EFFECTS OF GLYCINE BETAINE AND WATER REGIME ON DIVERSE COTTON CULTIVARS

Cassandra R. Meek and Derrick M. Oosterhuis[1]

RESEARCH PROBLEM

Water availability is considered the most limiting factor in crop production, and high yields are dependent on adequate water supply. A strategy that plants often use to overcome water deficit is the accumulation of solutes (osmotic adjustment) in the cell to help maintain plant water status, particularly turgor. This has not been made use of commercially in cotton production to alleviate drought. Recently, however, a new spray of glycine betaine, has been proposed to enhance osmotic adjustment and improve drought and heat stress. Our report addresses field tests of this product.

BACKGROUND INFORMATION

Glycine betaine has been exogenously applied to many crops that accumulate, or do not accumulate, glycine betaine in an effort to improve stress tolerance and yield. The effects of glycine betaine on plants during periods of inadequate water supply have been studied in maize and sorghum (Agboma *et al.*, 1997), and cotton (Gorham and Jokinen, 1998). Results have varied and appear to depend on numerous factors including type of crop, timing and rate of application, and environmental conditions. A preliminary field study was conducted in Arkansas in 1998 to evaluate the effects of foliar-applied glycine betaine on cotton with a mild drought stress imposed 2 weeks after first flower (FF) (Meek and Oosterhuis, 1999). This report summarizes the 1999 follow-up field studies.

RESEARCH DESCRIPTION

Two field studies were planted in early May 1999 into a Dundee silt loam soil at the Delta Branch Research Station in Clarkedale in Northeast Arkansas. Pest control and fertilizer management were provided according to Arkansas cotton production recommendations. Plots consisted of four rows, 15.24 m in length, spaced 0.97 m apart. Foliar sprays were applied with a CO_2 backpack sprayer calibrated to deliver 10 L of solution/ha. In both studies, a nonionic adjuvant, Monsoon, was used at 0.2% of total spray volume.

[1] Graduate Assistant and Distinguished Professor, respectively, Department of Crop, Soil and Environmental Sciences, University of Arkansas, Fayetteville.

Rate and Timing Study

In the rate and timing study, six replications of cultivar Suregrow 125 were arranged in a randomized complete-block design, with no irrigation. Foliar applications began at FF and continued for 4 weeks. Treatments consisted of three rates of glycine betaine (2, 4, and 6 kg/ha) applied weekly, biweekly, or monthly, and an untreated control for a total of 10 treatments. Yield was determined from the middle two rows of each plot harvested with a mechanical picker. Boll weights and fiber quality were calculated on the basis of 30 hand-picked mid-canopy bolls per plot.

Water-Stress and Cultivar Study

The water-stress and cultivar study consisted of six replications arranged in a split-split plot design. The three factors were (1) water: irrigated vs. nonirrigated, (2) foliar treatment: 4 kg/ha glycine betaine + adjuvant vs. adjuvant only, and (3) cultivar: Siokra L-23 (drought tolerant) vs. Stoneville 506 (drought sensitive). Treatments were applied at FF and FF + 2 weeks. Measurements of photosynthesis and osmotic adjustment were taken at 2, 4, and 6 weeks after FF. Yield was determined from the inside two rows of each plot with a mechanical picker. Boll numbers, boll weights, seed number, seed weight, lint percent, and fiber quality were determined by hand-harvesting 2 m^2.

RESULTS AND DISCUSSION

In the rate and timing study, no significant differences existed between control and glycine betaine-treated plants (Table 1). Although not significant (P=0.05), plants treated biweekly with 2 kg/ha glycine betaine had the highest lint yield. All other glycine betaine treatments appeared to have lower lint yields compared to the untreated control.

In the water-stress and cultivar study, there were no significant differences (P=0.05) in yield components (Table 2) between glycine betaine-treated and control plants. The drought-sensitive cultivar, Stoneville 506, had significantly (P=0.05) higher yields compared to the Siokra-L23. No significant differences were observed in photosynthetic rates or osmotic potential (Table 2). Glycine betaine-treated plants had numerically lower osmotic potentials, suggesting glycine betaine might enhance osmotic adjustment but this was not reflected in improved yields.

PRACTICAL APPLICATION

These studies have shown that foliar glycine betaine does not improve yields in field-grown cotton subjected to drought or well-watered conditions. This information is beneficial to producers who might consider this product in the future. While the yield results were disappointing, this research can provide insight into the response of cotton to drought conditions.

LITERATURE CITED

Agboma, M., M.G.K. Jones, P. Peltonen-Sainio, H. Rita, and E. Pehu. 1997. Exogenous glycinebetaine enhances grain yield of maize, sorghum and wheat grown under two supplementary watering regimes. J. Agron. and Crop Sci. 178:29-37.

Gorham, J. and K. Jokinen. 1998. Glycinebetaine treatment improves cotton yields in field trials in Pakistan. Abstracts. World Cotton Research Conference II, Athens, Greece. August, 1998. p. 329.

Meek, C.R. and D.M. Oosterhuis. 1999. Effects of foliar application of glycine betaine on field-grown cotton. *In:* D.M. Oosterhuis (ed.). Proc. 1999 Cotton Research Meeting and Summaries of Research in Progress. University of Arkansas Agricultural Experiment Station Special Report 193:103-105.

Table 1. Effects of foliar application of glycine betaine on boll weight and lint yield of dryland cotton in 1999 at Clarkedale, Arkansas.

Treatment	Boll Weight	Lint Yield
	g/boll	g/m^2
Control[z]	4.1	916
2 kg/ha weekly[y]	4.9	825
4 kg/ha weekly	4.4	841
6 kg/ha weekly	4.7	829
2 kg/ha biweekly[x]	4.7	931
4 kg/ha biweekly	4.7	857
6 kg/ha biweekly	4.6	801
2 kg/ha monthly[w]	4.6	864
4 kg/ha monthly	4.6	842
6 kg/ha monthly	4.7	827
LSD (0.05)	0.39	75.6

[z] Adjuvant was not applied to control plants.
[y] Rate of glycine betaine applied weekly from FF through FF + 4 weeks for a total of 5 sprays.
[x] Rate of glycine betaine applied biweekly from FF through FF + 4 weeks for a total of 3 sprays.
[w] Rate of glycine betaine applied monthly from FF through FF + 4 weeks for a total of 2 sprays.

Table 2. Effects of glycine betaine, water stress, and cultivar on boll weight, lint yield, photosynthesis, and osmotic potential in 1999 at Clarkedale, Arkansas. Differences between glycine betaine-treated and untreated plants were not significant.

Treatment	Boll Weight	Lint Yield	Photosynthesis[z]	Osmotic Potential[z]
	g/boll	g/m^2	$\mu mol/CO_2/sec$	MPa
Siokra L-23				
Water-Stressed				
Control	3.6	760	36.4	–1.84
Glycine Betaine[z]	3.4	671	36.4	–1.92
Well-Watered				
Control	3.8	811	38.1	–1.76
Glycine Betaine	3.7	777	37.0	–1.78
Stoneville 506				
Water-Stressed			34.1	–2.21
Control	3.3	823	34.1	–2.35
Glycine Betaine	3.5	887		
Well-Watered				
Control	3.8	1031	38.9	–1.49
Glycine Betaine	3.9	1242	34.0	–1.89

[z] Measurements were made at FF + 4 weeks.
[y] Glycine betaine applied at 4kg/ha at FF and FF + 2 weeks.