EFFECT OF AN ANTI-TRANSPIRANT ON COTTON GROWN UNDER CONVENTIONAL AND CONSERVATION TILLAGE SYSTEMS

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Abstract

The polyacrylamide anti-transpirant 'Anti-Stress 550' was applied twice during the 1996 growing season to cotton plants grown under conventional, minimum, and no tillage. There were no significant lint yield differences between tillage systems, although weed pressure, as measured by weed biomass, was highest in the no till system compared to the other two systems (P=0.02). The increased yield benefit from use of the anti-transpirant was observed only in conventional tillage (63%, P=0.13). Daily plant water use measured in the conventional tillage system on 18 June and 14 July was 42 and 48% lower in plants receiving anti-transpirant applications.

Introduction

Water curtailment for irrigated crop production in the Lower Rio Grande Valley of Texas (LRGV) has become a reality (Fipps, 1996). Because of the impact of the recent long term drought, the 1997 water allocation for cotton producers will result in fewer acres irrigated in the LRGV.

The successful implimentation of conservation tillage in the LRGV has been based on production economics (Smart and Bradford, 1996). Conservation tillage can improve soil gravimetric water (Blevins and Frye, 1993). Crop anti-transpirants have the potential of offering additional water savings. Farnesol, an endogenous growth substance which is produced by plants under water stress, was sprayed at the seventh leaf stage on cotton plants grown in 2.5 L containers at rates of 0 to 90.8 g a.i./ha (Walter et al, 1982). Leaf reflectance was increased and leaf water content decreased only in stressed plants not sprayed with farnesol. Plant dry weights were not significantly increased by any farnesol concentration in either stressed or watered plants. A white clay, kaoline, when sprayed as a 6% emulsion, was found to improve cotton leaf water content, reduce leaf water potential, and increase yield of seed cotton 2.37 q/ha over untreated cotton (Gidda and Morey, 1981). Phenyl mercuric acetate, sprayed at 2×10^{-4} M, though effective in reducing cotton leaf permeability and transpiration loss compared to control plants, became less effective as soil moisture tension increased (Pasternak and Wilson, 1971). Under rainfed conditions, cotton seed which had been soaked in 0.02% chlormequat chloride (CC) and foliarly sprayed with a mixture of 0.02% CC + 0.04% catechin or soaked in 0.1% succinic acid and then foliarly sprayed with a mixture of 0.1% succinic acid + 0.04% catechin at first flowering and again at boll initiation, had significantly higher yields than untreated cotton of 0.54 vs 0.3 t/ha (Shanmugham, 1991).

My objective was to evaluate, in conjunction with an on-going conservation tillage experiment, the performance of a polymeric anti-transpirant being recommended by the private sector for its potential in improving cotton yield and maintaining or reducing current irrigation requirements.

Material and Methods

'Delta Pine and Land 50' was planted on 3 Mar. 1996 into three existing (since 1995) tillage systems consisting of conventional cutivation, minimum tillage and no tillage (Smart and Bradford, 1996). The crop, planted into moisture on 78 cm centers in a Hidalgo sandy clay loam soil, was given 50 Kg N /ha on 3 May. Furrow irrigations were made on 30 Apr. and 24 May. An additional 8.2 cm of water was in the form of rainfall. The polyacrylamide 'Anti-Stress 550' (Polymer AG, Fresno, CA) was applied at 1:100 dilution on 17 June and again on 3 July. Plant leaf number, height, canopy girth, and cotton square, bloom and boll data were taken on 20 May, 13 June, and 15 July. Pesticide applications were made on 10 June, 14 June, and 25 June. Mature bolls were picked on 18 July (harvest 1) and 1 Aug. (harvest 2). Sub-plots consisted of 6 rows and were 4.6 x 73 m in size.

Soil moisture was monitored at 38, 76, and 114 cm depths in two of the replications by a neutron probe (Troxler, Raleigh, NC). In the conventional tillage treatment, only, soil moisture adjacent to plants being measured for transpiration loss (sap flow) was measured from a 0-30 cm depth at 6 hr intervals using transient time reflectance probes (Campbell Sci., Logan, UT). Plant sap flow (Dynamax, Houston, TX) was measured at 30 min. intervals on 6 June and 14 July and again on 17 July after a simulated irrigation. Only treated and untreated plants in a conventional tillage plot were measured for sap flow.

Tillage systems were whole plots and anti-transpirant treatments were sub-plots in a randomized complete block design having 4 replications.

Results and Discussion

Mean plant populations between conventional (51,860 plants/ha), minimum tillage (49,708 plants/ha) and no tillage (47,771 plants /ha) were similar (P=0.35). Tillage system had no effect on plant leaf or flowering attributes measured during the season. The number of primary leaves tended to be higher in plants grown under conventional vs no tillage (P=0.10, data not shown). Conventionally tilled cotton had higher lint yields than either minimum tillage or no tillage

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(P=0.25) (Table 1). Anti-transpirant-sprayed plants averaged higher bolls/plant across all sampling dates than did unsprayed plants (3.76 vs 2.57, P=0.09), respectively. Anti-transpirant application improved plant lint yields by 63% compared to no anti-transpirant application only in conventionally tilled plants. Weed biomass (dry wt. basis) of 22, 61 and 309 kg/ha were similar between conventional and minimum tilled cotton but higher (P=0.02) in no till cotton, respectively. Although no-till grown cotton matured earlier, presumably from weed competition, anti-transpirant application had no effect on cotton lint maturation (data not shown), but there was a tillage x treatment interaction in yield (Table. 1).

Soil moisture at 38 cm was uniform between tillage systems until late in the growing season, when weed pressure developed in the conservation tillage systems (Fig. 1). At soil depths of 76 and 114 cm, the no till system had nominally higher soil moisture content than did the soil in the other tillage systems. Within each tillage system there were no differences or trends in soil moisture in plots where plants had or had not been sprayed with an anti-transpirant.

Soil moisture monitored at the 0 - 30 cm depth in sub-treatment plots of conventionally grown cotton tended to have higher soil water content (%) when plants were sprayed with the anti-transpirant (Fig. 2). Daily plant sap flows were 19 vs. 27 g water/g plant dry wt or 42% less on 18 June and 8.0 vs. 11.8 g/g or 48% less on 14 July in the plant sprayed with the anti-transpirant compared to the plant sprayed with water. After irrigating test plants on 15 July, the non-sprayed plant became very porous to water loss relative to the plant which was sprayed with anti-transpirant. Daily water transpiration increased 99% in the unsprayed plant compared to the sprayed plant (14.7 vs 7.4 g/g). There appeared to be daily qualitative transpirational differences between treatments (Fig. 3).

Summary

'Anti-Stress 550' may be useful in improving lint yield and conserving gravimetric soil water loss of conventionally tilled cotton by reducing plant transpirational water loss. In this experiment, the inability to control weeds in the no-till treatment may have masked the potential benefits in soil moisture savings to conservation tillage-grown cotton. The efficacy of other polymeric anti-transpirants, particularly in conjunction with insecticide applications, should also be evaluated.

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Table 1. Effect of an anti-transpirant on lint yield when cotton was grown under three tillage systems.

	Lint Weight (kg/ha)	Lint Yield (%)
Tillage system:		
Conventional	472 a	49 a
Min. tillage	370 b	33 b
No tillage	338 b	34 b
	0.25[z]	0.18
Anti-transpirant:		
No	355 b	38 a
Yes	432 a	40 a
	0.14	0.60
Interaction:		
Conv. X No	359 b	46 a
Conv. x Yes	585 a	53 a
Min. till x No	380 b	33 a
Min. till x Yes	359 b	33 a
No till x No	326 b	34 a
No till x Yes	351 b	34 a
	0.13	0.64

[z] Probability of a greater 'F' value. Mean separation at probability value given.

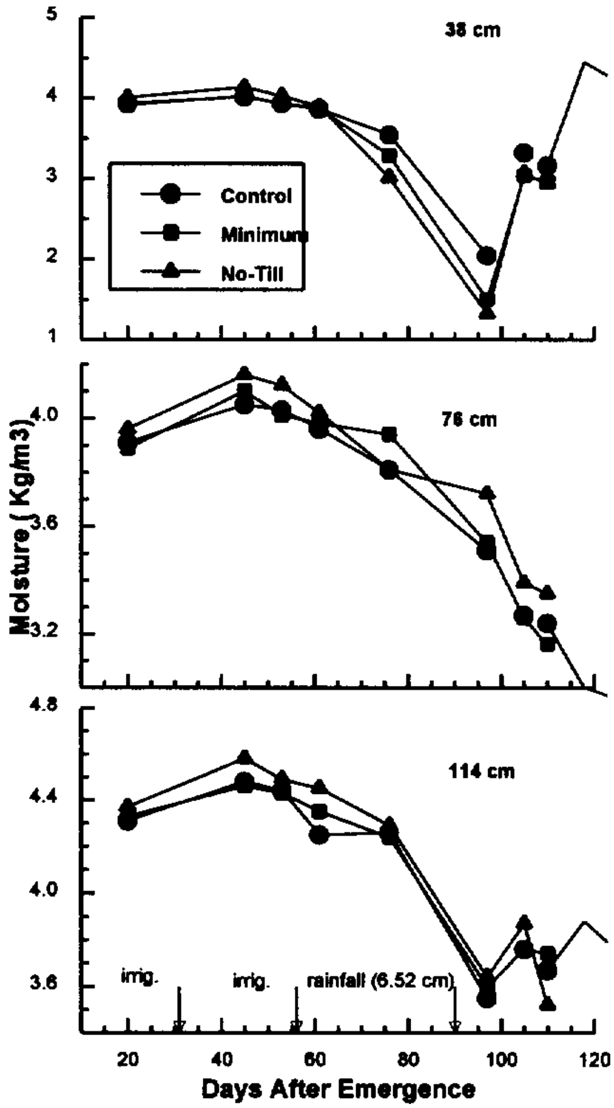

Figure 1. Seasonal soil moisture at three soil depths in conventional (control), minimum, and no-till systems.

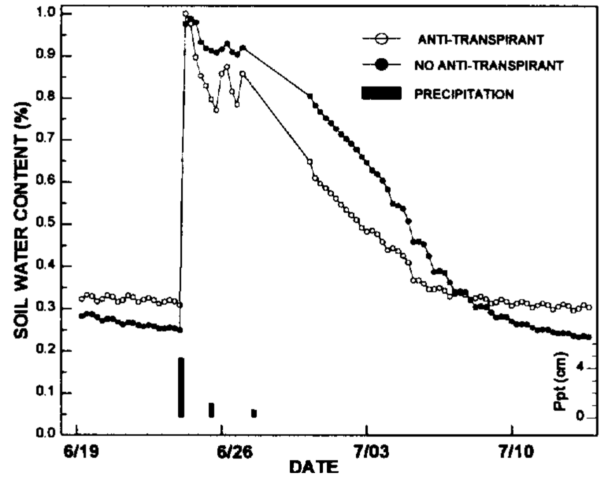

Figure 2. Soil water content of respective conventional tillage subplots during period of control and anti-transpirant sap flow measurements.

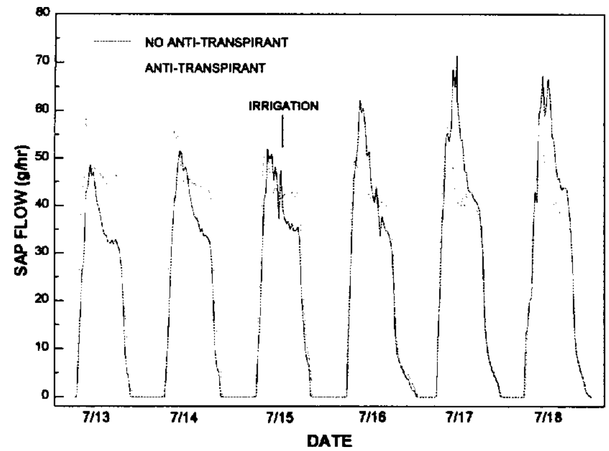

Figure 3. Daily sap flow rates of plants either sprayed or not sprayed with anti-transpirant before and after irrigation.