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USING INTERSEED RYE TO ENHANCE RAINFALL CAPTURE IN DRYLAND COTTON PRODUCTION

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Abstract

Rainfall is the most limiting factor in dryland cotton production in the Texas Rolling Plains. Cropping systems that enhance rainfall capture and storage during the season 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. Studies were conducted at the Chillicothe Research Station on a Abilene clay loam from 2001-2003. The objectives were to (1) compare rainfall capture and sediment displacement in three cropping systems and (2) determine the effects of five different cropping systems on soil moisture profiles and plant yield response.

In strip-till and no-till plots, two rows of rye were planted each fall between cotton rows. Rye was chemically terminated at 50% heading the following April. Shortly after cotton emergence, soil moisture sensors were placed at 1-foot and 3-foot depths within plots to determine soil moisture extraction profiles over the season. Soil moisture readings were taken weekly until cotton matured. 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. Sediment load in the runoff was also determined.

The 2001 and 2003 growing season were abnormally dry and hot, whereas the 2002 growing season was more normal with respect to rainfall amount, distribution, and temperature. In 2001, the furrow-diked and the strip-tilled with rye systems were numerically the last to dry out at the 3-ft depth. In 2002, the no-till with rye, strip-till with rye, and furrow-diked systems contained more soil moisture at the 3-ft depth at the end of the growing season than the conventional-till and reduced-till systems. In 2003, soil moisture profiles were similar to those in 2001, but shifted later in the growing season by about two weeks due to late spring rain.

The conventional-till system resulted in the greatest amount of runoff and sediment displacement in 2 of 3 years. Strip-till with interseeded rye resulted in the least amount of runoff and sediment displacement. This system matched the water retention and reduction in sediment displacement capability of the diked system.

Lint yields were not significantly affected by tillage system in 2 of 3 yrs or when averaged over all 3 yrs. Results are encouraging as strip-till with rye and no-till with rye systems require fewer field operations than conventional or diked systems and may result in greater economic returns while providing seedling protection from wind as well as conservation of soil resources.

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, 1991 and 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-tilled, furrow-diked system. Water-use efficiency also was not altered. The authors indicated that wheat may have been allowed to develop too long before it was terminated, and perhaps 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 dryland cotton producers in the Rolling Plains for a number of reasons. Although furrowing-diking has resulted in increased yields, producers have not made 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. Our hypothesis is that a reduced-till system utilizing a partial cover crop will provide an equivalent alternative to a furrow-diking system in capturing rainfall and one that would more likely be adopted by dryland cotton producers.

The objectives of this study were to (1) compare rainfall capture and sediment displacement in three tillage systems and (2) determine the effects of five different tillage systems on seasonal soil moisture profiles and plant yield response.

Materials and Methods

The study was conducted at the Chillicothe Research Station on an Abilene clay loam. Tillage systems included conventional, reduced-till (re-hipping a stale seed bed), reduced-till with dikes, strip-till with interseeded rye, and no-till with interseeded rye. Two rows of 'Bates' rye were interseeded at 90 lbs/acre between cotton rows in the fall and terminated at 50% heading in April with glyphosate. Plots were strip-tilled following rye termination. Paymaster 2280BG/RR was planted in May of each year at 4 seeds per foot of row. Plots consisted of eight rows wide and 310-feet long. Row width was 40 inches. The five tillage systems were arranged in a randomized complete design with three replications. Rainfall runoff was determined from 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.

Runoff was directed into a sunken collection tube fitted with a sump pump and float switch (Fig. 1). which pumped water into a 2-foot-high by 6-foot-diameter stock tank. Water level depth was measured so that the volume of water in the tank could be estimated and converted into gallons per acre. Tank water was thoroughly stirred to suspend solids and a water sample taken for sediment analysis. Gypsum blocks (Irrometer Co., Inc., Riverside CA) were monitored weekly to quantify soil moisture at the 1-foot and 3-foot depths. Two center rows were machine harvested in October/November for lint yield. Prior to planting the third year, soil compaction readings were taken across rows to identify changes in soil physical properties among tillage systems. Controlled traffic patterns were maintained throughout the study. Data were subjected to analysis of variance and means separated using protected LSD (P=0.05).

Results and Discussion

Weekly rainfall totals for each year are shown in Fig. 2. Rainfall was extremely limited in 2001 and to a lesser extent in 2003 during critical portions of the growing season. Rainfall was more abundant and more evenly distributed across the growing season in 2002.

Figures 3 and 4 show soil moisture profiles at 1-foot and 3-foot depths. There were few differences in soil moisture in any year, but moisture differences were more pronounced in 2002. In 2002 at the 1-foot depth, moisture availability was greatest in the no-till with rye > strip-till with rye > reduced-till > reduced-till with dikes > conventional-till. At the 3-foot depth, moisture was greatest in the no-till with rye > strip-till with rye > reduced-till with dikes > conventional-till > reduced-till. Moisture availability followed similar trends in 2001 and 2003.

Table 1 provides total seasonal water runoff and sediment displacement data for the 3 years. As expected, conventional tillage resulted in the greatest amount of runoff and sediment displacement compared with reduced-till with dikes and strip-till with rye. The strip-till with rye system captured more rainfall and resulted in the least sediment displacement of the three systems evaluated. The strip-till with rye system matched the rainfall capture capability of the diked system all 3 years.

In 2 of the 3 yrs, there were no significant differences in yield among tillage systems. In 2003, the conventional and diked systems out-yielded the systems with interseeded rye (Fig. 5). However, when data were averaged across the 3-yr period, there were no significant (P=0.05) differences among tillage systems (Fig. 6), with lint yields averaging 254 lbs/ac. It is not known why there were differences among tillage systems in 2003, since soil moisture differences at the 3-foot level were minor and essentially non-significant from mid-August on.

Soil compaction differences were noted in systems with rye and those systems where tillage was employed to prepare a seedbed (Fig. 7). At the 0- to 8-inch depth, strip-till and no-till systems with rye were more compacted than conventional-till, reduced-till and reduced-till with dikes. Compaction in the row was considerably less than in either the traffic furrow or the non-traffic furrow. At the 10- to 18-inch depth, soil compaction was greatest in the no-till with rye in all observation areas. It is not known if these compaction levels were high enough to affect plant growth and development. There were no obvious plant height differences among treatments during the growing season.

Conclusions

While water retention was greater in the strip-till with rye, no dryland cropping systems resulted in significant yield differences (P=0.05) over conventional tillage averaged over the 3-yr period. No-till and strip-till with rye required fewer field operations prior to planting cotton: two for no-till and three for strip-till. Five trips were required for conventional-till. These reduced-till systems may result in economic returns while providing seedling protection from wind as well as conservation of natural resources. Furthermore, these systems are more likely to be adopted by dryland cotton producers than diking systems to capture rainfall.

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.

Clark, L. E., H. T. Wiedemann, C. J. Gerard, and J. R. Martin. 1991. A Reduced Tillage System with Furrow Diking for Cotton Production. Soil Sci. Soc. Am. J. 34:1597-1603.

Table 1. Surface water runoff and sediment from three tillage systems, Chillicothe, Texas during the 2001 and 2002 growing seasons.

	Tillage System			Total
Year	**Conventional**	**Strip-till**	**Reduced-till with dikes**	**Rainfall (in)**
	----------Runoff (gal/ac)----------			
2001	12173[a]	4603[b]	6985[b]	3.48
2002	16629[a]	9238[a]	6151[a]	8.66
2003	37539[a]	4562[ab]	885[b]	9.37
	----------Sediment (lb/acre)----------			
2001	1431[a]	284[b]	227[b]	3.48
2002	876[a]	507[a]	97[a]	8.66
2003	1113[a]	189[ab]	42[b]	9.37

Figure 1. Runoff collection system.

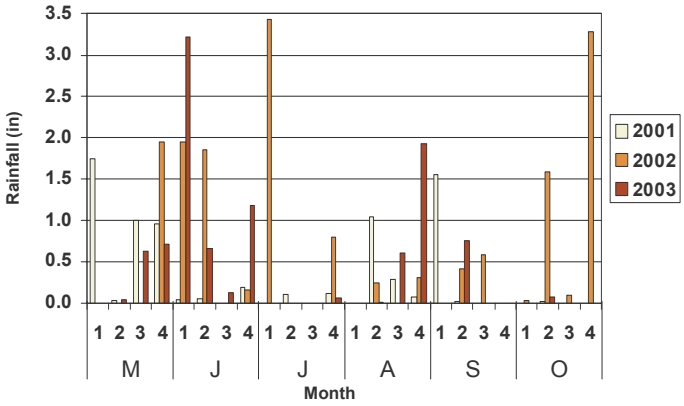
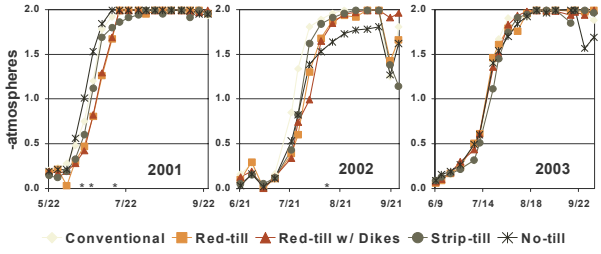
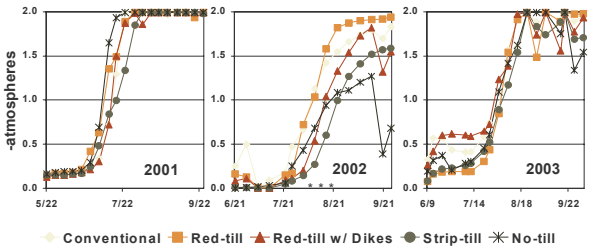


Figure 2. Weekly rainfall totals during the cotton growing seasons.



* Signifies weeks where soil moisture significantly differed between tillage types (*P*<0.05)

Figure 3. Seasonal soil moisture profiles at 1ft.



* Signifies weeks where soil moisture significantly differed between tillage types (*P*<0.05)

Figure 4. Seasonal soil moisture profiles at 3ft.

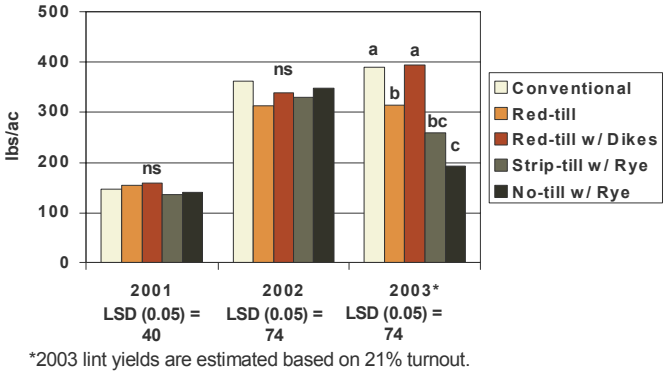


Figure 5. Lint yields for five tillage systems over three growing seasons.

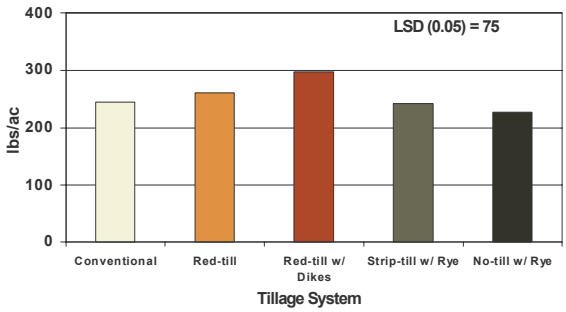


Figure 6. Lint yields for five tillage systems averaged over three growing seasons.

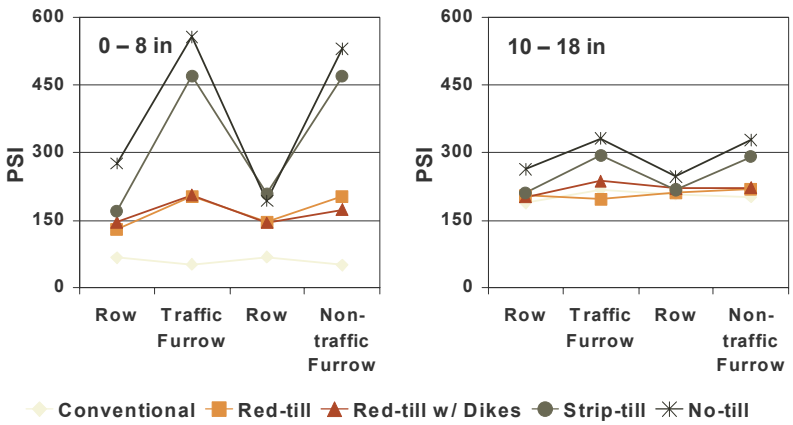


Figure 7. Soil compaction profile for five tillage systems, 2003.