EVALUATING THE REMOVAL OF CORN RESIDUE ON CROP PRODUCTION AND SOIL QUALITY

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Abstract

Removal for corn residue as a possible feedstock for the biofuels industry leaves many producers with a number of unanswered questions. These include what impact will this have on the following crop and also the impact on soil quality associated with this practice. A field study was established in 2000 to address these and other questions. Experimental treatments include three corn residue removal levels (low, mid and high); corn harvested for grain and all residue remains on the soil surface, corn harvested for grain, residue racked, baled and removed, and corn removed as silage respectively, all conducted in under no-till soil management. There was no difference in soybean yield following corn residual. Soil organic carbon levels decreased for the high residue removal treatment compared to the low residue removal treatment at all of the sampling depths. Changes in organic carbon from 2000 to 2005 resulted in an increase in soil carbon at all depths for the low residue removal treatment; with the mid and high treatments have a net loss in organic carbon. Although removal of corn residue appears not to have a negative impact on the following crop (soybean) yield in the short run (5 years), there was a negative impact of soil carbon under a no-till situation when residue was removed from the production practice. Additional research is underway to evaluate the impact of residue removal on other measures of soil quality, and also crop mineral nutrition.

Introduction

The production of biofuels is one of the most important aspects of the President's plan to reduce our dependence on imported petroleum products. Producers throughout the corn-belt are prepared to increase production of corn grain, corn stover and other crop necessary to supply adequate feedstocks for the bioethanol industry. However, the economic and environmental impacts associated with this shift within the production systems need to be evaluated.

The long-term success of the biofuels industry is only feasible if sustainable cropping practices are followed. Producers are interested in utilizing crop residue as an additional commodity, but additional information is need on the agronomic importance of these residues. Ensuring we maintain environmental quality so future generations can utilize our natural resources, while supplying the necessary feedstocks. Additional research is needed to understand how these new production systems will impact our natural resources and what agronomic value is contained within the feedstock utilized.

The biofuels industry is providing an additional outlet for producers to market and sell their crop commodities (grain, and residue fractions). In the past producers have been price-takers for their commodities and have been unable to pass along increasing input cost onto consumers for their products (Costantini and Bracceva, 2004). The prospect of utilizing crop residue as a feedstock for ethanol production brings an additional value to their current production system increasing the economical sustainability of the farming operation. The objective of this research is to evaluate the impact of removing corn residue on soil and crop quality.

Materials and Methods

The experiment was established in 2000 at Brookings, SD as a randomized complete block design with three replications. Treatments include three corn residue removal levels (low, mid and high); corn harvested for grain and all residue remains on the soil surface, corn harvested for grain, residue racked, baled and removed, and corn removed as silage respectively. The experiment was conducted under no-till soil management in a two-year corn/soybean rotation with all crops present each year. Nitrogen fertilizer was applied to the corn phase of the rotation in-season based upon soil test recommendations for an 8000 kg ha^{-1} yield goal as ammonium nitrate. Plots were 30 X 30 m with 0.76 m row spacing.

All crops were present each growing season to account for differences in environmental conditions. Initial and annual soil samples were collected and analyzed for various physical and chemical analyses. During the course of the experiment, data collection included environmental characteristics (rainfall, air temperature, etc. using standard techniques), crop emergence and growth (stand counts, phenological development stage, plant biomass production and nutrient concentration), and yield quality (combine harvest with determination of yield, yield components, seed moisture, nutrient concentrations, oil content), soil physical properties (bulk density, aggregate stability), and soil chemical properties (soil organic matter, total nitrogen, inorganic nitrogen, phosphorus and potassium levels).

Soybean yield was estimated by harvesting four rows of each plot using a plot combine. Seed moisture and test weights were determined. Soybean yield was adjusted to 13 % moisture. Seed samples were oven dried at 125^{0}F, ground, and analyzed for N concentration using dry combustion and for oil content using near infrared reflectance spectroscopy. Soil samples are collected each fall following harvested and separated into the following increments (0-7.5, 7.5-15, 15-30, and 30-60 cm). Samples are air dried, and ground to pass a 2 mm sieve. Total N concentration was determined on all samples using dry combustion (Schepers et al., 1989). Data analysis was performed using the GLM procedure in SAS (SAS Institute, 1988).

Results and Discussion

Soybean yield was used as an indication of the impact or residue removal on crop yield and quality, over the duration of the experiment there has not been any significant difference in soybean yield due to the different corn residue removal (data not shown). Changes in soil organic matter levels through the five years of the experiment decreased for the two treatments in which residue was removed with the silage (high) treatment having the largest decrease in soil carbon (Fig 1). Carbon levels were lower in the silage treatment for all years samples were collected (2000, 2003 and 2005) for all three sampling depths (Fig 2-4). Separations between the different reside treatments increase significantly between 2000 and 2005 for the top two depths (Fig 2-3).

Although removal of corn residue appears not to have a negative impact or soybean yield in the short run (5 years), there was a negative impact of soil carbon under a no-till situation when residue was removed from the production practice. Additional research is underway to evaluate the impact of residue removal on other measures of soil quality, and also crop mineral nutrition. In the fall of 2006 research plots were split with one half of the plot receiving a cover crop applied in the corn at tasseling and a cover crop applied to the soybeans at R6 to help decrease the negative impact of residue removal on soil carbon.

References

SAS Institute. 1988. SAS/STAT procedures. Release 6.03 ed. SAS Inst., Cary, NC.

Schepers, J.S., D.D. Francis, and M.T. Tompson. 1989. Simultaneous determination of total C, total N and ^{15}N on soil and plant material. Commun. Soil Sci. Plant Anal. 20:949-959.

Figure 1: Average mean change in soil carbon, by sampling depth. Brookings, SD 2000-2005.

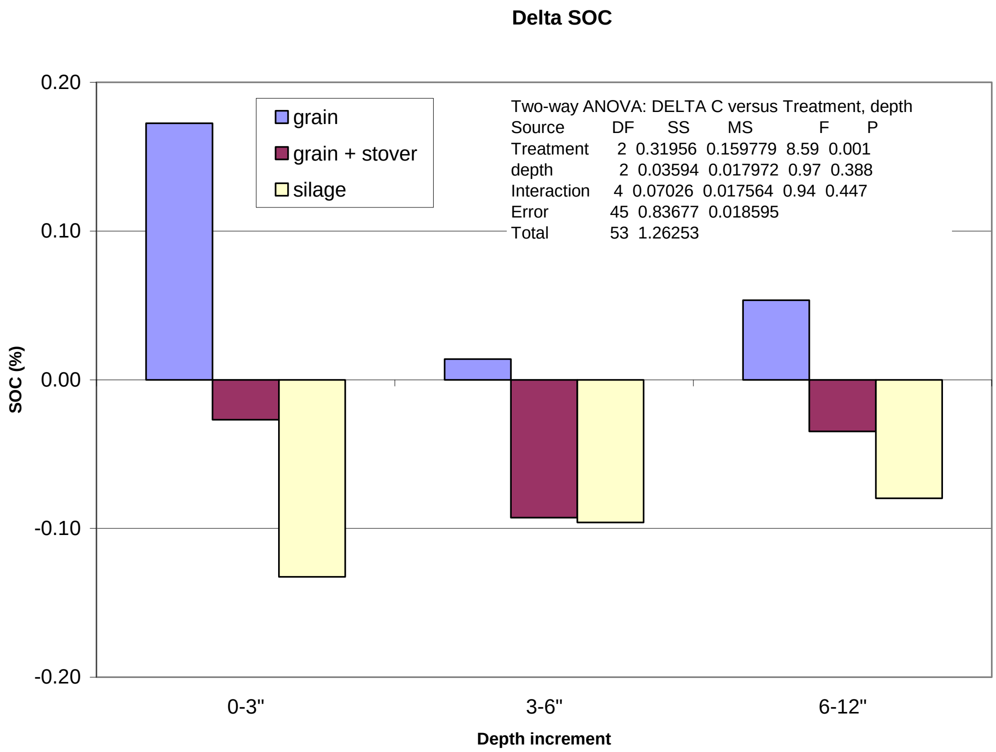


Figure 2: Soil organic carbon, by year and residue management (0-3 in), Brookings, SD.

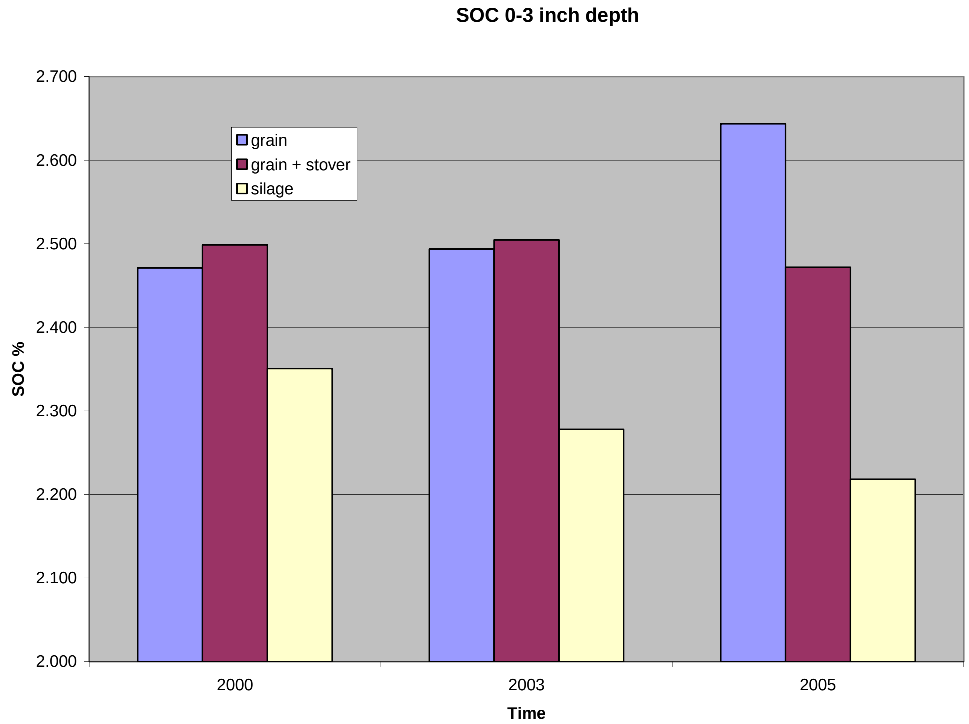


Figure 3: Soil organic carbon, by year and residue management (3-6 in), Brookings, SD.

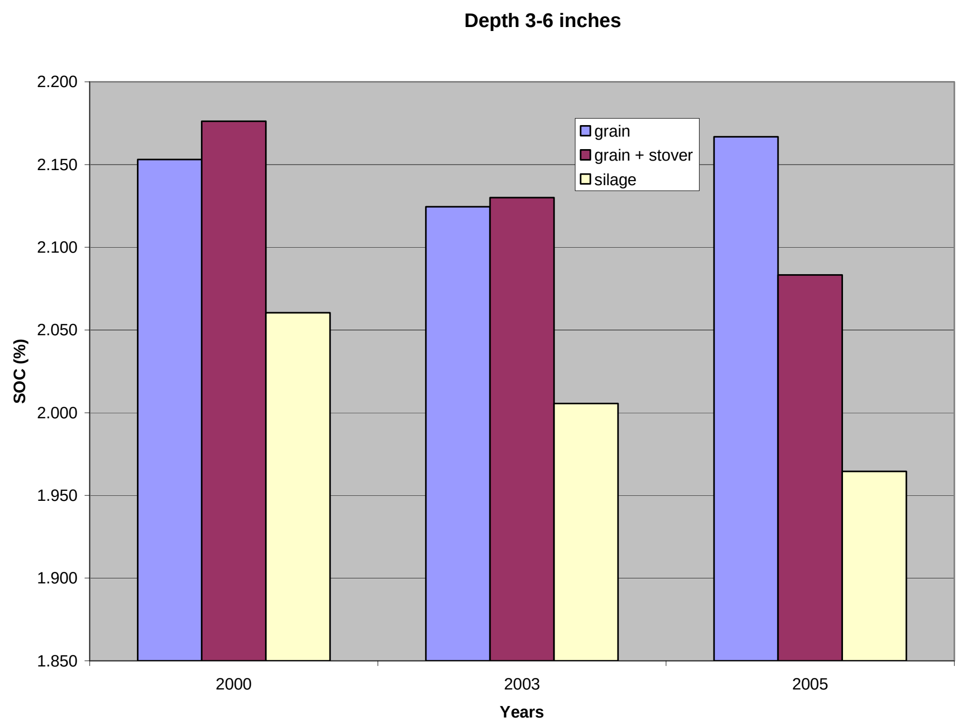
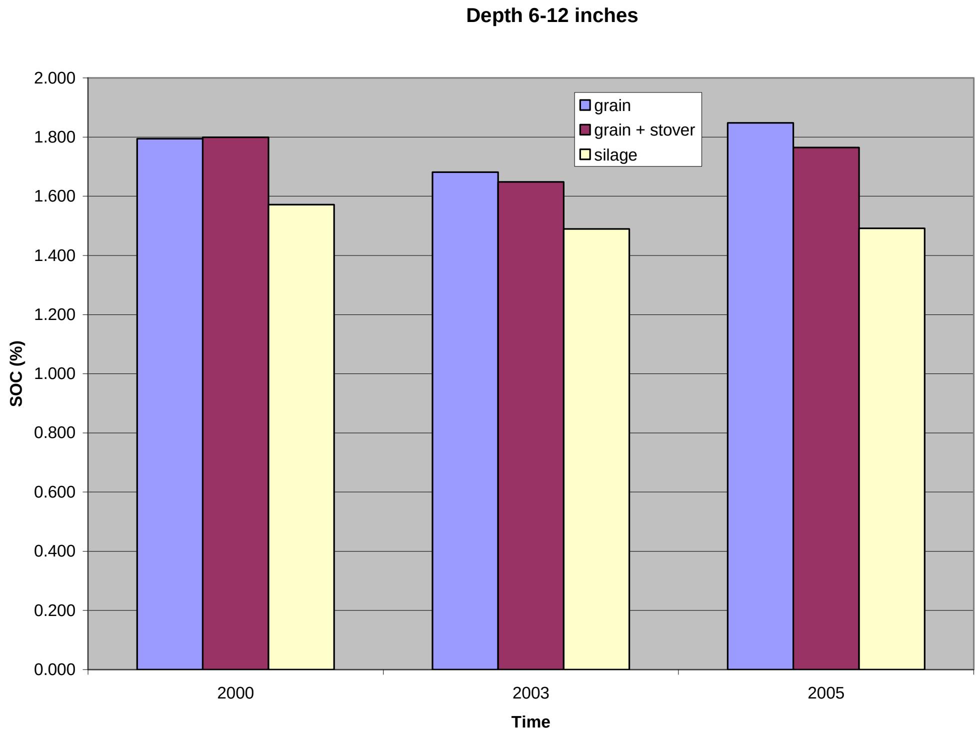


Figure 4: Soil organic carbon, by year and residue management (6-12 in), Brookings, SD.



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