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Effect of Mepiquat Chloride and Nitrogen Levels on Yield, Growth Characteristics, and Elemental Composition of Cotton

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Abstract. A 3-year study was conducted to determine the effects of mepiquat chloride and N levels on yield and quality of cotton (*Gossypium hirsutum* L.). Mepiquat chloride (MC) treatments did not significantly affect yields; however, cotton lint yields (1980) were 688, 949, 1,011, and 1,045 kg/ha for N rates of 0, 45, 90, and 135 kg/ha, respectively. Nitrogen by MC interactions on yield were not significant for any of the 3 years. MC treatments reduced plant height for all N levels. Plant height averages over all N levels were reduced 15–33% by the addition of MC. The MC treatments significantly increased the percent of Ca and Mg in the cotton leaves on a dry-weight basis. Nitrogen concentrations of the leaves were not affected by MC treatments. Leaf N levels were not significantly affected by N fertilization in 1979, but leaf N levels in 1980 were significantly increased at the 90 kg N/ha rate when compared with the check treatment.

In many regions of the Cotton Belt, untimely and excessive rainfall and high soil nitrogen (N) levels cause excessive plant growth. The adverse effects of excessive plant growth have been associated with square and young boll shed and decreased sunlight penetration into the canopy (Briggs 1980, Eaton 1955, Guinn 1982, Heilman et al. 1977). In addition, a dense plant canopy reduces the effectiveness of insecticide applications and increases the incidence of boll rot and other plant diseases. The overall combined effects of the above factors are reductions in picker efficiency, yield, fiber quality, and overall production efficiency.

Control of excessive plant growth has been reported with the chemical mepiquat chloride (MC). Reported changes in morphological characteristics of the cotton plant following MC application are increased leaf thickness, reduced leaf area, decreased plant height, shorter branch lengths, and a reduced number of main stem nodes (Gausman et al. 1979a,b, Kerby et al. 1984, Namken et al. 1978, Walter 1980).

Both yield increases and decreases have been reported with MC applications (Kerby et al. 1982, York 1982). Application of MC to stressed cotton was the most often reported cause of decreased yields. Increases in yield are associated with decreased plant size and earlier maturity as measured by increased yield of first pick; however, yield increases are variable and appear to be related to the environment, soil type, nitrogen, and overall fertility status of the soil.

The effects of MC on cotton fertilized to high N levels are increased petiole nitrate levels with variable results on yield, seed, and fiber properties (Cotton Research Institute 1982–83, Kerby et al. 1982, Stedman et al. 1982, York 1982). MC has not altered the optimum N rate or plant population (Heilman 1981, York 1983a,b).

The objectives of this study were to determine the effects of MC applications at various N rates on yields, lint quality, and mineral composition as measured in the cotton leaves, and to determine its effect on controlling vegetative plant growth.

Materials and Methods

A 3-year study was conducted at the Soil and Water Conservation Research Farm in Weslaco, Texas, on a Hidalgo fine sandy loam soil (fine-loamy, mixed hyperthermic Typic Calciustolls). Midseason cultivars (Stoneville 213, planted in 1978, and McNair 220, planted in 1979–80) were used in the experiment. The cultivars were planted in single drills (102-cm center) on March 21, 1978; February 27, 1979; and March 14, 1980. In 1978 and 1979, the plots were irrigated after planting; in 1980, the plots were planted to moisture. Three post plant irrigations were applied for maintaining a high moisture regimen in the plots.

The experimental design was a split-plot randomized complete block with four replications with nitrogen levels as the main plots and MC levels as the subplots. Main plots were 16 rows × 15 m and subplots were 4 rows × 15 m. Treatments remained in the same location for the duration of the study.

The nitrogen levels (ammonium sulfate) were side-dressed at pinhead square growth stage at the rates of 0 (N-0), 45 (N-1), 90 (N-2), and 135 (N-3) kg N/ha. The MC levels were GR-0 (no MC), GR-1 (49 g/ha at pinhead + 25 g/ha as 1st bloom), and GR-2 (74 g/ha at 1st bloom). In 1979 and 1980, an additional MC treatment was added. This treatment, GR-3 (74 g/ha at 1st bloom + 25 g/ha 20 days later), added 25 g/ha of MC following first bloom.

Plant height measurements were made at weekly intervals after the first application of MC. Once first bloom was observed, bloom counts were made on a daily basis to determine the cumulative number of blooms for each treatment. In 1980, 10 blooms per treatment were tagged daily for determining the percent bloom set. The first mature leaf from the top of the plant was collected for chemical analysis. The plant leaf samples were collected biweekly beginning immediately before the first MC application and used for the determination of Ca, Mg, K, and total N. Two rows, 15 m in length, were hand-picked for yields for each treatment.

Table 1. The effect of MC on lint cotton yields averaged over all N treatments in kg/ha.

MC level	1978	1979	1980
GR-0	1,298	973	924
GR-1	1,026	971	885
GR-2	1,077	948	934
GR-3	—	968	958
$LSD_{0.05}$[a]	n.s.	n.s.	n.s.

[a] Least significant difference.

Table 2. The effect of N application rates on lint cotton yield averaged over all MC treatments in kg/ha.

Nitrogen application	1978	1979	1980
N-0	1,105	950	688
N-1	1,147	992	949
N-2	1,075	982	1,011
N-3	1,206	935	1,045
$LSD_{0.05}$[a]	n.s.	n.s.	47

[a] Least significant difference.

Results and Discussion

There was not a significant interaction between MC treatments and N levels. The effects of MC on lint cotton yields are presented in Table 1. The application of MC did not significantly affect yields in any of the 3 years. Yield losses on medium-textured soils in the Lower Rio Grande Valley are associated with excessive rainfall during either the fruiting or the harvest period. Unfavorable weather conditions did not occur during the 3 years of the study. It is important that in the absence of unfavorable weather conditions, MC did not reduce yields when compared with the check plots.

The effect of N application rates on lint cotton yields is presented in Table 2. Nitrogen rates did not significantly affect lint cotton yields for 1978 and 1979; however, lint cotton yields were significantly increased by N treatments in 1980. The available mineralized soil N in the check treatment had been utilized by the 1980 growing season. The addition of 45 kg/ha N (N-1) significantly increased lint cotton yields above the check. The 90 kg/ha (N-2) rate increased lint cotton yield to 1,011 kg/ha and was significantly greater than the N-1 N rate. The lint cotton yield from the N-2 N rate was not significantly different from the 135 kg/ha N (N-3) lint cotton yield. To maintain cotton productivity, added nitrogen fertilizer needs exceeded 45 kg/ha. This is in agreement with the generally recommended rate of 67 kg/ha N currently being used in the Lower Rio Grande Valley (Gausman et al. 1979a).

The effect of MC and N treatments on the cumulative number of blooms for 1979 is presented in Figs. 1 and 2. Neither timing nor amount of MC significantly affected the number of blooms during the fruiting period. MC treatments (1980) did not affect the percent boll set. The average seasonal percent boll set

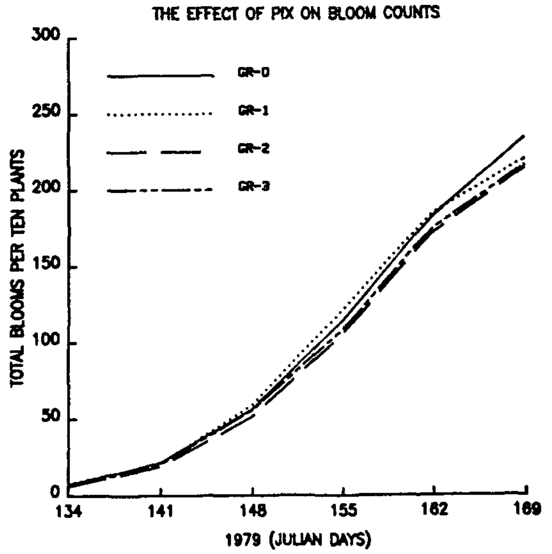

Fig. 1. The effect of MC averaged over all N levels on cumulative number of blooms.

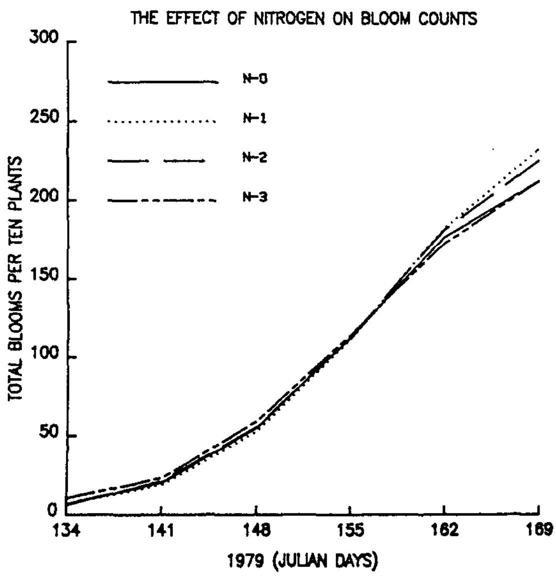

Fig. 2. The effect of nitrogen levels averaged over all MC levels on total cumulative number of blooms.

averaged for all N levels was 47%. Additional N above the check level did not affect the total number of seasonal blooms. The percent boll set was significantly increased at the N-2 (49%) rate as compared with the check N (44%) plots. Similar results were obtained in 1978 and 1980. These physiological effects of MC on the plant were apparently limited to those factors associated within the plant that alter plant growth and did not affect the reproductive fruiting pattern of the plant.

MC treatments did not affect fiber quality as measured by micronaire, fiber

Table 3. The effect of MC treatment on cotton lint quality as measured by micronaire, length, strength, and percent lint.

Measurement	MC level	1978	1979	1980
Micronaire (index)	GR-0	4.6	4.7	4.7
	GR-1	4.7	4.8	4.7
	GR-2	4.7	4.7	4.8
	GR-3	—	4.8	4.7
$LSD_{0.05}$[a]		n.s.	n.s.	n.s.
length (inches)	GR-0	1.08	1.05	1.10
	GR-1	1.08	1.05	1.10
	GR-2	1.08	1.06	1.10
	GR-3	—	1.05	1.11
$LSD_{0.05}$		n.s.	n.s.	n.s.
strength (g/tex)	GR-0	24.0	24.0	23.9
	GR-1	24.1	23.6	24.6
	GR-2	24.0	23.4	24.6
	GR-3	—	23.8	25.0
$LSD_{0.05}$		n.s.	n.s.	n.s.
Lint (%)	GR-0	35.0	38.0	36.0
	GR-1	33.0	36.0	34.0
	GR-2	33.0	36.0	34.0
	GR-3	—	36.0	34.0
$LSD_{0.05}$		1.7	0.7	1.4

[a] Least significant difference.

length, or fiber strength when compared with the untreated check during any of the 3-years (Table 3). All MC treatments significantly decreased lint percent.

MC significantly increased the percent of calcium in the first mature cotton leaf for all 3 years (Table 4). Ca increased in the first mature leaf within 7 days of the MC application. Mg was significantly increased in 1980. Although not significant at the 0.05 level, there was an indication that MC had increased Mg in the 1979 sampling. The K percent was not affected by MC application. In addition, N was not significantly affected by MC.

Plant height was significantly reduced by the application of MC for all N levels (Table 5). The 74 g/ha (GR-2) rate was more effective in reducing plant height (1978 and 1979) than the same total rate applied in a split application at first square and first bloom (GR-1). In 1980, plants did not recover or grow out of the control 49 g/ha rate of MC applied at first bloom (GR-1). An additional 25 g/ha rate of MC (GR-3) applied 20 days after first bloom was not significantly different from the GR-2 treatment.

Conclusion

MC was effective in controlling cotton vegetative growth under conditions of high N and moisture conditions. As anticipated at the initiation of the study, there was not a significant interaction between MC and N levels. This is con-

Table 4. The effect of MC treatment on percent Ca, Mg, K, and N on cotton leaves taken at peak bloom (averaged for all N levels).

Element	MC level	Percent 1978	Percent 1979	Percent 1980
Ca	GR-0	4.0	2.8	3.4
	GR-1	4.2	3.1	4.2
	GR-2	4.6	3.4	4.3
	GR-3	—	3.5	4.2
$LSD_{0.05}$[a]		0.6	0.3	0.8
Mg	GR-0	—	0.35	0.41
	GR-1	—	0.40	0.57
	GR-2	—	0.42	0.56
	GR-3	—	0.44	0.54
$LSD_{0.05}$		—	n.s.	0.11
K	GR-0	—	1.8	3.0
	GR-1	—	3.7	3.3
	GR-2	—	3.8	3.1
	GR-3	—	1.8	3.2
$LSD_{0.05}$		—	n.s.	n.s.
N	GR-0	—	3.9	3.3
	GR-1	—	4.1	3.6
	GR-2	—	1.7	3.1
	GR-3	—	1.8	3.2
$LSD_{0.05}$		—	n.s.	n.s.

[a] Least significant difference.

Table 5. The effect of MC treatments on final plant height of cotton (averaged for all N levels).

MC level	1978 cm	1978 % reduction	1979 cm	1979 % reduction	1980 cm	1980 % reduction
GR-0	127		130		72	
GR-1	107	16	104	20	51	29
GR-2	95	25	93	28	61	15
GR-3	—		87	33	60	17
$LSD_{0.05}$[a]	17		8		7	

[a] Least significant difference.

sistent with similar findings of other researchers (Walter 1980, Yor 1983b). Mepiquat did not affect lint yields or quality, but did significantly affect the uptake of Ca as measured in the cotton leaves. Apparently, the beneficial effects of MC are indirect and related to adverse environmental and biological situations such as occur with excessive rainfall and high N soil levels. Under these conditions, poor insect control and boll rot commonly occur. Mepiquat ameliorates these hazards through the control of excessive vegetative growth. If new cultural practices for cotton such as 76-cm row spacings are adopted, the use of growth regulators for vegetative control could well be an essential part of the production scheme because without vegetative control, higher plant populations and narrower rows will intensify the hazards caused by excessive vegetative plant growth.

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