotation and tillage system as either completely removing all loose residues (residue removal) or leaving the residues in place (residue maintenance). In the residue removal plots all of the loose residues across the whole plot were removed. The plot design is a strip-split-split randomized complete block with four replications. The plot size is 30' x 30'.

Traverse hard red spring wheat was seeded at 1.2 million pure live seeds on April 22, 2008. Nitrogen fertilizer (70 lbs/a) as urea was broadcast applied to the wheat plots on May 16, 2006. Corn (Dekalb 46-22 RR/YGPL) was planted at 30,000 seeds/a on May 5, 2008. Nitrogen (100 lbs/a) was broadcast applied as urea on corn plots on May 16, 2006. Soybeans (Asgrow 1401RR) were planted at 200,000 seeds/a on May 28, 2008. Spring wheat was sprayed with Puma (10 oz/a), Buctril (1 pt/a), and MCPA Ester (1.25oz/a) on June 10, 2008 for weed control. Corn plots were sprayed with Roundup Weather Max (22 oz/a) on May 28 and July 4, 2008. Soybean plots were sprayed with Roundup Weather Max (22 oz/a) on June 16 and July 28, 2008. Soybean plots were sprayed with Hero (5 oz/a) on July 28, 2008 for aphid control. Spring wheat was harvested on Aug. 14, 2008 with a plot combine. Wheat straw was gathered from a 125 ft^2 sub-section of each plot, weighed and a sub-sample obtained for nutrient analysis. Straw was returned to the residue maintenance plots and removed from the residue removal plots on August 15, 2008. Soybeans were harvested on September 30, 2008. Soybean residue was removed on October 3, 2008. Corn was harvested on October 10, 2008. Corn residue was removed on October 20, 2008. Spring wheat and soybean grain proteins as well as soybean grain oil were measure by standard NIR techniques. Dependent variable statistics were computed with SAS.

Results and Discussion

Statistical analysis of data was performed for each crop. Analysis by tillage method and residue management was performed within each crop. Grain yields were very good considering the hot and dry climatic conditions during June, July, and August.

Spring Wheat (Table 1)

ANOVA showed no single source of variation significantly influencing grain yield, protein, or residue weight at the 0.05 significance level. The only significant SOV interaction was residue*rotation for grain protein. ANOVA by each tillage system and residue maintenance level did not show any significant response except for no-till grain protein. ANOVA by residue maintenance did not show any significant response for tillage method. Spring wheat grain yields were very good.

Corn (Table 2)

ANOVA showed that grain yield was not significantly influenced by any single source of variation. The Corn/Soybean/Wheat crop rotation had higher grain yield when compared to the Corn/Soybean rotation, which was similar to 2007. Stored soil moisture probably wasn't an issue for the 2008 growing season since the soil profile was near full capacity from precipitation received during the Fall of 2007 and Spring 2008. Corn yields were low because precipitation was below normal during July, August, and September.

Soybeans (Table 3)

ANOVA showed that tillage method significantly influenced grain protein and crop residue dry weight. Conventional tillage had significantly higher grain protein and residue weights. Soybean grain yields were low because precipitation was below normal during July, August and September.

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Table 1. Spring wheat grain yield and protein as influenced by crop rotation, tillage method, and residue management at Brookings SD, in 2008. (29708)

	Grain @ 13 % moisture		Residue Weight
Source of Variation	Yield	Protein	Dry basis
	---------- Pr>F ----------		
tillage method (till)[1]	0.71	0.27	0.59
residue maintenance (res)[2]	0.84	0.29	0.37
crop rotation (rot)	0.07	0.30	0.23
till * res	0.19	0.27	0.09
till * rot	0.84	0.90	0.54
res * rot	0.31	0.01	0.65
till * rot * res	0.10	0.75	0.30
Tillage Method	bu/a	%	lbs/a
No-till	54.8	12.5	2853
Conventional	53.4	13.1	3037
LSD $_{(.05)}$	NS	NS	NS
Residue Management			
Removed	53.9	13.0	2835
Maintained	54.2	12.7	3056
LSD $_{(.05)}$	NS	NS	NS
Crop Rotation			
Soybean / Wheat	52.5	13.0	2826
Corn / Soybean / Wheat	55.7	12.6	3065
LSD $_{(.05)}$	NS	NS	NS
---------- ANOVA by tillage method ----------			
Conventional Tillage	bu/a	%	lbs/a
Residue Removed	51.6	13.1	2794
Residue Maintained	55.3	13.1	3280
Pr>F	0.36	0.96	0.20
LSD $_{(.05)}$	NS	NS	NS
No-till	bu/a	%	lbs/a
Residue Removed	56.3	12.9	2875
Residue Maintained	53.3	12.2	2831
Pr>F	0.10	0.04	0.79
LSD $_{(.05)}$	NS	0.6	NS
---------- ANOVA by residue maintenance ----------			
Residue Removed	bu/a	%	lbs/a
No-till	56.3	12.9	2875
Conventional	51.6	13.1	2794
Pr>F	0.06	0.52	0.84
LSD $_{(.05)}$	NS	NS	NS
Residue Maintained	bu/a	%	lbs/a
No-till	53.3	12.2	2831
Conventional	55.3	13.1	3280
Pr>F	0.74	0.23	0.19
LSD $_{(.05)}$	NS	NS	NS

[1] conventional or no-till
[2] crop residues removed or maintained
NS = not significant
LSD = least significant difference

Table 2. Corn grain yield and test weight as influenced by crop rotation, tillage method, and residue management at Brookings SD, in 2008. (29708)

Source of Variation	Grain @ 13 % moisture Yield	Residue Weight Dry basis
	---------- Pr>F ----------	
tillage method (till)[1]	0.29	0.96
residue maintenance (res)[2]	0.07	0.52
crop rotation (rot)	0.30	0.87
till * res	0.09	0.87
till * rot	0.67	0.10
res * rot	0.60	0.93
till * rot * res	0.06	0.47
Tillage Method	bu/a	lbs/a
No-till	109.7	3109
Conventional	112.7	3114
LSD $_{(.05)}$	NS	NS
Residue Management		
Removed	116.0	3143
Maintained	106.3	3079
LSD $_{(.05)}$	NS	NS
Crop Rotation		
Corn / Soybean	106.9	3149
Corn / Soybean / Wheat	116.4	3074
LSD $_{(.05)}$	NS	NS
---------- ANOVA by tillage method ----------		
Conventional Tillage	bu/a	lbs/a
Residue Removed	115.5	3174
Residue Maintained	109.9	3054
Pr>F	0.07	0.73
LSD $_{(.05)}$	NS	NS
No-till	bu/a	lbs/a
Residue Removed	116.6	3112
Residue Maintained	102.7	3105
Pr>F	0.07	0.98
LSD $_{(.05)}$	NS	NS
---------- ANOVA by residue maintenance ----------		
Residue Removed	bu/a	lbs/a
No-till	116.6	3112
Conventioanal	115.5	3175
Pr>F	0.77	0.88
LSD $_{(.05)}$	NS	NS
Residue Maintained	bu/a	lbs/a
No-till	102.7	3105
Conventioanal	110.0	3054
Pr>F	0.04	0.85
LSD $_{(.05)}$	6.4	NS

[1] conventional or no-till

[2] crop residues removed or maintained

NS = not significant

Table 3. Soybean grain yield and test weight as influenced by crop rotation, tillage method, and residue management at Brookings SD, in 2008. (29708)

	Grain @ 13 % moisture			Residue Weight
Source of Variation	Yield	Oil	Protein	Dry basis
	---------- Pr>F ----------			
tillage method (till)[1]	0.38	0.78	0.04	0.02
residue maintenance (res)[2]	0.93	0.61	0.21	0.28
crop rotation (rot)	0.42	0.84	0.28	0.18
till * res	0.95	0.05	0.54	0.08
till * rot	0.78	0.54	0.55	0.85
res * rot	0.70	0.28	0.59	0.75
till * rot * res	0.96	0.73	0.89	0.46
Tillage Method	bu/a	%	%	lbs/a
No-till	32.0	16.9	28.6	1245
Conventional	33.2	17.0	29.3	1399
LSD $_{(.05)}$	NS	NS	0.6	117
Residue Management				
Removed	32.5	17.0	29.1	1337
Maintained	32.6	16.9	28.7	1307
LSD $_{(.05)}$	NS	NS	NS	NS
Crop Rotation				
Corn / Soybean	32.0	16.9	28.8	1226
Wheat / Corn / Soybean	33.7	17.0	28.7	1356
Wheat / Soybean	31.9	17.0	29.2	1383
LSD $_{(.05)}$	NS	NS	NS	NS
---------- ANOVA by tillage method ----------				
Conventional Tillage	bu/a	%	%	lbs/a
Residue Removed	33.1	16.9	29.5	1444
Residue Maintained	33.3	16.9	29.0	1354
Pr>F	0.93	0.74	0.28	0.02
LSD $_{(.05)}$	NS	NS	NS	61
No-till	bu/a	%	%	lbs/a
Residue Removed	31.9	17.0	28.7	1230
Residue Maintained	31.9	16.8	28.4	1259
Pr>F	0.99	0.14	0.16	0.54
LSD $_{(.05)}$	NS	NS	NS	NS
---------- ANOVA by residue maintenance ----------				
Residue Removed	bu/a	%	%	lbs/a
No-till	31.9	17.0	28.7	1230
Conventional	33.1	16.9	29.5	1444
Pr>F	0.11	0.62	0.01	0.01
LSD $_{(.05)}$	NS	NS	0.4	136
Residue Maintained	bu/a	%	%	lbs/a
No-till	31.9	16.8	28.4	1259
Conventional	33.3	17.0	29.0	1355
Pr>F	0.59	0.45	0.15	0.12
LSD $_{(.05)}$	NS	NS	NS	NS

[1] conventional or no-till

[2] crop residues removed or maintained

NS = not significant

LSD = least significant difference