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RESPONSE OF DP 555 BG/RR TO MEPIQUAT CHLORIDE (MC) UNDER VARYING GROWTH CONDITIONS

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Abstract

DP 555 BG/RR is a high yielding mid to full season variety that exhibits above average growth potential during the flowering period. Growers familiar with the variety have been more inclined to use MC treatments to control any excessive vegetative growth that might occur. Much of the US cotton belt is reliant on rainfall to sustain growth during the flowering period, hence, future growth is not always predictable. MC yield response trials using DP 555 BG/RR were conducted from Texas to North Carolina in 2003 on research farms as well as grower cooperator fields. All but one of the 14 trials were conducted in 2003. All locations had a treatment comparison of control and MC application estimated to achieve 15 ppm in plant tissue following application. Several locations had additional MC treatment rates such that there were 22 total MC treatments compared across 14 environments in this study. Plant monitoring data were collected during and at the end of the season to quantify treatments. Regression and multiple regression analysis were used to determine the relationship between plant monitoring variables and MC response. Average IID early (IID cotyledons to 8) was positively associated with MC response. Values less than 1.3 inches per node generally had no yield response to MC application while values above 1.5 had a consistent response. Average IID during the late squaring to early flowering stage (IID 8 to 14) showed a low probability of response to MC at values at or below 2.5 inches per node while values at or above 2.7 inches per node had a high probability of MC response. A total of three fields had good early growth, but limited growth during the middle of the season, but still had slightly positive MC responses. Many of the trials had better than average mid to late season growth due to favorable rainfall throughout many of the test locations resulting in an average yield increase from MC treatment to achieve 15 ppm MC at the first application date. Trials will be continued in 2004 with in an attempt to obtain additional data under conditions of good to excellent early growth followed by mid or late season stress to further document DP 555 BG/RR response to MC applications.

Introduction

Use of Mepiquat Chloride (MC) for control of excess vegetative growth in cotton has been available since the beginning of the 1980's. Much has been learned and many reports have been published documenting various responses. Control of plant height was one of the first benefits recognized (Willard and Kupelian 1977; York 1983, Stuart et al. 1984, and Kerby 1985). Yield response has been variable, however, a detailed discussion of MC and yield is beyond the scope of this paper. The work of many researchers on yield response due to MC was reviewed by Kerby et al. (1996). There is general agreement that earliness may be achieved with the proper use of MC (Willard and Kupelian 1977, Kerby et al. 1983, Graham et al. 1987, Kerby et al. 1986, and Cathey and Meredith 1988). Niles and Bader (1986) reported that full-season varieties were more likely to demonstrate yield responses than short-season varieties.

A significant commercial launch of DP 555 BG/RR occurred in 2003 in the US. Previous experience by Delta and Pine Land Company suggested the variety demonstrated capacity for above normal vegetative growth during early boll set compared to other popular varieties and that DP 555 BG/RR could be more likely to respond to MC because of this additional vegetative growth potential (Pustejovsky and Albers 2003, Lege and Leske 2003, and Kerby et al. 2003).

MC response trials were conducted across 14 environments in 2003 (one location in 2002) where detailed plant monitoring was collected to measure performance of DP 555 BG/RR against a range of growth conditions.

Materials and Methods

DP 555 BG/RR was planted on Delta and Pine Land Company research stations as well as on grower field trials. On research stations plot were 4 rows by approximately 45 feet with four replications. Field trials ranged from 4 to 8 rows the length of grower fields. Some grower fields were strip plots only (no replications) while others were replicated. Mean treatment data was used for each location in all regression analysis of response. Treatment descriptions are given in Table 1. Some locations only utilized a single treatment regime, while others had multiple treatment comparisons. All locations contained a control

and MC 15 ppm treatment. Rates to apply to achieve 10 to 15 ppm were based on a proprietary Delta and Pine Land Company Excel micro utilizing the functions described by Landivar et al. 1995 to estimate plant MC concentration. The goal was to apply MC to some locations where growth control would not suggest MC response in order to measure the potential negative effect on DP 555 BG/RR.

Plant height, number of nodes, and plant density were calculated for each treatment in order to determine MC rates (Landivar et al. 1995). At the end of the season, plant height, number of nodes, and internode distance for each main stem node (up to 25) were collected for each treatment. Our plant map micros only accommodate 25 nodes, hence, if a treatment had more than 25 nodes, only the first 25 were counted. All trials utilized a minimum of 20 plants to establish the treatment mean. A proprietary Delta and Pine Land Company Excel micro was utilized to collect and summarize Individual Internode Distance (IID) for each treatment / location combination according to the methods previously described by (Kerby et al. 2003). For regression analysis, average IID from cotyledons to node 8, nodes 8 to 14, and nodes equal or greater than 15 were used to estimate the average growth condition in each location (environment) for early, mid, and late season, respectively. The node of peak IID for control plants was determined based on location means for the treatment. Differences between control plants and MC treatment in IID were determined for each node. The node of peak IID for control plants, and the IID difference between control and MC treatments was determined.

Results

MC response to 15 ppm application rates in these trials averaged 128 lbs lint/A (14%) over non-treated. This was more than expected and likely due to sustained adequate moisture during much of the flowering period for many of the test locations in 2003. Averaged across locations, final plant height for MC 15 ppm treatment averaged 39.3 compared to 49.5 for the control. Number of nodes at the end of the season (with a count limit of 25) averaged 21.6 for MC 15 ppm treatments compared to 23.0 for control plots. On average, 19.1 ounces of MC were applied for 15 ppm treatments with the average first application timing at 13.6 nodes. Four locations had only a single treatment, six locations two sequential applications, and four locations had three sequential applications (Table 1).

A correlation matrix was determined for the following variables: Dependent variables included lint yield and MC response (MC treated yield – control). Independent variables included final number of nodes, final plant height, IID nodes C to 8, IID nodes 8 to 14, IID nodes 15 and greater, plant MC concentration following the first application, node for the first MC application, MC concentration following the last MC application, average MC concentration (from first application to end of season), peak IID, node of peak IID, and the difference in peak IID (control – MC treatment). Table 2 summarizes these relationships. Average yield was associated in a positive way with IID at all portions of the season. This is not surprising given that stress would be expected to reduce both IID and yield.

Other observations are available in Table 2, but the focus of this manuscript is to understand MC response in DP 555 BG/RR. Step-wise multiple regression was utilized to consider a range of variables that could help explain the MC response. The significant variables are given in Table 3. Five variables accounted for 81.8 % of the variability in MC response across the 22 treatment comparisons. The low 10% distribution (as given in Table 3) represents the value for the variable where only 10% of the fields in the sample data would be below this value. Conversely, the high 90 % distribution is the variable value for the upper 90 % of fields (only 10 % would be expected to have a higher value).

The order for improvement in R^2 is given in Table 3 on the left side along with the intercept and variable coefficient. Comparing the 10 and 90 % distribution ranges provides a feel for the range of the data making up the analysis. The order of improvement in R^2 is listed top to bottom on the left side of Table 3. However, this is not necessarily the order of magnitude the variable has on MC response. The magnitide the five variables had on MC response is estimated by the response range (10 % to 90 %) in Table 3. This was calculated by setting four of the five variables at their mean value and solving for MC response for one variable at a time for the 10 % and then the 90 % range for the variable. The difference between the response at the 10 % and 90 % field distribution represents the real impact the variable had on MC response.

IID 8 to 14 had the greatest positive influence on MC response. IID at the end of the season represents fully elongated internodes. Kerby et al. 2003 presented data for the IID concept noting that the end of season IID for a node is approximately equivalent to Maximum Internode Distance (MID) which is measured by looking at the internode distance four nodes below the terminal node. MID is a good measure of current growth rate as it is the internode just completing elongation. Hence, IID 8 to 14 really represents the in season growth rate of node 12 to 18. This is just before and after flowering and is generally accepted as being important to yield potential and to probability for MC response. IID 8 to 14 had a response range (10 % to 90 % range of fields) of 450 (Table 3). The variable with the next greatest impact is IID 15+ with a negative effect of – 231, this is followed by IID C to 8 with a positive effect of 219. Node with peak IID also had a negative effect of – 147. The significant variable with the smallest impact on MC response was the difference between the control and MC treated plots in peak IID (node with the highest value). This variable was 108.

Generalizing on these relationships suggests DP 555 BG/RR responsiveness to MC application is positively influenced by high IID early (IID cotyledons to 8) and mid season (IID nodes 8 to 14), but is negatively impacted by high IID in late season growth (IID15+). When there is strong growth at nodes above the 15th fully expanded internode (node 19), MC response becomes less likely. Node of peak IID is negatively associated with MC response. This suggests that MC response is less likely (or of a smaller magnitude) when the strongest growth occurs later in the season. The amount of IID reduction from MC treatment for the node with peak IID for control plants is positively associated with yield. These data suggest that MC response is likely as long as IID during the early or middle part of the season is above some acceptable level. Furthermore, it indicates that if growth level is likely to elicit a response to MC application, on time applications are more effective than later applications.

Regression analysis of MC response versus IID of cotyledons to node 8 suggest that a response is not likely when IID averaged less than 1.3 inches per node. At or above 1.5 inches per node (average IID cotyledons to 8) all treatments in this data set resulted in positive response to MC treatment. It should be noted many of these trial locations experienced good growth during the middle portions of the season. Analysis of MC response versus IID nodes 8 to 14 indicated a response to MC would not be likely for average internodes less than 2.5. All locations showed a positive response above average IID 8 to 14 of 2.7.

These data indicate a MC response of DP 555 BG/RR from treatment is reasonably expected when field growth conditions indicate 2.7 inch internodes for the recent fully expanded internode around the time of late squaring to early flowering. Even for several fields (three fields) that had good growth at early flowering, but subsequent growth was poor, these fields still had positive responses to MC treatment, but the response level was less than for fields with good growth following MC treatment. These tests will be repeated in 2004 with the hope that additional data sets can be obtained for fields with moderate to good early season growth followed by a stress environment during peak flowering.

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Table 1. MC test locations, treatments, application rate, node stage for MC treatment, final plant height and nodes, and lint yield for data used in regression analysis for DP 555 BG/RR MC response.

		MC Application		Final Plant		Lint Yld
Location	**Treatment**	**oz/A**	**Node**	**Height**	**Nodes**	**lbs/A**
Courtland, AL	Control			54.7	25.0	715
Courtland, AL	MC 15 ppm	19	17.7	38.1	23.0	850
Brownfield, TX	Control			19.1	17.0	524
Brownfield, TX	MC 15 ppm	12	13	17.6	15.9	432
Bardwell, TX	Control			37.5	21.5	796
Bardwell, TX	MC 15 ppm	11	12	27.2	19.8	783
Lenox, GA	Control			50.5	22.6	814
Lenox, GA	MC 15 ppm	22	18.6	44.4	21.6	773
LaGrange, NC	Control			29.0	19.7	363
LaGrange, NC	MC 15 ppm	11; 8	14.8; 17.4	27.0	19.8	411
Hartsville 1-03, SC	Control			56.3	24.5	753
Hartsville 1-03, SC	MC 15 ppm	12; 10	14.0; 16.0	43.7	22.1	1011
Greenwood Springs, MS	Control			66.1	24.7	901
Greenwood Springs, MS	Pentia	8; 8	9.0; 14.7	41.0	22.6	1301
Greenwood Springs, MS	MC 15 ppm	8; 10; 10	9.0; 15.2; 21.8	44.8	23.4	1151
Scott, MS	Control			55.4	23.4	1097
Scott, MS	MC 10 ppm	15; 8	13.8; 17.2	40.2	20.0	1549
Scott, MS	MC 15 ppm	12; 8; 4	11.4; 14.9; 16.7	46.3	21.3	1573
Winterville 1-03, MS	Control			56.6	24.9	1362
Winterville 1-03, MS	MC 10 ppm	8	13.9	52.0	24.9	1351
Winterville 1-03, MS	MC 15 ppm	8; 12	11.2; 13.5	44.9	24.4	1212
Wintervillle 2-03, MS	Control			74.7	25.0	866
Wintervillle 2-03, MS	MC 10 ppm	12; 12	13.1; 17.4	58.6	25.0	1087
Wintervillle 2-03, MS	MC 15 ppm	12; 12; 10	12.1; 16.4; 19.6	54.0	24.8	1228
Wintervillle 2-03, MS	Pentia	12; 4	17.3; 20.2	69.0	25.0	1229
Hartsville 2-03, SC	Control			56.3	24.3	769
Hartsville 2-03, SC	MC 10 ppm	10; 5; 3	14.0; 15.0; 18.0	39.2	20.4	1111
Hartsville 2-03, SC	MC 15 ppm	14; 7; 4	14.0; 18.0; 19.0	40.4	21.3	1101
Hartsville 2-03, SC	Grower	8; 8	13.0; 18.0	43.3	21.5	1092
Altus, OK	Control			33.7	22.7	1159
Altus, OK	MC 15 ppm	10; 8	11.2; 17.0	30.1	22.3	1177
Newelton, LA	Control			66.7	25.0	1362
Newelton, LA	MC 15 ppm	16; 16	16.0; 22.0	61.4	24.6	1494
Hartsville 1-02, SC	Control			35.9	22.3	1306
Hartsville 1-02, SC	MC 10 ppm	6; 10	14.2; 16.9	31.3	20.7	1372
Hartsville 1-02, SC	MC 15 ppm	8; 8	14.9; 17.4	30.2	17.9	1388

Table 2. Significant simple linear correlations between variables of interest. All comparisons have n = 22.

Variable			Significance
Dependent	**Independent**	**Correlation**	**Level**
Yield	MC response	0.449	0.036
Yield	IID C to 8	0.521	0.013
Yield	IID 8 to 14	0.697	0.000
Yield	IID 15+	0.554	0.007
Yield	Peak IID	0.707	0.000
MC response	IID C to 8	0.781	0.000
MC response	IID 8 to 14	0.429	0.047
MC response	Node peak IID	-0.622	0.002
Node 1st MC	Peak IID Trt Diff (C-T)	-0.447	0.037

Table 3. Predicted field response (lbs/A lint) to application of Mepiquat Chloride. Results based on multiple regression of 22 Mepiquat Chloride treatments in 14 different environments. Ranges are calculated from the distribution curves to show the value for the lowest 10% of fields and highest 90% of fields. MC response given is for calculated values for the variable value listed while keeping all other variable values at their mean or 50% value. MC response range is calculated change in response for the variable when evaluated at 90% minus the value at 10%.

Intercept = 303.6			Low 10% Dist.		High 90 % Dist.		Response Range
Variable	**R^2**	**Coefficient**	**Value**	**MC Response**	**Value**	**MC Response**	**10% to 90%**
IID C to 8	0.610	337.9	1.023	52	1.671	271	219
N Peak IID	0.678	-21.9	7.300	250	14.00	103	-147
IID 8 to 14	0.704	209.8	1.056	-137	3.200	313	450
IID 15+	0.782	-186.7	1.193	286	2.432	54	-231
Peak IID (c-t)	0.818	77.7	-0.188	115	1.200	223	108