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Cotton Response to Mepiquat Chloride and Nitrogen under Ultra Narrow Plant Spacing

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Abstract: Mepiquat chloride (1-1-dimethyl-piperidinium chloride) as a plant growth regulator that can be used by producer to manage the crop development, uniformity and maturity. Field experiment was conducted during 2005-06 to evaluate the affect of plant spacing, Nitrogen fertilizer and mepiquat chloride application on cotton (*Gossypium hirsutum* L.) var. MNH789. Three plants spacing (15, 23 and 30 cm), four nitrogen fertilizer level (0, 50, 100 and 150 kg ha^{-1}) with two rates of Mepiquat chloride (2×100, 2×200 mL ha^{-1}) were evaluated for seed cotton yield and yield components. Results showed that Plant Height (PH), Monopodial branches per plant (MB), Node of first fruiting branch (NFB), sympodial branches/plant (SB), No. of bolls/plant and seed cotton yield were different among plant spacing, nitrogen fertilizer while MB, NFB, SB and total main stem nodes/plant were not differed significantly among the Pix application. Whereas MB, B. wt was not affected significantly by the plant spacing, nitrogen fertilizer and pix application. Cotton grown in narrow plant spacing (15 and 23 cm) had higher seed cotton yield (4218 and 4171 kg ha^{-1}) at high dose of fertilizer (150 kg ha^{-1}) with low dose of pix (2×100 mL ha^{-1}). This combination of treatment increased the total main stem nodes, SB and bolls/plant while the internodal length decreased. From present study it is concluded that high seed cotton yield can be achieved at low plant spacing, high nitrogen fertilizer with use of pix to manage the excessive plant growth.

Key words: Cotton, mepiquat chloride, plant spacing, nitrogen fertilizer

INTRODUCTION

Cotton is the most important cash crop of Pakistan. Its yield is nearly stagnant in Pakistan for the last 10 years. Cotton farmers are faced with a difficult task of selecting management study under rising production cost and static or declining net profit. One alternative factor to meet this problem and to optimize profit is growing of cotton in narrow rows. Ultra narrow row system require plant cotton in rows of 45 cm or less. Producing cotton in ultra narrow rows requires careful consideration of several management components, which includes the use of plant growth regulators to control plant size and growth. To avoid from the insect pest attack pressure and high humidity in ultra narrow cotton requires that plant be kept less than 76 cm tall for efficient control of insect pest attack, good retention and to save bolls from rottening. This can be achieved by selecting short stature, early maturing varieties and by use of growth regulators such as mepiquat chloride (1.1 dimethyl-piperidinum chloride). Mepiquat chloride was introduced to the market in the Lat 1970's as plant growth regulator to suppress excessive plant growth by decreasing plant height, number of nodes, branches length and leaf area (Kerby *et al*., 1982; Reddy *et al*., 1990; Stuart *et al*., 1984; York, 1983; Zummo *et al*., 1984). As a result of maximizing inputs for cotton production under optimum growing conditions plants often become excessively tall and vegetative (Cathey and Luckett, 1980). Excessive vegetative growth may result in fruit shed (Gausman *et al*., 1979; Walter, 1980), fewer nodes (Reddy *et al*., 1992; Atwell *et al*., 1996), shortened internodes and produce fewer reproductive branches, (Malik *et al*., 1990) observed the effect of PIX on yield and growth of cotton. As a result the effect of mepiquat chloride has been used to decrease plant height (Walter *et al*., 1980), increase earliness (Briggs, 1980), decrease boll rot (Snow *et al*., 1981) and to facilitate insect management. Seed cotton yield response to Mepiquat chloride remained inconsistent. Some researchers have found increase in seed cotton yield. Walter *et al*. (1980), Briggs (1980), Schott and Schroeder (1979), Williford (1992) and Iqbal *et al*. (2005), with the application of mepiquat chloride whereas other have observed yield decrease or no yield effects (Cathey and Meredith, 1980; Feaster *et al*., 1980; Thomas, 1975; Steve *et al*., 2003). Response of mepiquat chloride application for seed cotton yield appear to be related to environmental factors

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encountered by plant throughout growing season and genetic constitution of a variety. Positive yield response is associated with condition that favour excessive vegetative growth, such as high nitrogen rates, excessive rainfall, thick stand and tall growing variety.

Cotton production in utra-narrow row requires a uniform pant density without skips and control of excessive growth for efficient picking. So the use of mepiquat chloride may be a good fit in ultra narrow row management system, particularly on fields with a history of excessive vegetative growth. Several researchers have evaluated the use of mepiquat chloride in ultra narrow row systems in recent years. Kerby (1998) reported that early low application of mepiquat chloride is more important than high application rates in later Gwathmay (1998) reported 7% increase lint yield in 25 and 51 cm treated with mepiquat chloride in a 4 year study. A two year study in south Caroline consisting of mepiquat chloride rate (4×0.29, 2×0.58 and 4×0.88 L ha^{-1}) and 3 row spacing (19, 38 and 76 cm) found no differences in seed cotton yield, Jones (2001). In ultra-narrow row cotton system use of mepiquat chloride may be dependent on rainfall, fruit load, soil fertility and other related factors. Wright *et al.* (2000) suggested inter-nodal length of crop should be maintained and managed for 5 cm or less and mepiquat chloride used as required and according to crop situation.

The objective of this study was to evaluate the effectiveness of spacing, Nitrogen and mepiquat chloride management strategy on cotton variety MNH789 in view to growth and seed cotton yield.

MATERIALS AND METHODS

Field experiment was conducted during 2005-06 at Cotton Research Station, Multan to evaluate the growth of cotton cv. MNH789 (developed at Cotton Research Station, Multan) under low plant spacing, high nitrogen fertilizer and pix application. The detail of treatments was as:-

Plant spacing	= (P×P = 15, 23 and 30 cm)
Nitrogen fertilizer	= (zero, 50, 100 and 150 kg ha^{-1})
Pix	= 2(2×100, 2×200 mL ha^{-1})

Treatments were arranged in Split Randomized Complete Block design keeping the plant distance in main plot, nitrogen fertilizer in sub- plot and pix in sub-sub plot. Planting date was Ist week of May 2005 and sowing was done by dibbling method. Nitrogen fertilizer was applied in split three doses. Pix was sprayed 60 and 70 days after planting in 246 L ha^{-1} water. All other cultural practices were performed to optimize the seed cotton yield. Data was collected for following traits:-

- Plant height (Fortnightly after 40 days from sowing date)
- Number of nodes per plant (as per height record).
- Node of First fruiting Branch (NFB)
- Monopodial branches/plant (MB)
- Sympodial branches/plant (SB)
- Boll No.
- Boll Wt.
- Seed cotton yield

All data were subjected to analysis of variance. Means were separated using Fisher's protected Least Significant Difference (LSD) test. In all statistical test significance was determined at p = 0.05. Interaction between plant spacing, Mepiquat chloride and Nitrogen fertilizer level for each variable was measured.

RESULTS AND DISCUSSION

From analysis of variance (Table 1) it is indicated that effect due to plant spacing significant for plant height (P. Ht), Monopodial branches per plant (MB), node of first fruiting branch (NFB), No. of sympodial branches per plant (SB), No. of bolls/plant and seed cotton yield while nitrogen fertilizer and its interaction with plant spacing has significant effects on plant height, No. of nodes per plant, Monopodial branches per plant, sympodial branches per plant, No. of bolls per plant and seed cotton yield while non-significant effect was observed for boll weight due to plant spacing and nitrogen fertilizer and their interaction. Growth hormone (pix) has significant effect for plant height, No. of nodes per pant, No. of bolls per plant and seed cotton yield and non significant effect observed for Monopodial branches per plant, No. of bolls/plant, sympodial branches and boll weight. Interaction of pix with plant spacing was significant for plant height, sympodial branches per plant, No. of bolls per plant, where as interaction of Pix and nitrogen fertilizer was significant only for plant height, Monopodial branches per plant, No. of bolls per plant and seed cotton yield.

Height of the plant is attributed by No. of nodes and internal length. From Table 8 it is evident that significant differences exist for plant height while non-significant differences were observed for No. of nodes per plant which leads to conclude plant spacing, nitrogen and pix change the internodal length of the plant, which increase by increasing nitrogen fertilizer and decreasing the plant spacing while it reduced by Pix application gradually.

Table 1: Means squares for analysis of variance for plant height, total No. of nodes, Monopodial branches/plant, node of first fruiting branch/plant, boll weight and seed cotton yield

SOV	df	pH	Node	Mono	NFB	Symp.	Boll. No.	Boll. wt	Yield
Replication	2	230.51*	0.38 NS	0.02 NS	0.84	4.68NS	0.68NS	0.04NS	7648.29NS
Spacing	2	1144.8*	26.26NS	11.28*	8.37*	47.05	101.24*	0.09NS	3817606.29
Error 1	4	32.13	7.09	0.04	0.52	0.76	0.83	0.06	41440.83
Nitrogen	3	2743.8*	102.16*	1.32*	2.56*	404.69*	125.04*	0.01NS	7824515.82*
Nit×Sp	6	87.21*	57.52*	0.24*	0.51*	21.77*	3.61*	0.02NS	88375.36NS
Error II	18	9.22	3.30	0.2	0.09	2.03	0.55	0.03	63511.54
Pix	1	5185.0*	30.68*	0.003NS	0.01NS	1.74NS	13.09*	0.06NS	1210568.0
Sp×P	2	26.34*	11.34NS	0.06NS	0.008NS	5.32*	2.66*	0.01NS	64808.37NS
Nit×P	3	66.75*	5.12NS	0.125*	0.0016NS	3.51NS	7.00*	0.07NS	489271.18*
Sp×Nit×P	6	36.31*	11.12NS	0.094*	0.027NS	2.60NS	2.19*	0.03NS	146536.6*
Error III	24	5.65	4.25	0.023	0.022	1.40	0.47	0.02	35565.9

Note * = Significant at 0.05%, NS = Non Significant, SP = Spacing, P = Pix, Nit = Nitrogen, PH = Plant Height NFB = Node of first fruiting branch

Table 2: Effect of plant spacing on plant height, No. of main stem nodes, monopodial branches. NFB, sympodial branches, boll wt and seed cotton yield

Spacing	Plant height	No. of nodes	Monopodia	NFB	Sympodia	Boll No.	Boll wt.	Yield
6 inch	100.75	29.25	0.41	10.3	25.0	9.2	4.2	3274.2
9 inch	97.91	30.45	1.39	9.6	26.7	10.7	4.3	2697.4
12 inch	87.62	31.33	1.73	9.1	27.8	13.2	4.3	2508.7
CD%	3.20	NS	0.11	0.40	0.49	0.51	NS	115.10

Table 3: Effect of nitrogen on plant height, No. of main stem nodes, monopodial branches. NFB, sympodial branches, boll wt. and seed cotton yield

Nitrogen (Bag)	Plant height	No. of nodes	Monopodia	NFB	Sympodia	Boll No.	Boll wt.	Yield
0	82.00	27.77	0.80	9.38	21.60	8.48	4.33	2172.2
1	89.83	29.16	1.17	9.47	24.40	9.90	4.33	2537.3
2	98.72	31.22	1.33	9.87	27.60	11.25	4.37	2882.7
3	110.94	33.22	1.41	10.20	32.65	14.64	4.30	3714.9
CD%	1.50	0.90	0.07	0.15	0.70	0.37	NS	125.37

Table 4: Effect of pix on plant height, No. of main stem nodes, monopodial branches. NFB, sympodial branches, boll wt. and seed cotton yield

Pix (mL)	Plant height	No. of nodes	Monopodia	NFB	Sympodia	Boll No.	Boll wt.	Yield
100	103.91	31.0	1.17	9.71	26.40	10.64	4.32	2669.1
200	86.94	29.69	1.18	9.74	26.71	11.49	4.36	2956.5
CD%	0.81	0.70	NS	NS	NS	0.23	NS	64.74

Table 5: Mean performance under interaction of spacing and nitrogen for different characters

Spacing×Nitrogen	Plant height	No. of nodes	Monopodia	NFB	Sympodia	Boll No.	Boll wt.	Yield
SP1×N1	87.33	28.00	0.28	10.03	22.18	7.06	4.2	2518.8
SP1×N2	91.83	28.66	0.38	10.48	24.36	8.16	4.3	3489.1
SP1×N3	103.33	29.33	0.48	10.26	24.63	9.95	4.3	415.6
SP1×N4	120.50	31.00	0.50	10.58	29.15	11.71	4.2	2937.5
SP2×N1	83.50	29.83	0.96	9.36	21.73	8.38	4.4	2108.8
SP2×N2	91.16	31.16	1.48	9.35	23.68	9.55	4.4	2575.3
SP2×N3	102.33	30.50	1.61	9.37	27.95	10.03	4.3	3667.3
SP2×N4	114.66	30.33	1.50	10.31	33.60	14.85	4.3	2438.3
SP3×N1	75.83	25.50	1.15	8.75	20.88	10.01	4.4	1889.1
SP3×N2	86.50	27.66	1.65	8.58	25.15	11.98	4.2	2236.3
SP3×N3	90.50	33.83	1.90	9.61	30.23	13.76	4.4	2583.6
SP3×N4	97.66	38.33	2.23	9.70	35.20	17.36	4.3	3325.8
CD%	2.60	1.50	0.12	0.25	1.22	0.64	NS	NS

Table 6: Performance of different characters under interaction of plant spacing and Pix

Spacing×PIX	Plant height	No. of nodes	Monopodia	NFB	Sympodia	Boll No.	Boll wt.	Yield
SP1×P1	109.66	30.58	0.40	10.30	25.35	9.15	4.2	3180.8
SP1×P2	91.83	27.91	0.41	10.37	24.80	9.30	4.3	3367.7
SP2×P1	107.16	30.41	1.33	9.67	26.08	9.96	4.3	2508.2
SP2×P2	88.66	30.50	1.45	9.70	27.40	11.44	4.4	2886.6
SP3×P1	94.91	32.00	1.77	9.16	27.78	12.81	4.3	2402.4
SP3×P2	80.33	30.66	1.69	9.15	27.95	13.75	4.3	2615.0
CD%	1.41	NS	NS	NS	0.70	0.41	NS	NS

Both traits Monopodial branches and NFB are used to determine the earliness of a variety. Ray and Richmond (1966), Richmond and Ray (1966) and Iqbal *et al.* (2005). The result of present studies showed that NFB value is not affected by the interaction of three factors i.e., plant spacing, nitrogen fertilizer and Pix interaction but NFB affected by plant spacing and nitrogen fertilizer and their interaction (Table 2, 3 and 5). NFB increased by

Table 7: Performance of different characters under interaction of nitrogen fertilizer and Pix

Nitrogen×PIX	Plant height	No. of nodes	Monopodia	NFB	Sympodia	Boll No.	Boll wt.	Yield
P1×N1	90.55	28.88	0.68	9.35	21.87	8.79	4.3	2258.2
P1×N2	73.88	26.66	0.91	9.41	21.32	8.21	4.3	2086.3
P1×N3	98.00	29.44	1.21	9.42	24.34	9.61	4.3	2630.1
P1×N4	81.66	28.88	1.13	9.52	24.45	10.18	4.3	2444.6
P2×N1	105.11	32.33	1.30	9.88	27.53	10.78	4.2	2656.7
P2×N2	92.33	30.11	1.36	9.85	27.67	11.71	4.4	3108.6
P2×N3	122.00	33.33	1.48	10.20	31.87	13.41	4.3	3429.0
P2×N4	99.88	33.11	1.33	10.20	33.42	15.87	4.2	4000.8
CD%	1.63	NS	0.10	NS	NS	0.47	NS	129.49

Table 8: Mean Performance of different characters under interaction of spacing nitrogen and Pix

Spacing, Nitrogen×Pix	Plant height	No. of nodes	Monopodia	NFB	Sympodia	Boll No.	Boll wt.	Yield
SP1×N1×P1	94.33	29.66	0.23	9.93	22.90	7.53	4.1	2726.3
SP1×N1×P2	80.33	26.33	0.33	10.13	21.46	6.60	4.2	2311.3
SP1×N2×P1	101.66	28.66	0.43	10.40	23.83	7.73	4.3	3096.6
SP1×N2×P2	82.00	28.66	0.33	10.56	24.90	8.60	4.3	3881.6
SP1×N3×P1	108.66	30.33	0.43	10.36	26.13	9.56	4.1	4084.6
SP1×N3×P2	98.00	28.33	0.53	10.16	23.13	10.33	4.5	2815.6
SP1×N4×P1	134.00	33.66	0.53	10.53	28.56	11.76	4.2	4218.6
SP1×N4×P2	107.00	28.33	0.46	10.63	29.73	11.66	4.2	3059.3
SP2×N1×P1	91.66	30.33	0.60	9.36	21.63	8.33	4.3	2089.3
SP2×N1×P2	75.33	29.33	1.33	9.36	21.83	8.43	4.4	2128.3
SP2×N2×P1	98.33	31.00	1.53	9.26	23.26	9.36	4.4	2383.3
SP2×N2×P2	84.00	31.33	1.43	9.43	24.10	9.73	4.4	2493.3
SP2×N3×P1	111.00	32.33	1.56	9.73	26.76	9.63	4.2	2397.0
SP2×N3×P2	93.66	28.66	1.66	9.73	29.13	10.24	4.4	2753.6
SP2×N4×P1	127.66	28.00	1.63	10.33	32.66	12.53	4.3	3163.3
SP2×N4×P2	101.66	32.66	1.36	10.30	34.53	17.16	4.2	4171.3
SP3×N1×P1	85.66	26.66	1.23	8.76	21.10	10.43	4.5	1959.0
SP3×N1×P2	66.00	26.33	1.06	8.73	20.66	9.60	4.2	1818.3
SP3×N2×P1	94.00	28.66	1.66	8.60	25.93	11.73	4.2	2135.0
SP3×N2×P2	79.00	26.66	1.63	8.56	24.36	12.23	4.3	2337.6
SP3×N3×P1	95.66	34.33	1.90	9.56	29.70	13.16	4.3	2476.6
SP3×N3×P2	85.33	33.33	1.90	9.66	30.76	14.36	4.5	2690.6
SP3×N4×P1	104.33	38.33	2.30	9.73	34.40	15.93	4.4	3039.0
SP3×N4×P2	91.00	38.33	2.16	9.66	36.00	18.80	4.3	3612.6
CD %	2.82	NS	0.18	NS	NS	0.82	NS	2242.9

decreasing the plant spacing and increasing nitrogen fertilizer which leads to conclude that by increasing, nitrogen fertilizer dose and increasing plant spacing the cotton crop will move towards the maturity. The present findings are in according to the Reddy *et al.* (1990), Wright *et al.* (2000) and Iqbal *et al* (2005) who also reported similar results.

In narrow plant spacing Monopodial branches decreased significantly as compared to wider plant spacing (Table 2 and 8), while nitrogen fertilizer and its interaction with space for Monopodial branches (Table 3, 5 and 8) is also significant.

Sympodial branches/Fruiting branches played an important role in seed cotton yield indirectly. Sympodial branches are significantly affected by plant spacing, nitrogen fertilizer while Pix has non-significant difference for this trait (Table 2-5). From the present studies it is concluded that by increasing the nitrogen fertilizer at proper plant spacing, fruiting branches are increased as the nitrogen fertilizer has positive impact on plant photosynthesis and vegetative growth (Schott and Schoeder, 1979; Kerby *et al.*, 1982). From present result it is further concluded that Pix reduced the internodal length of the plant but no of nodes remain unaffected. Number of bolls per plant and boll weight (B. wt) are the two major important components of seed cotton yield. Boll weight is least affected by the plant spacing, Nitrogen, nitrogen and pix, spacing and pix and spacing interaction to plant nitrogen and Pix interaction (Table 2-7) which indicated that as the nitrogen fertilizer increases the vegetative growth enhanced and the application of Pix reduces the extra vegetative growth of plant used more photosynthete. From present study it is concluded that use of high dose of nitrogen fertilizer under low plant spacing is available for fruit and retention and boll filling not fruitful without using the pix as growth retardant (Table 6). These results confirmed the previous findings of Briggs (1980) and Iqbal *et al.* (2005). Seed cotton yield is significantly affected by the all factors and their interaction under this study (Table 2-8). The highest seed cotton yield (4218.6 kg) was achieved at SP1, N4 and Pl. These results clearly indicated that maximum seed cotton yield can be achieved under high plant population with high nitrogen fertilizer and applying proper dose of pix reduces excessive vegetative growth of plant but if vegetative growth is not managed by pix under low plant spacing and high nitrogen fertilizer, the seed cotton yield will reduce drastically. These results are also confirmed the previous finding of Thomas (1975) and Kerby *et al.* (1982).

From the present studies it is concluded that under high plant population, vegetative growth should be managed properly with growth retardant (Pix) to achieve maximum seed cotton yield.

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