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Response of cotton (*Gossypium hirsutum*) to mepiquat chloride and topping under varying levels of nitrogen

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) seasons of 1999 and 2000 at New Delhi to examine the response of cotton (*Gossypium hirsutum* L.) to nitrogen, mepiquat chloride and topping. Application of N significantly increased plant height, bolls/plant, boll weight, seed-cotton yield/plant and seed-cotton and lint yield/ha. Mean increase in seed-cotton yield with the application of N at 45 and 90 kg/ha was 19 and 31% over the control respectively. Higher levels of N application delayed the maturity of cotton. Application of mepiquat chloride significantly reduced the plant height by 26%, but increased the yield and yield attributes. Topping had no significant influence on yield and yield attributes.

Key words : Cotton, Mepiquat chloride, Topping, Seed-cotton yield, Nitrogen

Nitrogen is the most important component for cotton production and is necessary to achieve optimum yield. Excessive vegetative growth may result in shedding of squares and young bolls (Gausman *et al.*, 1979), delayed maturity and increased boll rot (York, 1983). Excessive vegetative growth may be suppressed to some extent by modifying cultural practices (topping and spray of growth hormones), but it is not always feasible. Use of mepiquat chloride (1,1-dimethyl piperidinium chloride) (MC) and topping have been suggested to counteract the detrimental effects of excessive vegetative growth in cotton. Mepiquat chloride suppresses excessive plant growth by decreasing plant height, internode length of main stem and branches and leaf area (Stuart *et al.*, 1984), resulting in a shorter, more compact plant. Topping checks plant growth, increases boll number and eliminates lodging by strengthening the main stem and branches (Bennett *et al.*, 1965). Keeping these points in view, the present study was undertaken to evaluate the effects of N, MC and topping on cotton.

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MATERIALS AND METHODS

A field experiment was conducted at the research farm of the Division of Agronomy, Indian Agricultural Research Institute, New Delhi, during the rainy (*kharif*) seasons of 1999 and 2000. The soil of the experimental site was sandy loam, low in organic carbon (0.41%) and available N (227 kg N/ha), and medium in available phosphorus (22 kg P_2O_5/ha) and potassium (254 kg K_2O/ha), with pH 8.1.

Twelve treatment combinations of N (0, 45 and 90 kg N/ha), mepiquat chloride (0 and 100 ppm) and topping (without topping and with topping) were laid out in randomized block design with 3 replications. Nitrogen was applied in 2 splits, half at sowing and the remaining at square-formation stage. Mepiquat chloride was sprayed at flowering stage. Topping, removal of main-stem terminal bud, was done 90 days after sowing. The seeds of cotton cv. 'Pusa N 3' were sown manually on the ridges at a spacing of 75 cm between ridges and 30 cm between plants on 24 and 23 May in respective years. Crop was irrigated twice and recommended plant-protection measures were adopted.

Ten plants were chosen from each plot to observe the plant height, bolls/plant, boll weight and seed-cotton yield/plant. First and second pickings were done on first week of November and December in respective years. Yield earliness was calculated as :

$$\text{Yield earliness (\%)} = \frac{\text{Seed-cotton yield of first picking}}{\text{Total seed-cotton yield}} \times 100$$

RESULTS AND DISCUSSION

The yield attributes and yield were better during 2000 than that of 1999. Total rainfall received during 2000 was 260 mm more than that in 1999. Comparatively more and uniformly distributed rainfall created favourable conditions for the crop in 2000.

Effect of nitrogen

A significant increase in plant height was observed only up to 45 kg N/ha (Table 1). Bolls/plant, boll weight and seed-cotton yield/plant were also significantly increased with the application of N. Nitrogen application leads to produce more leaf area and thus fovouring to produce more photosynthate which is the most important characteristics. As a result, boll retention was greater in N-applied plots compared to the zero N plot. The greater amount of boll weight with higher N doses was mainly owing to heavier seed. Increases in bolls/plant and boll weight owing to N application was also reported by Venugopalan and Blaise (2001). The increase in seed-cotton yield/plant was owing to an increase in bolls/plant and boll weight.

Seed-cotton and lint yield/ha were increased significantly with successive increase in N levels during both the years except lint yield in 2000 (Table 2). In 2000, lint yield/ha increase significantly with 45 kg N/ha, a further increased in N levels did not improve the lint yield significantly because of drastic decline in ginning (%) due to higher N level. The mean increase in seed-cotton yield with the application of N @ 45 and 90 kg/ha was

Table 1. Effect of nitrogen, mepiquat chloride and topping on yield attributes of cotton

Treatment	Plant height (cm)		Bolls/ plant		Boll weight (g)		Seed-cotton yield/plant (g)	
	1999	2000	1999	2000	1999	2000	1999	2000
Nitrogen								
0	98.4	101.0	14.0	15.2	3.9	4.3	47.6	58.0
45	103.8	106.9	16.1	17.3	4.2	4.5	57.5	66.5
90	105.0	108.3	17.2	18.9	4.5	4.6	63.7	71.8
CD (P=0.05)	3.32	5.20	0.97	1.06	0.14	0.16	4.46	5.23
Mepiquat chloride								
0 ppm	119.1	118.5	15.2	16.7	4.0	4.4	50.2	60.9
100 ppm	85.7	92.3	16.4	17.5	4.4	4.6	62.3	69.0
CD (P=0.05)	2.71	4.24	0.79	0.88	0.12	0.13	3.64	4.31
Topping								
No topping	103.5	106.1	15.6	17.0	4.2	4.5	55.1	64.1
Topping	101.3	104.8	16.0	17.3	4.2	4.5	57.4	66.7
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

*Weight of seed cotton/boll

Table 2. Effect of nitrogen, mepiquat chloride and topping on yield, harvest index and yield earliness of cotton

Treatment	Seed-cotton yield (kg/ha)		Lint yield (kg/ha)		Total dry-matter production (q/ha)		Harvest index		Yield earliness (%)	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
Nitrogen										
0	2,010.1	2,430.1	681.8	781.6	62.9	66.7	0.33	0.37	77.7	79.3
45	2,464.0	2,820.0	827.4	899.3	73.3	78.0	0.34	0.37	74.8	77.4
90	2,745.5	3,073.0	911.7	971.7	79.8	82.9	0.35	0.37	72.8	76.0
CD (P=0.05)	199.13	237.84	71.63	74.91	3.40	3.76	NS	NS	1.37	1.69
Mepiquat chloride										
0 ppm	2,238.3	2,602.5	757.5	837.2	77.4	81.5	0.29	0.32	72.5	75.3
100 ppm	2,575.0	2,946.3	856.6	931.2	66.6	70.3	0.39	0.42	77.6	79.9
CD (P=0.05)	162.58	1,94.20	58.49	61.15	2.78	3.07	0.02	0.01	1.12	1.38
Topping										
No topping	2,358.4	2,706.1	791.6	863.8	72.4	76.0	0.33	0.36	74.9	77.3
Topping	2,454.9	2,842.7	822.5	904.6	71.6	75.8	0.35	0.38	75.3	77.8
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.02	0.01	NS	NS

19.0 and 31.0% over the control respectively. Total dry-matter production progressively increased with successive increase in N levels. Harvest index was not significantly altered by the application of N. It was owing to simultaneous increase in seed-cotton yield and total dry-matter production with the application of N.

Maturity was significantly delayed by N fertilization (Table 2). The crop matured earlier in plots receiving no N fertilizer than the N-fertilized plots, confirming the results of Venugopalan and Blaise (2001). Enhanced maturity in N-deficient plants might be associated with accelerated leaf senescence, a shorter flower period and the appearance of the first fruiting node at lower mainstem node.

Effect of mepiquat chloride

Plant height was significantly reduced by the spraying of 100 ppm mepiquat chloride during both the seasons (Table 1). This plant-growth regulator perhaps inhibits the synthesis of gibberellins which have a role in cell division and cell expansion (York, 1983).

Bolls/plant, boll weight and seed-cotton yield/plant were significantly improved by spraying of 100 ppm mepiquat chloride (Table 1). Increase in bolls/plant due to mepiquat chloride application was also reported by Rajeswari and Ranganadhacharyulu (1997). The increase in boll weight in mepiquat chloride-treated cotton was because of an increase in seed and lint weight. Increase in bolls/plant and boll weight, finally contributed to an increase in seed-cotton yield/plant. Nitrogen and mepiquat chloride interaction was not significant.

Seed-cotton and lint yield/ha were significantly increased by 100 ppm mepiquat chloride application (Table 2). These increases in yield with mepiquat chloride was primarily owing to more number of

Table 3. Economics of cotton as influenced by nitrogen, mepiquat chloride and topping

Treatment	Cost of cultivation (Rs/ha)		Gross returns (Rs/ha)		Net returns (Rs/ha)		Benefit : cost ratio	
	1999	2000	1999	2000	1999	2000	1999	2000
Nitrogen								
0	13,467	14,097	34,450	41,368	20,983	27,271	2.56	2.93
45	14,628	15,162	42,115	48,025	27,487	32,864	2.88	3.17
90	15,530	16,021	46,880	52,270	31,351	36,249	3.02	3.26
Mepiquat chloride								
0 ppm	13,809	14,355	38,578	44,615	24,768	30,259	2.79	3.11
100 ppm	14,594	15,152	43,713	49,833	29,119	34,681	3.00	3.29
Topping								
No topping	13,990	14,511	40,370	46,117	26,381	31,606	2.89	3.18
Topping	14,484	15,066	41,921	48,331	27,437	33,265	2.89	3.21

Picking charges @ Rs 1.5/kg seed cotton; N @ 10.66/kg, mepiquat chloride @ Rs 280/litre, seed cotton @ 1,650/q, stalk@ Rs 30/q, topping charges @ Rs 350/ha

bolls/plant and secondarily due to more dry-matter partitioning to bolls.

Total dry-matter production was significantly reduced by mepiquat chloride application. The reduction in dry-matter production was due to decrease in plant height and leaf area. Moreover, stem elongation and node formation were affected by mepiquat chloride which ultimately resulted reduced dry-matter production. Harvest index was significantly improved by mepiquat chloride. This was attributed to decrease in vegetative growth with concurrent increase in seed-cotton yield. Significant increase in yield earliness indicated earlier maturity in the mepiquat chloride-treated cotton. The earlier maturity is thought to be due to greater boll retention on lower fruiting branches (Kerby *et al.*, 1982).

Effect of topping

Topping at 90 days after sowing did not increase plant height significantly (Table 1). Wankhade *et al.* (1991) also reported that topping at boll-development stage had no pronounced effects on plant height.

Though the bolls/plant, boll weight and seed-cotton yield/plant were slightly increased by topping, the effects were not significant.

Seed-cotton and lint yield/ha were not significantly influenced by topping (Table 2). However, topping resulted in an increase in seed-cotton yield by 4.1 and 5.1% over non-topped plants.

Total dry-matter production was not significantly influenced by topping. However, harvest index was significantly improved by topping. This was due to slight reduction in total dry matter with an increase in seed-cotton yield. Similar findings were also reported by Sawaji *et al.* (1994). Maturity determined by yield earliness, was not significantly affected by topping.

Economics

Gross and net returns increased with increase in N levels. The highest net returns of Rs 31,351 and Rs 36,249 were obtained with 90 kg N/ha during 1999 and 2000 respectively. The benefit : cost ratio of 3.02 was obtained with highest N level. Application of 100 ppm mepiquat chloride gave a net returns of Rs 29,199 and Rs 34,681 in respective years which was 17.65 and 14.6% more over the control. An increase in net returns of Rs 995 and Rs 1,590 over no topping was obtained with topping during 1999 and 2000 respectively. However, benefit : cost ratio was slightly increased owing to topping 1 year out of 2 years experimentation.

From these studies, an application of 90 kg N/ha is recommended to obtain maximum seed-cotton yield. Application of mepiquat chloride enhanced the maturity of cotton which showed the possibility of taking a wheat crop immediately after cotton. Though the seed-cotton yield was not significantly increased by topping at 90 days after sowing, it showed some promising effects in terms of net returns indicating that further investigation is needed with topping at different growth stages to explore the benefit effect of topping.

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