Soil Analysis after Growth of Winter Cover Crops in a Corn-Forage Sorghum Rotation

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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 erosion. Thus, the objective of this research was to determine the effect of two winter cover crops, winter wheat and winter pea, on the growth of two biofuel crops, corn and forage sorghum. Last year we reported results for the summer crops, i.e., cover crops had no effect on yields of corn or sorghum (Freeman et al., 2014). We also analyzed the soil to see if the cover crops changed the soil properties. In particular we wanted to see if the legume cover crop increased N in the soil. Here we report soil analyses.

MATERIALS AND METHODS

The experiment was carried out at two locations in Kansas: Manhattan and Tribune. In Manhattan, in northeastern Kansas, the experiment was done under rain-fed conditions (884 mm average annual rainfall), where the soil was a Bismarckgrove Kimo complex. This is a complex of two different soils that cannot be distinguished. The Bismarckgrove series is a fine-silty, mixed, superactive, mesic Fluventic Hapludolls. In the 0-18 cm depth, the series is a silt loam and in the 18-51 cm depth the soil is a silty clay loam. The Kimo series is a clayey over loamy, smectitic, mesic Fluvaquentic Hapludolls. In the 0-18 cm depth, the series is a silty clay loam and in the 18-38 cm depth the soil is a silty clay. In Tribune, in western Kansas, the experiment was done under irrigated conditions. Average annual rainfall in Tribune is 443 mm and 299 mm average total irrigation was applied each year during the study period. At Tribune, the soil was a Richfield silt loam (fine, smectitic, mesic Aridic Argiustolls).

There were three rotations, which began in 2009: continuous forage sorghum (*Sorghum bicolor* L. Moench); forage sorghum rotated with corn (*Zea mays* L.); and corn rotated with forage sorghum. The forage sorghum and corn were planted without tillage into the standing cover-crop residue, after the cover crops were planted. The cover crops were planted in the fall after harvest of the summer crops, and they were chemically terminated the following spring before planting of the summer crops. The cover crops were Austrian winter pea (*Pisum sativum* var. *arvense* Poir.) (shown in early spring in Figure 1) and winter wheat (*Triticum aestivum* L.) (shown after chemical termination in Figure 2). There also was a fallow control. There were two nitrogen treatments, applied at planting of the summer crops: 0 kg/ha and 101 kg/ha. No cover crops were planted in Tribune in the fall of 2009 due to equipment constraints. The experiment was a randomized complete block design with four replications. The treatment structure was a split, split, split plot; crops in rotation were the whole plots, cover crops were the sub-plots, and nitrogen rates were the sub-sub plots.

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).

At the time the cover crops were terminated in the springs, the soil was sampled in 2010 and 2011 at Manhattan and in 2011 and 2012 at Tribune. The samples were taken to a depth of 30 cm and were analyzed at the Kansas State University Soil Testing Laboratory for pH, organic matter, nitrogen, and carbon. The pH was determined using a 1:1 ratio of soil to water. Organic matter was determined using the Walkley-Black method. Nitrogen and carbon were determined using a combustion technique (Leco Corp., St. Joseph, MI).

RESULTS

No significant differences among the treatments occurred when the four replications were averaged together. Therefore, all treatments were averaged together. This resulted in 18 values (each of the 18 values was an average of the four replications), and results are shown in Table 1 for Manhattan and Table 2 for Tribune.

Table 1. Soil properties of the 0 to 0.3 m depth zone in sorghum-corn rotations at Manhattan, Kansas. Soil was sampled in the springs of 2010 and 2011 at the time of termination of two cover crops, Austrian winter pea and winter wheat, and before the sorghum or corn was planted. Cover crops were first planted in the fall of 2009. Mean and standard deviation are shown (n = 18).

Soil property	Manhattan, 2010	Manhattan, 2011
pH	5.8±0.6	6.1±0.1
Organic matter, %	0.6±0.2	1.0±0.2
Nitrogen, %	N.D.†	N.D.†
Carbon, %	0.48±0.15	0.72±0.10

† Not detected. Detection limit <0.1% N

Table 2. Soil properties of the 0 to 0.3 m depth zone in sorghum-corn rotations at Tribune, Kansas. Soil was sampled in the springs of 2011 and 2012 at the time of termination of two cover crops, Austrian winter pea and winter wheat, and before the sorghum or corn was planted. Cover crops were first planted in the fall of 2010. Mean and standard deviation are shown (n=18).

Soil property	Tribune, 2011	Tribune, 2012
pH	8.0±0.1	8.1±0.1
Organic matter, %	1.8±0.1	2.1±0.1
Nitrogen, %	0.13±0.01	0.14±0.01
Carbon, %	1.22±0.06	1.28±0.06

Tables 1 and 2 show the change in soil properties after two years of cover crops (2011 in Manhattan and 2012 Tribune). No change in pH and carbon in the soil occurred at either location. At Manhattan in both years of the study, nitrogen in the soil was below detection limits. Organic matter was increased at Tribune, probably because of the larger amounts of residue resulting from irrigation (Freeman, 2014).

CONCLUSION

The two years' growth of the cover crops increased the organic matter in the soil at Tribune, Kansas, but not Manhattan, Kansas, probably because irrigation increased growth of the cover crops at Tribune. After two years of growth of a legume cover crop (Austrian winter pea), nitrogen in the soil was not increased at either location.

REFERENCES

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