IMPACT OF COVER CROPS ON TEXAS ROLLING PLAINS COTTON PRODUCTION

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Abstract

Cover crops have recently received increased attention due to the USDA-NRCS soil health initiative. One region that warrants demonstration of cover crops to further adoption is the semi-arid Texas Rolling Plains. Soil moisture is often the most limiting factor in crop production within this environment and practices that are perceived to reduce the capability of soils to capture rainfall will hinder adoption. The objective of this research is to demonstrate the impact of cover crops in no-till cotton cropping systems on soil moisture and crop growth. Dryland and irrigated cotton systems were evaluated. The dryland system consists of seven treatments: 1) conventional tillage without a cover crop; 2) no-till without a cover crop; and no-till with cover crops consisting of 3) crimson clover; 4) Austrian winter field pea; 5) hairy vetch; 6) wheat, and 7) legume/grass mixture. The irrigated system consists of four treatments: 1) conventional tillage without a cover crop; 2) no-till without a cover crop; 3) no-tillage with a wheat cover crop; and 4) no-till with a legume/grass cover crop mixture. Neutron probes were inserted into each plot and soil moisture was evaluated bi-weekly throughout the year. Water use varied among cover crop species. Mixed species cover crops resulted in significantly less stored soil moisture entering cotton planting season. However, significant reductions in soil moisture did not translate to reduced lint yields.

Introduction

Cover crops are not a new concept and data examining the impact of cover crops on subsequent crop yields exists within the Texas Rolling Plains. Studies have concluded that winter cover crops do not appear to be a viable option in the Rolling Plains due to limited soil moisture for establishment and the removal of soil moisture by cover crops will likely hinder subsequent crop yields due to increased moisture deficit at planting (Dozier et al., 2008; Baughman et al., 2007). Keeling et al. (1996) concluded that it could be expected to obtain a protective ground cover 69% of the time in the Southern High Plains if the proper species is sown and that fall rainfall is adequate for germination and plant survival. In contrast, research has noted higher soil moisture availability in conservation tillage systems with cover crops compared to conservation tillage systems without cover crops and conventional tillage systems in the Rolling Plains (Sij et al., 2004). Multiple year studies in the Rolling Plains have also shown no impact of cover crops on cotton lint yields (Sij et al., 2004; DeLaune et al., 2012). As practices that are perceived to reduce the capability of soils to capture rainfall or use stored soil moisture will hinder adoption, our objective was to evaluate the impact of cover crops in cotton systems on stored soil moisture and liny yields.

Materials and Methods

A study was initiated Fall 2012 under sprinkler irrigation and no irrigation (dryland) at the Texas A&M AgriLife Chillicothe Research Station (CRS) near Chillicothe, TX. Plots within pivot systems (LESA) were 8 rows (40" row spacing) x 60 ft long and 8 rows by 40 ft long within the dryland systems. The dryland system consists of seven treatments: 1) conventional tillage without a cover crop; 2) no-till without a cover crop; and no-till with cover crops consisting of 3) crimson clover (15 lb/ac); 4) Austrian winter field pea (35 lb/ac); 5) hairy vetch (20 lb/ac); 6) wheat (30 lb/ac), and 7) legume/grass mixture. The irrigated system consists of four treatments: 1) conventional tillage without a cover crop; 2) no-till without a cover crop; 3) no-tillage with a wheat cover crop (30 lb/ac); and 4) no-till with a legume/grass cover crop mixture. The mixed species cover crop was planted after cotton harvest at 40 lb/ac in Fall 2012 and 30 lb/ac in Fall 2013. The 2012 mixture consisted of cereal rye (10 lb/ac), wheat (10 lb/ac), turnip (2 lb/ac), crimson clover (3 lb/ac), Austrian winter field pea (10 lb/ac), and hairy vetch (5 lb/ac). The 2013 mixture consisted of cereal rye (5 lb/ac), wheat (9.5 lb/ac), turnip (0.5 lb/ac), crimson clover (2.5 lb/ac), Austrian winter field pea (8 lb/ac), radish (0.5 lb/ac), and hairy vetch (4 lb/ac). Neutron probes were used to record stored soil moisture bi-weekly throughout the year to a depth of 56 inches at 8 inch increments. Cover crops were chemically terminated in mid to late April each year. Dryland plots were not fertilized; whereas irrigated plots were fertilized with 40 lb N/ac. Each plot was mechanically harvested and processed to determine lint yields. It should be noted that the research area was under exceptional drought conditions for the majority of the study period.

Results and Discussion

Cover Crop Biomass
Although exceptional drought conditions existed, cover crop and cash crop stands and production were achieved. Cover crop biomass and N accumulation is presented in Table 1. In Spring 2013, the mixed species cover crop and Austrian winter field pea produced the greatest biomass within dryland plots (Table 1). Within irrigated plots, the mixed species cover crops produced significantly more biomass than the wheat cover crop. It should be noted that the mixed species cover crop was dominated by rye and wheat, with minimal winter field peas. Remaining species within the mix were not evident. In 2014, Austrian winter field pea and the mixed species mix were again the greatest biomass producers (Table 1). Again, the mixed species were dominated by rye, wheat, and Austrian winter field pea. As expected, N accumulation was higher in legume species such as Austrian winter field pea and hairy vetch. Delayed planting of cover crops until cotton is harvested hampers the fall performance of legume species. Late fall plantings resulted in poor establishment of crimson clover each year. As evident in 2013, grass species such as rye and wheat can "mine" excess nitrogen from the soil profile (Table 1).

Table 1. Cover crop biomass and nitrogen accumulation in dryland and irrigated cotton systems in 2013 and 2014.

Cover Crop	Spring 2013 Biomass (lb/ac)	2013 N Accumulation (lb/ac)	Spring 2014 Biomass (lb/ac)	2014 N Accumulation (lb/ac)
Dryland				
Crimson Clover	383b	9.1b	319d	8.1c
Austrian Winter Field Pea	1881a	63.5a	1104a	40.6a
Hairy Vetch	1347ab	56.1a	627c	26.5b
Mixed	2171a	26.8b	936ab	11.9c
Wheat	1207ab	15.6b	798bc	11.2c
Irrigated				
Mixed	3672a	62.6a	1514	28.2
Wheat	1781b	32.9b	1099	21.6

† Different letters represent significant difference at $P<0.05$.

Stored Soil Moisture
Stored soil moisture was impacted by cover crop implementation (Figures 1A and 1B). Stored soil moisture was significantly lower as a result of mixed species cover crop entering 2013 cotton planting season in the dryland and irrigated systems (Figures 1A and 1B). Within the dryland system, no-till and conventional till plots had numerically higher stored soil moisture in May 2013. Stored soil moisture remained lower in the dryland mixed species cover crop plots throughout 2013 and continuing through May 2014 (Figure 1A). Although not significant, soil moisture levels in the dryland system was higher in plots with wheat, Austrian winter field, or hairy vetch as a cover crop in May 2014 compared with treatments without a cover crop (Figure 1A). Within the irrigated system, each cover crop treatment, mixed species and wheat, resulted in significantly lower stored soil moisture in the spring prior to cotton planting (Figure 1B). However, stored soil moisture was not different among treatments once irrigation began or a significant precipitation event was recorded. Beginning in June 2014, conventional tillage treatments had numerically lower stored soil moisture levels compared with the other treatments (Figure 1B). These data indicate that while cover crops do use soil moisture, water infiltration may be enhanced in some cover crop treatments. In addition, water use efficiency differs among cover crops species.

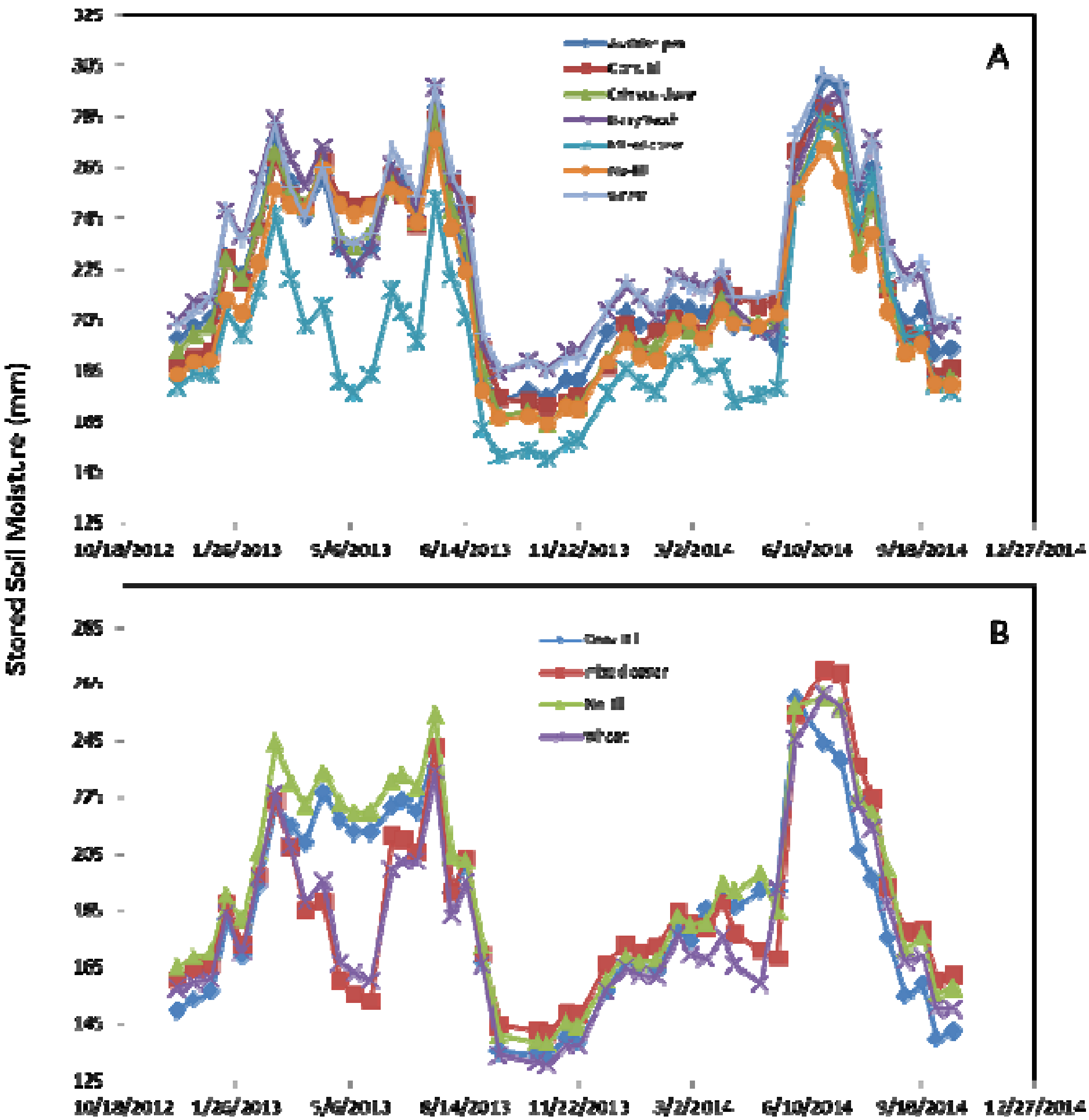

Figure 1. Stored soil moisture in the upper 56 inched of the soil profile in A) dryland and B) irrigated cotton systems for the period of December 2012 to October 2014.

Lint Yield

Lint yields are presented in Figure 2. Although soil moisture in the dryland system entering the 2013 planting season was significantly lower as a result of mixed species cover crop, the mixed species did not necessarily result in significantly lower ling yields. Lint yields were significantly lower for cotton following the mixed species and Austrian winter field pea cover crops compared with cotton following wheat and crimson clover cover crops (Figure 2). In 2014, there were no significant differences in lint yield among treatments in the dryland system. Within the irrigated system, no significant differences in lint yield were observed among treatments in 2013 or 2014 (Figure 2).

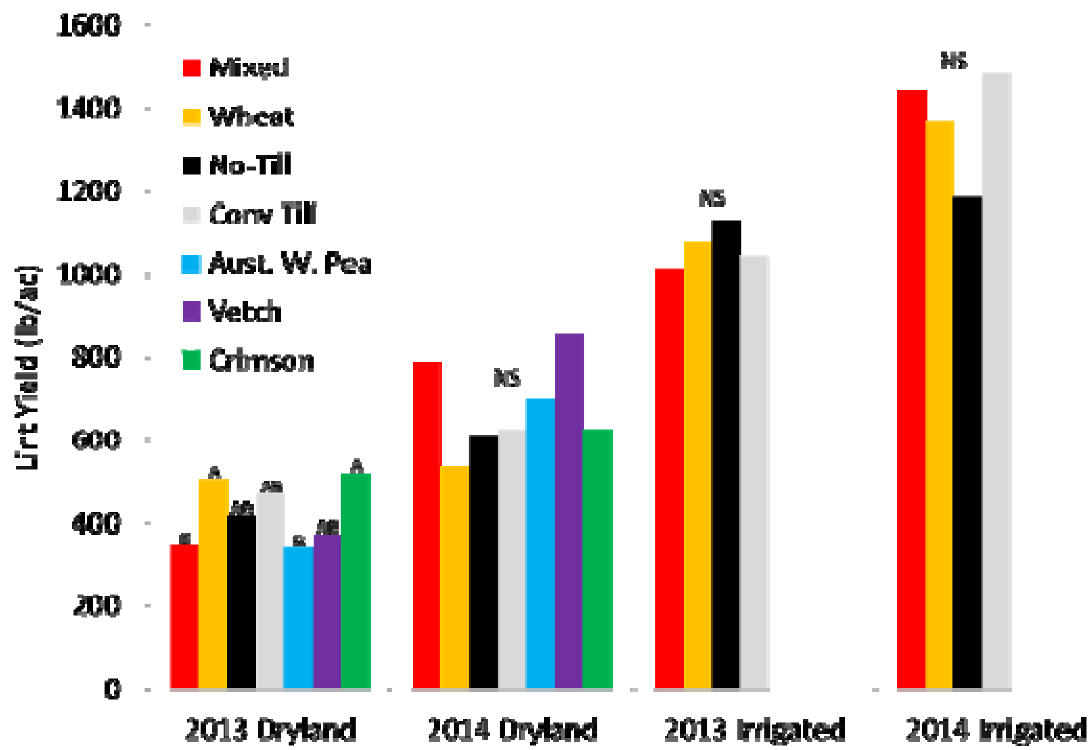

Figure 2. Lint yields as affected by cover crop treatment within dryland and irrigated cotton systems for 2013 and 2014.

Summary

Even in exceptional drought conditions, many evaluated cover crop species produced significant biomass and residue cover. Austrian winter field pea performed well among legume species and grass species performed well. Multi-species mixes consisting of legume/grass mixes were dominated by grass species, with little to no evidence of legumes and brassicas. The mixed species consisting of rye consistently resulted in lower stored soil moisture levels entering cotton planting for both dryland and irrigated cotton systems. However, lint yields were not significantly different among treatments within the irrigated system and year 2 of the dryland system. If lint yields are not affected, then the cost of input will greatly affect net returns. Ongoing research is evaluating economic impacts of cover crops in semi-arid cotton systems.

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