CONSERVATION TILLAGE RESEARCH IN TEXAS

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INTRODUCTION

The agricultural diversity across Texas is indicative of widely varying precipitation, temperature and soils. Average annual precipitation ranges from 18 to 51 inches from west to east. The number of frost-free days range from 180 at Amarillo in the Texas Panhandle to 346 at Brownsville in the Rio Grande Valley. This produces a wide variety of farming systems from a continuous winter wheat and summer fallow rotation in semi-arid West Texas to double cropping rotations of corn, cotton or sorghum with winter vegetables (lettuce, onion, carrots, etc.) in the Rio Grande Valley and creates a heterogenity in our tillage and cultural practices.

Research programs in Texas concerning conservation tillage farming systems reflect the climatic and edaphic variability in the state. Fourteen scientists from the Texas Agricultural Experiment Station, Texas A&M University System, or USDA-Agricultural Research Service have ongoing studies to improve soil-tillage farming practices for optimum crop productivity. Research topics receiving prominent attention in Texas are: soil compaction, soil erosion and residue management, methods to increase plant available soil water, fertilizer use efficiency and plant nutrition, and weed competition and control methods. Descriptions and results of ongoing studies are given below. Footnotes are used to identify the research activity with the respective scientist, location and research agency.

Soil Water Conservation. Tillage methods that increase rainfall catchment and infiltration and reduce soil evaporation are being investigated. Studies at Corpus Christi conducted during a 7 year period on a clay soil demonstrated significant difference in rainfall catchment with regards to the type of primary tillage performed (8). Soil water infiltration rates were greater for soil treated with a chisel or moldboard plow when compared to reduced tillage or no-tillage. However, soil water contents during the peak crop demand period (April-May) were not different among tillage methods during each of the 7 years. Grain yields of sorghum were not different between tillage methods when rainfall was adequate, but were significantly greater for no-tillage or reduced tillage when soil moisture was limited.

In semi-arid West Texas, cropping systems using no-tillage were found to increase soil water contents and grain yield of sorghum compared to methods requiring tillage on clay and loamy soils (7,12). Yields for 8 crop years averaged 3,150 and 2,190 pounds per acre for no-tillage and disk tillage, respectively. Yields of sunflower and corn were also greater under no-tillage, but yield differences were not as great as that of sorghum (12). On a weakly structured sandy loam soil, yields of cotton and grain sorghum were not different between reduced and conventional tillage methods in irrigated or rainfed situations for the last 4 years (1,11). However, yields of reduced till irrigated wheat were slightly but significantly reduced 1 out of 4 years, whereas yields of reduced till dryland wheat were slightly but significantly reduced 2 out of the 4 years (1).

Micro-catchment (furrow dikes) construction to reduce water runoff has been reported to increase sorghum and cotton yields in the semi-arid regions of Texas (4, 10). In 1981 and 1982, conventional tillage yields increased 32 and 108% by furrow diking cotton and sorghum, respectively. Furrow dikes in 1985 increased cotton and sorghum yields 11 and 14%, respectively. Combination of furrow dikes with reduced tillage practices are in the process of being investigated.

Soil Fertility. Studies are being conducted to determine the effects of tillage and cropping sequence on yield and nitrogen use efficiency of grain sorghum, wheat, soybean and cotton (2,5,6,8,9). On coarse-textured soils, significant tillage x nitrogen rate interactions occurred for yields of wheat and grain sorghum (6). For wheat, conventional tillage produced higher grain yields at lower N application rates whereas no-tillage had the highest yield at the largest N rate. No-tillage grain sorghum yields, however, were decreased at lower N rates compared to conventional tillage treatments at the higher N rates. On a fine-textured clay soil, grain sorghum yields were found to be generally higher, though not always statistically significant, for conventional tillage compared to no-tillage for any given N application rate (2,5,9).

Significant cropping sequence x N-rate interaction has been found for winter wheat (6). Continuous wheat produced higher grain yield than wheat in a sorghum-wheat-soybean rotation at the low N rates whereas wheat grown in the rotation had the highest yield at the higher N rates. Wheat yields in a wheat-soybean double crop rotation produced lower yields than continuous wheat at all N rates.

The use of winter annual legumes as a nitrogen source in double crop sequence with grain sorghum was investigated. Grain sorghum following a green manure treatment of sub-clover outyielded no-tillage treatments where clover residues remained on the surface and conventional tillage which had no clover but received N fertilizer (60 kg/ha). Decomposition of clover residues on the soil surface may be too slow to meet the N demands of sorghum. Studies indicate that rainfall levels and chemicals (glyphosate) applied to eliminate competition between a crop like sorghum and the winter legume significantly affect the rate of decomposition and nitrogen release from the legume residue (2,5,9).

Soil Compaction. Soil structural properties related to conservation and conventional tillage have been studied for varied soil textures (3,4,13). Results indicate that antecedent soil moisture significantly affected the saturated hydraulic conductivity of sandy 1oam soils (14). Slow soil drying resulting from low air temperature (25°C) or straw mulch increased the soil strength and bulk density. Incorporated residues, however, reduced bulk density and increased organic matter content (4). Although conservation tillage can reduce evaporation and increase moisture storage, these properties also modify the structure of the fragile soils and may contribute to reduced plant growth and crop yields (3,4,13).

Soil structural deterioration from wheel compaction can adversely affect root growth and crop development. Because of the concern of compaction, this research was conducted to determine the effect of controlled traffic lanes on soil physical properties and crop rooting for no-tillage and conventional tillage cropping systems on a swelling clay soil (2,5,9). Soil strength, bulk density and total porosity were not different between tillage treatments in areas not trafficked during the crop growing season. In areas subject to wheel traffick during the crop growing season, soil strength and bulk density were higher for the no-tillage treatments. Both soil strength and bulk density in the areas where wheel traffic was confined reached values reported to inhibit root growth to the 0.15 m depth. Measured crop rooting densities were not different with respect to the presence or absence of wheel traffic or tillage treatment. The data suggest that soil moisture and nutrients in controlled-traffic lanes will be available for crop use.

Weed Control. The herbicides AAtrex (atrazine), Milogard (propazine), Bladex (cyanazine), Cotoran (fluometuron), Igran (terbutryn), Glean (chlorsulfuron), Ally (metsulfuron) and Treflan (trifluralin) were evaluated with respect to tillage for herbicide toxicity and persistance (14). Available results do not give a clear indication of whether no-tillage affects herbicide toxicity and persistence. In a 1984 dryland sorghum stubble study, weed control was best after incorporation and poorest when herbicides were applied on bare soil. No-tillage results were intermediate. Herbicides persisted longest following incorporation. In a 1984 wheat stubble study, spraying herbicides on bare soil gave the best weed control and the herbicides persisted the longest. In a 1985 dryland wheat stubble study, control of volunteer wheat was equally effective between no-tillage and conventional tillage, but control was reduced when herbicides were sprayed on bare soil without incorporation. In contrast, results on sorghum stubble were just opposite of results obtained on wheat stubble in 1985. Control and persistence with Glean and Ally were approximately the same with no-till ore bare soil. This did not hold true for Treflan and AAtrex because they gave poor control and did not persist under no-tillage. Irrigation immediately after application did not effect initial toxicity or persistence of the herbicides in the soil even though it did not rain on the dryland part of the study for two months. At 0.012 lb/A, Glean and Ally persisted longer than AAtrex at 1.5 lb/A or Treflan at 0.75 lb/A regardless of the method of incorporation method. Soil samples evaluated in the greenhouse indicated that Glean and Ally leached into the 3 to 6 inch soil depth. Other herbicides remained in the 0 to 3 inch depth.

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