A No-till Dryland Cropping System to Increase and Stabilize Cotton Yields During Periods of Drought

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Abstract

Dryland cotton production is highly dependent on subsoil moisture going into the planting season as well as timely rainfall in season. We hypothesize that production systems that capture and retain rainfall should measurably stabilize and increase dryland cotton yields. The objective of the study was to identify production systems that capture and retain limited rainfall that have the potential to increase and stabilize cotton production during periods of drought and thereby enhance the economics of cotton production in the Rolling Plains. Six production systems were used in the current study and included double cropping and a cotton-wheat-fallow system. Soil moisture going into the 2004 cropping season was excellent and benefited cotton yield. By comparison, soil moisture going into the 2005 cropping season was limited, but above average rainfall in July and August (a critical reproductive period) resulted in good dryland cotton yields. Unfortunately, extreme drought from the fall of 2005 through July 2006 severely compromised wheat and cotton stand establishment and, subsequently, wheat and cotton yields. In addition, a hail storm in mid-June resulted in moderate to heavy damage to cotton. Late season rainfall enhanced growth and flowering, but was too late to affect cotton yields. The 2006 lint yield in the conventional-till treatment was only 160 lb/ac, compared with about 650 lb/ac in the previous two years. Wheat in the double crop treatments failed in 2006 due to drought and only yielded 19 bu/ac in the continuous wheat treatment, compared with 45 bu/ac in the previous two years. Because of crop failure and hail damage in 2006, a request was made to Cotton Incorporated to extend this study in 2007 in order to obtain additional field data from which to draw meaningful conclusions from this cropping systems research effort.

Introduction

Most cotton production on the semiarid Texas Rolling Plains is dryland. Clark et al. (1996, J. Prod. Agric. 9:55-60) reported that cotton yield on the Texas Rolling Plains was significantly correlated with soil moisture present in a 5-foot profile at the time of stand establishment. Furthermore, preseason precipitation from January through May 31 provided an even better prediction of yield than that of stored water. Hence, capturing, storing, and conserving rainfall is the key to profitable dryland cotton production. Furrow diking was successfully used to capture rainfall, but producers did not adopt this technology because furrow diking slowed field operations while crusting and seedling damage due to 'sanding out' were still present. Cover crops, like terminated wheat or rye) and reduced tillage enabled cotton producers to minimize erosion problems and maintained normal field operations. A terminated cover crop captures rainfall while protecting seedlings from wind damage.

A study was initiated in 2004 to study dryland production systems with a primary goal of promoting conservation tillage with a small grain cover crop, capturing rainfall, and increasing and stabilizing cotton yield during periods of drought. The objectives of this study were to (1) develop a no-till, doublecrop dryland production system with cotton and wheat that captures and stores rainfall during a fallow period to help stabilize and increase cotton yields, and (2) monitor the effectiveness of the cropping system to capture and store moisture. The 2005-2006 growing season was extremely dry, resulting in a general failure in wheat production and a 60% to 100% reduction in cotton production among treatments. Furthermore, cotton experienced moderate to heavy hail damage on June 15, 2006. Late season rainfall stimulated regrowth and flowering, but bolls did not have enough time to mature.

Materials and Methods

The study was conducted at the Chillicothe Research Station on an Abilene clay loam under dryland conditions. The cotton variety was PM 2280 BG/RR and the wheat variety was Cutter. Plot size was eight, 40-inch rows wide by 310 feet long. Treatments included (1) continuous conventional-till cotton (CC-Conv.), (2) continuous conventional-till wheat (WW-Conv.), (3) continuous cotton, strip-tilled, and interseeded with rye that was chemically terminated at heading (CC-ST w/R), (4) continuous no-till double crop cotton and wheat (CW-NT), (5) no-till double crop cotton-wheat-fallow (CWF-NT), and (6) no-till double crop cotton-wheat-fallow with strip tillage (CWF-ST). In treatment 3, two rows of rye were seeded between rows of standing cotton shortly after stripping with a specialized grain drill. Cotton was seeded at 3 plants per foot of row. Wheat was planted at 60 lb/ac. Fertilizer (65-20-0) was applied to wheat each year. Cotton received a fertilizer application of 40-20-0 each year. Weeds were controlled with various herbicides and cultivation as needed.

Double crop wheat failed and surviving plants were chemically terminated. Cotton was seeded into the failed wheat about 4 wk earlier than in previous years in an attempt to take advantage of the limited soil moisture. Hence, this treatment (CWF-NT) is atypical for 2006. All treatments were replicated four times in a randomized complete block design.

Two, 5-foot access tubes were placed in each plot to monitor soil moisture utilizing neutron probe technology. Soil moisture readings were generally taken every two weeks. Cotton yields were determined from a machine-harvested 2-row by 270-foot section from the middle of each cotton plot. Wheat plots were harvested with a small plot combine for grain yield. Grain yields were adjusted to 13% moisture.

Results and Discussion

Soil moisture going into the 2004 cropping season was excellent and benefited cotton yield. By comparison, soil moisture going into the 2005 cropping season was limited, but above average rainfall in July and August (a critical reproductive period) resulted in good dryland cotton yields. As a result, 2004 and 2005 dryland cotton yields were comparable. The 2005-2006 growing season was extremely dry (Fig.1). Furthermore, the research station received hail on June 15, causing moderate to severe damage on seedling cotton. Late season rainfall stimulated regrowth and flowering, but bolls did not have enough time to mature.

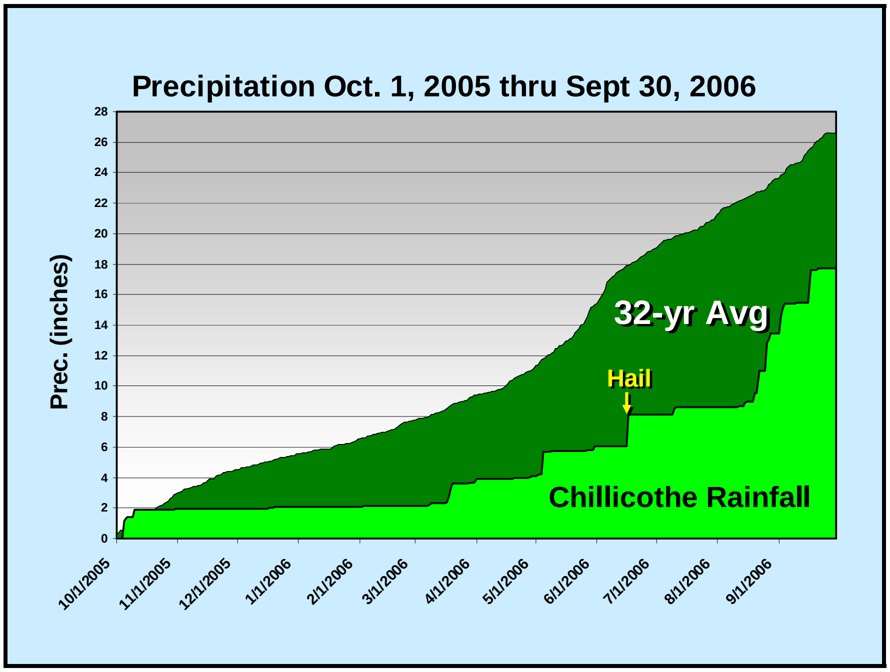

Figure 1. Seasonal rainfall in 2005-2006 compared with the 32-yr average. Hail occurred in mid-June.

Moisture profiles in the various treatments have already been discussed in earlier reports. Therefore, only 2006 data will be presented (Fig. 2).

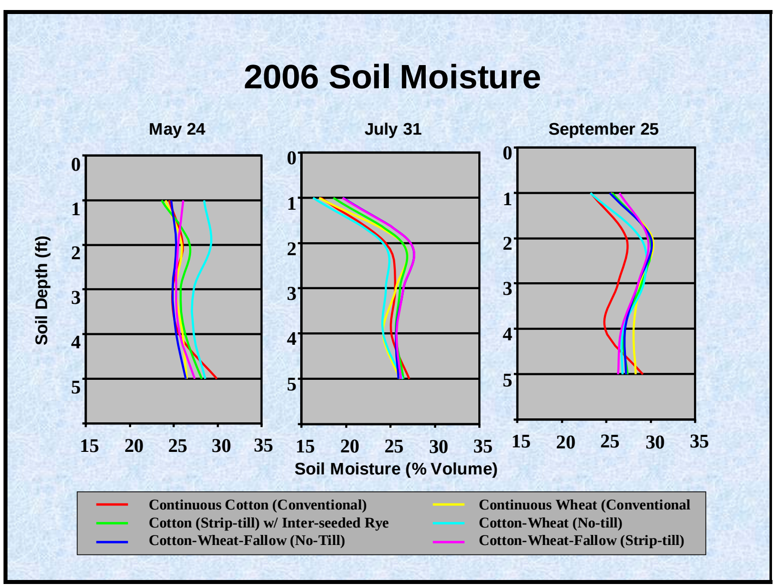

Figure 2. Soil moisture profiles among the 6 treatments at three seasonal dates.

In late May, the continuous cotton wheat double crop plots had the highest soil moisture content. This is probably due to the early termination of the failed wheat crop, resulting in soil moisture conservation. By the end of July, available soil moisture was nearly absent from the top 18 inches of soil in all treatments, and cotton was visibly under stress. By the end of September, late season rainfall replenished the upper profile. The continuous cotton treatment showed somewhat less soil moisture at the 2- to 4-foot level that the other treatments, including the continuous double crop cotton-wheat treatment (Fig. 2).

Hail damage was moderate to heavy on June 15 (Fig. 3). It was decided to not replant at this late date but allow plants to recover (Fig. 4). Even so, plants were "set back" at least 3 wk.

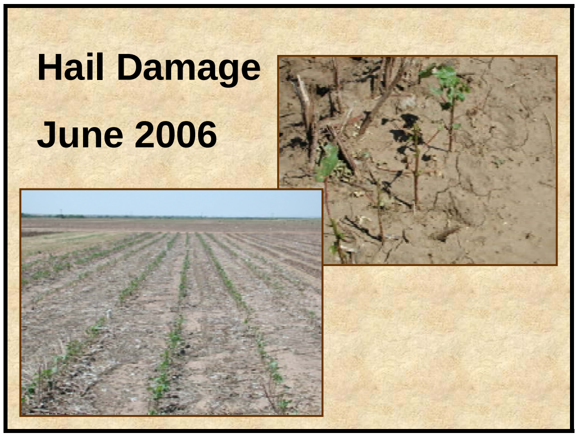

Figure 3. Moderate to heavy hail damage, photo June 20, 2006.

Figure 4. Cotton recovery from hail damage, photo Sept. 25, 2006.

Lint yields were substantially depressed from previous years (Fig. 5). The 2006 lint yield in the conventional-till treatment was only 160 lb/ac, compared with about 650 lb/ac in the previous two years. In 2006, cotton yield from the double crop cotton-wheat was significantly higher than that from the continuous conventional-till cotton. This may be due to the earlier planting (May 9 for the double crop versus June 13 for continuous cotton). Earlier established plants may have had deeper root systems and the terminated wheat, acting as a cover crop, may have resulted in soil water conservation. In the continuous cotton treatment, yield was reduced 75% compared with previous years.

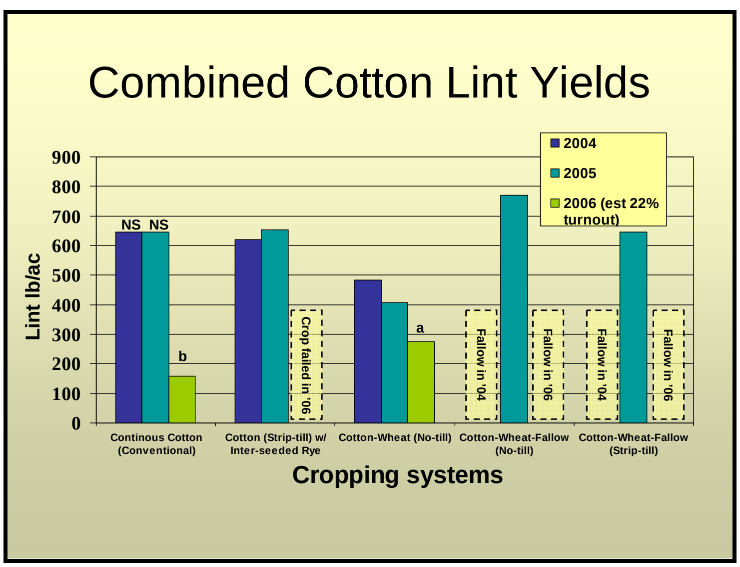

Figure 5. Effect of cropping systems on cotton yields, 2004-2006.

In 2006, wheat was only produced from the continuous conventional wheat system (Fig. 6). There was enough surface moisture to establish the crop, perhaps due to soil moisture retention from the summer fallow period between wheat crops. All other treatments with wheat failed in 2006 due to drought.

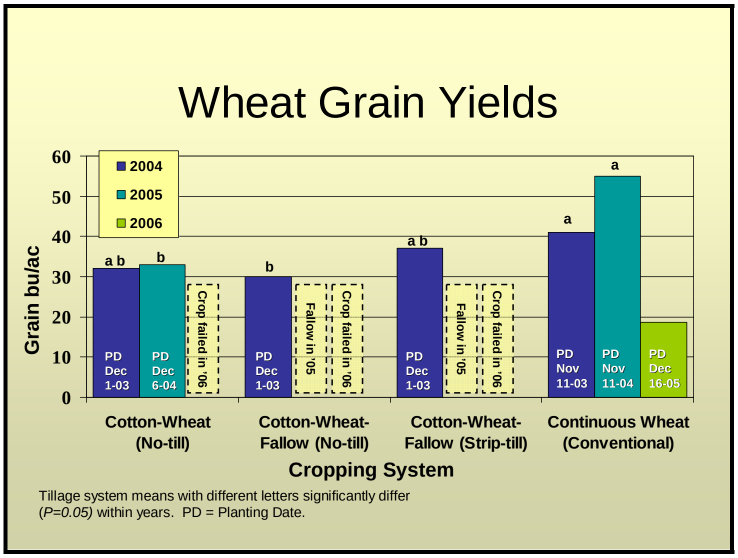

Figure 6. Effect of cropping system on wheat yields, 2004-2006.

Conclusions

- Extreme drought compromised wheat establishment in cotton rotational systems, only conventional wheat produced grain (yield reduced 60% compared to previous years)
- Moderate to severe hail damage plus drought reduced cotton yields 75% in the continuous cotton treatment compared with previous years
- Late season rainfall stimulated cotton growth, but too late to affect yield
- The study will be repeated an additional year

Acknowledgement

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