Comparative Responses of Three Cotton Varieties to Mid-July 2005 Application of Chaperone^{TM} in the Palo Verde Valley

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Abstract

Chaperone^{TM} was applied in mid-July to three different cotton varieties (DPL 449BR, DPL 555BR, STV 5599BR) being grown in the same field. Varieties differed in their responses, with application of Chaperone^{TM} resulting in fewer fruiting structures per plant than untreated DPL 449BR or STV 5599BR, but more such structures in DPL 555BR. Seed cotton yields were increased in DPL 555BR by almost 300 lbs./acre by application of Chaperone^{TM}, but were only about 20 lbs./acre greater in the other two varieties. A higher percentage of lint in seed cotton was associated with Chaperone^{TM} application in both DPL 449BR and STV 5599BR, but a lower percentage in DPL 555BR. Calculated lint yields increased in both DPL 449BR and STV 5599BR, but yields were almost identical for treated/untreated DPL 555BR in this experiment. Application of Chaperone^{TM} resulted in a slight increase in fiber uniformity in all three varieties.

Introduction

Cotton production in the low desert areas of Arizona and California is often hindered by the high summer temperatures which have deleterious effects on yield, with crop losses due to this factor estimated to be at least one bale/acre in many years. A number of plant growth enhancement chemistries have recently become available for usage on cotton, and the potential for negating the effects of high temperature exists. One such product is Chaperone^{TM}, a product registered for usage on Arizona cotton in 2005 (although currently non-registered for such usage in California).

Chaperone^{TM} is labeled as a protein transport enhancer, and consists of a three similar active ingredients. These are sodium p-nitrophenolate (0.30%); sodium o-nitrophenolate (0.20%), and sodium 5-nitroguaiacolate (0.10%). The label notes that this product increases the uptake of proteins that are necessary for plant growth resulting in increased yield. A number of posters and presentations at recent Beltwide Cotton Conferences have indicated that usage of Chaperone^{TM} in Texas and Arkansas resulted in yield increases. The exact reason for this is still unknown and may be partially a factor of increased insect control of lepidopterous insect larvae, as has been documented (under elevated temperatures) to increase protein concentration and therefore efficiency of endotoxin expression (Brown and Oosterhuis, 2005).

Yield increases from usage of Chaperone^{TM} in the low desert would be expected from better plant growth rather than from usage of this product due to insect control however. The most damaging lepidopterous pest (pink bollworm) is very adequately controlled by current cotton varieties containing *Bacillus thuringiensis* while other lepidopterous pests are prevalent in Texas and Arkansas area. Usage of Chaperone^{TM} for insect control in the low desert via enhanced protein concentration may be most effective in late summer and early fall period as days shorten and daily photosynthetic rates decrease, the same period that pink bollworms are surviving longer into their development with this effect thought associated with less expression of *Bacillus thuringiensis* in cotton plants at this time of year.

As cotton varieties differ in their genetics, the potential exists that differences in responses to application of Chaperone™ also exists, although this has not been evaluated under low desert production conditions. This study was initiated to determine if such differences exist for cotton varieties grown in the low desert in response to application of Chaperone™.

Methods and Materials

Three cotton varieties (DPL 449BR, DPL 555BR, STV 5599BR) were planted in 60 row blocks in the same field in approximately April 7, 2005, southeast of Blythe, CA, and then irrigated to initiate germination. Chaperone™ was applied at a rate of 5 oz./acre the morning of July 15 with a Melroe SpraCoupe calibrated to deliver 20 gpa. Prior to adding Chaperone™ to the mix tank, water was buffered with Tri-Fol® (25% aliphatic polycarboxylate, 3% calcium, Wilbur Ellis Co.) at a rate of 0.25% v/v. After Chaperone™ was in solution, First Choice® Solar™ was added to spray tank at the rate of 1 pt/100 gal with the intent of keeping product moist for a longer period of time, thereby increasing uptake and effectiveness. First Choice® Solar™ is a spreader sticker methylated seed oil, comprised of a proprietary blend of 99% polyalkyleneoxide modified polydimethylsiloxane nonionic emulsifiers and methylated seed oil (marketed by Western Farm Service, Inc.). Soil condition at time of application was very moist.

Treatment areas were eight rows wide (40 inch row centers) x field length (1,185 ft), resulting in four replications for each variety, and alternated with eight untreated rows. A few treated plots within a variety were only four rows wide if the Chaperone™ application straddled two cotton varieties. Prior to application, five plants were mapped per plot on July 14 to establish baseline plant growth condition at time of application (Table 1). A soil sample was taken the morning of July 15 immediately prior to application to establish soil fertility levels (Table 2).

Petioles for nitrogen, phosphorus and potassium analyses were obtained on August 4th by collecting 15-25 petioles of fifth leaves from plant terminal in each plot. Nutrient levels (ppm nitrate nitrogen, phosphorus, percent potassium) were determined through laboratory analyses (Stanworth Crop Consulting, Blythe, CA).

All plots were plant mapped in a three day period beginning August 16. Plant mapping was completed using five plants per plot. Data were obtained for plant height, total nodes, first fruiting node, and fruiting site retention at site 1-3 for each fruiting node as applicable. Averages were calculated for height:node ratio; plant height, first fruiting node, nodes, average retention for positions (fruiting sites) 1, 2, 3; and retention for positions 1-2 and positions 1-3.

Plots were harvested with a four-row John Deere picker on Dec. 29-30, 2005. All rows of each individual plot were harvested, and seed cotton weight for each plot was obtained using a "CrustBuster" boll-buggy. All rows of the same treatment of each variety were placed together in a module and kept separate from cotton from other treatments to obtain quality and turnout data after ginning. Commercial ginning (Modern Gin, Blythe, CA) was used for turn-out percentages for DPL 555BR and STV 5599BR, while a small (approximately 5-10 lb. sample) composite sample of seed cotton was obtained from each treatment by sampling each replicate after picking and then placing in a bag for the DPL 449 plots. These seed cotton samples were later ginned by University of Arizona personnel at the Maricopa Agricultural Center to obtain lint turnout percentages. Fiber analyses were conducted at the USDA cotton classing facility in Phoenix, AZ, from all bales after ginning. The turnout and other information were then utilized to calculated lint yields per acre as well as acreage values of cotton.

Means and separations for many variables as affected by treatment were calculated using Fisher's least significant difference (Statgraphics Plus for Windows, version 3; Manugistics, Inc.) as data set allowed. Some data (lint turnout, quality) consisted only of a single data point for each treatment and thus was unable to be statistically analyzed.

Results

Nutrient levels in petioles

No significant differences existed for nitrate or phosphate parts/million, nor for potassium percentage (Table 3). Application of Chaperone™ did result in numerically more nitrate and decreased phosphate in both DPL varieties, but less nitrate and more phosphate in STV 5599BR. Average potassium percentage was very similar ($\pm$0.07%) in both DPL varieties, but was 0.37% higher in Chaperone™ treated STV 5599BR cotton than in untreated cotton of this variety.

Differences in petiole nutrient levels was much greater due to cotton variety than due to treatment for all three nutrients (Table 4). STV 5599BR had significantly lower potassium percentage (2.02%) and phosphate levels (733 ppm) than either DPL variety (1,730 $\pm$405 ppm phosphate; 2.62 $\pm$0.11%potassium). STV 5599BR also had much higher nitrate levels (988.5 ppm) than DPL varieties, significantly more so than that of DPL 449BR.

Heights and nodes

Consistent differences in plant heights were not noted by application of Chaperone™, nor were number of nodes per plant (Table 5). Application of Chaperone™ resulted in slightly taller plant heights of DPL 555BR, but shorter heights in both DPL 449BR and STV 5599BR when compared with the untreated check (Table 5). Effect on number of nodes also varied by variety with a numeric increase noted in DPL 449BR, a decrease in STV 5599BR and almost identical mean numbers of nodes for DPL 555BR when compared with untreated cotton of the same variety. Similar trends were noted for first fruiting node and numbers of fruiting nodes.

Retention percentages

Retention percentages varied widely a result of both Chaperone™ application as well as variety (Table 6). Largest numerical difference due to treatment occurred at the first position of DPL 449BR, where untreated cotton had 23.2% higher retention than Chaperone™ treated DPL 449BR cotton. Substantial, but non-statistical, differences occurred at all positions which were plant mapped of this variety, indicating a negative response to Chaperone™ application.

The opposite findings were noted for DPL 555BR cotton, as application of Chaperone™ resulted in increased retention at all fruiting positions mapped (Table 6), with a small but statistical increase of 6.3% at position 1, similar to the increase at all positions on this variety. Retention percentages at the fruiting positions mapped for STV 5599BR were inconsistent, with untreated cotton having higher retention percentages (approximately 9%) for positions 1 and 2, but Chaperone™ treated cotton had 6.1% higher retention for position 3. The reason(s) for these different retention values is/are not clearly evident.

Calculated fruiting structures per plant

Significant differences were noted for numbers of fruiting structures/plant in mid-August, with differences thought to be a result of Chaperone™ interaction with variety as treatment results were very inconsistent. DPL 449BR and STV 5599BR results were similar, with decreased numbers of fruiting structures per plant noted for Chaperone™ treated cotton at positions 1, 2, 1-2 and 1-3. Greater differences were noted with DPL 449BR (almost 40% for combined positions 1-2 and 1-3) than for STV 5599BR at these positions (Table 7). Significantly more fruiting structures per plant at combined positions 1-2 were noted for untreated STV 5599BR cotton, but not at combined positions 1-3. This may be partially due to more fruiting structures per plant being noted on Chaperone™ treated cotton at position 3 (5.4) than untreated cotton (4.5) for STV 5599BR and is a reflection of the previously discussed increased retention at this position.

DPL 555BR cotton did not follow the same pattern as the other two varieties as Chaperone™ application resulted in increased numbers of fruiting structures/plant at all mapped positions (Table 7). Significant differences were noted at position 1 (7.2 vs. 5.9) as well as combined positions 1-2 (12.4 vs. 9.7). Chaperone™ application resulted in 21% more fruiting structures at combined positions 1-3 for DPL 555BR, very similar to the reduction in fruiting structures a these positions noted from STV 5599BR.

Seed cotton yields, turnout and lint yields

Usage of Chaperone™ resulted in a mean numerical increase in seed cotton for each variety, however this increase was not significant even when data were pooled for all varieties (Table 8). Greatest numerical increase of seed in a variety from Chaperone™ application was noted in DPL 555BR (291 lbs./acre). This was also the only variety that noted a significant increase in fruiting structures at positions 1-2 associated with Chaperone™ application (Table 6), as other varieties had fewer such structures at these sites.

A consistent increase in turn-out percentages due to Chaperone™ application was not noted (Table 8) but this may be due to the methods utilized. Usage of Chaperone™ on DPL 449 did result in improved turn-out compared to untreated DPL 449BR cotton. (36.36% vs 34.21%). These data are thought to be precise due to the entire small sample being ginned and are thought to accurately represent the entire harvested area for each.

Turn-out percentage for STV 5599BR was also greater in Chaperone™ treated cotton (39.398% vs. 36.08%), but application resulted in reduced turn-out for DPL 555BR cotton (33.24 vs. 35.99%) (Table 8). It should be noted that the turnout percentages for these varieties was received from commercial ginning of each treatment's module and may reflect some extra/shortage of each module related to finishing commercial bales. Each module did contain a number of bales however (8+). Further testing is recommended utilizing multiple data points to verify turnout percentages (and related calculated lint yields) noted in this experiment, thereby increasing confidence of data accuracy.

Lint yields/acre were calculated using the turn-out percentages and seed cotton yields/acre. Chaperone™ treated DPL 449BR cotton yielded 87 lbs./acre more lint than untreated DPL 449BR cotton, and Chaperone™ treated STV cotton yielded 112 lbs./acre more lint than untreated STV 5599BR cotton (Table 8). Yields of DPL 555BR cotton were almost identical (1,275 lbs./acre vs. 1,274 lbs./acre). Pooled data indicated that application of Chaperone™ to cotton in this experiment increased lint yields by an average of 71 lbs/acre.

Quality

A few effects on cotton quality associated with usage of Chaperone™ was noted in this experiment, with some effects being positive and others negative, and most were inconsistent from variety to variety. The exception to this was for uniformity, which increased due to Chaperone™ application in each of the three varieties (Table 9).

In DPL 449BR cotton Chaperone™ application resulted in a less white color grade (41 vs. 31 for untreated cotton), but slightly increased fiber strength (29.1 g/tex vs. 28.5) and fiber length (1.09 vs 1.08 inches). Micronaire was similar (4.6 vs. 4.5). Data indicate that leaf content and staple length were unaffected by application of Chaperone™ (Table 9).

Leaf content of DPL 555BR cotton quality was significantly increased by application of Chaperone™ (Table 9), although strength decreased by 0.1 g/tex. A significant increase in uniformity (0.4%) was noted. Other lint quality parameters were very similar.

Quality effects were more difficult to note in STV 5599BR cotton, as no differences were noted for white color grade (31), leaf content (3.0) or fiber length (1.08 inches). Micronaire was also very similar (4.6 vs. 4.5 for untreated cotton). Higher uniformity was noted from Chaperone™ treated cotton (80.2 vs. 79.6) but this was accompanied by lower strength (30.2 vs. 30.8 g/tex).

Lint Value

Chaperone™ treatment had little effect on economic values per pound of lint (Table 8) based upon actual payment to the grower. Chaperone™ treatment did result in a slight decrease in mean price of approximately 0.09-0.25 ¢/lb., with more effect noted in STV 5599BR than in DPL 555BR cotton. Actual lint value data from DPL 449BR are not available due to field mixing of treated and untreated cotton together in the module.

Lint value/acre was therefore highly correlated with actual yield as little economic difference due to quality was noted as a result of Chaperone™ treatment to two cotton varieties in this experiment. As yields of DPL 555BR were very similar, lint value/acre was almost identical for treated and untreated cotton ($699.14 vs $699.71/acre). As yields were higher for Chaperone™ treated STV 5599BR cotton (1,254 lbs./acre) than for untreated cotton of this variety (1,142 lbs./acre), lint value/acre was therefore greater in Chaperone™ treated than untreated STV 5599BR cotton ($654.72 vs. $599.54/acre).

In this experiment the turnout data for each treatment are represented only by a single datum. Additional experimentation and data collectiona are necessary to increase confidence of turnout data associated with Chaperone™ application when compared with untreated cotton of these varieties, especially when yields and economics are derived using such data.

Literature Cited

Brown, R.S., and D.M. Oosterhuis. 2005. Enhanced physiological functioning and increased protein levels with Chaperone™ under high temperature stress. Proc. 2005 Beltwide Cotton Conferences, New Orleans, LA.

Acknowledgments

This project was supported in part by the California State Support committee of Cotton Incorporated (project #05-645CA).

Table 1. Average plant height, nodes and percent fruiting retention of varieties on July 14, 2005.

Variety	Height (inches)	Nodes	Percent Retention Fruiting position 1	2	3
DPL 449BR	28.6	18.2	64.4	62.9	74.3
DPL 555BR	35.8	21.2	70.6	64.9	72.7
STV 5599BR	36.6	19.4	57.2	60.6	78.7

Table 2. Soil nutrient levels (ppm) at time of Chaperone™ application on July 15, 2005.

NO_3-Nitrogen	15.0	PO_4 Phosphorus	9.0
Potassium	132	Calcium	5,979
Magnesium	460	Sodium	345
Iron	28.7	Manganese	9.7
Zinc	2.32	Copper	2.02
ESP	4.23%	ECe	1.73 dS/cm

Table 3. Effect of Chaperone™ on N, P, K of August 4th for 5th terminal petiole data for upland three varieties following treatment with Chaperone™ on July 15, 2005.

Treatment	Variety	N (ppm)	P (ppm)	% K
Chaperone™ @ 5 oz.acre	DPL 449BR	520.3a	1,211.3a	2.77a
Untreated Check		295.5a	1,448.5a	2.70a
Chaperone™ @ 5 oz.acre	DPL 555BR	1,227.5a	1,707.3a	2.48a
Untreated Check		749.5a	2,558a	2.55a
Chaperone™ @ 5 oz.acre	STV5599BR	493.3a	817.3a	2.20a
Untreated Check		507.0a	649.5a	1.83a
Chaperone™ @ 5 oz.acre	Averages	747.0a	1,245.3a	2.48a
Untreated Check		522.3a	1,552.0a	2.36a

Means in sub-columns followed by the same letter are not statistically different at the $P \leq 0.05$ level (Fisher's LSD test).

Table 4. Mean varietal averages of fifth leaf from terminal petioles for nitrates, phosphates and potassium on August 4th of three upland cotton varieties following application of 5 oz./acre of Chaperone™ on July 15, 2005, Blythe, CA.

Variety	NO 3 (ppm)	PO 4 (ppm)	% K
DPL 449 BR	407.9a	1,329.9 b	2.73a
DPL 555BR	507.6ab	2,132.6 c	2.52a
Stoneville 5599BR	988.5 b	733.4a	2.02 b

Means in columns followed by the same letter are not statistically different at the $P \leq 0.05$ level (Fisher's LSD test).

Table 5. Mean plant heights, nodes, and fruiting nodes per plant August 16-18 following application of 5 oz./acre of Chaperone™ on July 15, 2005, Blythe, CA.

		Height	Nodes			Ht:Node
Variety	Treated?	(inches)	Plant	First Fruit	Fruiting	Ratio
DPL449 BR	Yes	38.7a	25.1a	5.6a	19.5a	1.54a
	No	39.8a	23.7a	4.9a	18.8a	1.69a
DPL 555BR	Yes	40.9a	25.5a	6.0a	19.5a	1.61a
	No	39.7a	25.0a	5.85a	19.2a	1.59a
STV 5599BR	Yes	38.4a	22.7a	4.7a	17.9a	1.70a
	No	40.0a	24.4a	5.1a	19.3a	1.65a

Means in sub-columns followed by the same letter are not statistically different at the P≤0.05 level (Fisher's LSD test).

Table 6. Mean retention rates of fruiting structures on three cotton varieties August 16-18 following application of 5 oz./acre of Chaperone™ on July 15, 2005, Blythe, CA.

		Fruiting postion(s)				
Variety	Treated?	1	2	3	1-2	1-3
DPL449 BR	Yes	34.1 b	35.7a	35.2a	34.9a	35.0a
	No	57.3a	52.0a	41.2a	54.7a	50.2a
DPL 555BR	Yes	36.9a	27.3a	36.2a	32.1a	33.5a
	No	30.6 b	20.1a	33.4a	25.3a	28.0a
STV 5599BR	Yes	33.7a	26.4a	29.6a	29.1 b	29.3a
	No	41.1a	35.0a	23.5a	38.1a	33.2a

Means in sub-columns followed by the same letter are not statistically different at the P≤0.05 level (Fisher's LSD test).

Table 7. Mean calculated fruiting structures per plant August 16-18 following application of 5 oz./acre of Chaperone™ on July 15, 2005, Blythe, CA.

		Fruiting postion(s)				
Variety	Treated?	1	2	3	1-2	1-3
DPL449 BR	Yes	6.7a	6.9a	6.8a	13.7a	20.4a
	No	10.9a	9.9a	7.6a	20.7a	28.3a
DPL 555BR	Yes	7.2a	5.3a	7.0a	12.4a	19.5a
	No	5.9 b	3.8a	6.5a	9.7 b	16.1a
STV 5599BR	Yes	6.0a	4.8 b	5.4a	10.8 b	16.1a
	No	8.0a	6.7a	4.5a	14.7a	19.2a

Means in sub-columns followed by the same letter are not statistically different at the P≤0.05 level (Fisher's LSD test).

Table 8. Effect of Chaperone™ application on July 15, 2005 on seed cotton yields, turnout percentages, lint yields and value of three upland varieties, Blythe, CA.

		Seed Cotton	Turnout[1]	Lint Yield	Lint Value[2]	
Variety	Treated?	Lbs./acre	Percent	(lbs./acre)	¢/ lb.	per acre
DPL 449BR	Yes	3,744a	36.36	1,361a	NA	NA
	No	3,724a	34.21	1,274a	NA	NA
DPL 555BR	Yes	3,833a	33.24	1,275a	54.834	$699.14
	No	3,542a	35.99	1,274a	54.922	$699.71
STV 5599BR	Yes	3,185a	39.38	1,254a	52.211	$654.72
	No	3,164a	36.08	1,142a	52.499	$599.54
Averages	Yes	3,547a		1,292a		
	No	3,445a		1,221a		

Means in sub-columns followed by the same letter are not statistically different at the P≤0.05 level (Fisher's LSD test).

[1] Turnout percentages for DPL 555BR and STV 5599BR are a single number from commercially ginned modules, those for DPL 449BR are a single sample derived using a composite of small bag samples obtained from each replicate.

[2] Values are actual amounts grower received, data for DPL 449BR were not available as lint from plots was mixed together in module.

Table 9. Effect of Chaperone™ treatment on lint quality values[1] of three upland cotton varieties.

					Length		Strength	Color		
Variety	Treated?	Grade	Leaf	Mic	Staple	1/100"	g/tex	C rd	c+b	Uniform
DPL449 BR[1]	Yes	41	2.0	4.6	35	109	29.1	77.3	6.5	79.8
	No	31	2.0	4.7	35	108	28.5	79.0	7.0	79.6
DPL 555BR	Yes	26.7a	3.0 b	4.2a	35a	108a	28.7 b	83.4a	6.60a	78.8a
	No	25.4a	2.3a	4.2a	35a	108a	28.8a	83.3a	6.69a	78.4 b
STV 5599BR	Yes	31a	3.0a	4.6a	35a	108a	30.2 b	78.3a	7.85a	80.2a
	No	31a	3.0a	4.5 b	35a	108a	30.8a	78.9a	7.65a	79.6 b

Means in sub-columns followed by the same letter are not statistically different at the P≤0.05 level (Fisher's LSD test).

[1]DPL 555BR and STV 5599BR are averages of a number of commercially ginned bales, those for DPL 449BR are a single sample derived using a composite of small bag samples obtained from each replicate.