Soil Carbon Levels in Irrigated Western Corn Belt Cropping Systems

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Introduction

Cropping system effects on soil properties provides information necessary to evaluate sustainability of cropping practices and their effect on environment quality. These evaluations are becoming critical given significant increases in petroleum costs and proposals in recent reports for the use of massive amounts of crop residues and other lignocellulosic biomass for biofuel production. Corn residue is presented as a major resource available for biofuel production and is considered essentially a low cost waste material. Any amount of residue above that needed for erosion control was considered sustainably available for removal and use in biofuel production. Later reports have asserted that maintaining soil organic carbon or soil quality may require retention of more stover than that needed to control soil erosion. Our objective was to determine the long-term effects of 3 irrigated cropping systems and their stover production levels on soil organic carbon.

Materials and Methods

An irrigated monoculture corn, monoculture soybean, and soybean-corn cropping systems study was initiated in 1991 on a uniform site in the Platte Valley near Shelton, Nebraska. Four corn hybrids were tested in both monoculture and rotation systems in combination with 5 N fertilizer rates (0, 50, 100, 150, and 200 kg N/ha). A similar approach was utilized for soybean in monoculture and rotation systems. The treatments were replicated 4 times and irrigation was accomplished using a linear drive sprinkler system. Corn and soybean dry matter samples were collected at maturity each year to determine grain, stover, and total dry matter production in each of the cropping systems.

Prior to initiation of the study, the experimental area was grid sampled and various soil properties including soil organic C levels were determined. In 2005, soil samples were taken from all 3 cropping systems to a depth of 30 cm in 0 to 7.5, 7.5 to 15, and 15 to 30 cm increments. Bulk density was determined for all samples. All samples were air-dried, ground to pass a 2 mm screen, and then analyzed for total C using an automatic C analyzer. Total soil C was calculated for each depth using the specific bulk density value for that sample.

Soil C data were analyzed both within and across cropping systems using regression analyses.

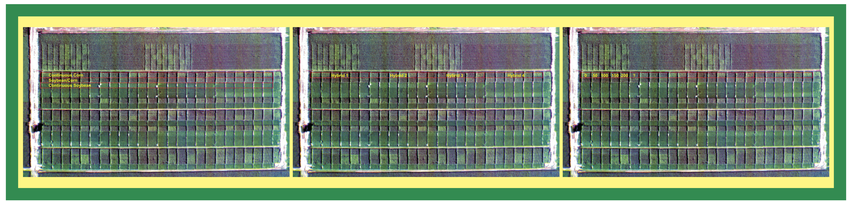


Fig 1.

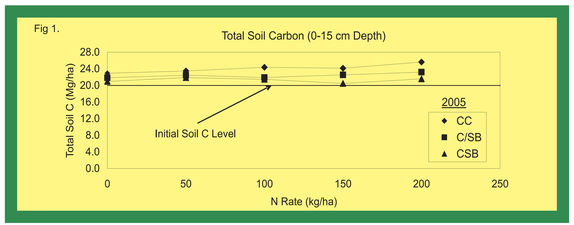
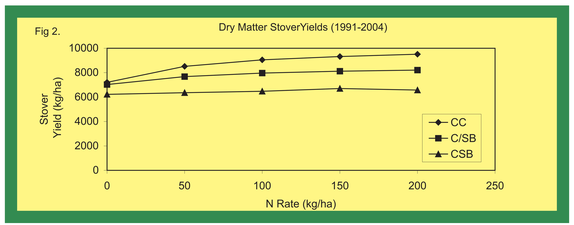


Fig 2.



Results

There were significant differences in SOC values between rotations at all depths and between N rates at the 0 to 7.5 and 0 to 15 cm depths. To better understand the effects of these cropping systems and N fertilizer treatments on SOC, total SOC values for the 0 to 7.5 and 7.5 to 15 cm depths were summed to examine the effects in only the 0 to 15 cm depth where most of the significant changes had occurred (Fig. 1).Total SOC results for samples taken in 2005 from the study are compared in Fig. 1 to those obtained from grid samples from the entire experimental area in 1991 prior to initiation of the experiment (0 to 15 cm depth) . Over the duration of our study (1991 to 2005), SOC levels in the 0 to 15 cm depth have remained the same or increased, depending on the management system (Fig. 1).

Discussion

The above results were somewhat unexpected, especially in the continuous soybean cropping system. Earlier reports from other locations have shown decreases in SOC levels in continuous soybean cropping systems. Why have SOC levels either remained at prestudy levels or increased after 14 years at this location depending on cropping system? Since total dry matter samples were collected over the years from both corn and soybean in each cropping system, we determined the amount of above ground dry matter that was being returned to the soil in each cropping system. The average amount of residue returned to each of the cropping systems over the period is shown in Fig. 2. As would be expected, the amount of residue produced was greatest for continuous corn>soybean-corn>continuous soybean cropping systems (Fig. 2).

Our results provide additional data that can be used to evaluate the effects of aboveground residue on SOC levels over an extended period of time in a tilled study. It is evident that greater amounts of residue are produced in irrigated studies and at these levels of production, SOC levels have been maintained or even increased in certain cropping systems (Fig. 1). It is not clear as to whether increases in SOC also equate to significant increases in soil quality and production.