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MANAGEMENT STRATEGIES FOR DRYLAND COTTON PRODUCTION IN WEST TEXAS

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Abstract

Over 1.8 million acres of dryland cotton production exist annually on the Southern High Plains of Texas. As irrigation water supplies continue to dwindle and Conservation Reserve acreage is brought back into production, dryland cotton acreage will grow to well over 3 million acres. Dryland cotton yields across this area exhibit large year-to-year variation, but the trend line is flat over the last 30 years. Analyses of the rainfall pattern reveals that 70% of the annual precipitation occurs from mid-April through mid-October, the cotton growing season, which should fit dryland cotton production well. Further analysis of the weather patterns reveals that over 70% of the rainfall events are less than 0.5 inch per event. Low volume rains coupled with the high evaporative demand (over 0.30 inches per day) during the growing season results in over 50% of the rainfall being wasted to bare soil evaporation in the current skip-row pattern. Our hypothesis is that planting solid cotton in rotation with grain sorghum will provide the Texas High Plains dryland cotton producer with numerous advantages when compared to the current skip-row system, such as equivalent yields/reduced costs, conservation compliance, and agronomic/economic diversity. Within the solid cotton/sorghum rotation, there are numerous opportunities to enhance utilization efficiency of the rainfall for cotton production with individual management strategies. The overall objective is to combine the “Best Management Strategies” into a production system that maximizes yield and efficiency through better utilization of the total water resource. This paper summarizes eight years of testing our hypothesis.

Introduction

Most of the dryland cotton production on the Texas High Plains reflects a cotton monoculture using a skip-row planting pattern on a 40-inch row spacing management system. The weather patterns for this area consist of a spring-summer rainfall period, characterized by low volume events, and high evaporative demands. Little winter precipitation is received and rarely is it sufficient enough to fill the soil profile; therefore, the crop is growing on the current water supply rather than stored water supply. The blank row in the skip-row pattern is subsequently wasting water due to the bare soil evaporation from the low volume rainfall events. We believe that solid-planted cotton in rotation with grain sorghum is more productive and less wasteful of the total water resource. Solid-planted, narrow row cotton can shade the ground faster reducing bare soil evaporation and the sorghum residue left on the soil surface through reduced tillage enhances water infiltration and reduces evaporation.

Managing a crop to achieve optimum productivity is highly important in areas where both water and fertility are considered limiting factors. By using individual management strategies, a best-fit production system can be established in order to reduce the amount of stress the crop experiences. Under dryland production practices, the majority of the management decisions are made prior to planting. Decisions such as varietal choice, seeding rate, and fertility application are critical components affecting water use efficiency of a crop. Varietal choice includes type of growth habit (degree of indeterminacy) and fiber quality properties such as length and strength. Seeding rate or final plant population has a major effect on volume of soil available to each individual plant. We have previously developed a relationship between water supply and bolls per plant, which is the main component of yield. When water supply is adequate to support cotton growth and development, the nutrient supply, especially the nitrogen component, usually represents the next major limiting factor. We have previously determined that cotton requires 5 pounds of nitrogen per inch of total available water supply.

Materials and Methods

The experimental system used to test this hypothesis was established in 1995 and occupies over 50 acres of land area in Terry County, TX. The soil is a loamy, fine-sand typical of the vast dryland acreage in the Southern High Plains of Texas. A split plot arrangement is used to test the major components of the experiment, continuous skip-row cotton versus solid-planted cotton in rotation with grain sorghum. These production systems are not replicated in space but rather in time. Within each production system, the experimental design is a split plot randomized block with a minimum of four blocks for each variable. Within each system, we compare row spacing, variety, plant population, and fertility. A narrow row spacing, (30-32 inches), was compared to the conventional 40-inch row spacing common to this area. Genetic differences were evaluated from different growth habit types instead of concentrating on various commercial varieties. We have evaluated target plant populations of 2, 4, and 6 plants per foot of row. We planned on 65% of the planted seed producing a plant. However, depending on initial seed quality and weather following planting we can get more or less than 65% emergence and stand establishment. Based on stored water supplies prior to planting and long term average rainfall during the growing season, we predicted that we have at least 400 pound per acre yield potential. In order to make 400-500 pound per acre yields we needed to provide 50-60 pounds Nitrogen and 12-15 pounds P_2O_5. Both application rate and time were management variables. All fertilizer was applied pre-plant or in split-applications. Two rates were used pre-plant. One was the 60 pounds N plus 15 pounds P_2O_5, which was required to support 400-500 pound/acre yields. The second was 50% of that or 30 N and 8 P_2O_5. The time variable was 50% pre-plant plus 50% side-dressed at first square. The data are not only being evaluated for agronomic significance but also for economic comparisons. The project has successfully completed and reported the 1995-2002 results in previous reports to the Texas State Support Committee and Cotton Incorporated. This report summarizes the overall efforts and also provides the 8-year historical results for each parameter.

Results and Discussion

Throughout the 8-year period of this project, we have accumulated sufficient consistent responses that allow us to draw some conclusions. The solid-planted cotton has produced 85% of the yield of the skip-row on a planted-acre basis, meaning that on a land-acre basis the solid-planted yielded over 30% more than the skip-row pattern (Figure 1). The cotton in rotation with grain sorghum yielded over 10% more than continuous cotton, which nearly offsets the yield advantage of the skip-row pattern. Additionally, the grain sorghum yields have averaged over 2500 pounds/acre providing additional direct income, plus the benefits to cotton. The cost savings associated with the skip-row pattern do not offset the yield advantages of solid-planted cotton. The benefit of the rotation with grain sorghum compensates for the extra soil volume available for water storage in the skip-row system.

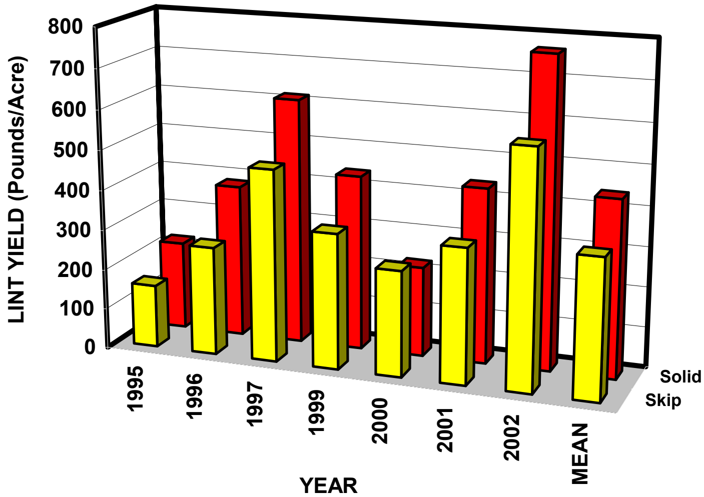
Within each system, various management strategies have been tested and consistent results were obtained for some. Variety choice is one of the most important decisions a cotton producer makes due to genetic influences on fiber quality. Previous dryland research on the Texas High Plains indicated that the more-indeterminate type cultivars had an advantage under rain fed conditions. This advantage was attributed to the indeterminacy allowing the plant to slow development under stress and then reinitiate growth and development when the stress was relieved. We have evaluated a large number of adapted cultivars since this project began. The results obtained suggest that no real significant difference exists between the more-determinate types versus the more-indeterminate types. The key to cotton production in a short growing season is to keep the plant from experiencing water stress prior to flowering to allow the establishment of as many fruiting sites as possible. A plant going into stress prior to flowering limits the number of mainstem nodes and thus fruiting sites. It is much better to have high yield potential at flowering than to have restricted plant size. Once flowering begins, the cotton plant can never recover until the boll load that was established is mature. If rains occur late, regrowth occurs.

Under limited water supply conditions individual plant productivity is strongly influenced by plant density. Plant density is a combination of row-spacing and plants per unit row length. We have clearly shown over the past 20 years the benefit of narrow rows (30-32 inch spacing) over 40 inch rows. The spacing in the row becomes critical to provide each plant with adequate space to reduce its risk of stress. We consistently found that planting 2.5 to 3 seed per foot does not produce a uniform stand if any crusting occurs. Apparently 4-5 seed per foot results in neighbor-helping-neighbor during emergence. The results obtained over the years strongly suggest that in-row plant populations of 2-4 plants per foot of drill row maximize yield within the limits of the water supply (Figure 2).

The last management strategy, that impacts yield and water use efficiency, is fertility management. We had three fertility treatments to achieve different amounts and timing, 60 pounds N plus 15 P_2O_5 pre-plant, 30 pounds N plus 8 P_2O_5 pre-plant, and the lower rate pre-plant with an additional 30 pounds of N side-dressed. The pre-plant application of 60 pounds N plus 15 P_2O_5 produced the highest yield (Figure 3), primarily because we never tilled the soil again to prune roots and secondly because the type of in season rains we received did not result in Nitrogen leaching below the root zone. The 50% rate was not adequate to produce maximum yield. The split application had very little rain following application and the applied fertilizer had little opportunity to disperse into the root system.

Conclusions

After eight years on this project we are able to conclusively state that narrow (30-32 inch) rows consistently out-yield wider (38-40 inch) rows across a wide range of production environments. We have consistently observed solid-planted cotton to out-yield skip-row cotton on a land-acre basis. We have seen benefit from rotation with grain sorghum. Cotton yields have been about 10-12% greater following sorghum compared to following cotton. We have averaged about 3000 pounds per acre of grain sorghum. At today's price, this is an additional $100/acre for land that occupies the blank row in the skip-row system. Plant populations of 2-3 plants per foot have consistently out-yielded 5-6 plants per foot of row. Pre-plant application of fertilizer for a realistic yield goal has been better than side-dressed applications. The individual components of the production system are falling into place to increase dryland cotton yields. Dryland cotton yields in West Texas can be increased using a systems approach comprised of these individual management strategies.



	1995	1996	1997	1999	2000	2001	2002	MEAN
Skip	156.72	269.81	478.58	336.72	263.46	335.80	586.92	346.86
Solid	220.66	382.30	613.76	436.83	224.08	436.03	768.00	440.24

Figure 1. Lint yield expressed on a land acre basis comparing skip-row to solid planted cotton.

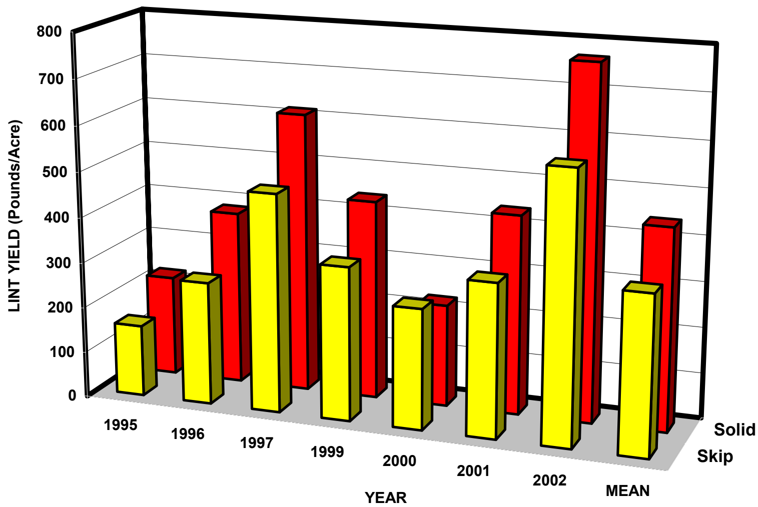


Figure 2. Lint yield response to plant population (plants/foot of drill row).

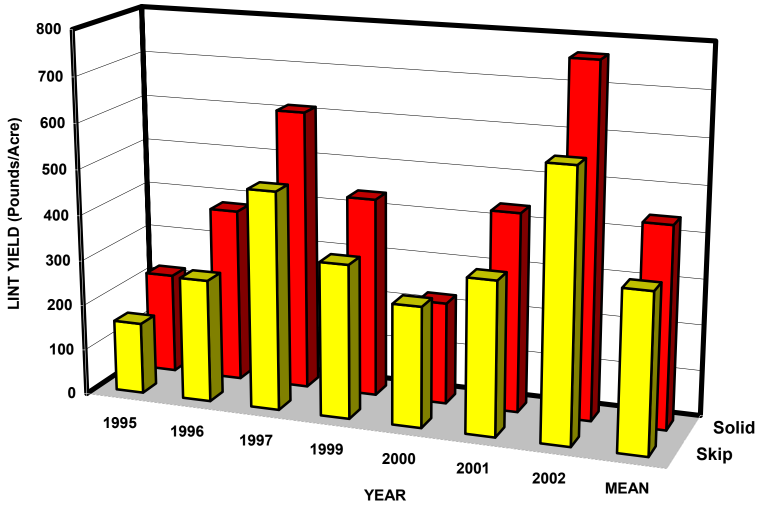


Figure 3. Lint yield response (averaged across all other treatment variables) to Nitrogen rate and time of application.