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PIMA GROWTH MANAGEMENT: RESPONSES TO IRRIGATION AND GROWTH REGULATOR MANAGEMENT

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Abstract

Mepiquat chloride recommendations developed for Acala cotton in CA are based upon the concept that growth regulators should be used when within-season plant mapping information indicates low to moderate fruit retention combined with moderate to high vigor measured as plant height or growth rates. Field history which indicates consistent problems with too high vigor can also be used as an indicator that growth regulator responses would likely be positive. In more recent studies with Pima cotton conducted over a long time period, results indicate that mepiquat chloride materials can be effective in helping manage vegetative growth, but impacts on yield are smaller and less consistent than found with Acala cotton. Results also show that the potential impact of delayed irrigations in combination with growth regulator use on plant growth and lint yields depends to a significant extent on fruit retention and the intensity of water stress.

Introduction

Under conditions of the San Joaquin Valley of CA, Pima cotton has a different general growth habit than most Acala cotton varieties. Pima generally requires a longer growing season, has 3 to 5 more total fruiting branches than Acala varieties grown under similar full-season conditions, and 2nd, 3rd, and even 4th position fruit are important to attaining high yields. Fruit on vegetative branches can also represent as much as 8 to 10% of total yield under some conditions. All of these fruiting pattern characteristics make Pima varieties quite different from Acala varieties, so there are few reasons to assume that mepiquat chloride growth regulator rate and timing recommendations developed for Acala varieties will "transfer" to Pima grown under similar conditions.

Timing and Rate Studies on Pima

Pima studies done by University of CA Specialists, Farm Advisors and other research staff during the early through mid-1990's found little consistency in response to mepiquat chloride (PIX, other materials) at the 0.5 pts/acre rate typically used with the 4.2% formulation on Acala cotton (Munk et al, 1997, 1998). Further rate studies in 1993 through 1997 focused on higher PIX rates and on sequential mepiquat chloride (PIX) treatments that combined different rates applied at some combinations of: (1) first or early bloom; (2) 10-14 days after first bloom; and/or (3) 11-17 days after the second application timing. Some of the results from studies done during the 1993 through 1997 period were summarized previously (Munk et. Al., 1997, 1998), but not all test sites were included in those summaries. Across all University of CA and USDA-ARS test locations, the best PIX treatments identified in the 1993 through 1997 multi-location field trials were:

1. 0.5 pts PIX (4.2% formulation) per acre at both full bloom and again 2 weeks later – averaging <u>104.7% of the untreated control</u> in 1993 through 1997 studies.
2. 0.75 pts PIX per acre at full bloom, plus 0.5 pts per acre 2 weeks later – averaging <u>103.5% of the untreated control</u> in 1993 through 1997 trials.

These sequential applications gave the best combination of favorable yield responses and significant control of vegetative growth (plant height and total branch # were reduced - data not shown). It is important to note, however, that even when yield increases with PIX applications did occur, they often only exceeded yields of untreated controls by 50-75 lbs lint/acre or less. Though a focus on yield responses is important, many growers are also interested in effective control of excess vegetative growth, since it helps with preparation for a timely harvest with reduced impact on fiber quality. This report focuses on continuing studies with a range of growth regulator and irrigation management approaches with Pima cotton in the San Joaquin Valley.

Materials and Methods

1993 through 1996 Studies – Clay Loam Soil Site

Several large-scale subsurface drip and furrow irrigation studies were run by Hutmacher and other staff at the USDA-ARS Water Management Research Laboratory (Fresno, CA) in the early through mid-1990's, with the actual field research conducted at the Univ. of CA West Side Research and Extension Center in a deep, clay loam soil. Irrigation water application amounts ranged from 100% of estimated crop evapotranspiration (Etc) during the entire season down to deficit irrigation of 60 or 80% of Etc during the bloom or post-cutout period. Data obtained from these studies with the Pima varieties "S-6" and "S-7" will be used as brief examples of the difference in responses to soil water stress and mepiquat chloride when early and mid-season fruit retention is low (> 55% early fruit retention). In this and subsequent studies, plant mapping information was collected during the growing season as well as final mapping done during early- to mid-September. Yields were measured in the center two rows within four-row plots using a full-size, commercial-type spindle picker.

1999 Through 2001 Studies

Field trials were initiated in 1999 to evaluate plant growth and yield responses to differential irrigation treatments (designed to produce two different levels of water stress) and specific growth regulator treatments. Growers have in recent years started to show widespread interest in a broader range of varieties with different growth habits, both more determinate types of Pima (such as the variety "S-7") and more indeterminate types (such as variety "Phytogen-57"). For this reason, the study was also set up to include both of these varieties in order to compare varietal differences in responses to irrigation and growth regulator treatments. The combination of varieties, irrigation treatments, and growth regulator treatments used is shown in Table 1.

In addition to an untreated control (UTC), there were three types of growth regulator treatments evaluated, as shown in Table 1. All involve variations on mepiquat chloride, with applications beginning as early as 1st bloom, and following at about 14 day intervals as in previous years. In addition, a BASF experimental (BAS-130-01W) was included as a second application material in one of the sequential treatments (Treatment #4), since other research has shown it to be stronger than the 4.2% formulation of mepiquat chloride in impact on late vegetative growth.

Results and Discussion

1993, 1995 and 1996 STUDIES

Early and mid-season first-position fruit retention was good in 1993 (>65%) while it was between 38 and 52% through mid-bloom in 1995 and 1996 studies (data not shown). Lint yields are shown in Figure 1 as percent of the untreated (no growth regulator) control irrigated at the 100/100/100 level (where the three #'s, in order, are the irrigation rate as a percent of crop evapotranspiration (Etc) during the pre-bloom, bloom through cutout, and post-cutout periods, respectively). Yields in 1993 (good retention year) were improved slightly by growth regulator applications (Figure 1) at the higher irrigation levels (100/100/100 and 100/100/80), while yields were reduced 3 to 5% by growth regulator applied to plants receiving less irrigation water and therefore subject to more water stress (100/80/60 and 100/60/60).

In years with lower fruit retention in the early- to mid-season (1995, 1996 in Figure 1), growth regulator applications improved yields by several % in the higher irrigation treatments. Even with the lower fruit retention, plants in the more water-stressed treatments had a slight negative response to growth regulator applications in 1995 and 1996 (Figure 1).

Leaf water potentials were as much as 6 to 8 bars lower in the 100/60/60 treatment than in the fully irrigated treatment during late July and through August all three years (data not shown).

1999 Through 2001 Studies. Two irrigation treatments and three growth regulator treatments plus an untreated control were evaluated these years. PIX Plus application rates were always 0.75 pts/acre, while BAS-130-01W applications were at 0.5 pts/acre. Early and mid-season fruit retention were quite high in 1999 and 2000 (Table 2), in contrast to the 1995 and 1996 studies just discussed. Early fruit retention in 2001, by comparison, was moderate.

In both varieties (S-7 and Phy-57), and in both irrigation treatments, plant height was quite responsive to growth regulator applications (data not shown). Similar results were seen across treatments in all years, with the greatest impacts on leaf area and plant height with the BAS-130-01W compound, especially if used in combination with delayed irrigation (data not shown). Table 2 also shows the impact of growth regulators and delayed irrigation (Irrigation Treatment #2) on other plant parameters.

Expansive growth (leaf area and plant height) were impacted by delayed irrigation treatments, and part of the response can be explained by impacts on leaf gas exchange. Impacts of slowly-developing water deficits (expressed as leaf water potential (LWP)) on upper-canopy single leaf photosynthetic rates are shown in Figure 2, where the impacts of leaf water potential on photosynthesis are shown as percent reduction in leaf photosynthetic rates relative to that of non-stressed controls (where afternoon LWP ranged from –16 to –19, depending upon growth stage).

Yields in 1999 Through 2001 Studies. Under conditions of high early fruit retention which were observed in both 1999 and 2000 studies, growth regulator treatment #2 (with an early first PIX PLUS application at first bloom), generally had a modest negative impact on lint yields (1999, Figure 3) or little impact (irrigation treatment # 1 in 2000) (Figure 4). In most other cases, treatments with the more recommended, later timing of first PIX application (10-14 days after first bloom) had little impact on yield except with the more water-stressed plants of Irrigation Treatment #2 in 2000 and 2001.

In 1999, the delays in irrigation with Irrigation Treatment #2 brought about more severe water stress and reduced yields when compared with the same treatments in 2000 due to the presence of some coarser texture soil within the 1999 plot area. The severity of water stress brought about with the delayed irrigation in 2000 was less severe, and actually had a positive impact on the Phy-57 variety. The impact of varieties on relative impact of the combination of delayed irrigation and growth regulators can be seen in comparing the more negative impact of growth regulator treatment # 4 on the more determinate S-7 variety (Figures 3, 4, 5).

Summary and Conclusions

As in earlier studies of Munk et al (1997, 1998), mepiquat chloride growth regulators have consistent performance in control of vegetative growth parameters with applications made from early bloom through 4 weeks after first bloom. Over numerous years of this and prior studies, the most consistent impacts of mepiquat chloride on lint yield have been with sequential applications made at the 0.75 or 0.5 pts per acre rate starting at about 10-14 days after first bloom, and continuing with one or two additional applications at 10-14 day intervals after the first application.

The most recent studies have included delayed irrigation treatments similar to what some growers are trying in order to assist with vegetative growth control . Where early fruit retention is low to moderate or where high vigor conditions exist due to high water and nutrient levels, delayed irrigations which produce moderate water stress (mid-afternoon LWP of –21 to –23 bars) can reduce vegetative growth rates while limiting negative impacts on yield. However, under conditions where fruit retention is high and can help hold down vegetative growth, delayed irrigations and water stress may help manage growth, but can also reduce yields under high yield potential conditions.

Acknowledgements

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References

Munk, D., B.L. Weir, S.D. Wright, R.N. Vargas, and D.J. Munier. 1997. Pima cotton growth and yield responses to mepiquat chloride (PIX). p. 1401-1403. *In:* P. Dugger and D. Richter (ed.) Proc. Beltwide Cotton Conf., New Orleans, LA. 6-10 Jan., 1997. Natl. Cotton Council Amer., Memphis, TN.

Munk, D.S., B.L. Weir, S.D. Wright, R.N. Vargas and D.J. Munier. 1998. Pima Cotton Growth and Yield Responses to Late-Season Applications of Mepiquat Chloride. J. Cotton Sci. 2:85-90.

Table 1. Varieties, irrigation treatments and growth regulator treatments used in 1999 through 2001 studies at Univ. of CAWest Side REC.

VARIETIES

- Pima S-7 (medium-stature under most conditions, moderately determinate for a Pima variety).
- Phytogen-57 (larger plant under most conditions, more indeterminate compared to most Pima).

IRRIGATION TREATMENTS

- IRRIGATION TREATMENT #1:

Irrigations 1st week June, 1st week July, end of July or first week of August (avoids leaf water potentials below -20 bars).

- IRRIGATION TREATMENT #2:

Irrigations 1st week June, mid July, mid August (irrigations delayed to produce stress equivalent to as low as -23 bars).

GROWTH REGULATOR TREATMENTS

- TREATMENT #1: Untreated Control (UTC).
- TREATMENT #2: PIX Plus at 1st bloom, & again 2 more times at14 day intervals.
- TREATMENT #3: PIX Plus 14 days after 1st bloom, again once more 14 days later.
- TREATMENT #4: PIX Plus 14 days after 1st bloom, BAS 130-01W applied 14 days later.

Table 2. Average plant parameters at final plant mapping time (second week of September) as a function of growth regulator, variety and irrigation treatment for select combinations of treatments in 1999 and 2000 studies at the West Side REC, western Fresno County, CA.

Variety	Irrigation Treatment	Growth Regulator Treatment	Ht. To node ratio (in.)	% fruit retention of 1st position sites: Bot-5 sites	% fruit retention of 1st position sites: 95% zone	# fruiting branches 95% zone all bolls
			1999			
S-7	Irrig. Trt. # 1 (typical scheduling)	Un-Treated Control	1.85	88.0	89.0	11.9
	"	Trt. # 2	1.80	90.7	83.3	11.8
	"	Trt. # 3	1.76	94.7	85.4	11.4
	"	Trt. # 4	1.74	92.0	86.5	11.6
	Irrig. Trt. # 2 (delayed irr.)	Trt. # 3	1.49	88.0	73.8	10.7
Phy-57	Irrig. Trt. # 1 (typical scheduling)	UTC	2.07	94.7	88.2	12.7
	"	Trt. # 3	1.92	88.3	82.9	12.4
	Irrig. Trt. # 2 (delayed irr.)	Trt. # 3	1.65	76.0	75.2	11.1
			2000			
S-7	Irrig. Trt. # 1	UTC	1.85	70.6	89.2	12.8
	"	Trt # 3	1.76	74.3	85.2	12.6
	Irrig. Trt. # 2	Trt # 3	1.49	68.1	74.3	11.7
Phy-57	Irrig. Trt. # 1	UTC	2.07	70.4	75.2	13.6
	"	Trt. # 3	1.92	77.2	83.6	13.2
	Irrig. Trt. # 2	Trt. # 3	1.65	79.3	80.9	12.5

IRRIGATION BY PIX STUDIES - 1993, 1995, 1996

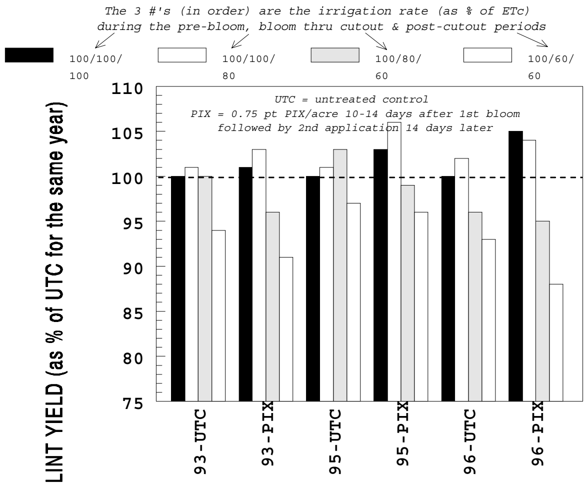

Figure 1. Lint yield as a function of irrigation rate (% of Evapotranspiration – Etc across growth periods) and mepiquat chloride treatment (Untreated control (UTC) versus PIX applications) in 1993, 1995 and 1996 studies at the West Side REC location.

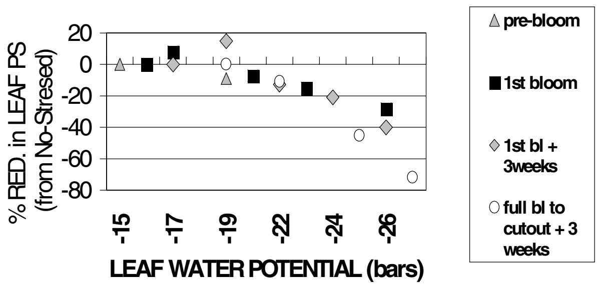

Figure 2. Single leaf net photosynthetic rates as a function of leaf water potential and growth stage for Pima variety S-7 in growth regulator:irrigation trials at the West Side REC site. Impacts on photosynthetic rates are expressed as percent reduction in rates from those measured on non-stressed control plants with LWP of –16 to –19 bars.

Pima responses in irrigation by Mepiquat Chloride evaluations (1999)

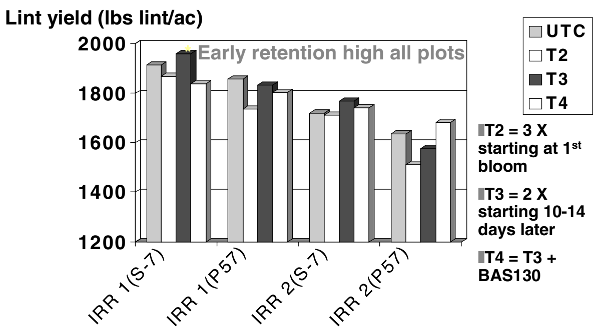

Figure 3. Lint yield as a function of irrigation treatment (IRR. #1 or IRR. #2) for the varieties S-7 and Phytogen-57 in untreated controls (UTC) and PIX treatments in 1999 at the West Side REC site.

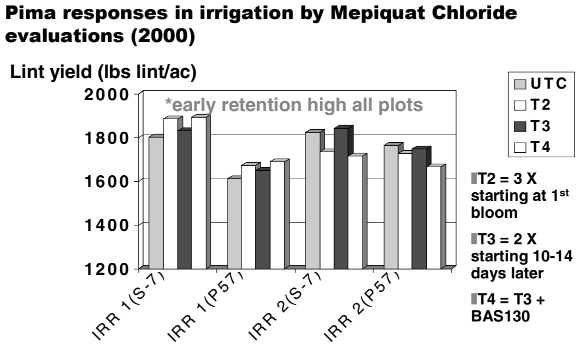

Figure 4. Lint yield as a function of irrigation treatment (IRR. #1 or IRR. #2) for the varieties S-7 and Phytogen-57 in untreated controls (UTC) and PIX treatments in 2000 at the West Side REC site.

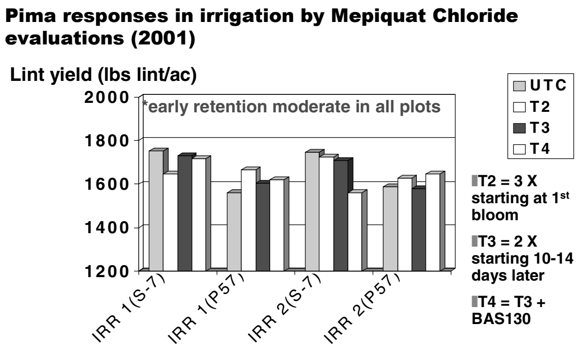

Figure 5. Lint yield as a function of irrigation treatment (IRR. #1 or IRR. #2) for the varieties S-7 and Phytogen-57 in untreated controls (UTC) and PIX treatments in 2001 at the West Side REC site.