Effect of plant growth regulators on total dry matter production, leaf area and yield components in hybrid cotton

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ABSTRACT

Field experiments were conducted at Agricultural Research Station, Dharwad, University of Agricultural Sciences, Dharwad during *Kharif* 2005-06 and 2006-07 to find out the effect of plant growth regulators on total dry matter production, leaf area and yield components in hybrid cotton. Significant differences were observed in all parameters studied during two years. Among the growth regulators, naphthalene acetic acid (NAA 10, 20 30 ppm) recorded significantly higher dry matter and leaf area as compared to other treatments. Yield in these treatments was also more because of the retention of more bolls and diversion of higher proportion of photosynthates to reproductive parts. Among the treatments, growth retardant treatments recorded the lowest of these values.

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Key words : Cotton, PGRs, Hybrid cotton, Interspecific hybrid, Morphology

INTRODUCTION

It is the oldest among the commercial crops of the world and is regarded as white gold. Presently, India is the second largest producer of cotton in the world having largest acreage. Cotton growing areas in India fall within 8^0 – 32^0 N latitude and 70^0 – 80^0 E longitude with an elevation ranging from 0 – 950 m above mean sea level. The physiological efficiency of plant can be improved by prolonging photosynthesis, reducing photorespiration, better partitioning of photo assimilates, improving mineral ions uptake and stimulating nitrogen metabolism. All these processes are inter-linked through several interactions and influence growth and productivity. Plant growth regulators have been found to influence these processes in one way or the other. Plant growth regulators are substances when added in small amounts modify the growth of plant usually by stimulating or inhibiting the natural growth regulation. Cotton often produces more vegetative growth than is needed for maximum boll production and yield especially when climatic conditions favour vegetative growth, thereby directing the photo-assimilates towards the vegetative growth rather than reproductive growth. However, in the recent past, different workers have emphasized the use of various growth regulating chemicals for the control of vegetative growth in cotton. Derrick *et al.* (2000) suggested that mepiquate chloride application to cotton reduces plant height, vegetative growth by shortening internodal length. Cotton yield depends not only on total dry matter production but also its distribution into reproductive parts. In cotton it may happen that there may be too much of vegetative growth resulting in lesser cotton yield under certain adverse conditions.

Total dry matter production and supply of required photosynthates for the developing bolls largely depends on leaf area and leaf area index. The photosynthetic efficiency of crop plants as measured by net assimilation rate is dependent upon photosynthetic capacity expressed as leaf area index (Watson, 1952).

MATERIALS AND METHODS

Field experiments were conducted during *Kharif* 2005-06 and 2006-07 to evaluate the effect of plant growth regulators on total dry matter, leaf area and yield components of hybrid cotton. Five plants from each treatment were selected randomly and tagged for recording various observations. The design adopted for the experiment was Randomized Block Design with three replications. The genotype used for the experiment was DHB-290. Various treatments given were cycocel (40, 60, 80 ppm), mepiquat chloride (50, 100 ppm), naphthalene acetic acid (10, 20, 30 ppm) and sprayed at 70, 90 and 70 + 90 days after sowing. But, all naphthalene acetic acid concentrations sprayed at 60 days after sowing.

RESULTS AND DISCUSSION

The results obtained from the present investigation

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are presented in Table 1, 2 and 3.

Total dry matter and leaf area:

The data on total dry weight and leaf area are presented in Table 1. Yield improvement in any crop could be attributed to the better partitioning of photo-assimilates towards reproductive/economic sinks. The rate of dry matter accumulation may also have an influence on dry matter partitioning and it is difficult to establish a cause and effect relationship between the partitioning and growth rate. Cotton yield depends not only on total dry matter production but also its distribution into reproductive parts. In cotton it may happen that there may be too much of vegetative growth resulting in lesser cotton yield under certain adverse conditions. Cotton is basically an indeterminate crop where the vegetative and reproductive phases overlap resulting in intra-plant competition for photosynthates between the developing bolls and vegetative parts (mainly stem, lateral branches and leaves). The dry matter production was slow upto peak flowering stage and increased subsequently in a logarithmic fashion in the sigmodial pattern.

In general, all the treatments recorded maximum total dry matter at 150 DAS. Among the growth regulators, NAA 10, 20 and 30 ppm recorded significantly higher dry matter (276.3, 279.5 and 282.5, respectively) and leaf area (69.6, 70.5 and 71.7, respectively) as compared to other treatments (Table 1). Yield in these treatments was also more because of the retention of more bolls and diversion of higher proportion of photosynthates to reproductive parts. Similar observation on dry matter partitioning and yield was made by Nagabhushana *et al.* (1993).

Application of growth retardants at one stage either at 70 DAS or at 90 DAS recorded higher total dry matter as compared to application at both the stages. The distribution of dry matter in different plant parts showed that at early stages, leaves contributed a greater proportion to total dry matter, but at later stages, stem and reproductive parts contributed more. The amount of TDM produced is an indication of the overall efficiency of the utilization of resources and better light interception. At later stages of crop growth, the dry matter accumulated

Table 1 : Effect of plant growth regulators on total dry weight (g plant^{-1}) and leaf area (dm^2 plant^{-1}) at different growth stages in cotton

Treatments	Total Dry Weight (g plant^{-1})						Leaf Area (dm^2 plant^{-1})					
	120 DAS			150 DAS			120 DAS			150 DAS		
	05-06	06-07	Pooled	05-06	06-07	Pooled	05-06	06-07	Pooled	05-06	06-07	Pooled
T_1 – CCC (40 ppm) at 70 DAS	198.0	220.7	209.3	234.8	260.6	247.7	44.0	48.0	46.0	55.0	59.9	57.4
T_2 – CCC (40 ppm) at 90 DAS	199.4	226.3	212.9	236.6	264.9	250.8	45.6	53.4	49.5	55.1	60.7	57.9
T_3 – CCC (40 ppm) at 70 + 90 DAS	196.0	214.9	205.5	232.1	254.2	243.2	43.6	45.6	44.6	54.2	57.6	55.9
T_4 – CCC (60 ppm) at 70 DAS	197.2	216.6	206.9	233.3	257.7	245.5	43.6	45.0	44.3	54.9	58.5	56.7
T_5 – CCC (60 ppm) at 90 DAS	198.3	223.0	210.7	236.0	263.6	249.8	45.3	53.3	49.3	55.0	59.2	57.1
T_6 – CCC (60 ppm) at 70 + 90 DAS	194.3	211.0	202.7	231.3	251.6	241.5	43.3	43.6	43.5	54.2	57.0	55.6
T_7 – CCC (80 ppm) at 70 DAS	196.0	213.2	204.6	230.8	253.2	242.0	43.4	42.6	43.0	53.4	57.3	55.4
T_8 – CCC (80 ppm) at 90 DAS	197.6	220.3	209.0	235.1	259.2	247.2	45.4	53.6	49.5	54.7	58.4	56.6
T_9 – CCC (80 ppm) at 70 + 90 DAS	192.8	207.6	200.2	228.7	248.6	238.7	43.1	42.0	42.5	53.4	55.5	54.5
T_{10} – MC (50 ppm) at 70 DAS	198.7	221.2	210.0	235.8	261.1	248.5	44.1	48.3	46.2	55.1	59.5	57.3
T_{11} – MC (50 ppm) at 90 DAS	200.2	227.7	213.9	237.7	266.9	252.3	45.6	53.3	49.5	55.1	60.8	57.9
T_{12} – MC (50 ppm) at 70 + 90 DAS	196.4	216.8	206.6	233.1	255.2	244.2	43.7	49.3	46.5	54.2	59.0	56.6
T_{13} – MC (100 ppm) at 70 DAS	196.0	213.8	204.9	230.8	252.9	241.9	43.4	46.6	45.0	53.4	57.4	55.4
T_{14} – MC (100 ppm) at 90 DAS	197.6	220.6	209.1	235.1	258.6	246.8	45.4	53.2	49.3	54.7	58.6	56.7
T_{15} – MC (100 ppm) at 70 + 90 DAS	192.8	207.8	200.3	228.8	247.5	238.1	43.1	45.6	44.4	53.4	56.0	54.7
T_{16} – NAA (10 ppm) at 60 DAS	224.2	249.9	237.1	263.6	289.0	276.3	55.0	63.3	59.1	66.8	72.3	69.6
T_{17} – NAA (20 ppm) at 60 DAS	225.4	258.2	241.8	265.4	293.6	279.5	55.3	65.3	60.3	67.3	73.6	70.5
T_{18} – NAA (30 ppm) at 60 DAS	227.6	260.5	244.1	268.2	296.8	282.5	55.7	65.6	60.7	69.0	74.4	71.7
T_{19} – Water spray	190.9	222.6	206.7	231.3	263.9	247.6	49.6	58.6	54.1	60.0	68.0	64.0
T_{20} – Control	190.5	220.2	205.4	230.8	261.2	246.0	49.3	59.0	54.1	59.6	68.3	64.0
Mean	200.5	223.6	212.1	238.0	263.0	250.5	46.4	51.8	49.1	56.9	61.6	59.3
S.E.$\pm$	6.47	3.38	3.71	8.88	3.72	4.90	1.95	1.64	1.59	2.16	2.01	1.47
C.D. (P=0.05)	18.52	9.68	10.62	25.41	10.64	14.02	5.57	4.71	4.55	6.19	5.76	4.21

at a decreasing rate, which could be attributed to reduced source activity leading to lesser dry matter accumulation in the leaf and stem. Dry matter production, particularly of reproductive parts is an important yield contributing character and the basic vegetative phase essential for the development of reproductive organs. It is therefore, inferred that the PGR's have profound effect not only on the production of dry matter but also its partitioning between various organs of the plant. Correlation study (Table 3) revealed that total dry matter at 150 DAS had highly significant positive correlation with yield (r=0.805), number of bolls (r=0580), boll weight (r=0.692) and harvest index (r=0.652). In general leaf area increased with the age of crop until 150 DAS and decreased thereafter. Significant difference among all the treatments at all the stages was observed except at 60 DAS. An increase in leaf area may, therefore, improve the yield, provided such an increase is commensurate with an increased rate of dry matter production in reproductive parts. Leaf area over unit ground area gives a fairly good idea of the photosynthetic surface. Significant differences were noticed with regard to leaf area and leaf area index among the growth regulator treatments. Leaf area increased with the age of the crop upto 150 DAS and decreased at harvest, which was due to ageing and senescence of leaves. Leaf area at 150 DAS was found to have positive correlation with yield (r=0.561), number of sympodia (r=0.746), plant height (r=0.808), number of leaves (r=0.680) and TDM (r=0.768).

Yield and yield components:

The data on yield (kg/ha), boll weight (g), number of bolls per plant and harvest index are presented in Table 2. There was significant difference between treatments on yield and yield components. Major factors attributed for the variation in the yield of seed cotton are the yield components *viz.*, boll weight, number of bolls per plant, kapas weight per plant, morphological characters like number of monopodial and sympodial branches and plant height. It is well known that, adverse climatic conditions bring an imbalance in the growth and development of plants leading to the drying of reproductive parts, thereby reducing the yield considerably in cotton. The growth regulators are capable of redistributing dry matter in the

Table 2 : Effect of plant growth regulators on yield and yield components in cotton

Treatments	Yield (kg/ha)			Boll weight (g)			No. of bolls/plant			Harvest index (%)		
	05-06	06-07	Pooled	05-06	06-07	Pooled	05-06	06-07	Pooled	05-06	06-07	Pooled
T_1 – CCC (40 ppm) at 70 DAS	943.7	1230.0	1086.8	3.33	3.76	3.54	19.3	20.4	19.9	22.6	27.7	25.2
T_2 – CCC (40 ppm) at 90 DAS	1087.0	1266.7	1176.8	3.39	3.80	3.59	21.3	22.4	21.9	25.6	28.2	26.9
T_3 – CCC (40 ppm) at 70 + 90 DAS	894.7	1156.0	1025.3	3.11	3.42	3.27	18.3	19.4	18.9	21.7	26.3	24.0
T_4 – CCC (60 ppm) at 70 DAS	907.0	1222.0	1064.5	3.21	3.70	3.46	19.1	20.1	19.6	21.8	27.6	24.7
T_5 – CCC (60 ppm) at 90 DAS	1037.3	1257.0	1147.2	3.25	3.78	3.51	21.0	22.1	21.5	24.5	28.1	26.3
T_6 – CCC (60 ppm) at 70 + 90 DAS	852.3	1118.3	985.3	3.09	3.41	3.25	18.0	19.0	18.5	20.7	25.5	23.1
T_7 – CCC (80 ppm) at 70 DAS	864.3	1207.0	1035.7	3.17	3.64	3.41	18.3	19.4	18.9	20.9	28.0	24.4
T_8 – CCC (80 ppm) at 90 DAS	970.0	1232.3	1101.2	3.20	3.74	3.47	20.2	21.2	20.7	23.1	27.6	25.4
T_9 – CCC (80 ppm) at 70 + 90 DAS	791.7	1077.0	934.3	3.09	3.36	3.23	16.8	18.0	17.4	19.3	24.8	22.1
T_{10} – MC (50 ppm) at 70 DAS	992.0	1238.0	1115.0	3.51	3.79	3.65	20.6	21.5	21.1	23.7	27.8	25.8
T_{11} – MC (50 ppm) at 90 DAS	1103.7	1278.0	1190.8	3.56	3.83	3.70	22.4	23.3	22.9	25.9	28.3	27.1
T_{12} – MC (50 ppm) at 70 + 90 DAS	911.3	1157.0	1034.2	3.18	3.43	3.31	19.3	20.2	19.8	22.0	26.3	24.2
T_{13} – MC (100 ppm) at 70 DAS	877.0	1210.7	1043.8	3.18	3.65	3.42	18.3	19.4	18.9	21.2	27.5	24.4
T_{14} – MC (100 ppm) at 90 DAS	987.7	1235.7	1111.7	3.21	3.75	3.48	20.2	21.2	20.7	23.5	27.7	25.6
T_{15} – MC (100 ppm) at 70 + 90 DAS	816.7	1080.3	948.5	3.10	3.37	3.24	16.9	18.0	17.4	19.9	24.9	22.4
T_{16} – NAA (10 ppm) at 60 DAS	1112.7	1317.3	1215.0	3.95	4.06	4.01	24.3	25.6	25.0	24.6	27.3	25.9
T_{17} – NAA (20 ppm) at 60 DAS	1182.7	1332.3	1257.5	3.97	4.06	4.01	25.0	26.3	25.6	25.6	27.5	26.5
T_{18} – NAA (30 ppm) at 60 DAS	1234.3	1347.0	1290.7	3.99	4.09	4.04	25.1	26.6	25.9	26.5	27.7	27.1
T_{19} – Water spray	906.7	1072.0	989.3	3.08	3.34	3.21	16.3	18.3	17.3	21.9	24.5	23.2
T_{20} – Control	867.7	1068.7	968.2	3.07	3.33	3.20	16.2	18.1	17.1	21.0	24.5	22.7
Mean	967.0	1205.2	1086.1	3.33	3.66	3.50	19.8	21.0	20.4	22.8	26.9	24.9
S.E.±	43.83	40.22	26.76	0.193	0.117	0.114	1.366	1.908	1.584	1.12	0.914	0.737
C.D. (P=0.05)	125.49	115.16	76.62	0.554	0.334	0.327	3.910	5.463	4.536	3.21	2.615	2.11

Table 3 : Correlation co-efficient values of yield with growth and yield components in cotton hybrid as influenced by PGRS (Pooled)

Characters	Yield	Bolls/ plant	Boll weight	No. of sympodia	Harvest index	Plant height	No. of leaves	Total dry matter	AGR	CGR	RGR	NAR	LA	LAI	SLW	LAD	Total chlorophyll	NRA
Yield	1																	
Bolls/ plant	0.491*	1																
Boll weight	0.680**	0.552*	1															
No. of sympodia	0.421*	0.400	0.455*	1														
Harvest index	0.928**	0.345	0.572**	0.236	1													
Plant height	0.480*	0.345	0.433	0.730**	0.333	1												
No. of leaves	0.424	0.283	0.394	0.563**	0.307	0.661**	1											
Total dry matter	0.805*	0.580*	0.692**	0.624**	0.652**	0.723**	0.580**	1										
AGR	0.150	0.037	0.108	0.170	0.160	0.170	0.118	0.247	1									
CGR	0.337	0.007	0.250	0.216	0.338	0.311	0.185	0.256	0.397	1								
RGR	0.239	0.221	0.227	0.113	0.154	0.167	0.140	0.216	0.880	0.270	1							
NAR	0.200	0.209	0.247	0.278	0.145	0.320	0.262	0.194	0.687	0.170	0.812	1						
LA	0.561*	0.444	0.549*	0.746**	0.398	0.808**	0.680**	0.768**	0.199	0.293	0.158	0.335	1					
LAI	0.321	0.368	0.385	0.713**	0.159	0.851**	0.692**	0.592**	0.100	0.227	0.166	0.371	0.796**	1				
SLW	0.057	0.121	0.104	0.403	0.105	0.433	0.386	0.157	0.120	0.005	0.074	0.179	0.377	0.625	1			
LAD	0.354	0.408	0.418	0.726**	0.186	0.850**	0.704**	0.608**	0.078	0.222	0.193	0.382	0.803**	0.985**	0.622	1		
Total chlorophyll	0.065	0.127	0.054	0.417	0.161	0.617	0.569	0.221	0.024	0.139	0.061	0.295	0.538	0.805	0.623**	0.792	1	
NRA	0.409	0.358	0.409	0.185	0.302	0.046	0.070	0.386	0.030	0.082	0.218	0.072	0.147	0.027	0.259	0.006	0.401	1

plant thereby bringing about improvement in yield. In addition, crop yield depends not only on the accumulation of photosynthates during the crop growth and development, but also on the partitioning of photosynthates in favour of storage organs. These inturn are influenced by the efficiency of metabolic processes within the plant.

The seed cotton yield depends on the accumulation of photo-assimilates and partitioning of these in reproductive parts of the plant. The seed cotton yield was strongly influenced by the application of growth regulators indicating the role of these chemicals in increasing the seed cotton yield through their effect on various morpho-physiological and biochemical traits.

In the present investigation, higher yields were obtained with NAA 30 ppm (1290.7 kg/ha) application. This increased yield was due to higher seed cotton yield per plant, more number of bolls (25.9) and boll weight (4.04g) as compared to other treatments. Several authors have also reported increased seed cotton yield due to NAA spray (Patel, 1993; Sawan *et al.,* 1998). This was because of higher number of harvested bolls per plant and higher mean boll weight.

REFERENCES

Derrick, M., Oosterhuis and Duli, Z. (2000). Field evaluation of plant growth regulators. Proceedings of the 2000 Cotton. Research Meeting.

Nagabhushana, G.G., Nandagoudar, B. S., Manjunath, M. and Thimmaiah, G. (1993). Comparison of dry matter partitioning in two upland cotton cultivars. *Karnataka J. agric. Sci.*, **6** : 59-60.

Patel, J.K. (1993). Response of cotton (*G. hirsutum*) to triacontanol and naphthalene acetic acid sprays. *Indian J. agron.*, **38**(1) : 97-101.

Sawan, Z.M., Sakr, R. A. and Momtaz, O.A. (1998). Effect of á naphthalene acetic acid concentrations and the number of application on the yield components, yield and fibre properties of Egyptian cotton (*G. barbadense* L.). *Australian J. agric. Res.,* **49** : 955-960.

Watson, D.J. (1952). The physiological basis for variation in yield. *Adv. Agron.,* **14** : 101-146.

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