1580 Management of Dryland Cotton Production Systems

Dr. Robert J. Lascano and Dr. Dan R. Krieg, Texas A&M University, and Texas Tech University, Lubbock, TX.

Abstract

In the semiarid Southern High Plains of Texas, several factors have contributed to an increase in land area shifting to dryland cotton production. These factors include, increases in the energy costs to pump water and a decline of water availability for irrigation. The management of dryland cotton production systems is challenging and is a high-risk enterprise given the uncertainty of rainfall during the growing season. The rainfall amount and distribution is variable and agronomic management practices have to be conducive to reduce runoff and thus capture rainfall for subsequent crop use. Factors that need to be considered to manage dryland cotton production are: cotton variety, row direction, planting density, and fertility. A long-term study (1995 to 2002) was conducted in Terry County, Texas to test best management strategies for dryland cotton production in a semiarid environment. Results showed that a row direction that reduces water runoff and offers wind protection, a more indeterminate stripper variety, a plant density of 6-7 plant per m of row, and 45 kg ha^{-1} of nitrogen and 15 kg ha^{-1} of P_2O_5 were the best choices to reduce risk and increase lint yield.

Introduction

Currently, approximately 750,000 ha of dryland cotton are planted in the Texas High Plains and several factors indicate that this area will increase to 1.2 million ha due to three main factors, which are:

1. Decline of water availability to irrigate from the Ogallala aquifer,
2. Increases in energy costs to pump irrigation water, and
3. Conservation Reserve Program (CRP) area returning to production.

Dryland cotton lint yields exhibit large year-to-year variability due to the erratic rainfall. The High Plains of Texas is characterized by a semiarid climate and 75% of the annual rain occurs from mid-April through mid-October, which is the length of the cotton-growing season. The average annual rainfall is 472 mm and 385 mm falls during the growing season (Figure 1). Furthermore, 70% of the rains are < 13 mm per event and the daily potential evaporative demand during the growing season may exceed 10 mm/d. Thus, the combination of low volume rains and high evaporative demand results in losses of 50% or more of the rainfall received (Lascano et al., 1987; 1994).

Management of Dryland Production Systems

The general strategy in areas where both water and fertility are limiting factors is to manage the crop to achieve optimum productivity. The management should fit the needs of the individual and should reduce the amount of stress the crop experiences. Under dryland conditions the majority of the management decisions are made *prior to planting* and for cotton include:

1. Varietal choice (degree of indeterminacy; fiber length and strength)
2. Seeding rate (planting pattern and plant population), which affects the soil volume available to each plant.
3. Fertilility applications.

The relationship between water supply and bolls/plant will determine lint yield and when water is adequate to support growth and development, nutrient supply, especially Nitrogen, represents the *next* limiting factor. We have determined that cotton requires 90 g of N per mm (5 lbs N/inch) of total available water supply (Ralston et al., 2003).

Hypotheses

The overall objective is to combine so-called *Best Management Practices* into a production system that maximizes crop yield and efficiency through better use of the total water resource. We present experimental data from eight-years where hypothesis 1 and 2, below were tested (Ralston, 2005). A statement of our hypotheses follows.

1. Given the erratic rainfall pattern and the high evaporative demand in the Texas High Plains we propose that under dryland conditions solid planted cotton is preferable than a skip-row pattern.
2. Solid cotton planted should be rotated with grain sorghum.
3. Dryland cotton should be planted in a circular pattern in combination with furrow dykes to reduce runoff, capture more water in the soil profile, and reduce the effects of wind damage on cotton seedlings.

Materials and Methods

Experimental fields were established in 1995 in Terry County, TX on 20-ha. The soil is an Amarillo fine sandy loam, typical of the dryland area of the southern High Plains of Texas. A split-plot arrangement was used to test major factors: A) continuous skip-row cotton vs. B) solid-planted cotton in rotation with grain sorghum. Within each of these two systems, the experimental design was a split-plot randomized block with a minimum of four blocks for each variable:

1. <u>Row-spacing</u>: narrow row spacing (0.76 - 0.81 m) vs. conventional 1.0-m. Used to evaluate if narrower rows take advantage of limited rain.
2. <u>Row direction</u>: East-West vs. North-South. Used to evaluate the degree of evaporation from the bare soil due to row shading and increased plant transpiration due to increased plant interception of solar irradiance.
3. <u>Variety</u>: genetic differences evaluated in terms of growth habit and not on commercial varieties planted
4. <u>Plant population</u>: 6-7, 12-13, and 18-20 plants/m of row (2, 4, and 6 plants/ft).
5. <u>Fertility</u>: based on two factors:

a. A target that 65% of the planted seed would produce a plant but this varied due to seed quality and weather, and
b. Stored water supplies prior to planting and long-term average rain, for a lint yield potential of 450 kg/ha.

To achieve this lint yield potential we provided 56 - 67 kg N and 13 - 17 kg P_2O_5 per ha. Both application rate and timing of application were management variables.

Fertilizer was applied pre-plant or in a split-application and was introduced in 1997. Two rates were used at pre-plant:

1) 60 kg N + 15 kg P_2O_5 per ha
2) Half (50%) of the above, i.e., 30 kg N and 8 kg P_2O_5.

The <u>timing of application</u> was 50% pre-plant plus 50% side-dressed at first square.

Each plot had an approximated area ~ 5.0 ha and half was solid-cotton in rotation with sorghum and the other half was continuous skip-row cotton.

<u>Summary of Results and Conclusions</u>

Based on results from the 8-year study we can draw some general conclusions:

1. Solid-planted cotton produced 85% of the lint yield of the skip-row on a planted-area basis, which translates that on a land-area basis the solid-cotton yielded >30% than the skip-row pattern (Figure 2).
2. Cotton in rotation with grain sorghum yielded >10% than continuous cotton, nearly offsetting the yield advantage of the skip-row pattern.
3. Grain sorghum yields averaged >2800 kg/ha providing additional income plus benefits to the subsequent cotton crop.
4. Cost-savings from skip-row cotton do not offset the yield advantages of solid-planted cotton.

Within each system, the various management strategies produced consistent results:

1. No significant differences were obtained between more-determinate types vs. more-indeterminate types. The key in this growing season is to keep the plant from experiencing water stress prior to flowering to establish as many fruiting sites possible. It is preferable to have high lint yield potential at flowering rather than having a restricted plant size.
2. Under limited water supply, plant productivity is influenced by plant density (row spacing and plants per row-length). Results indicated that plant populations of 12-13 plants/m maximize lint yield within the limits of water supply of the TX High Plains.
3. The pre-plant application of 60 kg/ha N + 15 kg/ha P_2O_5 produced the highest lint yield (Figure 3).
4. No statistical differences in lint yield were obtained from row orientation and thus

selection should be based on reducing runoff and wind-speed within rows *suggesting* that a *circular-row* planting pattern might be beneficial under dryland conditions. This is subject of further evaluation.

References

Lascano, R. J., C. H. M. van Bavel, J. L. Hatfield, and D. R. Upchurch. 1987. Energy and water balance of a sparse crop: simulated and measured soil and crop evaporation. Soil Sci. Soc. Am. J. 51:1113-112.

Lascano, R. J., R. L. Baumhardt, S. K. Hicks, and J. L Heilman. 1994. Soil and plant water evaporation from strip tilled cotton: measurement and simulation. Agron. J. 86:987-994

Ralston, W. 2005. Management strategies for dryland cotton production in West Texas. MS. Thesis, Plant and Soil Science, Texas Tech University, 41 pp.

Ralston, W., D.R. Krieg, and T. Gerik. 2003. Management strategies for dryland production in West Texas. Beltwide Cotton Conferences, Nashville, TN 1674-1677.

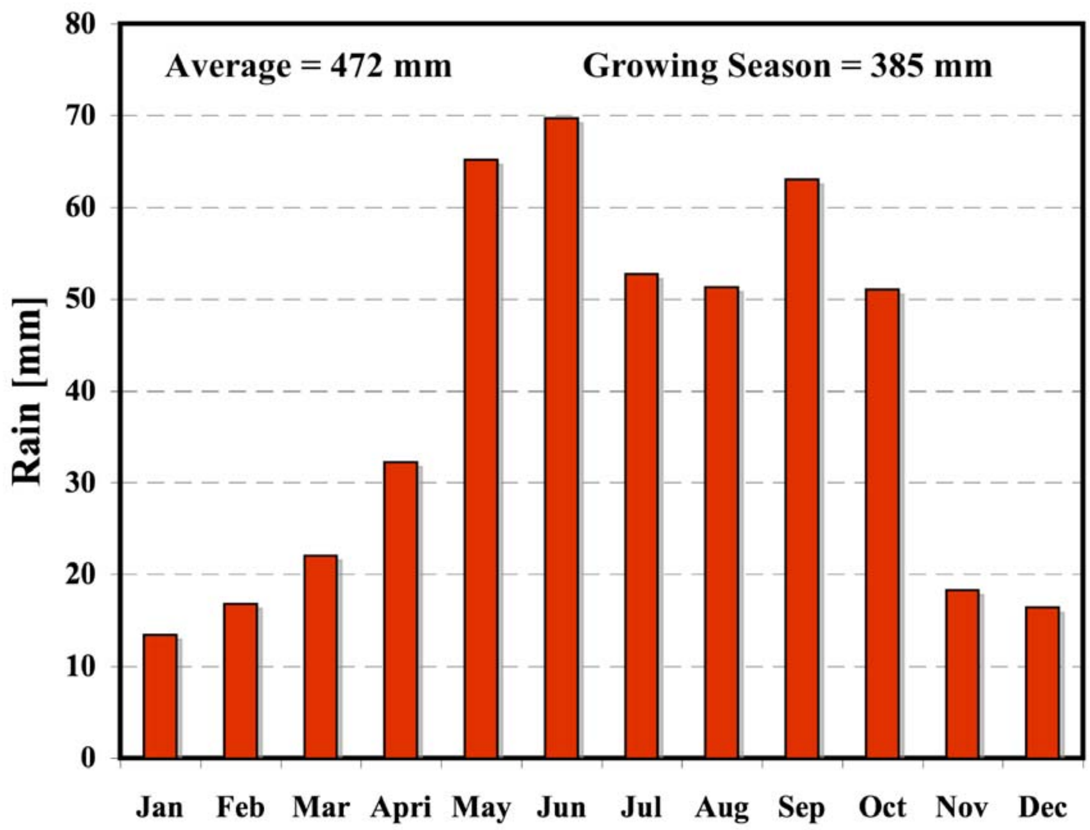

Figure 1. Monthly average rainfall (1925 – 2005), Lubbock, TX.

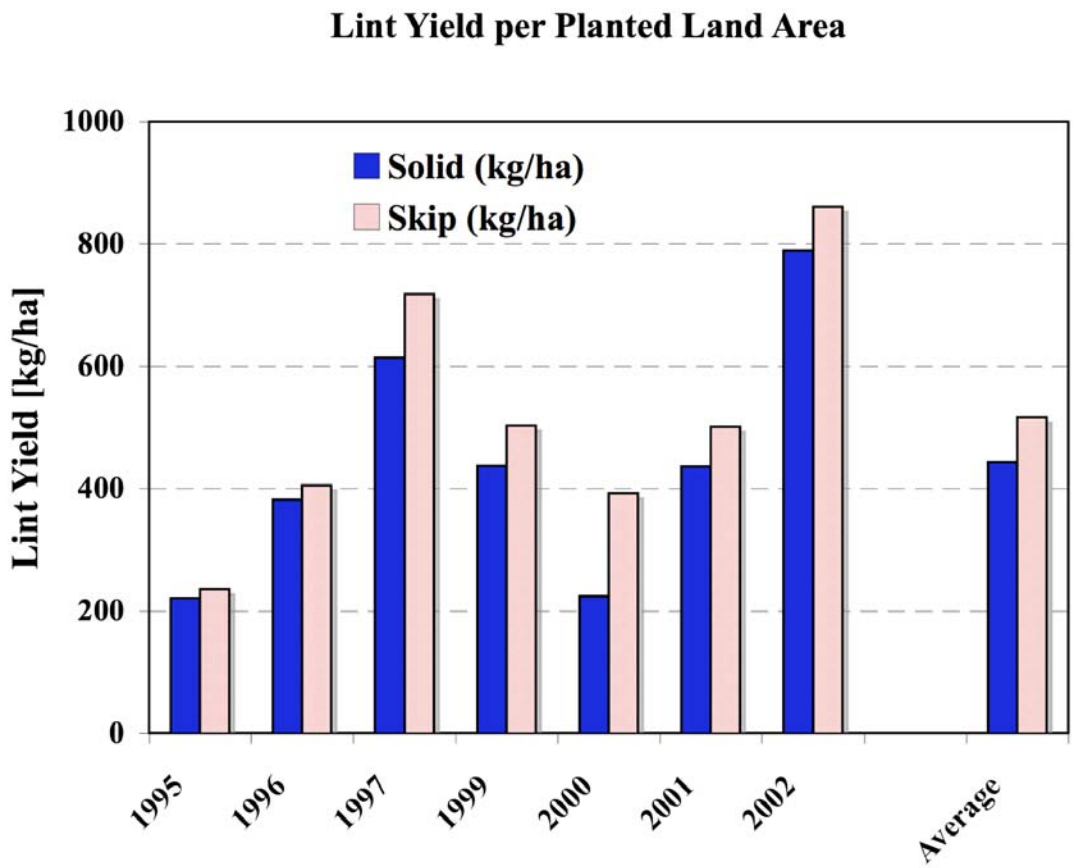

Figure 2. Lint yield per land area for skip-row vs. solid planted cotton.

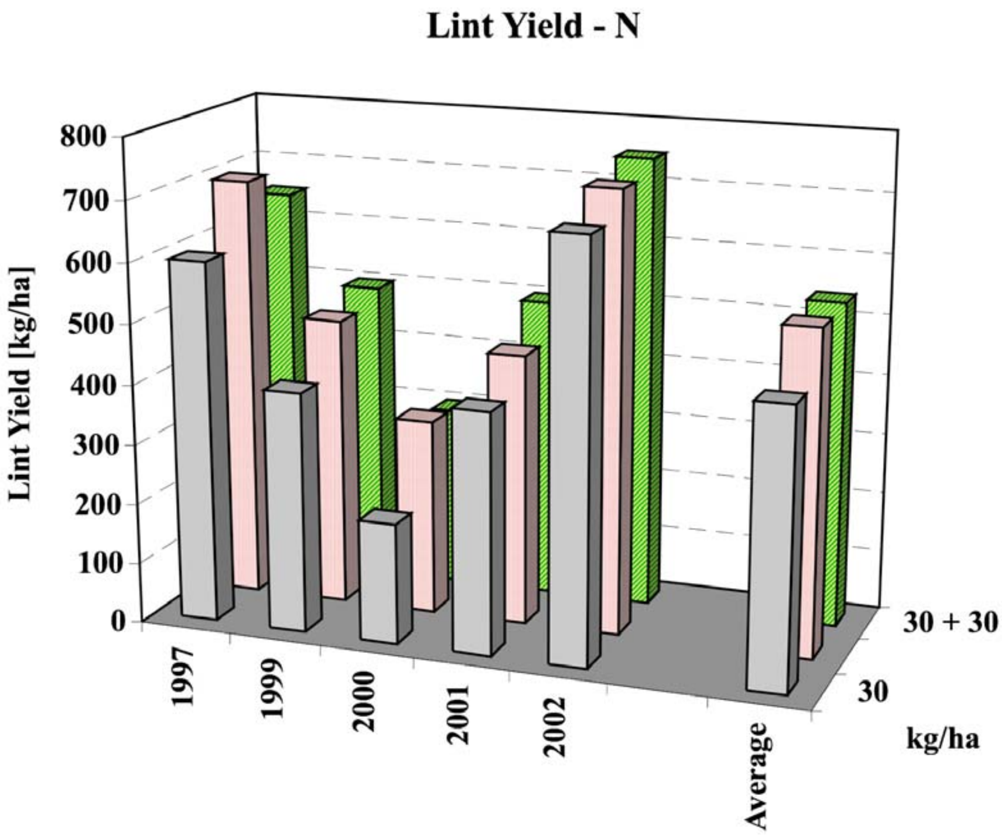

Figure 3. Cotton lint yield related to N fertility and timing of application.