EFFECTS OF CHAPERONE APPLICATION TIMING AND RATE ON FIBER QUALITY OF FIRST-POSITION BOLLS

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Abstract

A field study was conducted to better understand and assess the effects of foliar applications of Chaperone on production characteristics of sequential first-position bolls along the plant's main stem. This article presents results of fiber quality analyses of first-position bolls per sympodium obtained from the study conducted in 2005. Chaperone treatments consisted in combinations of two application times (early bloom or mid bloom) and two rates (5 or 10 oz/acre). Treatments, including an untreated check (UTC), were arranged in a randomized complete block design with four replications. The sympodium of the first-position bloom was tagged in 20 plants is each plot at the time of treatment. Upon defoliation at crop maturity, the first-position bolls in all 20-tagged plants were harvested and grouped by sympodium. Boll samples were ginned and fiber properties were analyzed. The mid-bloom application of 10 oz/acre of Chaperone increased the mean fiber length and the upper quartile fiber length in first position bolls of sympodia 5, 6, and 7, while the mid-bloom application of 5 oz/acre, either alone or as a second application, also increased the mean fiber length in sympodium 7. With the exception of the early bloom application of Chaperone at 5 oz/acre, all other Chaperone treatments affected positively the fiber quality of first-position bolls in sympodium 7 by decreasing the content of short fibers (<.5 inches), increasing the fiber maturity ratio, decreasing the content of immature fibers, and increasing the cell wall thickness.

Introduction

Foliar application at early bloom of Chaperone, a product whose active ingredients are 0.3% Na-p-nitrophenolate, 0.2% Na-o-nitrophenolate, and 0.1% Na-5-nitroguaiacolate, (Agrivert, Inc., New York, NY), showed significant yield increases in cotton under irrigated conditions and rain-fed conditions with adequate rainfall amounts during boll formation (Fernandez et al., 2002, 2003; Fernandez and Correa, 2004, 2005; Bynum et al., 2004; Lackey et al., 2004; Townsend, J. 2004; Fernandez, 2007). These studies showed that the yield increases were largely related to the increase in average boll mass, but did not provide information regarding which bolls in the plant were affected by the application of this protein enhancer. Since the growth of individual bolls is initiated over several weeks, a foliar application of Chaperone would unlikely affect the whole population of bolls equally.

To better understand and assess the effects of Chaperone on boll growth, a study was initiated to evaluate the effects of this product on production and fiber quality characteristics of sequential first-position bolls along the plant's main stem. Results obtained in 2005 showed that delaying the application of 5 oz/acre of Chaperone until mid bloom and increasing its rate to 10 oz/acre irrespective of timing of application both increased seedcotton production on several intermediate sympodia through the increase in boll retention and boll mass (Fernandez and Correa, 2007a), and decreased the number of vane seeds, increased the average seed mass and the average lint per seed (Fernandez and Correa, 2007b). The largest effects were obtained by the 10 oz/acre applied at mid bloom.

This article presents results of fiber quality analyses of first-position bolls per sympodium obtained from the study conducted in 2005.

Materials and Methods

The study was conducted at a rain-fed commercial farm in Nueces Co. The soil type at the experimental site is Victoria Clay (VcA). All crop production practices under full control of farmer. The field received a pre-planting broadcast fertilization of 90 N lbs./A and 40 P_2O_5 lbs./A. Cultivar FiberMax 832 LL was planted on April 1, 2005 to a plant population of 50,000 plants/A in 30-inch row spacing. Plots were 4 rows wide and 250 ft long. Main phenological events occurred on the following dates: emergence on Apr. 7, first square on May 11, first bloom on Jun. 12, and first open boll on Jul. 21.

Treatments were applied at a volume rate (water plus product) of 103 L ha^{-1} with a four-row plot sprayer (Model 3220-GC 2wd Lee Spyder Spray-Trac, Lee Company, Inc., Idalou, TX). Treatments, including an untreated check (UTC), were arranged in a randomized complete block design with four replications.

Chaperone was applied at two rates (5 and 10 oz/A) and at two different times (early bloom and mid bloom growth stages). The experiment included the following treatments:

1. Untreated check
2. 5 oz/A of Chaperone at early bloom (EB)
3. 5 oz/A of Chaperone at early bloom and mid bloom (EB+MB)
4. 5 oz/A of Chaperone at mid bloom (MB)
5. 10 oz/A of Chaperone at early bloom (EB)
6. 10 oz/A of Chaperone at mid bloom (MB)

Treatments, including an untreated check (UTC), were arranged in a randomized complete block design with four replications. Treatments were applied with a four-row plot sprayer (Model 3220-GC 2wd Lee Spyder Spray-Trac, Lee Company, Inc., Idalou, TX) on June 15 and June 24.

Plant growth and development on June 15 (early bloom) were as follows: height 27.8" (71 cm), 19 main-stem nodes, and 10 NAWF. On June 24 (mid bloom), Plant growth and development were: height 31.4" (78 cm), 20 main-stem nodes, and 6 NAWF.

Growing conditions were near average. Rainfall distribution was as follows: 1.8" from planting to first square; 2.0" from first square to first bloom; 2.7" from first bloom to first open boll, but all of this precipitation occurred at the end of this stage; and 0.8" from first open boll to harvest. Early growing conditions occurred under adequate water supply. A severe water deficit developed during most of the rapid boll growth stage, but late rains provided relief towards the end of this stage.

At treatment application, 20 plants were tagged in each replicated plot to mark the sympodium with the first-position bloom. The same number of plants was also tagged in the untreated plots at the time of early bloom application.

After defoliation, whole first-position bolls (including burrs) of 20 tagged plants in each plot were hand-picked and grouped in one sample per sympodium. Nine sympodia were harvested in each tagged plant. Two sympodia below the tag and seven sympodia above the tag were harvested in the early bloom treatments and the untreated check. Sympodia harvested in the mid-bloom treatments were two above the tag and seven below the tag. This tagging and sampling procedure allowed the comparison of first-position bolls of similar age across all treatments and the untreated check.

The seedcotton of each sample was ginned using a 10-blade Eagle Cotton Gin Model 502 (Continental Gin Co., Birmingham, AL) and fiber quality measurements using AFIS PRO method were conducted at the USDA-ARS-Southern Regional Research Center. Measurements included mean length, upper quartile length, short fiber content, maturity ratio, immature fiber content (degree of fiber circularity, theta, <.25), and cell wall thickness (not an AFIS PRO measurement) calculated from fineness and maturity ratio. Statistical analyses of data included analysis of variance and Fisher's Protected Least Significant Difference (LSD).

Results and Discussion

The mid-bloom application of 10 oz/acre of Chaperone increased the mean fiber length and the upper quartile fiber length in first position bolls of sympodia 5, 6, and 7 (Tables 1 and 2). The mid-bloom application of 5 oz/acre, either alone or as a second application, also increased the mean fiber length in sympodium 7 (Table 1).

With the exception of the early bloom application of Chaperone at 5 oz/acre, all other Chaperone treatments affected positively the fiber quality of first-position bolls in sympodium 7 by decreasing the content of short fibers (<.5 inches), increasing the fiber maturity ratio, decreasing the content of immature fibers, and increasing the cell wall thickness (Tables 3-6).

Table 1. Mean fiber length (in.) of lint harvested from first-position bolls in sympodial branches 3 to 7.

	Sympodium				
Treatment	**3**	**4**	**5**	**6**	**7**
Chaperone 5 EB	1.03 ab	1.04 a	1.01 b	0.97 ab	0.90b
Chaperone 5 EB+MB	1.05 ab	1.05 a	1.03 ab	0.98 ab	0.97 a
Chaperone 5 MB	1.03 ab	1.03 a	1.03 ab	0.98 ab	0.96 a
Chaperone 10 EB	1.01 b	1.04 a	1.02 ab	0.98 ab	0.95 ab
Chaperone 10 MB	1.07 a	1.08 a	1.07 a	1.02 a	0.98 a
UTC	1.05 ab	1.05 a	1.01 b	0.96 b	0.90 b

Values within same column with same letter are not significantly different at the 0.05 probability level.

Table 2. Upper quartile fiber length (in.) of lint harvested from first-position bolls in sympodial branches 3 to 7.

	Sympodium				
Treatment	**3**	**4**	**5**	**6**	**7**
Chaperone 5 EB	1.22 ab	1.23 a	1.20 b	1.18 ab	1.10 c
Chaperone 5 EB+MB	1.23 ab	1.23 a	1.22 ab	1.17 ab	1.16 ab
Chaperone 5 MB	1.22 ab	1.22 a	1.22 ab	1.16 b	1.16 ab
Chaperone 10 EB	1.20 b	1.24 a	1.22 ab	1.18 ab	1.14 abc
Chaperone 10 MB	1.26 a	1.27 a	1.26 a	1.22 a	1.18 a
UTC	1.23 ab	1.24 a	1.20 b	1.15 b	1.11 bc

Values within same column with same letter are not significantly different at the 0.05 probability level.

Table 3. Short fiber content (% of fiber with length <0.5 in.) in lint harvested from first-position bolls in sympodial branches 3 to 7.

	Sympodium				
Treatment	**3**	**4**	**5**	**6**	**7**
Chaperone 5 EB	6.9 a	6.7 a	7.1 a	9.1 a	13.5 a
Chaperone 5 EB+MB	5.7 a	5.2 a	6.2 a	7.6 a	8.1 b
Chaperone 5 MB	6.3 a	6.4 a	6.2 a	7.8 a	8.1 b
Chaperone 10 EB	7.0 a	6.3 a	7.2 a	8.3 a	9.4 b
Chaperone 10 MB	5.4 a	5.2 a	5.3 a	7.0 a	7.8 ab
UTC	5.8 a	5.8 a	7.2 a	9.6 a	13.9 a

Values within same column with same letter are not significantly different at the 0.05 probability level.

Table 4. Fiber maturity ratio of lint harvested from first-position bolls in sympodial branches 3 to 7.

	Sympodium				
Treatment	**3**	**4**	**5**	**6**	**7**
Chaperone 5 EB	.85 a	.87 a	.86 b	.86 a	.83 b
Chaperone 5 EB+MB	.88 a	.90 a	.90 a	.90 a	.89 a
Chaperone 5 MB	.86 a	.86 a	.89 ab	.88 a	.89 a
Chaperone 10 EB	.86 a	.88 a	.87 ab	.88 a	.88 a
Chaperone 10 MB	.87 a	.88 a	.88 ab	.89 a	.89 a
UTC	.87 a	.88 a	.88 ab	.86 a	.83 b

Values within same column with same letter are not significantly different at the 0.05 probability level.

Table 5. Immature fiber content (%) in lint harvested from first-position bolls in sympodial branches 3 to 7.

	Sympodium				
Treatment	**3**	**4**	**5**	**6**	**7**
Chaperone 5 EB	7.2 a	6.6 a	7.0 a	7.7 a	10.0 a
Chaperone 5 EB+MB	5.5 a	5.2 a	5.4 a	5.8 a	6.3 b
Chaperone 5 MB	6.5 a	6.4 a	5.7 a	6.1 a	6.2 b
Chaperone 10 EB	6.8 a	6.0 a	6.5 a	6.8 a	6.9 b
Chaperone 10 MB	6.0 a	5.7 a	5.5 a	6.0 a	6.6 b
UTC	6.2 a	6.1 a	6.4 a	7.6 a	10.6 a

Values within same column with same letter are not significantly different at the 0.05 probability level.

Table 6. Fiber cell wall thickness (µm) of lint harvested from first-position bolls in sympodial branches 3 to 7.

	Sympodium				
Treatment	**3**	**4**	**5**	**6**	**7**
Chaperone 5 EB	2.2 a	2.3 a	2.2 b	2.2 ab	2.1 b
Chaperone 5 EB+MB	2.3 a	2.4 a	2.4 a	2.4 a	2.4 a
Chaperone 5 MB	2.3 a	2.3 a	2.3 ab	2.3 ab	2.4 a
Chaperone 10 EB	2.2 a	3.2 a	2.3 ab	2.3 ab	2.3 a
Chaperone 10 MB	2.3 a	2.3 a	2.3 ab	2.4 ab	2.4 a
UTC	2.3 a	2.3 a	2.3 ab	2.3 b	2.1 b

Values within same column with same letter are not significantly different at the 0.05 probability level.

These fiber quality results complement and partially confirm the fiber production results reported before, in particular the ones regarding lint production per mature seed, and also broaden the spectrum of positive effects of Chaperone found on seed and fiber production in cotton. These results also confirm the benefits of conducting a more detailed analysis of the effects of plant growth regulators/enhancers on yield components in cotton. These results, however, were obtained under one particular set of environmental conditions and on particular cultivar and should not be extrapolated to other production environments or cultivars. More studies are needed to further evaluate and understand the effects of this nitrophenolates-based product on cotton grown under other production environments. Nonetheless, upon the data obtained from this study we still speculate that Chaperone may help maintain the photosynthetic/energy supply, the uptake of soil nitrogen, and the reduction of nitrogenous compounds needed for seed growth and fiber production under conditions of carbohydrate/energy and nitrogen stress.

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