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Effect of various plant growth regulators on yield of American cotton (*Gossypium hirsutum*)

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Abstract
The field experiment was conducted during *Kharif* season of 2012-13 at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, and District: Banaskantha (North Gujarat). The experiment was laid in factorial randomized block design with three replications. Eighteen treatment combinations comprised of the foliar spray of growth regulators and nutrients viz. 30 ppm NAA, 50 ppm GA_3, 200 ppm Mepiquat chloride, 2 % Urea and control were applied at 60 and 80 days after sowing. Foliar application of NAA @ 30ppm significantly gave early and higher number of flowers opening compared to other treatments. The application of NAA increased the flowering percentage, reduced the abscission and increased the flower retention percentage, which in turn helped in getting higher seed cotton yield. Higher seed cotton yield was obtained with application of NAA @ 30 ppm i.e. 1213.27 kg/ha., maximum biological yield i.e. 241.66 gm., maximum harvest index i.e. 37.10 %, which leads to interpret that higher seed cotton yield obtained because HI having significant positive effect on yield.

Keywords: PGRs, cotton, *Gossypium hirsutum* L., yield

Introduction

Cotton productivity in India is low due to the fact that more than 65 per cent of the Cotton area is under rainfed condition, low fertilizer consumption and low fertilizer use efficiency. In addition, India has about 28 per cent of area under desi Cotton (*G. herbaceum and G. arboreum*) which is intrinsically low yielders due to the genetic and physiological constraints like long duration, shedding of plant parts, leaf redening, and bad opening of bolls and are grown in areas of high biotic and abiotic stresses. Cotton under the conditions of high rainfall or irrigation produces excessive vegetative growth resulting in mutual shading and shedding of reproductive parts, thereby reducing the yield. The desire to optimize plant growth, while maximizing yield led to the use of interest in PGRs. In the past two decades many new plant growth regulators have been developed and tested under field conditions. 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 part of the natural growth regulation. They are considered as new generation of agrochemicals after fertilizers, pesticides and herbicides. Plant growth regulators are capable of increasing yield by 100-200 per cent under laboratory conditions, 10 - 15 per cent in the field conditions (Kiran Kumar, 2001) [14]. Generally sowing of cotton in Gujarat is done at the end of May to first week of June, so there will be maximum number of bolls per plant at the end of August to first fortnight of September. From last few years weather pattern has changed and rainfall withdraw at the end of August. So cotton faces moisture stress at this period on contrast to this plant of cotton at that time requires maximum water and foods for the development of bolls. The drought at this time create internal hormones imbalance i.e. production of abscisic acid and ethylene inhibits the production of Auxins, Gibberellins and Cytokinins which results into abscission of leaves and squares and in severe condition also abscission of bolls and ultimately parawilt condition in cotton yield. Management practices i.e. timely application of irrigations and fertilizers with artificial application of growth promoters like synthetic auxin (NAA) and gibberellins can overcome this parawilt situation in cotton. Considering this in view the present experiment was planned to test the different concentrations of plant growth regulators along with urea concentrations for the control of abscission of leaves, squares and bolls i.e. parawilt condition.

Material and Methods

The experimental site had an even topography with good drainage. It is suitable to variety of crops of semi-arid region. To find out physico-chemical properties of soil,

soil sample were taken randomly before the commencement of experiment from different spots in the field to a depth of 0-15 cm and 15-30 cm. The composite sample was prepared and analyzed for physical and chemical properties of the soil. The values of soil analysis along with methods followed are given in Table 1.

Table 1: Physico-chemical properties of soil of experimental field

S. No.		Properties	Soil depth (cm) 0-15	15-30	Method employed
[A]		**Physical Properties**			
	(a)	Sand (%)	84.90	84.98	International Pipette Method (Piper, 1966)
	(b)	Silt (%)	5.55	5.47	
	(c)	Clay (%)	9.29	9.47	
	(d)	Soil texture	Loamy sand		
[B]		**Chemical Properties**			
	(a)	Soil pH (1:2.5, Soil: Water Ratio)	7.6	7.4	Potentiometric method (Jackson, 1978)
	(b)	EC (dSm^{-1} at 25ºC)	0.13	0.18	Schofield method (Jackson, 1978)
	(c)	Organic carbon (%)	0.17	0.15	Weakley and Black's rapid titration method (Jackson, 1978)
	(d)	Available N ($kg\ ha^{-1}$)	149	138	Alkaline Permanganate method (Jackson, 1978)
	(e)	Available P_2O_5 ($kg\ ha^{-1}$)	29.24	32.93	Olsen's Method (Jackson, 1978)
	(f)	Available K_2O ($kg\ ha^{-1}$)	287	279	Flame photometer method (Jackson, 1978)

This zone is characterized by semi-arid climate. The weather conditions are quite favorable for normal growth and development of the crop. The standard week wise data for the period of the investigation recorded at the agro-meteorological observatory of the Department of Meteorology, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar are presented in Table 2.

Table 2: Standard week wise meteorological data recorded during crop season for the year 2012-13 at Sardarkrushinagar.

Standard Meteorological Weeks	Temperature °C Max.	Temperature °C Min.	Bright Sunshine (Hours)	Rainfall (mm)	Wind velocity (Km/hrs.)	Mean Humidity (%)
June, 2012						
22	40.2	24.9	8.7	0.0	8.8	56
23	38.6	26.5	5.3	0.0	12.8	56
24	38.3	26.3	8.8	38.0	8.2	62
25	38.0	26.7	7.7	0.0	14.2	61
26	37.9	26.9	7.1	0.0	14.3	59
July, 2012						
27	37.6	29.3	5.3	0.0	12.2	63
28	33.5	26.9	2.8	167.1	9.7	77
29	34.9	27.0	4.3	4.2	10.7	68
30	35.1	27.0	2.2	0.0	11.3	67
August, 2012						
31	32.7	25.9	1.2	5.6	12.8	74
32	32.3	25.7	1.1	30.0	6.8	78
33	28.8	24.4	0.2	173.5	5.7	87
34	31.9	25.4	1.6	4.0	5.5	75
35	31.6	27.2	2.3	12.8	23.0	29
September, 2012						
36	32.1	25.7	2.9	130.1	3.4	86
37	29.5	25.1	1.3	60.1	7.1	90
38	32.5	24.4	7.0	1.6	4.6	73
39	33.8	22.8	8.9	0.0	3.2	67
October, 2012						
40	37.1	22.2	9.8	1.2	2.6	58
41	36.5	18.8	9.5	0.0	2.5	51
42	36.0	19.7	9.6	0.0	2.5	52
43	32.8	18.8	9.5	2.0	4.2	48
44	33.9	13.7	9.5	0.0	2.9	54
November, 2012						
45	32.3	13.5	8.4	0.0	2.1	54
46	33.1	14.8	9.4	0.0	2.4	50
47	31.8	13.4	9.1	0.0	2.2	50
48	30.5	12.9	8.9	0.0	5.2	51
December, 2012						
49	30.9	14.2	7.7	0.0	2.8	58
50	29.4	12.9	7.6	0.0	2.2	63
51	28.9	12.4	8.1	0.0	6.4	55
52	28.6	8.2	9.2	0.0	2.5	51
January, 2013						
1	24.7	6.0	8.8	0.0	4.6	52
2	27.4	8.2	8.5	0.0	2.3	56
3	24.6	9.0	7.1	0.2	5.0	56
4	26.6	7.0	9.2	0.0	4.7	49
5	30.4	12.5	7.1	0.0	3.1	55

The experiments were carried out in FRBD (Factorial Randomized Block Design) design with three replications having the spacing 120 x 45cm. Treatment divided into two factor, 1) Factor A: Chemicals (C), 2) Factor B: Varieties (V): a) Bt. Cotton – Hybrid 6b) Non Bt. Cotton – G. Cot. Hybrid12. Hand-thinned to 5 to 6 plants per meter row when the seedlings had approximately three true leaves. The recommended dose of fertilizer to cotton is 160: 00: 00 N, P2O5 and K2O kg/ha. Among this 80 kg N was applied at the time of sowing as basal dose. A top dressing of 40 kg N each was applied at 30 DAS and 60 DAS.

Total eighteen treatment combinations were used. The details of treatments are as under.

Table 3: Treatment combinations

Treatments	Treatment combinations	Dose	Time of Spray
T_1	NAA (1-naphthalene acetic acid)	30 ppm	60 DAS
T_2	NAA (1-naphthalene acetic acid)	30 ppm	80 DAS
T_3	GA_3 (gibberellic acid)	50 ppm	60 DAS
T_4	GA_3 (gibberellic acid)	50 ppm	80 DAS
T_5	Mepiquat chloride (N, N-dimethyl piperdinium chloride)	200 ppm	60 DAS
T_6	Mepiquat chloride (N, N-dimethyl piperdinium chloride)	200 ppm	80 DAS
T_7	Urea	2 %	60 DAS
T_8	Urea	2 %	80 DAS
T_9	Control (No spray)		
T_{10}	NAA (1-naphthalene acetic acid)	30 ppm	60 DAS
T_{11}	NAA (1-naphthalene acetic acid)	30 ppm	80 DAS
T_{12}	GA_3 (gibberellic acid)	50 ppm	60 DAS
T_{13}	GA_3 (gibberellic acid)	50 ppm	80 DAS
T_{14}	Mepiquat chloride (N, N-dimethyl piperdinium chloride)	200 ppm	60 DAS
T_{15}	Mepiquat chloride (N, N-dimethyl piperdinium chloride)	200 ppm	80 DAS
T_{16}	Urea	2 %	60 DAS
T_{17}	Urea	2 %	80 DAS
T_{18}	Control (No spray)		

At the time of harvesting the tagged five plants utilized for observations recording and plants were harvested separately for recording Seed cotton yield(kg./ha), Biological yield (gm.), Harvest index (%), NAR (Net assimilative rate)(g^{-1} dm^{-2} day^{-1}) and RGR (Relative growth rate) (g g^{-1} day^{-1}). The data collected for all the characters were subjected to statistical analysis by adopting 'Analysis of Variance' techniques as described by Panse and Sukhatme (1978).

Result and Discussion

1. Relative growth rate (g $g^{-1}day^{-1}$) at 120-150 DAS

At 120-150 DAS, significantly higher RGR was recorded when NAA 30 ppm sprayed at 80 DAS (0.0047). However, it was at par with NAA 30 ppm at 60 DAS (0.0045). Significantly lower RGR was recorded in control (0.0029). (Table 4.1)

1.1. Interaction effect of different plant growth regulators on Bt. cotton and local hybrid cotton relative growth rate (RGR) at 120-150 DAS.

The effect of different plant growth regulators on Bt. cotton and local hybrid cotton on relative growth rate was found to be significant. In Bt. cotton the higher RGR was recorded with NAA 30 ppm sprayed at 80 DAS) (0.0049). However, it was at par with NAA 30 ppm at 60 DAS (0.0047). Significantly lower RGR was recorded in Control (0.0033). In local hybrid cotton the higher RGR was recorded with the spray NAA 30 ppm at 80 DAS (0.0045). However, it was at par with NAA 30 ppm at 60 DAS (0.0043). Significantly lower RGR was recorded in Control (0.0025). (Table 4.2)

2. Net assimilation rate (g^{-1} $dm^{-2}day^{-1}$) at 120-150 DAS

At 120-150 DAS, significantly higher NAR was recorded with spraying of NAA 30 ppm at 80 DAS (0.026). Significantly lower NAR was recorded in control (0.018). (Table 4.3)

2.1 Interaction effect of different plant growth regulators on Bt. cotton and local hybrid cotton net assimilation rate (NAR) at 120-150 DAS.

The effect of different plant growth regulators on Bt. cotton and local hybrid cotton on net assimilation rate was found to be significant. In Bt. cotton the higher NAR was recorded with the spraying of NAA 30 ppm at 80 DAS (0.028). Significantly lower NAR was recorded in control (0.018). In local hybrid cotton the higher NAR was recorded in NAA 30 ppm at 80 DAS (0.024). Significantly lower NAR was recorded in control (0.018). (Table 4.4)

3. Yield per plant (g $plant^{-1}$)

There was significant difference between treatments with yield (g $plant^{-1}$). Among the treatments, significantly higher seed cotton yield per plant was recorded with the spraying of NAA 30 ppm at 80 DAS (65.52) compared to other treatments. However, it was at par with NAA 30 ppm at 60 DAS (63.42) and $GA_3$50 ppm at 80 DAS (62.03). (Table 4.5)

3.1 Interaction effect of different plant growth regulators on Bt. cotton and local hybrid cotton on seed cotton yield per plant (g $plant^{-1}$).

The effect of different plant growth regulators on Bt. cotton and local hybrid cotton on seed cotton yield per plant was found to be significant. In Bt. cotton the higher seed cotton yield per plant was recorded with the spraying of NAA 30 ppm at 80 DAS (70.03). However, it was at par with NAA 30 ppm at 60 DAS (66.50), GA_3 50 ppm at 60 DAS (67.65) and GA_3 50 ppm at 80 DAS (68.05). Significantly lower seed cotton yield per plant was recorded in Control (51.70). In local hybrid cotton the higher seed cotton yield per plant was recorded with the application of NAA 30 ppm at 80 DAS (61.00). However, it was at par with NAA 30 ppm at 60 DAS (60.33) and GA_3 50 ppm at 80 DAS. (Table 4.6)

4. Seed cotton yield (kg ha^{-1})

Cotton spraying with NAA 30 ppm at 80 DAS (1213.27) recorded significantly higher seed cotton yield compared to other growth regulators. However, it was at par with NAA 30 ppm at 60 DAS (1174.38) and $GA_3$50 ppm at 80 DAS (1148.77). Significantly lower seed cotton yield was recorded with control (868.83). (Table 4.7)

4.1 Interaction effect of different plant growth regulators on Bt. cotton and local hybrid cotton on seed cotton yield (kg ha^{-1}).

The effect of different plant growth regulators on Bt. cotton and local hybrid cotton on seed cotton yield was found to be significant. In Bt. cotton the higher seed cotton yield was recorded with spraying of NAA 30 ppm at 80 DAS (1296.91). However, it was at par with NAA 30 ppm at 60 DAS (1231.48), GA_3 50 ppm at 60 DAS (1252.78) and GA_3 50 ppm at 80 DAS (1260.19). Significantly lower seed cotton yield was recorded in control (957.41). In local hybrid cotton the higher seed cotton yield was recorded in NAA 30 ppm at 80 DAS (1129.63). However, it was at par with NAA 30 ppm at 60 DAS (1117.28) and $GA_3$50 ppm at 80 DAS (1037.35). (Table 4.8)

5. Biological yield (g)

The data indicated significant differences in biological yield between the treatments. Spraying of NAA 30 ppm at 80 DAS (241.66) recorded significantly higher biological yield compared to other growth regulators. However, it was at par with NAA 30 ppm at 60 DAS (238.93). (Table 4.9)

5.1 Interaction effect of different plant growth regulators on Bt. cotton and local hybrid cotton on biological yield (g).

The effect of different plant growth regulators on Bt. cotton and local hybrid cotton on biological yield was found to be significant. In Bt. cotton the higher biological yield was recorded with NAA 30 ppm at 80 DAS (249.96) and it was at par with GA_3 50 ppm at 60 DAS (249.37) and GA_3 50 ppm at 80 DAS (245.96). In local hybrid cotton the higher biological yield was recorded with NAA 30 ppm at 60 DAS (236.37). However, it was at par with NAA 30 ppm at 80 DAS (233.35). Significantly lower biological yield was recorded in MC 200 ppm at 80 DAS (186.87). (Table 5.0)

6. Harvest Index (HI)

The data indicated significant differences in harvest index between the treatments. The spraying of NAA 30 ppm at 80 DAS (37.10) recorded significantly high harvest index compared to other growth regulators. However, it was at par with $GA_3$50 ppm at 80 DAS (36.77). (Table 5.1)

6.1 Interaction effect of different plant growth regulators on Bt. cotton and local hybrid cotton on harvest index.

The effect of different plant growth regulators on Bt. cotton and local hybrid cotton on harvest index was found to be significant. In Bt. cotton the high harvest index was recorded in NAA 30 ppm at 80 DAS (38.86) and it was at par with $GA_3$50 ppm at 80 DAS (38.13). In local hybrid cotton the high harvest index was recorded in $GA_3$50 ppm at 80 DAS (35.42). However, it was at par with NAA 30 ppm at 60 DAS (34.28) and NAA 30 ppm at 80 DAS (35.34). Significantly low harvest index was recorded in control (27.22). (Table 5.2)

The RGR was more during early stages and gradually decreased thereafter. This indicates that RGR in cotton is more closely associated with vegetative growth than seed cotton yield (Coy, 1976) [5]. At initial stage (60-90 DAS), higher RGR was recorded with NAA treatments. The increase in RGR by the application of growth regulators could be attributed to increased photosynthetic efficiency as a result of increased leaf thickness, higher chlorophyll content and efficient translocation of photosynthates (Joseph and Johnson, 2006) [13]. Net assimilation rate (NAR) expresses the rate of dry weight increase at any instant per unit leaf area and leaf representing an estimate of the size of the assimilatory surface area. The NAR decreased continuously from 90 DAS until harvest in all the treatments. The decrease in NAR at later stages could be due to mutual shading of leaves. From 60-90 DAS till 120-150 DAS, significantly higher NAR was observed in NAA treatments @ 30 ppm as compared to other treatments.

In the present investigation, higher yields were obtained with NAA @ 30 ppm application. This increased yield was due to higher seed cotton yield per plant. Several authors have also reported increased seed cotton yield due to NAA spray (Dastur and Bhatt, 1956; Bharadwaj and Santhanam, 1962; Sankaran and Balasubramanian, 1975; Jaganathan and Ireetharaj, 1982; Patel, 1993; Sawan *et al.*, 1998) [8, 3, 12, 17, 18]. This was because of higher number of harvested bolls per plant and higher mean boll weight (Bharadwaj and Sharma, 1971 and Bhale *et al.*, 1987) [4, 2]. Variable yield responses to mepiquat chloride have been related to environmental conditions by several researchers (Crawford, 1981) [6]. Yield increases have been observed more frequently under high rainfall conditions, while yield decreases have been observed in drought situations (Willard *et al.*, 1977; Crawford, 1981; Hoskinson and Krueger, 1982) [20, 6, 11]. In addition, MC increased the leaf thickness which in turn enhanced the photosynthesis. This was reported by Shaw *et al.* (1990) [19], Gadakh *et al.* (1992) [10], More *et al.* (1993) [15] and Dippenaar (1994) [9].

Biological yield is measured in terms of percent and is being utilized for the production of economic yield. Among the treatments, NAA (30 ppm) recorded the maximum biological yield.

Harvest index indicates the translocation efficiency of plants and is measured in terms of percent of dry matter being utilized for the production of economic yield. Among the treatments, NAA @ 30 ppm recorded the maximum harvest index. Harvest index was having significant positive correlation with yield. Basu and Bhatt (1987) [1] reported that genetic improvement of harvest index would improve the seed cotton yield.

Conclusions and Future Line of Work

PGRs are effective at low concentration. Foliar application of plant growth retardants before 90 DAS is detrimental to plant growth and yield. Growth retardants reduced the vegetative growth and retained more bolls and thus increased yield. Use NAA @ 30 ppm growth regulator for better boll retention and boll set. The potential use of growth retardants should be defined for specific soil moisture regimes. The influence of PGR's, particularly retardants should be studied on considerable number of genotypes. There are many PGRs available in the market. Therefore, there is a need for generating such information's requires for the mode of action in order to adopt their use in current cotton production system. The effect of growth regulators on the distribution of photosynthates in different plant parts and also on the activity of various enzymes is important. Impacts of PGRs on biophysical and biochemical constituents are to be studied in depth.

Table 4.1: Effect of plant growth regulators on relative growth rate (g g^{-1} day^{-1}) at different growth stages in cotton.

Treatments	120 - 150 DAS
Chemicals (C)	
T_1- NAA 30 ppm 60 DAS	0.0045
T_2- NAA 30 ppm 80 DAS	0.0047
T_3- GA_3 30 ppm 60 DAS	0.0043
T_4- GA_3 30 ppm 80 DAS	0.0044
T_5- MC 200 ppm 60 DAS	0.0041
T_6- MC 200 ppm 80 DAS	0.0042
T_7- Urea 2 % 60 DAS	0.0038
T_8- Urea 2 % 80 DAS	0.0039
T_9- Control	0.0029
S.Em±	0.00006
C.D. at 5%	0.0002
Varieties (V)	
Bt. Cotton	0.0043
Non Bt. Cotton	0.0039
S.Em±	0.00003
C.D. at 5%	0.0001
Interaction (C X V)	
S.Em±	0.00008
C.D. at 5%	0.0002
C. V %	3.45

Table 4.2: Interaction effect of plant growth regulators on relative growth rate (g g^{-1} day^{-1}) at different growth stages in cotton.

	120 - 150 Das	
	Bt	Non Bt
T_1- NAA 30 ppm 60DAS	0.0047	0.0043
T_2-NAA 30 ppm 80 DAS	0.0049	0.0045
T_3- GA_3 50 ppm 60 DAS	0.0044	0.0041
T_4- GA_3 50 ppm 80 DAS	0.0045	0.0042
T_5- MC 200 ppm 60 DAS	0.0042	0.0039
T_6- MC 200 ppm 80 DAS	0.0043	0.0040
T_7- Urea 2 % 60 DAS	0.0041	0.0035
T_8- Urea 2 % 80 DAS	0.0042	0.0036
T_9- Control (No Spray)	0.0033	0.0025
S.Em±	0.00008	
C.D. at 5%	0.0002	
C. V %	3.45	

Table 4.3: Effect of plant growth regulators on net assimilation rate (g^{-1} dm^{-2} day^{-1}) at different growth stages in cotton.

Treatments	120 - 150 Das
Chemicals (C)	
T_1- NAA 30 ppm 60 DAS	0.024
T_2- NAA 30 ppm 80 DAS	0.026
T_3- GA_3 30 ppm 60 DAS	0.023
T_4- GA_3 30 ppm 80 DAS	0.025
T_5- MC 200 ppm 60 DAS	0.023
T_6- MC 200 ppm 80 DAS	0.024
T_7- Urea 2 % 60 DAS	0.020
T_8- Urea 2 % 80 DAS	0.022
T_9- Control	0.018
S.Em±	0.0004
C.D. at 5%	0.0012
Varieties (V)	
Bt. Cotton	0.0242
Non Bt. Cotton	0.0211
S.Em±	0.0002
C.D. at 5%	0.0006
Interaction (C X V)	
S.Em±	0.0006
C.D. at 5%	0.0017
C. V %	4.44

Table 4.4: Interaction effect of plant growth regulators on net assimilation rate (g^{-1} dm^{-2} day^{-1}) at different growth stages in cotton.

	120 - 150 DAS	
	Bt	Non Bt
T_1- NAA 30 ppm 60DAS	0.026	0.022
T_2-NAA 30 ppm 80 DAS	0.028	0.024
T_3- GA_3 50 ppm 60 DAS	0.025	0.021
T_4- GA_3 50 ppm 80 DAS	0.027	0.023
T_5- MC 200 ppm 60 DAS	0.024	0.021
T_6- MC 200 ppm 80 DAS	0.025	0.022
T_7- Urea 2 % 60 DAS	0.022	0.019
T_8- Urea 2 % 80 DAS	0.023	0.020
T_9- Control (No Spray)	0.018	0.018
S.Em±	0.0006	
C.D. at 5%	0.0017	
C. V %	4.44	

Table 4.5: Effect of plant growth regulators on seed cotton yield (gm. / ha) of cotton.

Treatments	Seed cotton yield (gm. / ha)
Chemicals (C)	
T_1- NAA 30 ppm 60 DAS	63.42
T_2- NAA 30 ppm 80 DAS	65.52
T_3- GA_3 30 ppm 60 DAS	59.95
T_4- GA_3 30 ppm 80 DAS	62.03
T_5- MC 200 ppm 60 DAS	48.22
T_6- MC 200 ppm 80 DAS	49.52
T_7- Urea 2 % 60 DAS	50.42
T_8- Urea 2 % 80 DAS	50.78
T_9- Control	46.92
S.Em±	1.45
C.D. at 5%	4.17
Varieties (V)	
Bt. Cotton	59.504
Non Bt. Cotton	50.887
S.Em±	0.683
C.D. at 5%	1.96
Interaction (C X V)	
S.Em±	2.050
C.D. at 5%	5.89
C. V %	6.43

Table 4.6: Interaction effect of plant growth regulators on seed cotton yield (gm. / ha) of cotton.

	Seed cotton yield (gm. / ha)	
	Bt	Non Bt
T_1- NAA 30 ppm 60DAS	66.50	60.33
T_2-NAA 30 ppm 80 DAS	70.03	61.00
T_3- GA_3 50 ppm 60 DAS	67.65	52.25
T_4- GA_3 50 ppm 80 DAS	68.05	56.02
T_5- MC 200 ppm 60 DAS	47.28	49.15
T_6- MC 200 ppm 80 DAS	57.03	42.00
T_7- Urea 2 % 60 DAS	53.35	47.48
T_8- Urea 2 % 80 DAS	53.94	47.62
T_9- Control (No Spray)	51.70	42.13
S.Em±	2.05	
C.D. at 5%	5.89	
C. V %	6.43	

Table 4.7: Effect of plant growth regulators on seed cotton yield (kg. / ha) of cotton.

Treatments	**Seed cotton yield (kg. / ha)**
Chemicals (C)	
T_1- NAA 30 ppm 60 DAS	1174.38
T_2- NAA 30 ppm 80 DAS	1213.27
T_3- GA_3 30 ppm 60 DAS	1110.19
T_4- GA_3 30 ppm 80 DAS	1148.77
T_5- MC 200 ppm 60 DAS	892.90
T_6- MC 200 ppm 80 DAS	916.98
T_7- Urea 2 % 60 DAS	933.64
T_8- Urea 2 % 80 DAS	940.34
T_9- Control	868.83
S.Em±	26.84
C.D. at 5%	77.15
Varieties (V)	
Bt. Cotton	1101.934
Non Bt. Cotton	942.352
S.Em±	12.65
C.D. at 5%	36.37
Interaction (C X V)	
S.Em±	37.96
C.D. at 5%	109.10
C. V %	6.43

Table 4.8: Interaction effect of plant growth regulators on seed cotton yield (kg. / ha) of cotton

	Seed cotton yield (kg. / ha)	
	Bt	**Non Bt**
T_1- NAA 30 ppm 60DAS	1231.48	1117.28
T_2-NAA 30 ppm 80 DAS	1296.91	1129.63
T_3- GA_3 50 ppm 60 DAS	1252.78	967.59
T_4- GA_3 50 ppm 80 DAS	1260.19	1037.35
T_5- MC 200 ppm 60 DAS	875.62	910.19
T_6- MC 200 ppm 80 DAS	1056.17	777.78
T_7- Urea 2 % 60 DAS	987.96	879.32
T_8- Urea 2 % 80 DAS	998.89	881.79
T_9- Control (No Spray)	957.41	780.25
S.Em±	37.96	
C.D. at 5%	109.10	
C. V %	6.43	

Table 4.9: Effect of plant growth regulators on biological yield (gm.) of cotton.

Treatments	**Biological yield (gm.)**
Chemicals (C)	
T_1- NAA 30 ppm 60 DAS	238.93
T_2- NAA 30 ppm 80 DAS	241.66
T_3- GA_3 30 ppm 60 DAS	229.45
T_4- GA_3 30 ppm 80 DAS	229.48
T_5- MC 200 ppm 60 DAS	216.42
T_6- MC 200 ppm 80 DAS	210.87
T_7- Urea 2 % 60 DAS	208.45
T_8- Urea 2 % 80 DAS	214.97
T_9- Control	213.12
S.Em±	1.503
C.D. at 5%	4.32
Varieties (V)	
Bt. Cotton	233.268
Non Bt. Cotton	211.92
S.Em±	0.709
C.D. at 5%	2.04
Interaction (C X V)	
S.Em±	2.126
C.D. at 5%	6.11
C. V %	1.65

Table 5: Interaction effect of plant growth regulators on biological yield (gm.) of cotton.

	Biological yield (gm.)	
	Bt	**Non Bt**
T_1- NAA 30 ppm 60DAS	241.49	236.37
T_2-NAA 30 ppm 80 DAS	249.96	233.35
T_3- GA_3 50 ppm 60 DAS	249.37	209.53
T_4- GA_3 50 ppm 80 DAS	245.96	213.00
T_5- MC 200 ppm 60 DAS	211.63	221.22
T_6- MC 200 ppm 80 DAS	234.86	186.87
T_7- Urea 2 % 60 DAS	217.90	199.00
T_8- Urea 2 % 80 DAS	223.91	206.02
T_9- Control (No Spray)	224.34	201.91
S.Em±	2.12	
C.D. at 5%	6.11	
C. V %	1.65	

Table 5.1: Effect of plant growth regulators on harvest index (%) of cotton.

Treatments	Harvest index (%)
Chemicals (C)	
T_1- NAA 30 ppm 60 DAS	36.01
T_2- NAA 30 ppm 80 DAS	37.10
T_3- GA_3 30 ppm 60 DAS	35.54
T_4- GA_3 30 ppm 80 DAS	36.77
T_5- MC 200 ppm 60 DAS	28.40
T_6- MC 200 ppm 80 DAS	30.77
T_7- Urea 2 % 60 DAS	32.00
T_8- Urea 2 % 80 DAS	31.43
T_9- Control	28.53
S.Em±	0.34
C.D. at 5%	0.98
Varieties (V)	
Bt. Cotton	33.996
Non Bt. Cotton	31.901
S.Em±	0.16
C.D. at 5%	0.46
Interaction (C X V)	
S.Em±	0.48
C.D. at 5%	1.38
C. V %	2.53

Table 5.2: Interaction effect of plant growth regulators on harvest index (%) of cotton.

	Harvest index (%)	
	Bt	**Non Bt**
T_1- NAA 30 ppm 60DAS	37.74	34.28
T_2-NAA 30 ppm 80 DAS	38.86	35.34
T_3- GA_3 50 ppm 60 DAS	37.08	33.99
T_4- GA_3 50 ppm 80 DAS	38.13	35.42
T_5- MC 200 ppm 60 DAS	28.00	28.79
T_6- MC 200 ppm 80 DAS	32.26	29.28
T_7- Urea 2 % 60 DAS	32.38	31.62
T_8- Urea 2 % 80 DAS	31.69	31.17
T_9- Control (No Spray)	29.83	27.22
S.Em±	0.48	
C.D. at 5%	1.38	
C. V %	2.53	

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