Evaluation of Drip Irrigation Management Strategies in Cotton

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Summary:

Two subsurface drip irrigation management strategies were compared in terms of cotton lint yield and water use efficiency. As water becomes more valuable, conversion to the most efficient irrigation systems using optimum management is crucial. Cotton was grown in replicated, 0.5-ha plots using either high levels of nutrients, growth regulators, pest control, and ample irrigation (*High Input*), or traditional levels of cotton inputs (*Normal Input*). Based on the results to date, concentrating available water resources in a smaller area, meeting evaporative demand, and utilizing higher levels of inputs and management has resulted in 13% higher water value than traditional levels of inputs and management with SDI systems on the South Plains.

Progress Report:

Purpose: Limited irrigation supplies and high pumping costs continue to be major obstacles to profitable cotton production requiring the use of efficient delivery systems. The most efficient irrigation method is subsurface drip irrigation (SDI). The biggest drawback to wider use of SDI is its high initial cost. Comparisons of water use and economic efficiency of spreading limited irrigation water over large areas, using SDI with normal crop inputs, versus concentrating available water on smaller land areas, using SDI with more intense management, need to be made. Use of SDI as a water and energy saving tool will increase if initial installation costs can be reduced, cotton lint yields increased, or the system used to better deliver nutrients and pesticides compared to traditional methods.

Objectives: The objective of this study is to compare production inputs and resulting lint yields of two cotton management scenarios – *High Input* for maximum yield versus *Normal Input* for sustainable yield.

Procedures: A 4.9-ha SDI system was installed with drip lines in alternate 0.75-m furrows. Ten 0.5-ha zones were constructed with zone sizes of 400-m by 16 rows. Each zone was independently controlled and metered. In 2002, 2003 and 2004 two cotton management strategies were compared. The first strategy was a high-input, high-yield management scenario with the production goal of 1960 Kg lint/ha and no restriction on input levels (**High Input**). Following this strategy, one would install SDI in a limited area and apply all available supplemental water resources through the SDI system, with the remainder of the area devoted to dryland production. The second strategy (**Normal Input**) provided traditional input levels with an annual cotton lint yield goal of 1400 Kg lint/ha. Following this strategy, one would install SDI on a larger area, compared to the *High Input* scenario, limiting available irrigation water, therefore, not meeting 100% of crop water needs during peak demand periods.

The *High Input* protocol called for early planting with "less determinant" cotton varieties thereby increasing yield potential in normal growing seasons. Nutrients were applied with the SDI system based on yield potential and crop development. Insect pests were monitored on a weekly basis from crop emergence through mid-August and controlled at very low thresholds to prevent fruit loss or plant stresses. Growth regulators were applied to prevent excessive vegetation. Irrigation water was applied daily in quantities that slightly exceed estimated ET using local climatic inputs. The *Normal Input* protocol had been used in irrigation experiments from 1999 to 2001 at Halfway. Irrigations were limited by pumping capacity of 5.0 mm/d, most of the nitrogen applied prior to planting by ground application, a popular storm-proof cotton variety was planted, limited growth regulators were applied, and insect pests were treated at locally established thresholds.

The two management treatments were replicated four times. Two additional drip zones were treated as "dryland" areas receiving no seasonal irrigation. Volumetric soil water content was monitored with neutron attenuation techniques during the irrigation period. Cotton was harvested and lint yields were determined by machine stripping areas up to 27 m^2 at five locations within each plot and ginning sub-samples to determine lint turnout, fiber value and lint yields.

Results: Weather played a major roll in determining test results with the 2002 and 2003 growing seasons being extremely dry and 2004 being wet and cool. Table 1 gives lint yield, loan values, gross production values, seasonal irrigation water use efficiencies, and water values for the 2002, 2003 and 2004 test years. Until 2004, the *High Input* methodology resulted in significantly higher lint yield, better fiber quality resulting in higher loan values, and higher seasonal irrigation WUE than the *Normal Input* treatments. However, in the high rainfall year of 2004, the *High Input* treatment produced 55 Kg/ha less lint than the *Normal* treatment with respective yields of 1800 and 1855 Kg/ha. Estimated gross lint value was also higher in the *Normal Input* treatment than *High* treatment due to higher lint value and yield. Since smaller seasonal irrigation quantities were applied resulting in larger yields in 2004, water use efficiency was 42% higher in the *Normal* treatment (significant, $P<0.05$, Duncan) compared to the *High* treatment, 0.30 versus 0.211 Kg lint/m^3, respectively. The lack of yield differences among irrigated treatments in 2004 was attributed to the high seasonal rainfall and the unusually cool temperatures during the latter part of the year.

The average yield difference between the two management treatments over the three-year test period was 323 Kg/ha/yr in favor of the *High Input* treatment. The difference in the average gross value over this period was $395/ha/yr in favor of the *High Input* treatment. The most significant finding, however, is that the highest seasonal water value over this period came from the *High Input* treatment at \$0.392/m^3 versus \$0.346/m^3 from the *Normal* treatment or a 13% increase due to the *High Input* treatment. Therefore, producers can spend less on SDI installations and seasonal irrigation water can be sold at a higher value by using the strategy of concentrating available water and other resources on smaller areas rather than trying to irrigate the whole farm.

Conclusions: Based on the results to date, concentrating available water resources in a smaller area, meeting evaporative demand, and utilizing higher levels of inputs and management than normally used with traditional irrigation systems appears to the better option when using SDI systems on the South Plains. Evaluations will continue to better define optimum economic and water conserving options with SDI.

Recommendations: Based on the results to date, seasonal irrigation water can be sold at a higher price while produces spend less on SDI irrigation systems by concentrating water resources to meet the water needs of cotton compared to irrigating the entire farm and using traditional levels of inputs.

Table 1. Comparison of cotton lint yield, loan values, and water use efficiency, and water values from *Normal* and *High Input* treatments irrigated by SDI at TAES, Helms Farm, 2002, 2003, and 2004.

	Dry	Normal Input*	High Input	Difference From Normal to High
Seasonal Irrigation (mm)				
2002	0	295	399	104
2003	0	216	267	51
2004	0	310	415	105
Average		274	360	87
Yield (Kg/ha)				
2002	350	1182 b	1755 a	574
2003	350	1138 b	1590 a	452
2004	457	1855 a	1800 a	-55
Average		1392	1715	323
Loan Values ($/Kg)				
2002	0.96	0.98 b	1.06 a	0.08
2003	1.04	1.15 b	1.21 a	0.06
2004	1.09	1.09 a	1.04 b	-0.05
Gross Value @ Loan ($/ha)				
2002	336	1154	1871	717
2003	367	1308	1920	612
2004	498	2021	1876	-145
Average		1494	1889	395
Seasonal Irr. WUE (Kg/m^3)				
2002	-	0.282 b	0.353 a	0.071
2003	-	0.365 b	0.465 a	0.100
2004	-	0.300 a	0.211 b	-0.089
Seasonal Water Value ($/m^3)				
2002	-	0.277 b	0.385 a	0.108
2003	-	0.435 b	0.582 a	0.147
2004	-	0.327 a	0.209 b	-0.118
Average		0.346	0.392	0.046

* Means followed by the same letter in the same row are significantly different (P<0.05, Duncan)