CONSERVATION VS CONVENTIONAL TILLAGE, FALL DOUBLE CROPPING AND COVER CROP EFFECTS ON CROP WATER USE IN SUBTROPICAL SOUTH TEXAS

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ABSTRACT

Water for irrigation is becoming increasingly restricted, and production costs continue to rise in subtropical South Texas. Conservation tillage offers potential advantages in both areas, but requires effort to implement successfully. A study is currently underway in the Lower Rio Grande Valley to compare conservation vs conventional tillage and to evaluate fall double cropping and cover crops compared to fall fallow under conservation tillage. The cropping program being used is a cotton / sorghum biannual rotation. Soil water loss is reduced somewhat when crop residues are retained on the soil surface, but in-season crop water use by a spring crop is not affected by tillage method. In the fall, double cropping and cover crops withdraw significant water from the soil compared to fallow. In a single year, cotton yields were not affected by tillage method, but were lower following a fall double crop or cover crop compared to fall fallow. Grain sorghum production showed some improvement due to conservation tillage compared to conventional tillage for both fall fallow and fall double crop, but for an unknown reason, not for fall cover crop. Soil organic matter content has risen from 0.8% to 1.17% over a 4 year period, but shows no affect due to the cropping treatments applied. Some water savings have been found for conservation tillage, but the effects are not great and depend on rainfall patterns. Planting and weed control are major challenges, but substantial reductions in cost can be achieved.

INTRODUCTION

Water availability for irrigation has become a major concern for South Texas. Conservation tillage offers the advantage of reduced field operations compared to conventional tillage which should result in lower costs, better yields and reduced risk (Ribera et al., 2004; Smart & Bradford, 1999). Water loss is reduced, soil structure improves (Wright & Hons, 2005), and oxidation of organic residues is not as rapid (Salinas-Garcia et al., 1997) as tillage is reduced. Hopefully this will result more efficient water use as well as lower costs. No studies, however have thus far reported any water savings due to reduced tillage, and Licht & Al-Kaisi (2005) reported that soil moisture storage and crop water use efficiency were not affected by tillage system in Iowa. Double cropping and cover crops offer the potential to increase organic matter accumulation improving soil properties, but will increase initial water requirements. Planting and weed control are major challenges for implementing conservation tillage. The objective of this study is to compare conservation vs conventional tillage, and also to evaluate fall double cropping and cool season cover crops compared to fall fallow under conservation tillage.

MATERIALS AND METHODS

The study is being conducted in Lower Rio Grande Valley of Texas, an area with a climate that is subtropical (average daily temperature ranges from a high of 84°F in July to a low of 60°F in January), and semiarid (average annual rainfall <24 in.). A biannual cotton sorghum rotation is being grown, and four cropping treatments are being applied: 1) conventional tillage - fall fallow; 2) conservation tillage - fall fallow; 3) conservation tillage - fall double crop; 4) conservation tillage - fall cover crop. The double crops are corn following cotton, and soybean following sorghum; and the cover crops are black oats following cotton, and hairy vetch following sorghum. Spring crops are being furrow irrigated as required, and fall crops are being grown without irrigation. Treatments are being applied in plots16 rows wide spaced 40 in. apart by 150 ft in length, and are replicated 4 times in a randomized block design. The study was initiated in the fall of 2002 and is currently in the 4th spring crop, which will be the completion of the 2-year rotation for the 2nd time.

Conventional tillage consists of shredding following crop harvest, disking several times, deep chisseling in 2 directions, disking several times again, then bedding up the land. The field is cultivated as required to control any weeds until the next crop is planted, and as the crop is grown. Conservation tillage attempts to leave previous crop residues on the soil surface as long as possible, and to reduce tillage operations. Cultivation is typically performed prior to any furrow irrigation in order to maintain raised beds to facilitate furrow irrigation. Weed control is performed using herbicides.

Parameters being measured include various crop responses, irrigation requirements and changes in soil properties. Data was analyzed statistically using analysis of variance and mean comparisons using Duncan's multiple range test.

RESULTS AND DISCUSSION

The primary differences in soil water use between the tillage & cropping treatments in this study occurred during the fallow periods due to differences in the cover that was left on the soil surface, and in the fall due to differences in water use by the crop being grown (Fig. 1). Water use by the spring crops was affected only slightly by tillage and soil cover, cotton using between 30.6 and 32.4 inches and sorghum using between 17.6 and 18.5 inches of water. Water loss during the fallow periods was reduced 25% by the retention of crop residue on the surface.

Where no fall crop was grown, conservation tillage resulted in an average 11.5% reduction in water use compared to conventional tillage. The fall cover crops used an average 11.3 inches of additional water, but over half of that was recovered through savings from the reduced water loss due to the surface residue. Fall double crops use an additional 15 to 24 inches of water. Only about a third of this is recovered by reduced losses due to the crop residues. These differences are reflected in the amount of irrigation water required to furrow irrigate the cropping treatments the following spring (Fig. 2).

Cotton yields were not significantly affected by conservation tillage compared to conventional when left fallow in the fall, but both fall double cropping and a cover crop reduced cotton yields (Fig. 3). Grain sorghum production showed some improvement due to conservation tillage compared to conventional tillage for both fall fallow and fall double crop, but for an unknown reason, not for fall cover crop (Fig. 4).

Soil NO_3^--N levels measured in January were highest for fall fallow (conservation and conventional tillage) compared to fall double cropping and cover crops, which may reflect immobilization of soil N by the fall crop (Fig. 5). Soil N availability has been reported in other studies to be reduced by plant additions in the short term but enhanced in the long term (Franzleubbers et al., 1995). Organic matter contents rose from 0.8% at the initiation of this study to 1.17% after 3 years, but show no statistically significant differences due to the tillage treatments applied. Other studies have reported increases in organic C particularly near the surface at some point in time under no-till (Franzluebbers et al., 1995; Salinas-Garcia et al., 1997; Wright & Hons, 2005), but no increase in organic matter levels have been reported for any reduced tillage system that involves at least some tillage.

CONCLUSIONS

Conservation tillage in subtropical South Texas offers advantages over conventional tillage, but also poses significant challenges. New procedures and equipment modifications are required. Planting and weed control are difficult, but adequate yields can be maintained. Water savings are erratic depending on rainfall pattern, but improved soil moisture status at any given time would improve the changes of making a crop when drought conditions occur. Differences in soil water status so far have been due only to crop and surface residues, and not due to any long term changes in soil properties. Substantially lower costs, however, due to fewer field operations would be a definite benefit of conservation tillage.

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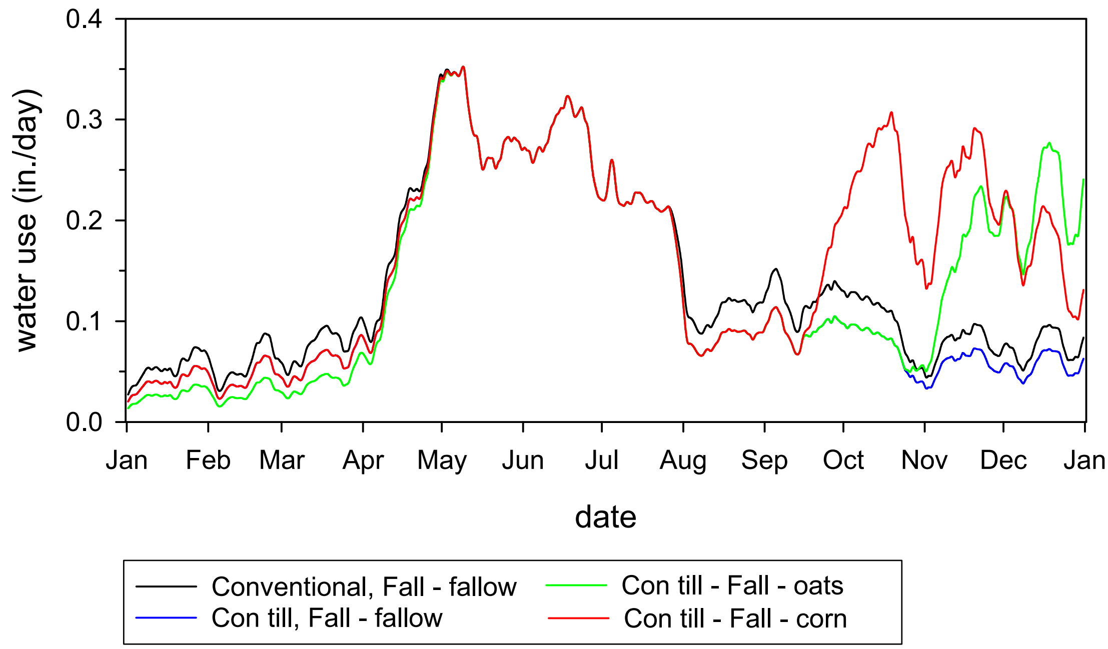

Figure 1. Daily crop water use based on evapotranspiration for the 4 cropping treatments in the cotton – corn/oats year.

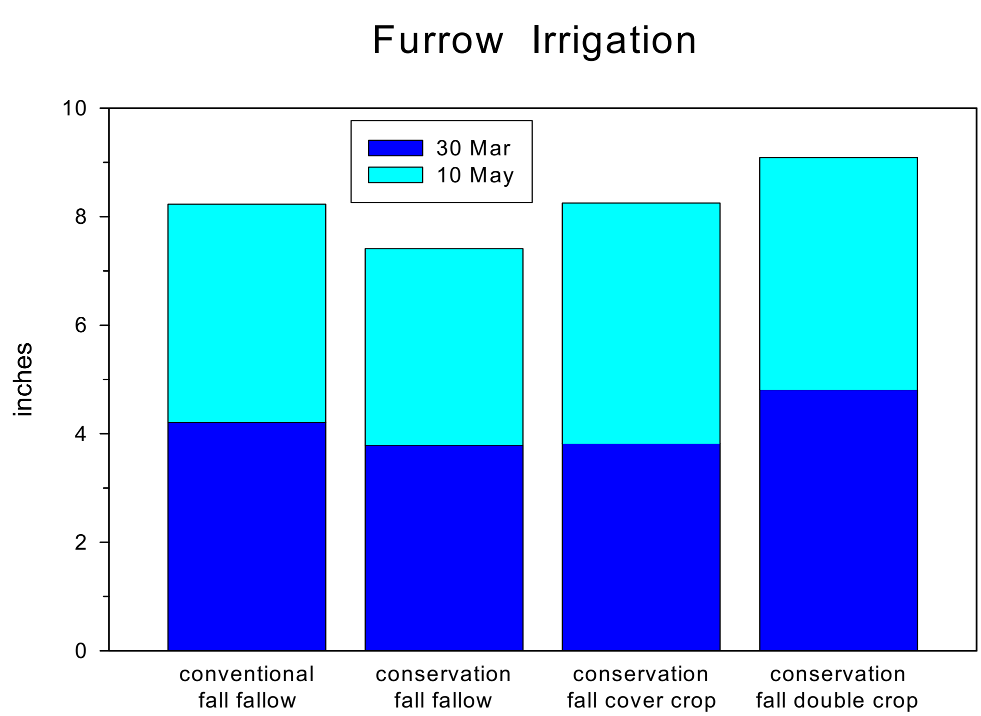

Figure 2. Amount of irrigation water applied to the 4 cropping treatments on 2 dates.

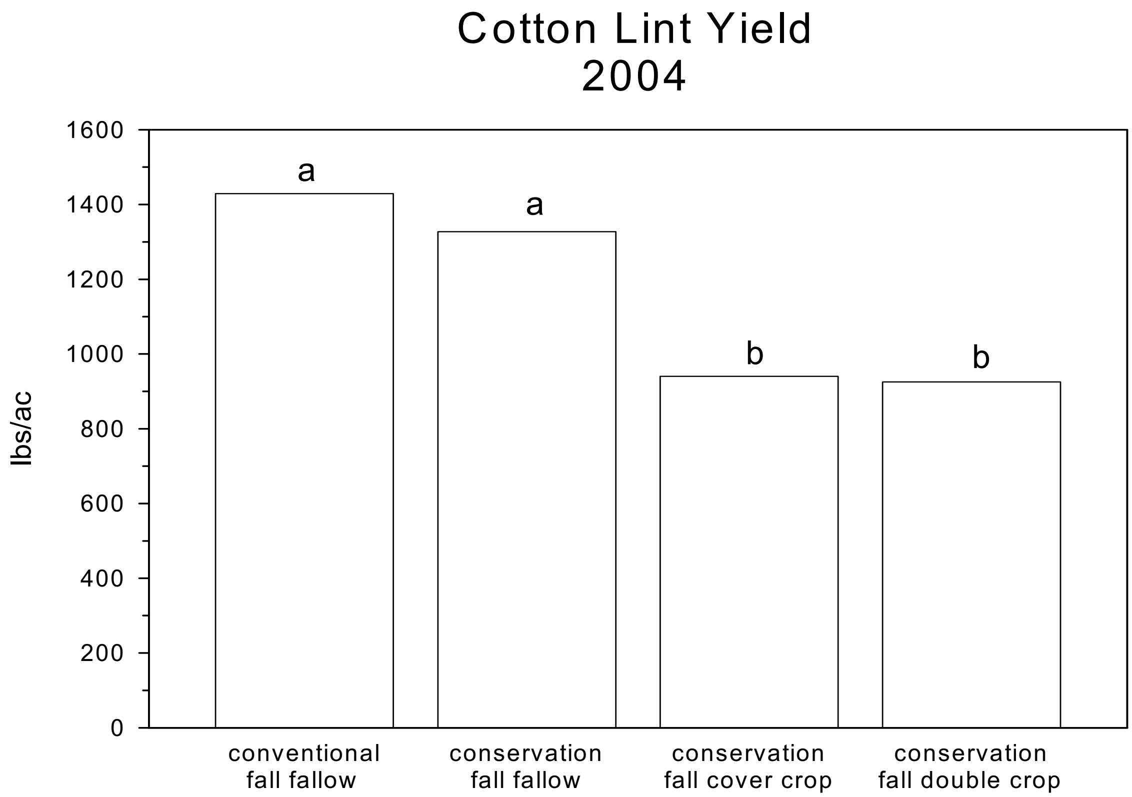

Figure 3. Cotton yields for the 4 cropping treatments.

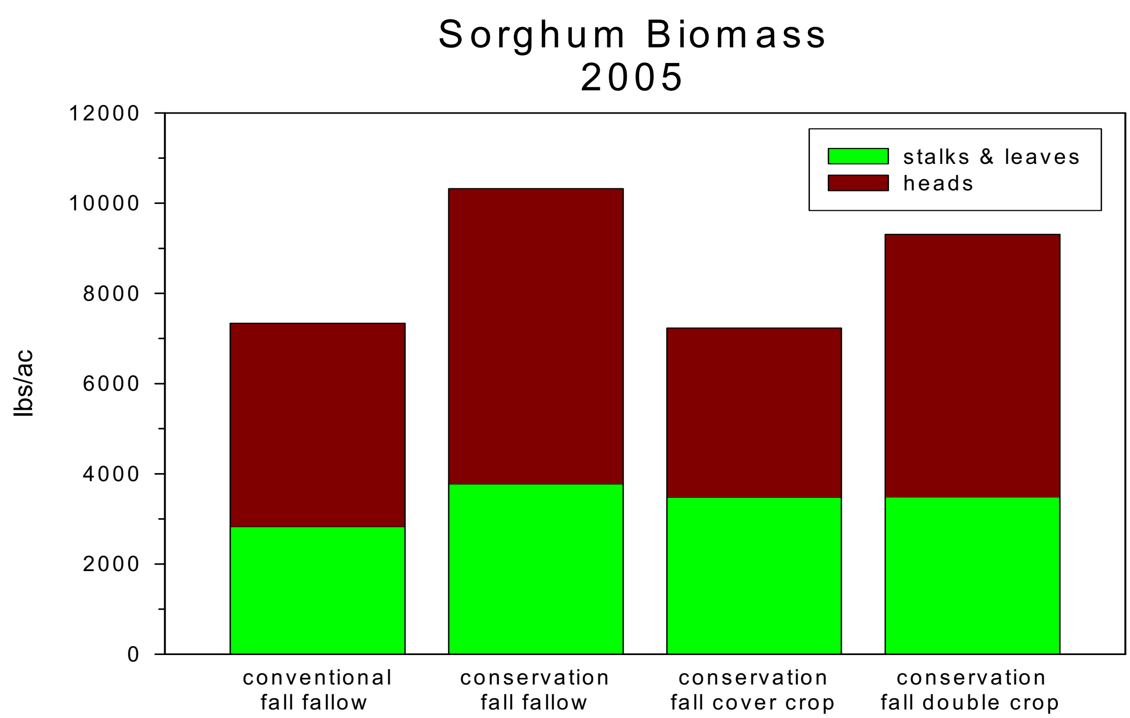

Figure 4. Grain sorghum stalk, leaf and head production for the cropping treatment.

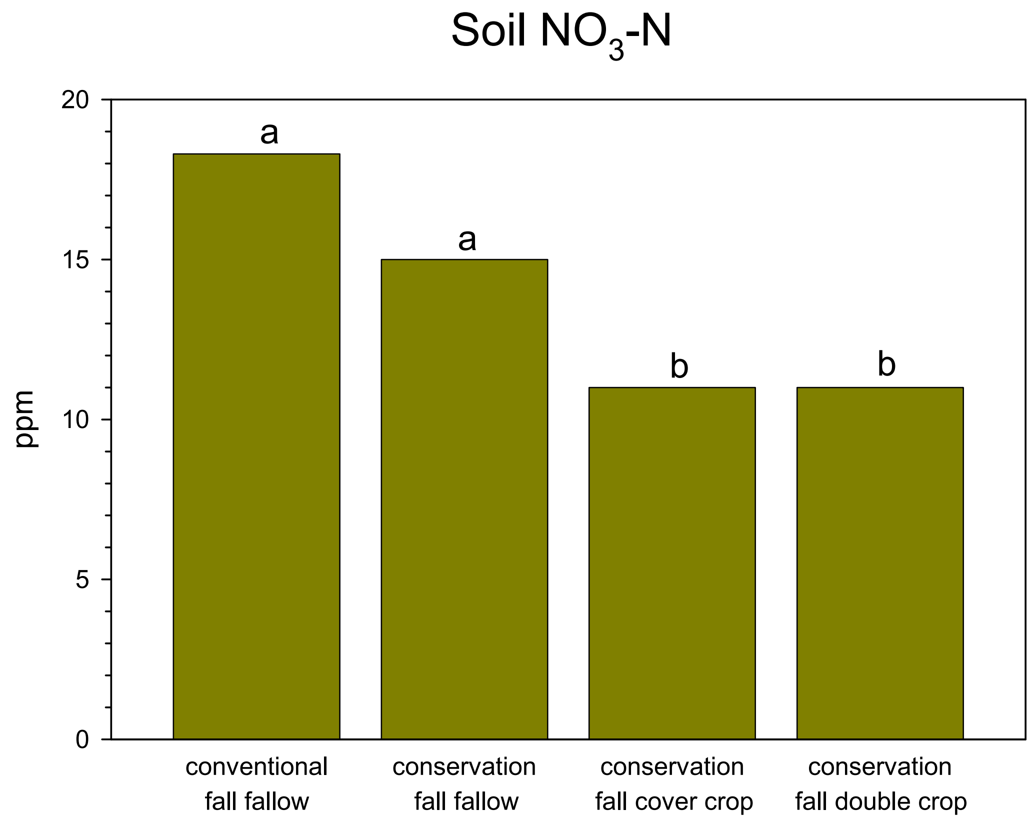

Figure 5. Soil nitrate-N levels for the 4 cropping treatments following the 2nd full crop year (cotton – corn/oats).