Winter Cover Crops in a Corn-Forage Sorghum Rotation in the Great Plains

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INTRODUCTION

In Kansas, winter cover crops may play a role in the development of summer crops for biofuel feedstocks. Harvesting the entire above ground biomass maximizes potential biofuel production but leaves the soil prone to erosion during the winter fallow period. Winter cover crops may facilitate maximum biomass harvest by protecting the soil from wind and water erosion. Little information exists concerning the use of cover crops in Kansas. Therefore, the objective of this research was to determine the effect of two winter cover crops on the growth of two biofuel crops, corn (*Zea mays* L.) and forage sorghum [*Sorghum bicolor* (L.) Moench] in a corn-forage sorghum rotation and in continuous forage sorghum.

MATERIALS AND METHODS

Two locations:

1. Rain-fed, Manhattan, northeastern Kansas, Belvue silt loam, 891 mm average annual precipitation during study period
2. Irrigated, Tribune, western Kansas, Richfield silt loam, 506 mm average annual precipitation during study period, 299 mm average total irrigation applied each year during study period

Crop within rotation treatments (all phases present each year, rotational crop planted in year before data collection, summer crops planted without tillage into standing cover crop treatment residue):

1. Continuous forage sorghum
2. Forage sorghum rotated with corn
3. Corn rotated with forage sorghum

Cover crop treatments (planted after harvest of summer crops in 2010 and 2011, chemically terminated the following springs before planting of the summer biomass crop, residue left in place after termination):

1. Austrian winter pea (*Pisum sativum* var. *arvense* Poir.) in early spring (Figure 1)
2. Winter wheat (*Triticum aestivum* L.) after chemical termination (Figure 2)
3. Fallow control

Nitrogen treatments (applied at planting of summer crops):

1. 0 kg/ha
2. 101 kg/ha

Figure 1. Austrian winter pea cover crop

Figure 2. Winter wheat cover crop

Figure 3. Forage sorghum crop in foreground with corn crop in background at Manhattan, KS location.

Figure 4. Response of corn crop to nitrogen application (without N on left, with N on right).

Experimental design, treatment structure, and statistical analysis:

1. Randomized complete block with four replications
2. Split, split, split plot with Crop-in-rotation whole plots, Cover crop sub-plots, and Nitrogen sub-sub-plots
3. Environments treated as random samples of potential environments where bioenergy cropping systems may be implemented

RESULTS

- No cover crops were planted at Tribune in 2010, so no data were collected at Tribune in 2010.
- Austrian winter pea did not establish a stand in fall 2012 due to late planting date and a dry seedbed. Therefore AWP means in Table 1 represent the average of only three environments.
- Analysis over three (summer crop results) or four (cover crop results) environments indicated no interactions of treatment main effects (crop in rotation, cover crop, nitrogen fertilizer) for any response variable (α = 0.05).

Table 1. Response of summer biomass crops and rotational cover crops to rotation, cover crop, and nitrogen treatments.

	Summer Crop†		Cover Crop‡	
Main Effects	Grain	Stover	Biomass	C:N
Crop in rotation		kg ha^{-1}		ratio
Continuous forage sorghum	5223 b§	16,090 a	1929 a	15.9:1
Rotated forage sorghum	5148 b	15,158 b	1865 a	14.7:1
Rotated corn	7517 a	14,653 b	939 b	14.9:1
Cover Crop				
Austrian Winter Pea	6042 ab¶	15,042	1338 b	13.8:1 b
Winter Wheat	6138 a	15,345	1818 a	16.5:1 a
Fallow	5707 b	15,514		
kg N ha^{-1}				
0	5619 b	14,175 b	1558	15.3:1
101	6306 a	16,426 a	1598	15.0:1

† Average of three site-years: Manhattan, KS, 2010; Manhattan, KS, 2011; and Tribune, KS, 2011.
‡ Average of four site-years: Manhattan, KS, 2011; Manhattan, KS, 2012; Tribune, KS 2011, and Tribune, KS, 2012.
§ Values within a column and main effect group followed by the same letter are not different at α = 0.05.
¶ Mean separations for this response variable within this main effect were made at α = 0.10.

Summer biomass crop response, averaged over three site-years:

- Corn produced the most grain, but the least stover.
- Continuous forage sorghum produced the most stover.
- Grain yields of summer biomass crops were greater following a winter wheat cover crop compared to fallow.
- Stover yields of summer biomass crops were not affected by rotational cover crop.
- Nitrogen fertilizer increased both grain and stover yields regardless of cover crop treatment (Figure 4).

Cover crop response, averaged over four site-years:

- Cover crop dry matter production before rotated corn was roughly half of the production before rotated or continuous forage sorghum because cover crops could grow about one month longer before termination prior to sorghum planting (growth differential of the two summer crops illustrated in Figure 3).
- Austrian winter pea produced less dry matter with a lower C:N than winter wheat, implying more rapid exposure of the soil surface, although the C:N for both cover crops was below the mineralization threshold of approximately 25:1.
- Nitrogen fertilizer applications to the sorghum and corn biomass crops did not influence cover crop dry matter production or C:N.

CONCLUSIONS

- The two winter cover crops, Austrian winter pea and winter wheat, did not reduce stover yields and tended to increase grain yield of the two biofuel crops, forage sorghum and corn. This suggests that cover crops can be used in Kansas to keep the soil from eroding during the winter with no reduction in potential biofuel production from summer crop feedstocks.
- Winter wheat established stands more consistently and produced more dry matter than winter pea, making it (and possibly other winter annual small grains) preferable for providing consistent winter cover to prevent erosion between summer biomass crops.
- Nitrogen management does not appear to be influenced by cover crops in this system in the short term.

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