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SHORT COMMUNICATION

EFFECT OF PLANT GROWTH REGULATORS ON PHYSIOLOGICAL COMPONENTS OF YIELD IN HYBRID COTTON

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A field experiment was conducted to study the effect of foliar spray of Mepiquat Chloride (MC) (25, 37.5 and 50 ppm), Chlormequat Chloride (CCC) (375 and 500 ppm) at 45 and 90 DAS and NAA (20 ppm) at 90 DAS on growth, yield, morphological, physiological and biochemical parameters of hybrid cotton (DHH-11). Application of NAA (20 ppm) was found to be most effective in increasing plant height, dry weight, rate of photosynthesis and seed cotton yield. MC treatment (50 ppm) sprayed at 90 DAS was found to be effective than CCC in reducing plant height, leaf area and showed higher photosynthesis which resulted in higher yield and boll weight. Application of growth retardants at early stage (45 DAS) reduced seed cotton yield significantly compared to other treatments.

***Key words*: Growth regulators, hybrid cotton, seed cotton yield.**

Cotton is a major economic crop with an indeterminate growth habit and is very responsive to environmental changes and management. Use of high dosage of fertilizers coupled with higher plant population leads to excess vegetative growth, greater fruit shed and reduced yield (Baker 1976). Consequently, producers and research workers have long been interested to alter the plant canopy to allow more light penetration and to maintain balance between source and sink. In comparison with other technologies bio-regulators/plant growth regulators (PGR's) so far have emerged as magic chemicals that could increase agricultural production at an unprecedented rate and help in removing and circumventing many of the barriers imposed by genetics and environment. Plant growth regulators have great potential and their applications having several striking economic success have already been achieved in many species. Use of growth regulators like MC, CCC and NAA is known to increase the rate of photosynthesis by increasing the chlorophyll content per unit area and the size of the mesophyll cells in the leaves. This leads to more rapid exchange of CO_2 into mesophyll cells by virtue of their larger surface area. (Dulizhao and Oosterhius 2000). In the present investigation effect of different concentrations of PGR's application at different growth stages and their relationship on seed cotton yield was studied.

A field experiment was conducted at the Agricultural Research Station, UAS, Dharwad, Karnataka during *Kharif* 2000-01. An intra-hirsutum hybrid (DHH-11) was seeded on medium black soil with a spacing of 90 x 60 cm in a randomized block design with three replications. Cultural practices and plant protection measures were undertaken as per the recommendations. The experiment consisted of following 12 treatments: T_1 - Mepiquat Chloride (25 ppm) at 45 DAS; T2 - Mepiquat Chloride (25 ppm) at 90 DAS; T_3 - Mepiquat Chloride (37.5 ppm) at 45 DAS; T_4 - Mepiquat Chloride (37.5 ppm) at 90 DAS; T_5 - Mepiquat Chloride (50 ppm) at 45 DAS; T_6 - Mepiquat Chloride (50 ppm) at 90 DAS; T_7 - Chlormequat Chloride (375 ppm) at 45 DAS; T_8 - Chlormequat Chloride (375 ppm) at 90 DAS; T_9 - Chlormequat Chloride (500 ppm) at 45 DAS; T_{10} -

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Chlormequat Chloride (500 ppm) at 90 DAS; T_{11} - NAA (20 ppm) at 90 DAS; T_{12} - Control

Five plants from each treatment were selected randomly and tagged for recording various observations on morphological, growth, physiological parameters and yield and yield components at 60, 90, 120, 150 days after sowing (DAS) and at harvest. Observations were recorded on plant height, leaf area and dry weight per plant, which was used further for computing other growth parameters like net assimilation rate (NAR) and specific leaf weight (SLW). Top fully expanded (second from top) leaf was collected for the estimation of biochemical constituents on 120 & 150 DAS. Total chlorophyll content and leaf nitrate reductase activity were measured as per the procedure described by Hiscox and Israelstam (1979) and Jawarski (1971) respectively. Leaf area was measured by using leaf area meter (LI-COR, Model, LI-3000). Rate of Photosynthesis, stomatal conductance and transpiration rate were measured on the top fully expanded leaf by using a portable photosynthesis system (LI-COR, Model LI-6400) at 120 and 150 DAS. Seed cotton yield was worked out based on the mean plot yield and expressed as kg ha^{-1}. Statistical analysis was carried out following the procedure of Panse and Sukhatme (1961).

NAA applied at 90 DAS increased the plant height compared to control (Table 1). This might be due to biological activities of auxins viz., stimulation of cell elongation and promotion of cell division (Pothiraj *et al.* 1995). MC and CCC sprayed at 45 and 90 DAS significantly reduced plant height than NAA and control. Individually, plant height was reduced with increasing concentration of growth regulators at all the stages recorded. Higher concentrations applied particularly at 45 DAS drastically reduced the plant height. This could be attributed to its inhibitory effect on the biosynthesis of GA-3, a growth promoter, thus causing shortening of plant height (Reddy *et al.* 1996; Thakar Singh & Brar, 1999). While both growth retardants reduced height significantly, only MC had a positive effect on yield while

Table 1. Effect of plant growth regulators on growth and yield of hybrid cotton.

Treatment	Plant height (cm)	Boll weight (g/boll)	Seed cotton yield (kg ha^{-1})	Total dry matter (g/plant) Days after sowing		Leaf area (dm^2/plant) Days after sowing		SLW (mg/dm^2) Days after sowing		NAR (g/dm^2/day) Days after sowing	
				120	150	120	150	120	150	90-120	120-150
T_1	90.4	5.10	730.79	129.56	135.12	47.00	59.72	925.45	782.09	0.0320	0.0405
T_2	94.4	5.25	848.51	131.18	149.18	55.39	71.04	795.02	725.86	0.0476	0.0466
T_3	87.7	5.25	729.99	129.93	138.01	45.92	57.90	949.78	823.81	0.0319	0.0386
T_4	92.3	5.15	986.47	147.27	164.35	51.73	66.80	955.69	850.42	0.0480	0.0430
T_5	85.6	5.31	704.62	122.39	139.97	45.36	56.82	905.68	851.40	0.0304	0.0404
T_6	86.7	5.58	1040.42	153.56	169.45	49.95	62.99	1109.18	951.66	0.0489	0.0433
T_7	80.5	4.16	685.18	115.69	142.03	43.19	56.48	899.22	869.27	0.0286	0.0404
T_8	96.2	5.53	835.55	139.47	157.34	50.15	65.92	926.94	825.03	0.0461	0.0433
T_9	76.1	4.80	584.62	103.44	125.92	42.64	54.10	814.26	804.54	0.0291	0.0402
T_{10}	85.1	5.40	769.44	133.67	148.01	48.13	60.08	932.35	851.48	0.0436	0.0426
T_{11}	131.0	5.56	1330.91	190.01	211.15	57.51	76.69	1032.00	929.80	0.0467	0.0394
T_{12}	121.5	5.41	929.62	170.43	181.14	57.23	70.04	999.74	893.91	0.0459	0.0478
CD (P=0.05)	10.5	0.52	187.25	8.69	9.40	2.02	2.78	120.12	89.13	0.006	0.0021

Treatment details are given in the text.

CCC had a negative effect on yield. Among the treatments, foliar spray of NAA (20 ppm) showed highest leaf area (57.51 and 76.69 dm^2/plant at 120 and 150 DAS respectively) followed by MC (25 ppm) sprayed at 90 DAS (71.05 dm^2/plant) as compared to control. SLW increased up to 120 DAS and decreased thereafter. Significant differences in SLW were observed among the treatments. Lowest SLW was recorded with NAA 20 ppm (1032.00 mg/dm^2) and highest SLW was observed with MC (50 ppm) sprayed at 90 DAS (1109.18 mg/dm^2) over the control. It may be due to longer palisade and strong spongy parenchyma cells within the leaf mesophyll (Gausman *et al.* 1979). MC (50 ppm) sprayed at 90 DAS showed highest NAR; however there was inconsistency among the treatments.

Among the treatments, growth retardants showed higher total chlorophyll content than NAA and control. Within the growth retardants, total chlorophyll content expressed on leaf area basis was higher with CCC (375 ppm) sprayed at 90 DAS (1.693 and 1.595 mg/g fresh weight at 120 and 150 DAS respectively) followed by MC (50 ppm) sprayed at 90 DAS. This observation is in agreement with More *et al.* (1993) and Reddy *et al.* (1996). The effect of growth regulators exhibited significant differences in the nitrate reductase activity of leaf. Application of NAA (20 ppm) and MC (50 ppm) sprayed at 90 DAS resulted in higher nitrate reductase activity (90.51 and 85.52 µg NO_2/g fresh wt. respectively) over control. This is in agreement with the results of Eid *et al.* (1986). Photosynthetic rate and transpiration rate were influenced by growth substances in all stages (Table 2). Foliar spray of NAA (20 ppm) increased the photosynthetic rate by 20.1 per cent and transpiration rate by 9.44 per cent over control. Similar trend was observed in case of stomatal conductance with 39.9 per cent higher than that of control at 120 DAS. Such an increase in the rate of photosynthesis is due to increased stomatal aperture, which facilitates more CO_2 conductance (Guinn and Brummett, 1993). Irrespective of the concentrations of growth retardants applied at later stages (90 DAS) recorded higher rate of photosynthesis

Table 2. Effect of plant growth regulators on some physiological parameters of hybrid cotton.

Treatments	Total chlorophyll (mg g^{-1} fw)		Nitrate reductase (µg NO^-_2 g^{-1} fw h^{-1})		Photosynthesis (µmol CO_2 $m^{-2}s^{-1}$)		Transpiration (mmol m^{-2} s^{-1})		Stomatal conductance (µmol m^{-2} s^{-1})	
	120	150	120	150	120	150	120	150	120	150
T_1	1.472	1.383	33.89	23.23	21.09	18.93	4.27	2.54	0.245	0.112
T_2	1.546	1.432	73.40	25.98	23.04	20.13	4.12	2.91	0.304	0.131
T_3	1.406	1.362	38.19	24.17	19.95	17.63	4.08	2.41	0.241	0.109
T_4	1.546	1.453	81.39	25.48	22.12	19.51	4.16	2.87	0.307	0.135
T_5	1.315	1.355	51.77	26.73	19.24	16.39	3.98	2.32	0.238	0.104
T_6	1.612	1.569	85.52	32.34	21.25	18.93	4.18	2.99	0.320	0.140
T_7	1.445	1.402	30.24	22.49	19.23	17.48	4.00	2.61	0.243	0.109
T_8	1.693	1.595	67.46	27.75	22.67	20.17	3.99	3.16	0.273	0.136
T_9	1.400	1.385	74.30	25.45	18.95	16.56	3.72	2.48	0.247	0.112
T_{10}	1.431	1.475	76.63	34.34	21.29	19.34	3.65	3.09	0.287	0.139
T_{11}	1.430	1.377	90.51	35.03	24.98	21.79	4.52	3.14	0.340	0.149
T_{12}	1.192	1.131	53.23	24.31	20.79	17.86	4.13	2.77	0.243	0.103
CD (P=0.05)	0.151	0.062	20.31	6.68	2.19	2.28	0.02	0.33	0.055	0.018

Treatment details are given in the text.

compared to earlier stages (45 DAS) against control. However, MC (50 ppm) sprayed at 90 DAS recorded lower photosynthetic rate due to reduction in leaf diffusive resistance and decreased CO_2 uptake. This is in agreement with Gausman *et al.*, 1979. Lower values of transpiration rates and stomatal conductance were recorded with CCC (500 ppm) sprayed at 90 DAS and MC (50 ppm) sprayed at 45 DAS respectively over control.

The data on total dry matter (TDM) as affected by PGR's is presented in Table 1. The TDM differed significantly at all the stages of the crop growth period. At 120 and 150 DAS, significantly higher TDM was recorded in NAA (20 ppm) sprayed at 90 DAS (190.01 and 211.15 g/plant respectively) as compared to control. Least TDM was recorded in case of CCC treatments at both stages. NAA (20 ppm) sprayed at 90 DAS was found high boll weight of 5.56 (g) also recorded significantly higher yield (1330.91 kg/ha) which is due to cumulative effect of more number of bolls and boll weight as compared to control (929.62 kg/ha). Among the growth retardants, MC (50 ppm) sprayed at 90 DAS recorded high boll weight of 5.58 (g), which resulted in significantly higher yield (1040.42 kg/ha). The yield increment due to NAA (20 ppm) sprayed at 90 DAS was 43.16, 58.41 and 85.11% as compared to untreated control, MC and CCC respectively. MC (50 ppm) sprayed at 90 DAS recorded 11.9% higher yield compare to control. However, plants treated with MC accounted 18.21% higher yield than that of plants treated with CCC.

REFERENCES

Baker, S.H. (1976). Response of cotton to row pattern and plant population. *Agronomy J.* **68**: 85 – 88.

Dulizhao and Derrick M. Oosterhuis, (2000). Dixplux and Mepiqut Chloride effects on physiology, growth and yield of field-grown cotton. *J. Pl. Growth Regul.* **19**: 415 – 422.

Eid, E.T., Ismail, M.S., Abdel, A.L., M.H., El-Akkad, M.E. and Yousef, A.E.M.(1986). Effect of Mepiquat Chloride in Mc Nair 200 cotton variety under Egyptian conditions. *Ann. Agr. Sci.,* **31**: 1077 – 1087.

Gausman, H.W. Walter, H. Stein, E., Rittige, F.R., Leamer, R.W. Escobar, D.E. and Rodrignez. (1979). Leaf CO_2 uptake and chlorophyll ratios of pix treated cotton. Proc. 6th Ann. Meeting of Pt. Gr. Reg. Wrk. Grp, pp. 117-125. Las Vegas.

Guinn, G. and Brummett, D.L. (1993). Leafage, decline in photosynthesis and changes in abscisic acid, IAA and cytokinin in cotton leaves. *Field Crop Res.*, **32**: 3-4.

Hiscox, J.D. and Israelstam, G.F., (1979). A method for extraction of chlorophyll from leaf tissue without maceration. *Can. J. Bot.*, **57**: 1332 – 1134.

Jawarski, E. (1971). Nitrate reductase assay in intact plant tissues. *Biochem. Biophys. Res. Comm.*, **43**: 1274 – 1279.

More, P.R., Waykar, S.K. and Coulwar, S.B.(1993). Effects of Cycocel (CCC) on morphological and yield contributing characters of cotton. *J. Maharashtra Agr. Univ.*, **18**: 294 – 295.

Panse, V.G. and Sukhatme, P.V.(1967). Statistical Methods for Agricultural Workers, ICAR Publication, New Delhi.

Pothiraj, P., Jaganathan, N.T., Venkitaswamy, R., Premshekhar, M. and Purushothaman, S. (1995).Effect of growth regulators in cotton cv. MCU-9. *Madras Agri. J.* **82**: 283 – 284.

Reddy, A.R., Reddy, K.R. and Hodges, H.F. (1996), Mepiquat Chloride (PIX) induced changes in photosynthesis and growth of cotton. *Plant Growth Regul.*, **20**: 179-183.

Thakur Singh and Brar,Z.S. (1999). Effects of growth regulators and defoliant on yield and maturity of upland cotton under irrigated conditions. *Indian J. Agron.* **44** : 179 – 184.