2002 BELTWIDE COTTON CONFERENCES, ATLANTA, GA – JANUARY 8-12

DRYLAND CROPPING SYSTEMS TO ENHANCE SOIL MOISTURE CAPTURE AND WATER-USE EFFICIENCY IN COTTON

John W. Sij, Todd A. Baughman, Brian L. S. Olson*,
David Bordovsky and Jason P. Ott
Texas Agricultural Research and Extension Center
Texas A&M University
Vernon, TX
***Kansas State University**
Colby, KS

Abstract

Rainfall is the most limiting factor in dryland cotton production in the Texas Rolling Plains. Cropping systems that enhance rainfall capture during the season and limit runoff offer the most promise for increased dryland cotton yield. This project was initiated in 2001 to study cropping systems that offer a means to capture limited rainfall other than furrow-diking and at the same time offer seedling cotton protection from blowing sand. The research was conducted at the Chillicothe Research Station. The objectives include (1) a comparison of rainfall capture and soil moisture profiles in five cropping systems that include furrow-diked, conventional tillage, minimum-till, flat-planted and an *in-furrow-seeded* small grain that is terminated prior to cotton planting, (2) determining the effects of different cropping systems on plant response and yield parameters in each of the above systems, and (3) develop educational programs to disseminate information obtained from this research. The test contained three replications of each cropping system.

Two rows of rye (7.5-inch spacing) were planted on 15 November 2000 between the future cotton rows. Rye was terminated at 50% heading on 9 April 2001 with Roundup Ultra. Paymaster 2280 RR/BG was planted on 9 May 2001 at 4 seeds per foot of row on 40-inch rows. On 11 May 200, soil moisture probes were placed at 1-foot and 3-foot intervals within plots to determine soil moisture extraction profiles over the season. Probes were read weekly and soil moisture at each depth was plotted against time. A runoff collection system was installed mid-May to collect rainfall runoff from three systems: conventional, strip-till with inter-seeded rye, and reduced-till with furrow dikes.

The 2001 growing season was extremely dry with only four rainfall events (totaling 3.48 inches) resulting in minor runoff. Soil moisture probe data indicated that all moisture was extracted from the top foot of soil by 9 July in all cropping systems. By 1 August all soil moisture was extracted at the 3-foot depth in all systems. Furrow-diked plots and the strip-tilled plots with inter-seeded rye were numerically the last to dry out at each recording depth. However, statistically there were few differences among cropping systems.

Surface water runoff was recorded in May and again in September. Data indicated significant differences in runoff from the first rainfall event on 21 May, with conventional tillage resulting in nearly twice as much runoff as the strip-tilled with rye and the diked systems. Over the growing season strip-till with terminated rye reduced runoff by about 40% and the diked system about 60% compared with conventional tillage.

Due to the extreme drought of 2001, lint yields were not significantly different among the five systems. However, the runoff results are encouraging in that the strip-tilled system approached that of furrow-diking with respect to rainfall capture.

Introduction

Dryland cotton production (nearly 400,000 acres) in the Rolling Plains means low input and marginal returns compared with other cotton production regions of the state. Producers are dependent on subsoil moisture going into the cropping season and seasonal rainfall. Since rainfall is sporadic and limited, any cropping system that captures rainfall offers cotton producers a means to increase cotton yields and improve profitability. Previous studies from the Vernon Research Center (Clark, et. al, 1996) have shown that furrow-diking and reduced tillage offered a means to capture rainfall and increase lint yield. Generally, this resulted in economic yield increases up to 21% over conventional tillage. Clark and Barnett (1995) recognized that a furrow-diked system did not, however, provide a satisfactory means of reducing crusting and blowing soil. They used cover crops in an attempt to protect cotton seedlings and compared results to continuous cotton in a reduced-tillage system with furrow-diking. Their results showed that terminated Austrian winter pea and wheat cover crops did not result in a significant yield increase over continuous cotton in a reduced system with furrow-diking. Water-use efficiency also was not altered. The authors indicated that wheat was allowed to grow too long before it was terminated. Perhaps late-terminated wheat extracted too much moisture prior to planting cotton.

Although furrow-diking has the potential to reduce runoff and subsequent soil erosion, furrow-diking has never been widely adopted by producers for a number of reasons: (1) new equipment had to be purchased, (2) the equipment would not hold up and needed constant repair, (3) putting in dikes slowed field preparation operations, (4) the dikes had to be plowed out and re-established after cultivating and spraying, (5) dikes had to be removed prior to harvest, and (6) crusting and wind erosion were still present.. Although furrowing-diking resulted in increased yields, producers did not make the investment in equipment, time, and labor. With the advent of transgenic crops and new tillage equipment, new and/or novel production systems may offer producers a means to efficiently capture rainfall while protecting the soil from erosion by water and wind as well as cotton seedlings from blowing sand. The goal is to identify a cropping system that will equal or exceed lint yield observed in a furrow-diked system but without the drawbacks of furrow-diking. Specific objectives include: (1) compare rainfall capture and soil moisture profiles in cropping systems that include furrow-diked, conventional tillage, minimum-till, flat-planted, and an interseeded small grain that is terminated prior to cotton planting, (2) determine the effects of different cropping systems on plant response and yield parameters in each of the above systems, and (3) develop educational programs to disseminate information obtained from this research.

Materials and Methods

The study was conducted at the Chillicothe Research Station. Paymaster 2280BG/RR was planted on 9 May at 4 seeds per foot of row. Plots consisted of eight rows wide and 310-feet long. Row width was 40 inches. Five cropping systems were arranged in a randomized complete design with three replications. Rainfall runoff was determined from one of the two middle rows of conventional, strip-tilled with interseeded rye, and furrow-diked systems. Runoff was limited to 50 feet of row so as not to overwhelm the collection system during heavy rainfall events. Gypsum blocks (Irrometer Co., Inc., Riverside CA) were used to measure soil moisture at the 1-foot and 3-foot depths, and data were taken weekly. Two center rows were machine harvested on 9 October for lint yield. Data were subjected to analysis of variance and means separated using protected LSD (P=0.10). Table 1 provides additional experimental design information in an abbreviated form.

Results and Discussion

The runoff collection system is shown in Figure 1. Runoff is directed into a sunken collection tube fitted with a sump pump and float switch. Runoff water is pumped into a 2-foot -high by 6-foot-diameter stock tank. Water level depth is measured and volume of water calculated. Runoff is then converted into gallons per acre.

Figure 2 visually shows the degree of soil erosion among three tillage systems. Conventional tillage shows the greatest amount of soil loss with surprisingly little runoff. No attempt was made to quantify soil loss.

Figure 3 and 4 show soil moisture profiles at the 1-foot and 3-foot depths. Virtually all soil moisture was extracted in 3-feet of soil by the end of July. There were few significant differences among tillage systems due to extreme drought.

Figure 5 shows lint yields for 2000 and 2001. Yields were low and there were no significant differences in yield among treatments.

Table 2 shows runoff data from three tillage systems. Only two rainfall periods provided runoff in 2001. No rainfall event in June, July, or August resulted in runoff. Nevertheless, furrow diking reduced total runoff by 60% and strip-till with interseeded rye reduced seasonal runoff by 40%.

In summary, an abnormally dry year is a confounding factor in studies designed to evaluate cropping systems that have potential to capture rainfall and thus increase cotton yields. Soil moisture extraction profiles indicate that cotton extracted moisture below three feet by the first week of July. Due to extremely dry conditions there were only minor differences in extraction profiles among cropping systems; although the furrow-diked and strip-tilled system with inter-seeded rye appeared to have soil moisture levels somewhat higher than conventional tillage at the time the conventional-till plots were devoid of moisture. Lint yields were low (ca. 160 lb/ac) from all tillage systems. Results from runoff measurements indicated that furrow-diking reduced runoff 60% and strip-till with inter-seeded rye reduced runoff 40% compared with conventional tillage systems. These tillage systems need to be evaluated under environments representative of more normal rainfall conditions.

References

Clark, L. E., and J. L. Barnett. 1995. Winter Cover Crops in Conservation Tillage Systems for Cotton Production in the Rolling Plains of Texas. *In* M. R. McClelland, et al. (eds.) Conservation-tillage Systems for Cotton - a Review of Research and Demonstration Results from Across the Cotton Belt. Special Report 169. Arkansas Agric. Expt. Sta., Univ. of Arkansas, Fayetteville.

Clark, L. E., T. R. Moore, and J. L. Barnett. 1996. Response of Cotton to Cropping and Tillage Systems in the Rolling Plains. J. Prod. Agric., 9:55-60.

Table 1. Agronomic information for dryland cropping systems at Chillicothe**.**

Five cropping systems: conventional, reduced-till, furrow diked, no-till, strip-till
Three replications
Plot size: 8 rows, 40-inch centers, 310 feet long
Measurements: soil moisture, surface water runoff, cotton lint yield
‘Bates’ rye planted 15 November 2000, 90 lbs/ac, two rows per furrow
Fertilizer: 23 March 2001, 65-30-0 knifed in
Cotton variety: Paymaster 2280 BG/RR
Planting date: 9 May 2001
Seeding rate: 4 seed/ft
Moisture blocks: installed 11 May 2001
Diked: 11 June 2001
Herbicide: 23 March, Prowl (3.3EC) @ 2.4pts/ac; 9 April, Roundup Ultra @ 1qt/ac to terminate rye; 25 May, Staple @ 0.6oz/ac with Roundup Ultra @ 1qt/ac
Harvest: 9 October 2001

Table 2. Surface runoff from three tillage systems, Chillicothe, Texas 2001.

	Date of Rainfall				
Tillage System	**May 21**	**May 30**	**Sep. 5**	**Sep. 6**	**TOTAL**
		gallons/acre			
Conventional	8170	3430	300	270	12 170
Strip-till	4180	2640	0	160	6990
Reduced-till with dikes	2280	2070	0	200	4550
LSD (0.05)	3210	NS	NS	NS	

Figure 1. Runoff collection system. Runoff is channeled into a sunken tube (upper left) from approximately 50 feet of row (lower left). Runoff water is pumped into a 6-foot diameter stock tank (upper right and lower right).

Figure 2. Visual comparison of soil erosion differences among three tillage systems: strip-till interseeded (left), conventional-till (center), furrow-diked (right).

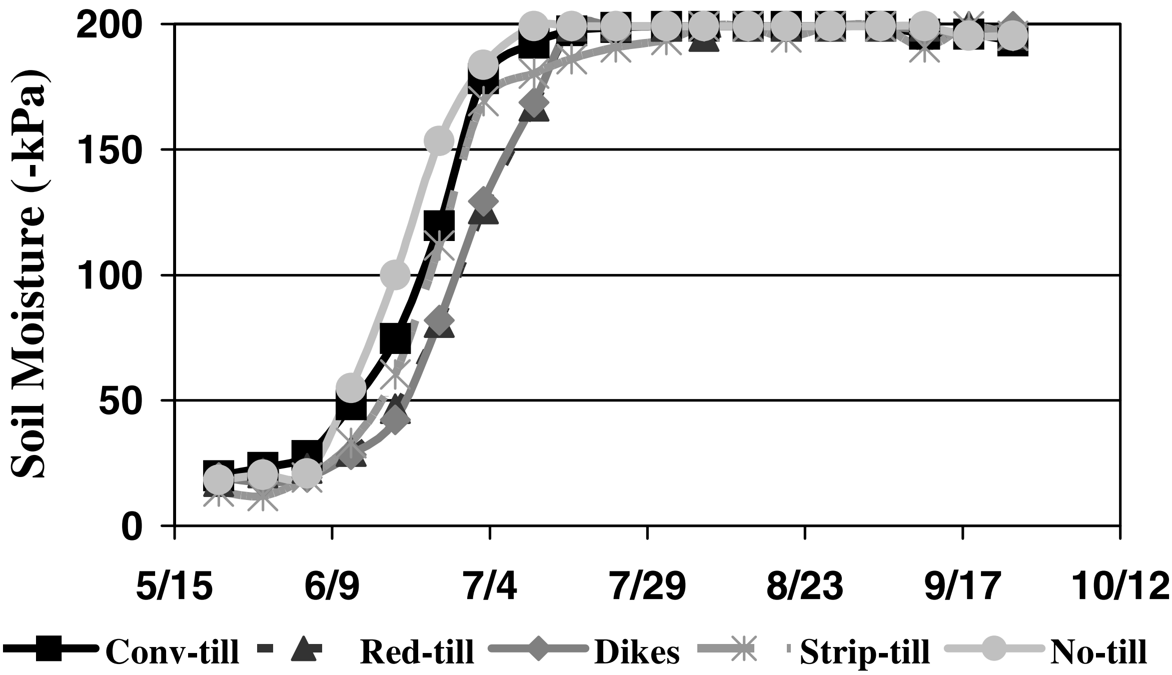

Figure 3. Seasonal soil moisture profile at the 1-foot depth. A reading of -200 indicates all soil moisture has been extracted.

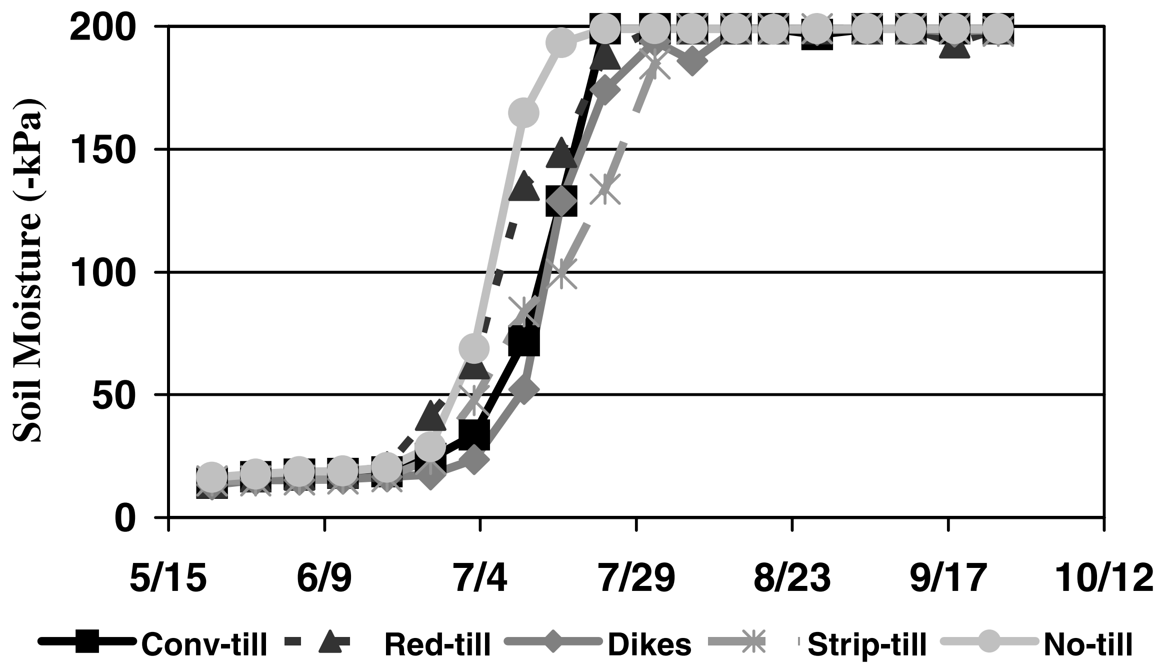

Figure 4. Seasonal soil moisture profile at the 3-foot depth. A reading of -200 indicates all soil moisture has been extracted.

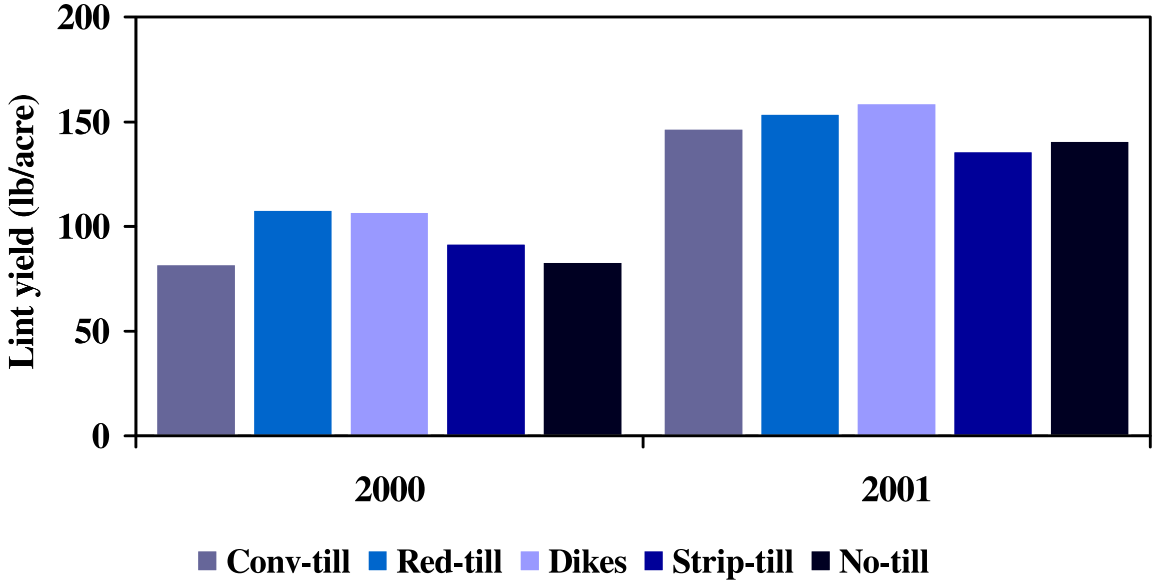

Figure 5. Cotton lint yields from five tillage systems.