Effects of Calcium Containing Foliar Fertilizers on DPL449BR Cotton in the Palo Verde Valley, 2005

Michael D. Rethwisch, D. Michael Ramos, Manuel Luna and Jessica Wellman

Abstract

Seven foliar fertilizers containing calcium were applied to DPL449BR cotton in the Palo Verde Valley on June 24, 2005, immediately after three consecutive days of level one stress. Plants had been blooming prior to application and had several open blooms per plant at time of application. All treatments increased level of leaf chlorophyll by at least 7.4% when compared with the untreated check as with a Minolta 502 SPAD meter on July 7, with greatest (21.3%) increase noted from Calcium Metalosate®. No statistical differences were noted for this parameter on July 13, and by July 21 highest mean leaf chlorophyll content was noted from untreated cotton. Leaf chlorophyll was lowest in untreated cotton on July 25 however. Shortest stigma lengths beyond anthers on July 13 was noted in treatments with highest amounts of calcium applied per acre, while all treatments had numerically fewer abnormal flowers than the untreated check on July 21. Treatments resulted in slightly taller plants than the untreated check on July 6 and 21, and more nodes on July 6. Most treatments also resulted in more fruiting nodes per plant on July 21 and August 4. Greatest height:node ratios were noted in CalMax® treated cotton on all three sample dates. Highest retention percentages were noted in untreated cotton on July 6 and August 4. All treatments resulted in numerically more fruiting structures/plant than the untreated check on July 21, although only CalMax® treated cotton had significantly more. Most treated cotton had fewer such structures per plant on August 4 than on July 21, however such structures in untreated cotton increased during this time. Calcium Metalosate® was the only treatment that resulted in more seed cotton/acre than the untreated check. Calculated lint yields varied, and reflected the single datum turnout percentage for each treatment derived from commercial ginning of modules. Wide variation in turnout data do not appear to be supported with differences in cotton quality data, as similar economics were noted for all cotton lint on a per pound basis.

Introduction

Heat stress of cotton during the summer in the low desert has been noted to result in elongated styles, reduced pollen viability, reduced retention, hook-beaked bolls and associated reduction in yield (Brown and Zeiher, 1997). Spring heat is not unusual in the low desert, but is not thought to affect flowers and subsequent fruiting structures.

The spring of 2005 was very abnormal however, in that it was a wet winter followed by an unusually cool early season production period, followed by a very rapid increase in both daytime and night temperatures shortly after mid-May. This resulted in daytime high temperatures reaching 110°F and low temperatures of only 70°F, about a month previous to first bloom of many later planted fields in the area. This early heat stress was thought to have affected pinhead and developing embryonic reproductive structures, with this damage becoming quite obvious some time later (as elongated styles with stigmas some distance beyond the anthers) throughout the Palo Verde Valley.

Calcium has been shown in laboratory studies to serve as an anti-oxidant in stressed cotton (Banks et al., 2001), and therefore could potentially be beneficial for low desert cotton during heat stress conditions. Previous limited evaluation of foliar fertilizers containing calcium in low desert cotton associated with heat stress had shown mixed results. Calcium applied to SureGro 521BR cotton grown under a very short season production window resulted in increased retention from stressed areas of the field when Calcium Metalosate® was used but not other products (Rethwisch et al., 2003). All three calcium containing foliar fertilizer treatments resulted in lower lint yields but also increased lint quality and value per acre over the untreated check (Rethwisch et al., 2003). Plant growth regulator treatments containing calcium resulted in lint increases of 119-261 lbs./acre in two trials involving Pima S-7 cotton in the low desert (Rethwisch et al., 1996).

Evaluation of two foliar fertilizers containing calcium applied to DPL 555BR cotton shortly after first bloom resulted in a small numeric increase in yield but slight decreases in quality (Rethwisch et al., 2004). This experiment involved long season (top crop) production, and was characterized by a very hot growing season, reduced retention and few bolls during the first fruiting cycle, and a vast majority of crop being set as top crop.

As little research has been completed on the effects of foliar fertilizers containing calcium on cotton production in the low desert, this experiment was initiated to compare a number of calcium containing foliar fertilizers and to document their effects, if any, on stigma positioning in relation to anthers in heat stressed cotton as well as subsequent fruit retention, yields and quality.

Methods and Materials

Treatments were applied to DPL 449BR cotton the morning of June 24, 2005, immediately following three successive days of Level 1 heat stress (Fig. 1). A tractor mounted sprayer calibrated to deliver 16 gpa with a single nozzle T-Jet 8008 nozzle positioned over each row was used for the application. Plots were eight rows wide (40" spacing) by field length (approximately 1,200 ft.), with four replications using a randomized complete block design. Ten plants were mapped to establish size of plants at time of application, with plants averaging 19.6 nodes, were 19 inches tall and 24-25 inches wide at application.

Seven foliar fertilizers containing calcium were applied to the field. Treatments were:
a) 2 qt./acre of Calcium Metalosate®, an amino acid chelated calcium (2-0-0, 6% calcium, 10.0 lbs./gal, Albion Laboratories, Clearfield, Utah). Actual calcium applied/acre = 0.3 lbs.

b) 1 qt/acre CalBit® + 1 qt/acre MegaFol®. Both of these products are manufactured by Valagro, and marketed by Nutrecology. The CalBit® formulation is 4-0-0, with 12% calcium and 0.4% boron (12.08 lbs./gallon). MegaFol® is a 4-0-2 formulated product, with the label stating that it is "specially formulated to improve the quality and vigor of fruits, vegetables and field crops". This special formulation may be due to the large number of amino acids (aspartic acid, glutamic acid, alanine, arginine, cystine, glycine, histidine, isoleucine, leucine, lysine, methionine, praline, phenylalanine, serine, threonine, tryptophan, tyrosine, and valine) contained in the product which weighs 12.08 lbs/gallon. Actual calcium applied/acre = 0.329 lbs.

c) CalMax® at 2.5 qt./acre. CalMax® is a foliar fertilizer marketed by Western Farm Services consisting of 10% nitrogen, 11% calcium, 1.2% magnesium, 0.1% iron, 0.1% manganese, 0.05% boron, 0.05% copper, 0.05% zinc, and 0.001% molybdenum. 12.52 lbs./gal. Actual calcium applied/acre = 0.86 lbs.

d) FoliGro® Aminofol® Maximize at 2 qts/acre (Wilbur-Ellis Company). This product consists of 5% calcium, 1.25% zinc, and also contains 0.25% N Acetyl-thiazolidin-4-Carboxylic Acid (ATCA). 10.17 lbs/gallon. The product label notes that this product helps to supplement calcium during periods of rapid plant growth when "localized calcium deficiency" occurs while the zinc helps to promote auxin production. Actual calcium applied/acre = 0.254 lbs.

e) 1 lb./acre of Calcium Chelate (Miller Chemical), 9.5% chelated calcium, chelated with EDTA (ethylenediaminetetra acetic acid). Actual calcium applied/acre = 0.095 lbs.

f) 1.6 pts./acre Calexin (Miller Chemical). This product contains 2% calcium, as well as amino acids, carbohydrates and a plant vitamin package. 9.13 lbs./gal. Actual calcium applied/acre = 0.0365 lbs.

g) 1.5 qts./acre of EleMax Phos-Cal LC, + 1 pt./acre of Trafix® + 1 pt./acre of MegaFol®. Ele-Max Phos-Cal LC 3-23-0, also contains 3% Ca (Helena Chemical). Each gallon weighs 10.95 lbs. Trafix® consists of 0.01% humic acids derived from leonardite, and weighs 8.69 lbs./gal (Helena Chemical). Actual calcium applied/acre = 0.123 lbs.

Calcium Chelate had the surfactant NuFilm 17 (Miller Chemical) added at the rate of 4 oz./acre, and Aminofol® Maximize had the surfactant R-56 (Wilbur Ellis Co.) added at the rate of 1 qt/100 gal.

Several aspects of plant growth parameters were examined to determine if treatments affected plant growth, which included chlorophyll content, plant mapping and stigma/anther distances. Chlorophyll data were collected from plants on roughly a weekly basis for five weeks beginning July 7 with a Minolta 502 SPAD meter. Data were collected from the fifth terminal leaf of 15-25 plants per plot.

Plant mapping was conducted on July 6, 21 and August 4. Mapping consisted of removing five plants per plot, and counting and recording numbers of nodes, plant height, first fruiting node, and presence/absence of fruiting structures at the first three positions for each fruiting branch. Percent retention and fruiting structures/plant were then calculated.

Open flowers were examined on July 13 and 21, and flowers were recorded as being either normal (stigmas not beyond anthers) or abnormal (minimum of one mm between the anthers and stigma), with 100-150 flowers so examined per plot on each sample date. Distance between anthers and stigmas were also recorded of 25 flowers per plot to determine if treatments affected this floral aspect.

Plots were harvested Dec. 22-23, 2005. All eight rows of each individual plot were harvested, and seed cotton weights were then obtained using a Crust Buster boll buggy. All 32 rows of the same treatment were placed together in a module and kept separate from cotton from other treatments to obtain quality and turnout data after ginning (Modern Gin, Blythe, CA). The turnout and other information were then utilized to calculate lint yields per acre as well as acreage values of cotton.

Data and treatment means were statistically analyzed using Fisher's least significant difference (Statgraphics for Windows, Manugistics, Inc.).

Results

Chlorophyll levels

All treatments resulted in increased levels of leaf chlorophyll when measured with a Minolta 502 SPAD meter on July 7, with greatest increase (21.3%) noted from Calcium Metalosate® (Table 1). No statistical differences were noted for this parameter on July 13. On July 21 highest mean leaf chlorophyll content during any of the first four sample dates was noted from untreated cotton (57.25), which had significantly more chlorophyll than four other treatments on this date. Leaf chlorophyll was lowest in untreated cotton (51.48) on July 25 however (Table 1), significantly less than the FoliGro® Aminofol® Maximize (55.45) on this date.

The Aminofol® Maximize treatment was the only treatment which resulted in increasing chlorophyll levels on each subsequent sampling date from July 13-Aug. 4 (Fig. 2). Chlorophyll levels of cotton receiving either of the two treatments containing MegaFol were similar in trends over time, but were higher cotton treated with CalBit® + 1 qt/acre MegaFol® than with EleMax Phos-Cal LC, + 1 pt./acre of Trafix® + 1 pt./acre of MegaFol®, perhaps due to more MegaFol® in the former treatment. Chlorophyll levels of cotton treated with Calcium Metalosate® remained very constant during this same period (52.9-53.9) and had the lowest chlorophyll level of chlorophyll on August 4, although it had the highest levels of leaf chlorophyll on the first sample date after application.

Distance between anthers and stigma

Large distances between stigmas and anthers were not noted during the two July sample dates, and therefore were thought to have little effect on cotton yields. Statistical differences were noted on July 13, but only CalMax® had

significantly less elongation distance (0.2 mm) than the check (0.64 mm) on this date (Table 2). Several of the treatments had numerically larger distances between anthers and stigmas when compared with the check on July 13. It is interesting to note that the three treatments resulting in shortest stigma elongations also had the highest (0.3+ lbs./acre) amounts of applied calcium (CalMax®, 0.86 lbs./acre applied calcium, 0.2 mm stigma elongation beyond anthers; Calcium Metalosate®, 0.3 lbs./acre calcium, 0.40 mm distance; CalBit® + MegaFol®, 0.328 lbs., 0.40 mm distance). This is suggestive of a rate response and/or a minimum rate/acre for effectiveness, but further testing is necessary to establish such as fact.

Elongation distance differences increased for all cotton when measured on July 21 (Fig. 3), but no statistical differences existed. Shortest distance was noted from cotton receiving the CalBit® + MegaFol® application (1.07 mm). This was the only treatment resulting in less distance between anthers and stigmas than the untreated check.

Greatest increase was between the two sample dates was noted from cotton treated with CalMax® (1.12 mm increase), followed by Calcium Metalosate® (0.86 mm). Treatments resulting in the least amount of increased mean stigma distance beyond anthers besides the untreated check (0.50 mm) included Trafix® + PhosCal + MegaFol® (0.52 mm), and Calcium Chelate (0.54 mm). The smaller increases in distance may be associated with less/no calcium available from these treatments which may have resulted in less anti-oxidant activity than the higher calcium content fertilizers. As calcium availability from the higher calcium content foliar fertilizers decreased over time, it is possible that plants treated with these higher levels experienced a greater net increase in stress over a short duration (in comparison with plants exhibiting stress earlier) at the time the calcium levels diminished below a certain level, due to previous stress protection afforded by the higher levels of calcium (Table 2).

No treatment resulted in a significantly different percentage of abnormal flowers on July 13 than the untreated check (36.2) with the exception of Aminofol® Maximize (48.9%). It may be that flowers opened on this date were not as affected by the heat of June 21-23 as percentages of abnormal flowers increased greatly between the two sample dates. Calcium treatments may have affected percentage of abnormal flowers on July 21, as all foliar fertilizers had a smaller percentage of such flowers than the untreated check, however, only cotton treated with CalMax® had statistically fewer abnormal flowers than the untreated check on this sample date.

Plant heights and nodes

Application of CalMax® resulted in a significant increase in cotton plant height on the first two sample dates (July 6, 21) when compared with the untreated check (Table 3). Cotton treated with Calcium Metalosate® and Calcium Chelate were also significantly shorter than CalMax® on July 6th, but only the Calcium Metalosate® continued to be significantly shorter on the July 21 sample date. A large increase (2+ inches) in plant height was noted between the two sample dates only for cotton treated with Calcium Chelate. This large increase appears odd especially in light of a decrease in mean plant height noted as a result of this treatment in the subsequent sample date (Aug. 4). Decreases in mean plant height between July 21 and Aug. 4 was also noted for Aminofol® Maximize and Calexin. These decreases in mean plant heights are thought to have occurred due to wide variations in plant heights associated with field variations that were not evident at time of application. CalMax® treated cotton continued to increase in height, and was the tallest on the Aug. 4 sample date (32.3 inches). It is possible that the initial calcium amount applied affected cotton plant height, as a much higher amount of calcium per acre was applied in the CalMax® treatment (0.86 lbs/acre) than in any other treatment (next highest treatment was 0.328 lbs./acre, CalBit®).

Numbers of nodes did not exhibit unusual increases and decreases as previous noted for plant height (Table 3). Mean node numbers at the first plant mapping (July 6) after application were very similar, ranging from a high of 18.6 nodes/plant (Calcium Metalosate®) to 17.3 (untreated check). Statistical differences were noted on each of the subsequent sample dates however. Cotton treated with CalBit® + MegaFol® had more nodes (20.55) on July 21 than did cotton treated with Aminofol® Maximize or Calcium Metalosate® (both 18.7). No treatment resulted in significantly different mean number of nodes/plant when compared with the untreated check on this sample date.

Data from August 4 also indicated that treatments did not result in significantly different numbers of nodes than the untreated check (20.3 nodes/plant), with the exception of CalMax® (23.15). The CalMax® treatment also resulted in significantly more nodes/plant than several other treatments including Aminofol® Maximize (20.3), Calcium Metalosate® (20.4), CalBit® + MegaFol® (20.85) and Calexin (19.7).

A trend for first fruiting node being higher on cotton stems as the season progressed was noted, although no treatment resulted in a significant differences for this plant parameter when compared with the untreated check on any of the three sample dates, although the untreated check did have numerically more fruiting nodes than any treated cotton on August 4 (Table 4).

A few statistical differences were noted for number of fruiting nodes/plant, but only on July 21 and August 4. On July 21 all treatments had numerically more fruiting nodes per plant than untreated cotton (13.8) with the exception of Calcium Metalosate® (13.6). Calcium Chelate was the only treatment (15.7) which resulted in statistically more fruiting nodes than both of the these treatments on this date (Table 4). Highest amounts of seed cotton per acre were noted from Calcium Metalosate® and the untreated check in this experiment, although correlations between the relationships of reduced fruiting nodes and seed cotton yields as effected by high temperature stress have not been evaluated. Numbers of fruiting nodes per plant increased between July 21 and August 4. CalMax® (18.5) had significantly more such nodes than the untreated check (14.9), Calcium Metalosate® (15.6),FoliGro® Aminofol® Maximize (15.2) and Calexin (14.5) on this date (Table 4).

Height:node ratios were very similar during this experiment (Table 4). No treatment resulted in a statistically different ratio on the three samples dates with the exception of CalMax® (1.57) on July 6 (Table 4).

Retention

Significant differences for retention varied by position and sample date (Tables 5-6). Several treatments (CalBit® + MegaFol®, Aminofol® Maximize, Calcium Chelate) had significantly reduced retention at position 1 as well as combined positions 1-2 when compared with the untreated check on July 6, although no treatments were significantly different than the check at this position on July 21 or Aug. 4. Treatments were not significantly different than the check at positions 2 or 3 on July 6 either, although numerically highest retention rates were noted on this date from untreated cotton for position 1 (85.9%) or 2 (83.6%) on this date (Table 5).

Retention rates decreased between July 6 and 21 by about 30%. Cotton treated with CalMax® had highest retention rates on July 21 for combined positions 1-2 (56.6%), and only this treatment resulted in significantly greater retention percentage than the untreated check (49.7%) or CalBit® + MegaFol® (48.5%) on the July 21 sample date (Table 6). Although no statistical differences existed for retention at position 3 when compared with the untreated check (35.0%), differences did exist on July 21 among treatments with Calcium Chelate resulting in significantly greater retention (48.8%) than the Aminofol® Maximize (31.9%), and CalBit® + MegaFol® (30.4%) treatments on this date (Table 5). Only CalMax® (50.3%) and Calcium Chelate (50.7%) treatments resulted in retention rates above 50% for combined positions 1-3 on July 21 (Table 5), with this being statistically greater than only the CalBit® + MegaFol® treatment (30.4%).

Continued reduction in retention rates of about 7% was noted on August 4 for treated cotton when compared with the previous (July 21) sample date, although that of the untreated check remained similar to that of July 21 (Tables 5-6). No treatments were significantly different than the check on August 4 at positions 1 or 3 (Table 4) although differences did exist at position 2 and between some treatments at position 1. CalMax® had the highest retention percentage (52.4) at position 1, but the almost the lowest at position 2 (38.7).

Significant differences did exist for combined positions 1-2 and 1-3 (Table 6) with highest percentages being noted for the untreated check. This was statistically greater than Calcium Chelate (48.1% vs. 41.0%) at positions 1-2, and statistically greater than several other treatments at positions 1-3. The noted higher retention rates for the untreated check are thought to be partially related to numbers of fruiting nodes, as untreated cotton had fewer fruiting nodes on August 4 than all but one other treatment (Table 6).

Fruiting structures per plant

No differences in numbers of fruiting structures per plant (almost all were flowers) were noted on July 6 at positions 1, 2, or 3 (Table 7) nor for combined positions 1-2 or 1-3 (Table 8). This may be due to the small amount of time between application (June 24) and the sample date which did not allow for differences to be expressed.

Some differences were noted on the July 21 sample date. All treatments had numerically more fruiting structures per plant at position 1 than the untreated check (7.5), although CalMax® (9.4/plant at position 1, 8.4 at position 2) was the only treatment that resulted in a statistical increase when compared with the untreated check (Table 7). At position 3 the Calcium Chelate treatment resulted in significantly more fruiting structures/plant (7.7) than the untreated check (4.9), CalBit® + MegaFol® (4.7) or Aminofol® Maximize (4.6). Numerically fewer fruiting structures per plant were noted for the untreated check on July 21 for positions 1-2 and 1-3 (Table 8), but only CalMax® had statistically more such structures per plant and only for combined positions 1-2.

Fruiting structures per plant decreased from July 21 to August 4 at positions 1-3 in almost all treated cotton with the exception of Calcium Metalosate®, which increased slightly, as did the untreated check (Table 8). This mirrored data from position 2. At position 1 only cotton treated with CalMax® was noted to have a very slight increase in fruiting structures from July 21 (Table 7).

Seed cotton yields, lint turn-out and lint yields

While foliar fertilizers effects were documented to exist for approximately two weeks following application in late June (based on significant differences in cotton leaf chlorophyll), flowers which potentially resulted in harvested bolls continued to be produced through September. This long fruiting period after application may well have masked yield and quality differences that may have existed earlier in the season, especially in light of a very hot and humid period in July and August thought to have negatively affected cotton yields and growth.

Highest levels of seed cotton/acre in this experiment were obtained from cotton treated with 2 qts./acre of Calcium Metalosate® (4,329 lbs/acre), followed by the untreated check (4,148 lbs./acre). The lowest amount of seed cotton per acre was noted from cotton treated with 1.6 pts./acre of Calexin (3,873 lbs./acre), significantly less than that noted from Calcium Metalosate® treated cotton (Table 9).

Turnout percentages obtained from commercial ginning varied greatly, ranging from a high of 43.75% (Aminofol® Maximize) to 27.26% (CalBit® + MegaFol®). The turnout percentage of Aminofol Maximize was almost 10% higher than that noted for the untreated check (33.82%). Lint yields per acre therefore closely corresponded with turnout percentages. Lint yields per acre ranged from 1,099 (CalBit® + MegaFol®) to 1,796 (Aminofol® Maximize). Lint yield of Calcium Metalosate® treated cotton (which had the highest seed cotton yields/acre) was 1,277 lbs/acre, significantly less than that calculated for untreated cotton (1,415 lbs./acre).

It should be noted that the turnout percentage in this experiment is a single number received from the gin for the entire module rather than multiple data points, and lint yields are then calculated based upon this turnout percentage. Each module did contain a number of bales however (minimum of 7, maximum of 9). Further testing of the products involved is recommended and small sample turnout data obtained to verify turnout percentages noted in this experiment, thereby increasing confidence in results noted for calculated pounds of lint/acre as large differences in lint quality corresponding to these turnout data were not readily evident.

Lint Quality

A single application of foliar fertilizers containing calcium early in the fruiting cycle after the first heat stress did not result in increased lint quality when evaluated over the entire production year. Most treatments did not effect micronaire when compared with the untreated check with the exception of Calcium Metalosate®, which resulted in an increase of 0.1 (Table 10). Staple lengths were similar, although most treatments resulted in a slight decrease in fiber length.

Fiber strength was also decreased by almost every treatment with the exception of the Trafix® + PhosCal + MegaFol® treatment, which resulted in a very slight strength increase (0.1 g/tex). Similar results were also noted for uniformity for treatments as Trafix® + PhosCal + MegaFol® and the untreated check had highest uniformity (both 80.3). The only other treatment above 80% uniformity was CalMax® at 80.1% (Table 10).

Although no treatment resulted in statistically different leaf amounts when compared with the untreated check (leaf content = 3.0), one treatment (Calcium Chelate) did result in a numerically higher leaf content (3.1), while CalMax® and Trafix® + PhosCal + MegaFol® treatments were identical to the untreated check. Lowest leaf levels were noted in the CalBit® + MegaFol® (2.7) and Calcium Metalosate® (2.75) treatments (Table 10).

The three treatments which had the most calcium applied per acre (CalMax®, Calcium Metalosate®, and CalBit® + MegaFol®) also had the least amount of lint trash (1.63, 1.56 and 1.57 respectively).

Values

No significant differences in values of lint per pound were noted (Table 10) as lint length and micronaire was similar. Lowest value/lb. was received for the cotton treated with Calexin, although this was very similar to other treatments. Calculated values per acre therefore greatly reflected lint yields/acre, with highest values/acre noted from the Aminofol® Maximize treatment, and lowest value/acre noted in cotton treated with CalBit® + MegaFol®. It should be noted that little confidence exists for the comparative value/acre data due to the wide disparity in single sample turnout percentages (27.26-43.75%). Further experimentation is necessary to establish such data.

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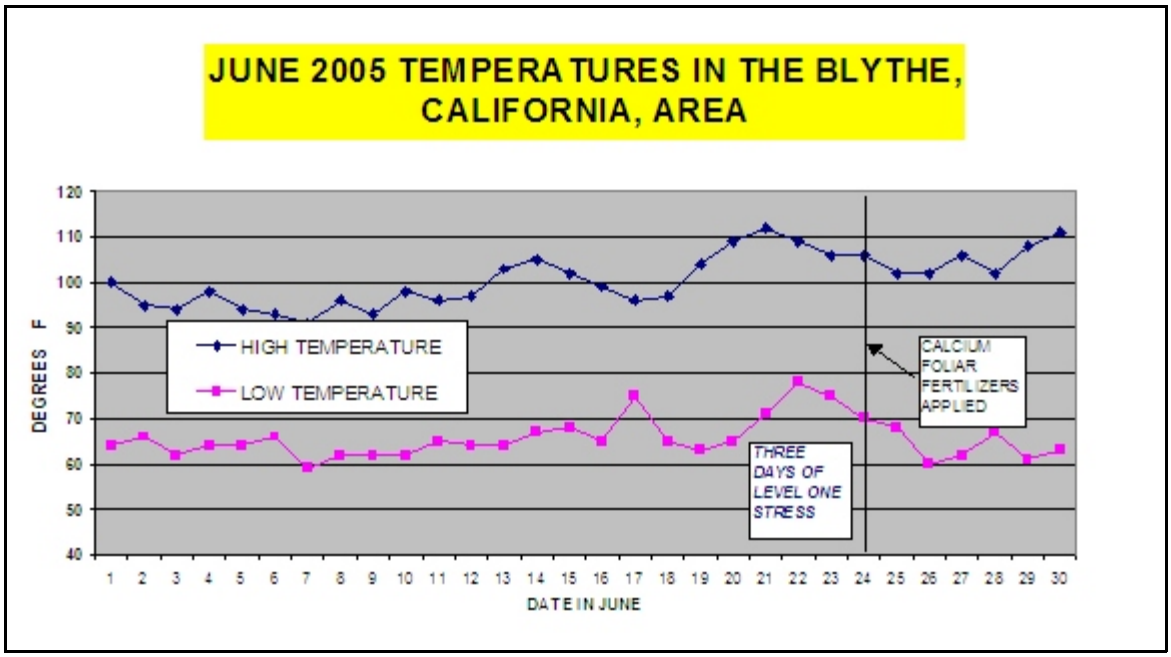
JUNE 2005 TEMPERATURES IN THE BLYTHE, CALIFORNIA, AREA
DEGREES F
DATE IN JUNE
HIGH TEMPERATURE
LOW TEMPERATURE
CALCIUM FOLIAR FERTILIZERS APPLIED
THREE DAYS OF LEVEL ONE STRESS

Table 1. Chlorophyll level (as measured with a Minolta SPAD 502) of 5th leaf from terminal of DPL449BR cotton plants after application of materials on June 24, 2005, Ripley, CA.

	Sample Date				
Treatment and rate/acre	July 7	July 13	July 21	July 25	Aug. 4
Aminofol Maximize @ 2 qts	51.6 b	49.93a	53.4 b	55.45a	57.05ab
CalBit @ 1 qt + MegaFol @ 1 qt	53.6 ab	53.65a	55.8 ab	54.93ab	56.98ab
Calcium Chelate @ 1 lb	50.9 b	52.9 a	55.55ab	52.88 ab	57.55a
Calcium Metalosate® @ 2 qts	56.475a	53.6 a	53.25 b	52.93ab	53.58 b
Calexin @ 1.6 pts	51.25 b	49.5 a	54.25ab	53.2 ab	54.78ab
CalMax @ 2.5 qts	51.25 b	53.7 a	52.68 b	52.5 ab	57.3a
Trafix @ 1 qt + EleMax PhosCal LC @ 1.5 qts + MegaFol @ 1 pt	50.025 bc	50.35a	53.05 b	52.73ab	56.5ab
Untreated check	46.55 c	50.3 a	57.25a	51.48 b	57.18ab

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

Table 2. Stigma elongations (mm) beyond anthers and percent abnormal flowers.

		Stigma Elongations		Percent abnormal flowers	
Treatment	Rate/acre	July 13	July 21	July 13	July 21
Aminofol® Maximize	2 qts	0.84 c	1.47a	48.9 c	72.6ab
CalBit® + Megafol®	1 qt + 1 qt	0.40ab	1.07a	39.4abc	78.5abc
Calcium Chelate	1 lb	0.82 bc	1.36a	45.2 bc	77.1abc
Calcium Metalosate®	2 qts	0.40ab	1.26a	36.3ab	73.1abc
Calexin	1.6 pt	0.52abc	1.14a	44.9 bc	79.8 bc
CalMax®	2.5 qt	0.20a	1.32a	28.8a	70.7a
Trafix® + PhosCal + Megafol®	1 qt + 1.5 qts + 1 pt	0.83 c	1.35a	31.0a	77.4abc
Untreated Check	----	0.64 bc	1.14a	36.2ab	81.7 c

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

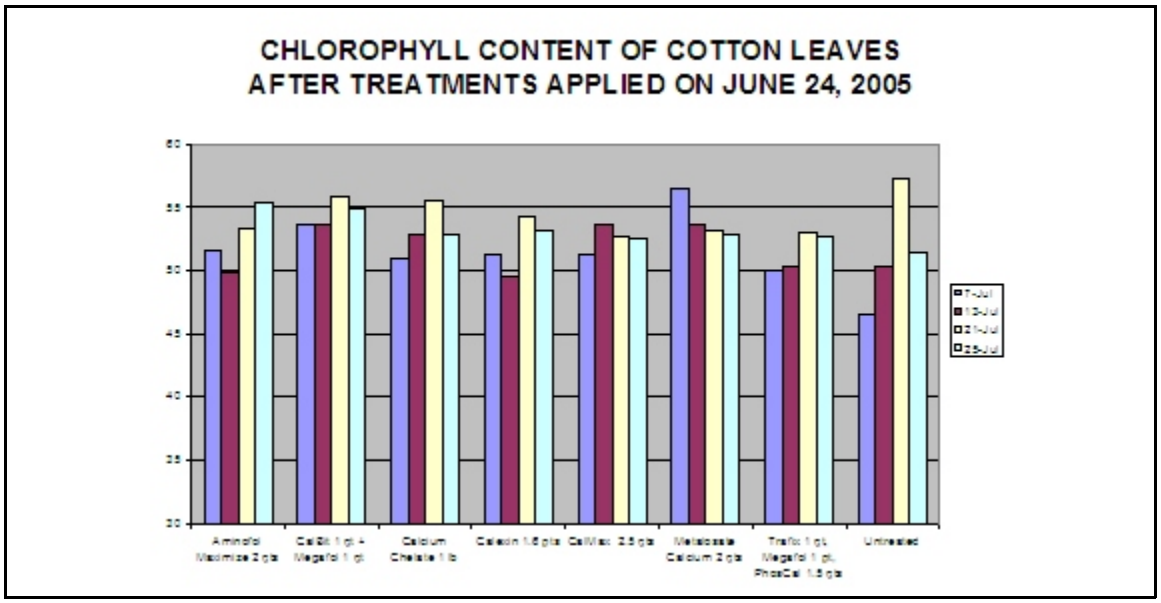

Fig. 2. Chlorophyll content of 5th cotton leaf from terminal after application of foliar fertilizers containing calcium.

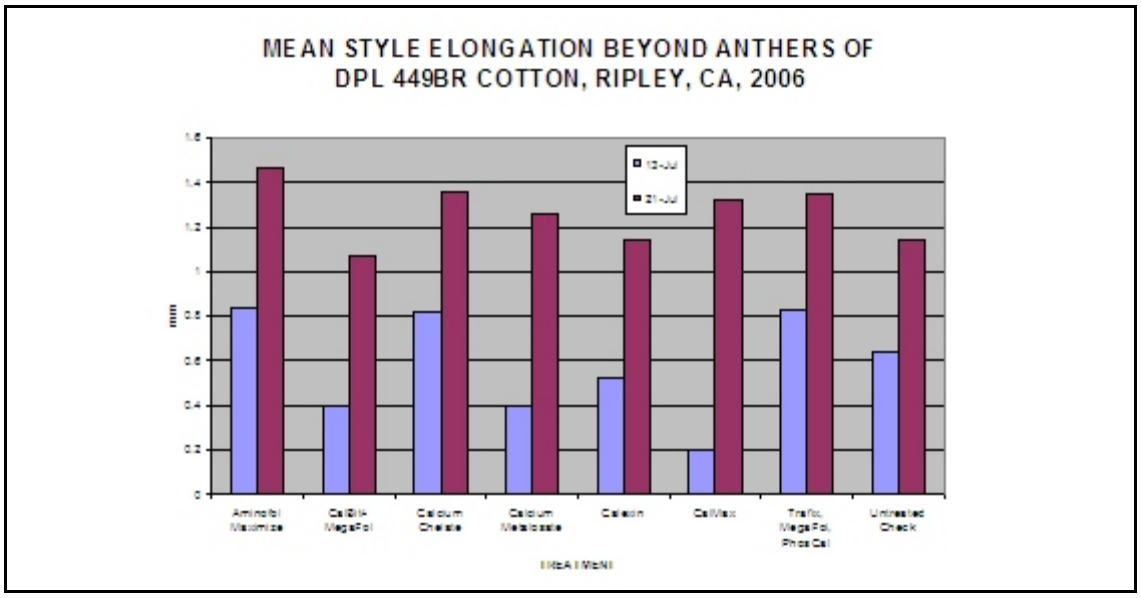

Fig. 3. Distance between anthers and stigmas after application of foliar fertilizers.

Table 3. DPL449BR cotton mean plant heights (inches) and nodes after application of foliar fertilizers containing calcium on June 24, 2005, Ripley, CA.

	Plant Heights			Nodes		
	Sample Date			Sample Date		
Treatment and rate/acre	July 6	July 21	Aug. 4	July 6	July 21	Aug. 4
Aminofol® Maximize @ 2 qts	26.15ab	27.1ab	26.7ab	18.3a	18.7 b	20.3 b
CalBit® @ 1 qt + MegaFol® @ 1 qt	25.75ab	27.3ab	27.3ab	18.35a	20.55a	20.85 b
Calcium Chelate @ 1 lb	24.8 b	29.5ab	27.4ab	18.3a	20.4ab	21.3ab
Calcium Metalosate®@ 2 qts	24.45 b	25.75 b	26.7ab	18.6a	18.7 b	20.4 b
Calexin @ 1.6 pts	25.8ab	27.3ab	24.5 b	17.35a	19.2ab	19.7 b
CalMax® @ 2.5 qts	28.9a	30.9a	32.3a	18.35a	20.35ab	23.15a
Trafix @ 1 qt + EleMax PhosCal LC @ 1.5 qts + MegaFol® @ 1 pt	25.95ab	26.7ab	27.8ab	17.5a	19.7ab	21.45ab
Untreated check	24.55 b	25.2 b	26.3ab	17.3a	18.75ab	20.3 b

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

Table 4. First fruiting node and mean number of fruiting nodes per plant.

	First Fruiting Node			Fruiting Nodes			Height:Node Ratio		
	Sample Date			Sample Date			Sample Date		
Treatment and rate/acre	July 6	July 21	Aug. 4	July 6	July 21	Aug. 4	July 6	July 21	Aug. 4
Aminofol® Maximize @ 2 qts	3.75a	4.4a	5.1a	14.6a	14.3abc	15.2 b	1.43abc	1.45a	1.36a
CalBit® @ 1 qt + MegaFol® @ 1 qt	4.1ab	5.2a	4.9a	14.3a	15.4abc	16.0ab	1.41ab	1.33a	1.31a
Calcium Chelate @ 1 lb	4.5ab	4.7a	5.3a	13.8a	15.7a	16.0ab	1.35ab	1.44a	1.29a
Calcium Metalosate® @ 2 qts	4.8 b	5.1a	4.85a	13.8a	13.6 c	15.6 b	1.31a	1.38a	1.31a
Calexin @ 1.6 pts	4.45ab	4.85a	5.25a	12.9a	14.4abc	14.5 b	1.49 bc	1.42a	1.25a
CalMax® @ 2.5 qts	4.1ab	4.9a	5.0a	14.3a	15.5ab	18.5a	1.57 c	1.51a	1.39a
Trafix @ 1 qt + EleMax PhosCal LC @ 1.5 qts + MegaFol® @ 1 pt	4.15ab	5.4a	4.75a	13.35a	14.3abc	16.7ab	1.48 bc	1.36a	1.29a
Untreated check	4.35ab	4.95a	5.45a	13.0a	13.8 bc	14.9 b	1.42ab	1.34a	1.30a

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

Table 5. DPL449BR retention rates at fruiting positions 1-3 after application of foliar fertilizers containing calcium on June 24, 2005, Ripley, CA.

	Position 1			Position 2			Position 3		
Treatment and rate/acre	July 6	July 21	Aug. 4	July 6	July 21	Aug. 4	July 6	July 21	Aug. 4
Aminofol® Maximize @ 2 qts	78.8 bc	53.7a	49.4ab	81.1a	47.1ab	41.8ab	78.0a	31.9b	33.2a
CalBit® @ 1 qt + MegaFol® @ 1 qt	76.4 c	53.4a	42.7 b	79.2a	43.7b	40.0ab	81.6a	30.4 b	31.4a
Calcium Chelate @ 1 lb	79.9 bc	54.2a	46.2ab	77.4a	49.2ab	35.8 b	84.9a	48.8a	28.7a
Calcium Metalosate® @ 2 qts	84.2ab	58.4a	50.2ab	79.5a	45.5ab	42.9ab	78.9a	41.2ab	35.7a
Calexin @ 1.6 pts	80.ab	60.0a	51.4ab	83.4a	47.8ab	41.2ab	78.8a	34.9ab	34.1a
CalMax® @ 2.5 qts	80.2abc	60.7a	52.4a	81.7a	53.2a	38.7 b	82.6a	37.2ab	29.0a
Trafix @ 1 qt + EleMax PhosCal LC @ 1.5 qts + MegaFol® @ 1 pt	81.9abc	56.6a	47.6ab	83.0a	48.3ab	42.8ab	85.4a	37.9ab	29.2a
Untreated check	85.9a	54.4a	48.2ab	83.6a	45.1ab	48.1a	83.0a	35.0ab	40.9a

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

Table 6. DPL449BR retention rates at fruiting positions 1-2 and 1-3 after application of foliar fertilizers containing calcium on June 24, 2005, Ripley, CA.

	Positions 1-2 Sample Date			Positions 1-3 Sample Date		
Treatment and rate/acre	July 6	July 21	Aug. 4	July 6	July 21	Aug. 4
Aminofol® Maximize @ 2 qts	80.0 bc	50.4ab	45.6ab	79.3a	44.2ab	41.4abc
CalBit® @ 1 qt + MegaFol® @ 1 qt	77.8 c	48.5b	41.4ab	79.0a	42.5b	38.0 bc
Calcium Chelate @ 1 lb	81.8abc	51.7ab	41.0 b	80.8a	50.7a	36.9 c
Calcium Metalosate® @ 2 qts	81.8ab	51.9ab	46.5ab	80.8a	48.4ab	42.9ab
Calexin @ 1.6 pts	78.6 bc	53.9ab	46.3ab	80.7a	47.9ab	42.3ab
CalMax® @ 2.5 qts	80.9abc	56.6a	45.6ab	81.5a	50.3a	40.1 bc
Trafix @ 1 qt + EleMax PhosCal LC @ 1.5 qts + MegaFol® @ 1 pt	82.5ab	52.4ab	45.2ab	83.4a	47.6ab	39.9 bc
Untreated check	84.7a	49.7b	48.1a	84.1ab	44.8ab	45.7a

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

Table 7. DPL449BR calculated fruiting structures/plant at positions 1, 2, and 3 after application of foliar fertilizers containing calcium on June 24, 2005, Ripley, CA.

	Sample Date								
	Position 1			Position 2			Position 3		
Treatment and rate/acre	July 6	July 21	Aug. 4	July 6	July 21	Aug. 4	July 6	July 21	Aug. 4
Aminofol® Maximize @ 2 qts	11.5a	7.7ab	7.5 b	11.8a	6.7ab	6.3a	11.3a	4.6 b	5.0a
CalBit® @ 1 qt + MegaFol® @ 1 qt	10.9a	8.2ab	6.8 b	11.3a	6.7ab	6.3a	11.6a	4.7 b	5.1a
Calcium Chelate @ 1 lb	11.0a	8.5ab	7.4 b	10.7a	7.7ab	5.8a	11.8a	7.7a	4.6a
Calcium Metalosate® @ 2 qts	11.6a	8.0ab	7.8ab	10.9a	6.2 b	6.6a	10.9a	5.6ab	5.6a
Calexin @ 1.6 pts	10.3a	8.6ab	7.4 b	10.8a	6.9ab	5.9a	10.2a	5.1ab	4.9a
CalMax® @ 2.5 qts	11.5a	9.4a	9.5a	11.6a	8.4a	7.0a	11.8a	5.9ab	5.2a
Trafix @ 1 qt + EleMax PhosCal LC @ 1.5 qts + MegaFol® @ 1 pt	10.9a	8.1ab	7.9ab	11.1a	6.9ab	7.1a	11.4a	5.4ab	4.9a
Untreated check	11.1a	7.5 b	7.1 b	10.8a	6.3 b	7.1a	10.8a	4.9 b	6.1a

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

Table 8. DPL449BR calculated fruiting structures/plant at positions 1-2 and 1-3 after application of foliar fertilizers containing calcium on June 24, 2005, Ripley, CA.

	Positions 1-2			Positions 1-3		
Treatment and rate/acre	July 6	July 21	Aug. 4	July 6	July 21	Aug. 4
Aminofol® Maximize @ 2 qts	23.3a	14.4ab	13.8ab	34.6a	19.0a	18.8ab
CalBit® @ 1 qt + MegaFol® @ 1 qt	22.2a	14.9ab	13.1 b	33.7a	19.6a	18.3ab
Calcium Chelate @ 1 lb	21.8a	16.3ab	13.2 b	33.6a	23.9a	17.9 b
Calcium Metalosate® @ 2 qts	22.6a	14.2 b	14.4ab	33.4a	19.8a	20.0ab
Calexin @ 1.6 pts	21.1a	15.5ab	13.4 b	31.3a	20.7a	18.3ab
CalMax® @ 2.5 qts	23.1a	17.8a	16.6a	34.9a	23.7a	21.8a
Trafix @ 1 qt + EleMax PhosCal LC @ 1.5 qts + MegaFol® @ 1 pt	22.0a	15.0ab	15.0ab	33.4a	20.5a	19.9ab
Untreated check	21.9a	13.8 b	14.3ab	32.7a	18.7a	20.4ab

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

Table 9. Yield, turnout percentages and lint value of DPL449BR cotton after application of foliar fertilizers containing calcium on June 24, 2005, Ripley, CA

Treatment and rate/acre	Lbs. Seed cotton/acre	Percent[1] turnout	Lbs. lint per acre[2]	Value ¢/lb.	Value $/acre[2]
Aminofol® Maximize @ 2 qts	4,106ab	43.75	1,796a	61.75	1,111.45
CalBit® @ 1 qt + MegaFol® @ 1 qt	4,033ab	27.26	1,099 d	61.75	688.01
Calcium Chelate @ 1 lb	4,057ab	30.77	1,248 c	60.74	795.20
Calcium Metalosate® @ 2 qts	4,329a	29.50	1,277 c	61.75	787.34
Calexin @ 1.6 pts	3,873 b	37.39	1,448 b	60.81	908.82
CalMax® @ 2.5 qts	4,134ab	34.24	1,415 b	61.75	899.66
Trafix @ 1 qt + EleMax PhosCal LC@ 1.5 qts + MegaFol® @ 1 pt	4,010ab	33.52	1,344 bc	61.75	814.05
Untreated check	4,184ab	33.82	1,415 b	61.27	877.87

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

[1] Data represent single data point as received from gin, extremely low confidence assigned to these percentages due to lack of replication and potential of more/less than one module under commercial ginning operations.

[2] Values calculated using percent turnout. Extremely low confidence is noted for these aspects of the experiment.

Table 10. Lint quality parameters of DPL449BR cotton after application of foliar fertilizers containing calcium on June 24, 2005, Ripley, CA.

		Fiber	Length	Strength	Color				
Treatment and rate/acre	Mic	1/100"	1/32"	(g/tex)	Rd	+b	Unif	Trash	Leaf
Aminofol® Maximize @ 2 qts	4.2	109	35a	30.2	80.5a	8.14a	79.5	1.70ab	2.8a
CalBit® @ 1 qt + MegaFol® @ 1 qt	4.2	108	35a	29.7	81.1b	8.40de	79.6	1.57ab	2.7a
Calcium Chelate @ 1 lb	4.2	110	35a	30.2	81.2bc	8.24ab	79.4	2.13bc	3.1 b
Calcium Metalosate® @ 2 qts	4.3	108	35a	28.3	81.6c	8.49e	79.7	1.63ab	2.75a
Calexin @ 1.6 pts	4.2	108	35a	28.5	80.8ab	8.30bc	79.9	2.22c	2.9ab
CalMax® @ 2.5 qts	4.2	108	35a	30.3	81.2bc	8.39cde	80.1	1.56a	3.0ab
Trafix @ 1 qt + EleMax PhosCal LC @ 1.5 qts + MegaFol® @ 1 pt	4.2	109	35a	30.7	81.2bc	8.25cde	80.3	2.18c	3.0ab
Untreated check	4.2	110	35a	30.6	80.9ab	8.3abcd	80.3	2.00abc	3.0ab

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

Data for each bale of each treatment were identical for micronaire, fiber length, strength and uniformity, hence each number in each of these columns statistically differs from that of another value.