

Effects of Tillage System on Corn and Soybean Production

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Introduction

Producers are concerned about the differences among tillage systems and how these affect corn and soybean production and profitability. The variation among modern tillage systems often causes confusion in terms of what factor is affected within the production system. There is also interest in being able to compare the effects of the different tillage systems across a wide range of soils and climates within Iowa. A study funded by IDALS in cooperation with HSTL is conducting a series of studies across Iowa at 10 sites to compare four different tillage systems on 1) changes in soil properties; 2) crop performance and economic return; 3) the response of local producers in each region to the study results; and 4) the potential behavioral change in producers in each region in terms of changing tillage practices that will increase profit and improve environmental quality.

Materials and Methods

The experimental layout at each site was similar with the four tillage systems—fall-chisel, fall-strip, spring-tillage, and spring-strip—planted in a minimum of 16 row lengths across the field. Corn and soybean were planted at each site each year, and the rotation was back into the tillage system. Measurements for each site provide a statewide data base on tillage system performance and provide producers with information useful to other soil-climate zones. At the onset of the project (Fall 2001) soil characteristics (e.g, soil carbon, nitrogen, pH, CEC, Ca/Mg ratio, depth of topsoil, wet and dry aggregate stability) were measured for each plot area within each site. The depth of the soil samples was 1.5 m and the cores were divided into depth increments representative for each

soil. Sampling locations were located with GPS equipment in order to sample near the same area throughout the experiment. These data are being used to evaluate the spatial variation across the site and within each plot prior to initiating tillage systems.

During this study, measurements will be made of the soil characteristics in the fall and spring for each plot at each site. Within the strip tillage systems, soil sampling protocols change to provide an estimate of the strip versus non-strip area to determine any differences being developed due to strip tillage. Visual estimation of relative surface runoff or erosion are made for each plot throughout the year.

Agronomic samples for each tillage practice compare planting conditions, emergence, and variability of emergence in each tillage practice. Days to achieve complete ground cover are measured by determining the number of days for the corn or soybean crop to completely shade the ground measured by weekly observations of percentage of ground cover. As a comparison of nutrient availability, leaf chlorophyll measurements are made with a leaf chlorophyll meter (SPAD meter) prior to tasseling and at the onset of grain-filling in corn. Grain yield for each tillage practice will be determined using a weigh wagon to relate these yields to producer practices in connection to yield monitor data on the combine. At harvest, an estimate of lodged plants will be recorded. These same protocols will be used for the corn and soybean crops. Records on the input and labor costs for each plot provide a database for economic comparisons of each tillage system.

Detailed microclimatic parameters for each tillage system are measured throughout the year. These parameters document the effect of various tillage systems on soil temperature and soil

water differences in the seed zone and the upper rooting profile. Soil temperatures will be measured with thermocouples placed in the upper soil profile at 1, 2, 5, 10, 25, and 50 inches. Soil water will be measured in the root zone. Soil water content in the seed zone will be measured with a hand-held unit on the day of planting for each site for the purpose of documenting differences in tillage practices on seed zone water content. At each site, a weather station will be deployed to record atmospheric data (air temperature, relative humidity, windspeed, wind direction, solar radiation, and precipitation) for each day.

In response to concerns expressed by producers, an additional study was conducted at the Kelley Farm site to compare the performance of eight corn hybrids and eight soybean cultivars with the fall-strip and spring-strip tillage systems. The genetic material was selected by the producers involved in the study to provide a range of potential responses to tillage systems.

Results and Discussion

Data through the 2003 growing season are the result of the first 2 years of a 3-year study, and the change in the tillage systems from the conventional practice of fall-chisel to the various tillage systems is beginning to be observed in the plant growth and yield responses. There were no significant differences in yield for the 2002 trials among the four tillage systems in either corn or soybean. In 2003 there were no differences among the four tillage systems for the soybean yield; however, the fall-chisel (146 bushels/acre) and spring-tillage (142 bushels/acre) systems had significantly higher corn yields compared with the fall-strip (130 bushels/acre) and spring-strip (119 bushels/acre). One of the reasons for these differences in yield among tillage systems was the precipitation pattern received in the spring of 2003. Across the state, rainfall patterns have a significant effect on the response of corn and soybean to tillage systems and ensure that a

single year precipitation pattern is not the dominant factor.

Yield differences among corn hybrids and tillage systems showed a significant hybrid by tillage interaction. This was due to one hybrid that had a reduced yield of 50 bushels/acre caused by poor root development early in the growing season. However, when the 2002 and 2003 data are combined there is no tillage by hybrid interaction showing the yearly effect of rainfall pattern. In the soybean cultivars, there was a 15 bushels/acre difference in yield from the highest to lowest yielding cultivars. These differences were not consistent within the 2 years of the study, making it difficult to quantify the effect of tillage systems. The response of genetic material to tillage and the interaction with rainfall would suggest that a minimum 5-year study be conducted to account for the yearly variation in rainfall patterns.

These studies at the Kelley farm are part of intensive field studies to document the changes in soil carbon, soil water, and nitrogen dynamics in the tillage systems. Intensive measurements of the soil carbon exchange and plant uptake patterns of carbon and nitrogen across the tillage systems are part of the program to understand how changing tillage may influence carbon storage in soils.

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