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Effect of Foliar Application of NAA, GA and Macronutrients on Growth And Development of Bt Cotton Hybrids

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ABSTRACT
Field experiments were conducted at Agricultural College Farm, Bapatla to find out the foliar application of growth regulators and macronutrients on growth and development of hybrid cotton varieties. some growth regulators (NAA, GA) and macronutrients in different concentrations and different stages of the were used. significance differences were observed in all the parameters studied during two years. The treatment KNO_3 2 % at all stages recorded significantly higher ,CGR, RGR and NAR as compared to other treatments. Yield in these treatments were also more because of the retention of more bolls and diversion of higher photosynthates to reproductive parts.
Key words : *Growth regulators, Macronutrients,foliar application,Growth, Yield. Bt Cotton Hybrids.*

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INTRODUCTION

Cotton regarded as the 'white gold' is an important commercial crop throughout the world. It is the chief source of raw material to the textile industry. The growth and yield of cotton is governed by the interaction of environment with the genetic makeup of the variety or hybrid, various inputs, such as water, fertilizer, pesticides etc. Among the various inputs, fertilizers play a major role in influencing the plant growth and development of cotton. Generally major nutrients viz., N, P and K are supplied to the crop through soil and foliar application and the micronutrients and growth promoting substances applied as foliar feeding. The yield of cotton is affected due to many reasons viz., flower and boll shedding due to imbalance in nutrients, hormones etc., Foliar fertilization can be used to improve the efficiency and rapidity of utilization of a nutrient urgently required by cotton crop for maximum growth and yield. However, foliar nutrition should only serve as a supplement to traditional soil applied fertilizer for a sufficient supply of nutrients to the developing cotton crop for optimum yields and fibre quality.

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. Exogenous application of plant growth regulators is a well recognized strategy to increase the yield, improve quality and alleviate stress-induced adverse effects on crop production Furthermore, there are some evidences that plant growth regulators can regulate the uptake and accumulation of mineral nutrients in plants.

One of the important physiological disorders which also reduce the seed cotton yield is boll shedding. To get maximum yield in cotton it is essential to retain more bolls per plant. Hence improved package of technologies are absolutely necessary to sustain cotton productivity of Bt cotton, which is occupied by 90% of area in India. To overcome yield barriers and to increase the productivity an attempt was made to study the present investigation on Influence of plant growth regulators and macro nutrients on growth parameters and quality of *Bt* cotton.

MATERIAL AND METHODS

Field experiment was conducted at Agricultural College Farm, Bapatla durig Kharif 2013-14 and 20114-15 to study the influence of plant growth regulator (NAA, GA) and foliar nutrition (Urea 2 %,DAP 2%, KNO3 2%) on Bt cotton for enhancing the productivity. The experiment was conducted in the field No. 23 of Northen block , Agricultural College Farm, Bapatla located 15° 54' N latitude and 80°30' E longitude at

an altitude of 5.49 meters above the mean sea level . The mean maximum and minimum temperature were 32.6 ^{0C} and 22.6 0C during 2013, and 28.7 0C and 23.3 0C during 2014, respectively, recorded during cropping period and relative humidity 84.6 per cent and 76.9 per cent, during 2013 and 2014, respectively. The soil of experimental site was clay loam in texture, slightly alkaline in reaction, medium in organic carbon, low in available nitrogen, medium in available phosphorus and high in available potassium. All the micronutrients were sufficient in the soil with values above their critical limits. The experiment was laid out in Split plot design with three replications. The treatments trial were plant growth regulator (NAA@ 30 ppm and GA @ 30 ppm) and foliar nutrition (Urea (2 %), DAP (2%), KNO3 (2 %) sprayed alone and combinations at peak squaring, peak flowering, peak boll formation and peak boll developmental stages. The seeds were sown adopting a spacing of 105 x 60 cm and recommended dose of N, P, and K 150-60-60 kg N, P2O5, K2O ha-1 was applied uniformly to all the plots. Full dose of P and K were applied as basal at the time of sowing. The N was applied in split application viz 50 % N at the time of sowing 25 % dose applied at earthing up and other 25 % dose at 45 days after sowing. Plant protection measures were taken as and when necessary. Observations on plant growth and yield factors and quality parameters were recorded. Soil and plant samples were analyzed as per the procedures.

RESULTS AND DISCUSSION

GROWTH PARAMETERS

The data on crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) recorded at different growth stages as influenced by foliar application of nutrients and growth regulators is presented in Table 1.

Spraying of plant nutrients and plant growth regulators significantly increased the crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) of two hybrids during both the years *i.e* 2013 and 2014. Among the tested cotton hybrids, Bhaskara recorded significantly higher crop growth rate (5.54, 5.48 g $m^{-2}day^{-1}$), higher relative growth rate (25.49, 24.08mg g-1 day^{-1}) and higher net assimilation rate (0.96, 0.91 mg cm^{-2} day^{-1}) compared to Bunny BGII hybrid crop growth rate (4.74, 4.74 g $m^{-2}day^{-1}$), relative growth rate (24.36, 23.71 g $m^{-2}day^{-1}$), relative growth rate (0.93, 0.87 mg cm^{-2} day^{-1}) in 2013 and 2014 respectively.

The data revealed that spraying of plant nutrients and growth hormones individually and in combinations recorded significantly higher crop growth rate compared to control. Crop growth rate did not vary significantly among the treatments of spraying of urea @ 2%, DAP @ 2%, KNO_3 @ 2% individually or in combination. However, KNO_3 @ 2% recorded higher crop growth rate (5.38 g $m^{-2}day^{-1}$, 5.28 g $m^{-2}day^{-1}$) in both years respectively.

Spraying of GA_3 @ 30ppm alone and in combination with urea @ 2%, DAP @ 2%, KNO_3 @ 2% and urea @ 2%+ DAP @ 2%+ KNO_3 @ 2% recorded significant variability with regard to mean relative growth rate in both the years. of spraying of urea @ 2%, DAP @ 2%, KNO_3 @ 2% individually or in combination. However, KNO_3 @ 2% recorded higher relative growth rate (26.27 mg $g^{-1}day^{-1}$, 25.35 mg $g^{-1}day^{-1}$) in both years respectively.

The data revealed that spraying of plant nutrients and growth hormones individually and in combinations recorded significantly higher net assimilation rate compared to control. NAR did not vary significantly among the treatments of spraying of urea @ 2%, DAP @ 2%, KNO_3 @ 2% individually or in combination. However, KNO_3 @ 2% recorded higher net assimilation rate (1.0 mg cm^{-2} day^{-1}, 0.94 mg cm^{-2} day^{-1}) in both years respectively.

The results of the present study in line with the Kiran Kumar, (2001) he concluded that significantly higher RGR was recorded in chamatkar (500 ppm) sprayed at 45 DAS followed by NAA (20 ppm) sprayed at 90 DAS . and also significantly higher NAR was found in NAA (20 ppm) sprayed at 90 DAS followed by chamatkar (1000 ppm) sprayed at 45 DAS as compared to control.

Table 1: Growth parameters of Bt cotton as influenced by foliar application of plant growth regulators and nutrients

Treatments	Crop Growth Rate (g $m^{-2}day^{-1}$)						Relative Growth Rate (mg g-1 day^{-1})						Net Assimilation Rate (mg cm^{-2} day^{-1})					
	2013			2014			2013			2014			2013			2014		
	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
T0 (Conrol)	4.84	4.05	4.44	4.79	4.06	4.43	24.79	23.38	24.09	23.38	22.77	23.07	0.95	0.88	0.91	0.89	0.82	0.86
T1(urea@2%)	5.58	4.74	5.16	5.62	4.77	5.20	26.97	24.96	25.97	25.67	24.44	25.06	0.99	0.96	0.97	0.97	0.89	0.93
T2(DAP@2%)	5.66	4.77	5.22	5.64	4.79	5.21	26.59	24.52	25.55	25.07	23.89	24.48	0.99	0.94	0.96	0.94	0.88	0.91
T3(KNO3@2%)	5.78	4.78	**5.38**	5.77	4.79	**5.28**	27.34	24.80	**26.27**	25.89	24.21	**25.35**	1.04	0.96	**1.00**	0.99	0.90	**0.94**
T4(U+D+K)	5.70	4.82	5.26	5.75	4.81	5.28	27.21	25.30	**26.25**	26.04	24.60	**25.32**	1.01	0.98	**0.99**	0.99	0.90	**0.94**
T5(NAA@30ppm)	5.66	4.85	5.25	5.69	4.60	5.15	26.74	25.57	26.15	25.56	23.87	24.71	1.00	0.96	0.98	0.95	0.85	0.90
T6(T1+T5)	5.67	4.85	5.26	5.60	4.87	5.24	26.04	24.50	25.27	24.63	24.01	24.32	0.95	0.93	0.94	0.92	0.87	0.90
T7(T2+T5)	5.43	4.87	5.15	5.30	4.91	5.10	23.95	24.51	24.23	22.31	24.11	23.21	0.90	0.93	0.92	0.86	0.89	0.87
T8(T3+T5)	5.57	4.97	5.27	5.54	4.96	5.25	25.06	25.10	25.08	24.00	24.43	24.21	0.93	0.97	0.95	0.90	0.90	0.90
T9(T4+T5)	5.77	4.82	**5.30**	5.64	4.87	**5.26**	26.54	24.43	**25.48**	24.68	24.04	24.36	0.96	0.93	0.95	0.91	0.87	0.89
T10(GA@30ppm)	5.35	4.62	4.98	5.33	4.63	4.98	24.17	24.15	24.16	23.01	23.56	23.29	0.93	0.91	0.92	0.89	0.84	0.86
T11(t1+t10)	5.59	4.83	5.21	5.50	4.85	5.18	24.83	23.53	24.18	23.40	23.12	23.26	0.93	0.92	0.92	0.89	0.86	0.87
T12(T2+T10)	5.46	4.80	5.13	5.41	4.73	5.07	23.66	23.86	23.76	22.39	22.88	22.64	0.91	0.91	0.91	0.87	0.84	0.86
T13(T3+T10)	5.42	4.62	5.02	5.29	4.67	4.98	23.82	23.25	23.54	22.17	22.71	22.44	0.90	0.89	0.90	0.86	0.84	0.85
T14(T4+T10)	5.58	4.79	5.18	5.48	4.81	5.14	24.59	23.53	24.06	23.04	23.09	23.07	0.93	0.91	0.92	0.88	0.85	0.87
Mean	5.53	4.74		5.49	4.74		25.49	24.36		24.08	23.71		0.96	0.93		0.91	0.87	
	2013			**2014**			2013			**2014**			2013			**2014**		
	Sem±	CD (P=0.05)	CV (%)	Sem±	CD (P=0.05)	CV (%)	Sem±	CD (P=0.05)	CV (%)	Sem±	CD (P=0.05)	CV (%)	Sem±	CD (P=0.05)	CV (%)	Sem±	CD (P=0.05)	CV (%)
Varieties (V)	0.03	0.17	3.54	0.07	0.44	9.54	0.38	2.32	10.24	0.14	0.87	4.00	0.011	0.065	7.550	0.006	0.039	4.872
Spraying of growth regulators and nutrients (T)	0.11	0.30	5.01	0.12	0.33	5.57	0.36	1.02	3.55	0.20	0.55	2.01	0.009	0.025	2.265	0.023	0.064	6.196
T at the same V	0.15	0.42		0.16	0.47		0.51	1.45		0.28	0.78		0.012	0.035		0.032	0.090	
V at the same or different T	0.15	0.43		0.17	0.59		0.62	2.52		0.30	1.08		0.016	0.068		0.031	0.093	

YIELD AND YIELD COMPONENTS:

The data on number of bolls dropped per plant, number of squares dropped per plant and yield (kg/ha), are presented in Table 2. There was significant difference between treatments at yield and yield components.

Results indicated that PGRs and macro nutrient sprays significantly decreased boll drop in *Bt* cotton hybrids and treated plots compared with the untreated cotton plots in both the years. Results of the study revealed that the cotton hybrids showed insignificant variability with regard to number of bolls dropped plant^{-1} in both the years of the study.

Spraying of GA_3 @ 30ppm in combination with DAP @ 2% (T_{12}) recorded significantly reduced boll drop plant^{-1} (1.10) followed by T_{12} (1.17) treatment in 2013, where as in 2014 Spraying of GA_3 @ 30ppm in combination with urea @ 2% + DAP @ 2%, +KNO_3 @ 2% (T_{13}) recorded lower boll drop compared to remaining treatments. Higher square drop was observed in control in both the years of study.

Spraying of GA_3 @ 30ppm in combination with urea @ 2% + DAP @ 2%, +KNO_3 @ 2% (T_{13}) recorded significantly reduced square drop plant^{-1} (2.50) followed by T_{12} (2.70) treatment in 2013, where as in 2014 Spraying of GA_3 @ 30ppm in combination with DAP @ 2% (T_{12}) recorded lower square drop compared to remaining treatments. Higher square drop was observed in control in both the years of study.

In this study reduced the boll drop and square drop due to application of nutrients and growth regulators is in agreement with **Khader and Prakash (2007**) they stated that foliar application of naphthalene acetic acid (20ppm) , 1% of diammonium phosphate (alternately) reduced the buds and bolls shed (16) leaf reddining in cotton crop (MCU-5) and increased the seed cotton yield (1970 kg/ha) significantly compared to control (24 and 1507 kg ha^{-1} respectively). The results also in agreement with the findings **Patel (1993).**

The mean seed cotton yield was significantly higher in bhaskara hybrid compared to Bunny BG II. Bhaskara hybrid recorded 25.06 % and 20.80 % higher mean seed cotton yield compared to Bunny BG II in both the years respectively. This might be due to Bhaskara hybrid recorded more sympodial branches, more leaf area, drymatter production, total chlorophyll and more number of bolls and boll weight compared to Bunny BG II. Spraying of GA @30ppm alone and in combination with urea @2%, DAP@2%, KNO_3@2% and urea @2%+ DAP@2%+ KNO_3@2% recorded significant variability with regard to mean seed cotton yield in both the years. Spraying of GA@30ppm in combination with KNO_3 @ 2 % recorded highest mean seed cotton yield of 2470 kg ha^{-1} in 2013 and 2916.7 kg ha^{-1} in 2014 compared to all other treatments. The increase in seed cotton yield was due to increased plant height and LAI and resulted in increase in photosynthetic activity and plant DMP.These results are in conformity with the report of Rajendran *et al.* (2010) in cotton crop.

The results also agree with the **Norton *et al*. (2005)** they studied that the effect of growth regulators which resulted in higher fruit load on cotton crop, which contributed to high yield, high fruit fiber and lint yield.

Table 2: Yield parameters of Bt cotton as influenced by foliar application of plant growth regulators and nutrients

Treatments	No of squares dropped/ plant						No of bolls dropped / plant						Seed Cotton Yield (kg ha^{-1})					
	2013			2014			2013						2013			2014		
	V1	V2	Mean		V1	V2	Mean		V1	V2	Mean		V1	V2	Mean		V1	V2
T0 (control)	7.13	8.00	7.57	8.20	7.53	7.87	5.60	5.60	5.60	6.33	5.73	6.03	2109.50	1666.20	1887.85	2548.30	2096.00	2322.15
T1(urea@2%)	5.07	6.00	5.53	5.47	4.87	5.17	4.13	4.20	4.17	3.80	4.07	3.93	2254.00	1831.00	2042.50	2670.20	2255.10	2462.65
T2(DAP@2%)	5.13	5.13	5.13	5.20	4.27	4.73	3.87	4.13	4.00	3.47	3.60	3.53	2297.00	1999.00	2148.00	2693.60	2232.00	2462.80
T3(KNO3@2%)	4.67	5.00	4.83	4.53	4.60	4.57	2.60	3.00	2.80	3.00	2.73	2.87	2208.00	1915.90	2061.95	2596.90	2298.50	2447.70
T4(U+D+K)	4.60	4.47	4.53	4.47	4.20	4.33	3.80	3.53	3.67	3.07	3.00	3.03	2273.10	1786.10	2029.60	2792.40	2312.40	2552.40
T5(NAA@30ppm)	5.00	4.73	4.87	4.80	5.00	4.90	2.53	2.53	2.53	2.47	2.33	2.40	2306.90	1817.40	2062.15	2895.70	2254.20	2574.95
T6(T1+T5)	4.13	4.00	4.07	4.20	4.27	4.23	2.33	2.40	2.37	2.27	2.20	2.23	2414.00	1984.60	2199.30	2930.70	2543.00	2736.85
T7(T2+T5)	4.13	4.20	4.17	4.67	4.13	4.40	2.00	2.00	2.00	2.13	1.80	1.97	2499.20	2007.00	2253.10	2996.63	2580.30	2788.47
T8(T3+T5)	4.00	3.47	3.73	4.00	4.00	4.00	1.87	2.00	1.93	1.60	1.53	1.57	2481.10	1941.00	2211.05	2995.30	2499.40	2747.35
T9(T4+T5)	3.27	3.33	3.30	4.00	3.53	3.77	1.67	1.60	1.63	1.40	1.40	1.40	2554.00	1991.10	2272.55	3074.60	2523.00	2798.80
T10(GA@30ppm)	3.27	4.27	3.77	3.27	3.53	3.40	2.13	2.27	2.20	2.00	2.20	2.10	2384.60	1886.00	2135.30	2908.50	2265.20	2586.85
T11(t1+t10)	3.07	3.40	3.23	3.13	3.00	3.07	1.67	1.47	1.57	1.47	1.40	1.43	2622.50	2094.30	2358.40	3106.90	2590.00	2848.45
T12(T2+T10)	2.60	2.80	2.70	2.87	2.13	2.50	1.00	1.20	1.10	1.13	1.13	1.13	2788.80	2119.00	2453.90	3184.30	2550.00	2867.15
T13(T3+T10)	2.87	3.00	2.93	2.87	3.27	3.07	1.33	1.00	1.17	1.33	1.20	1.27	2702.00	2239.47	2470.73	3222.50	2610.90	2916.70
T14(T4+T10)	2.47	2.53	2.50	3.00	2.40	2.70	1.20	1.27	1.23	1.00	1.20	1.10	2666.40	2155.40	2410.90	3163.57	2630.30	2896.93
Mean	4.09	4.29	4.19	4.31	4.05	4.18	2.52	2.55	2.53	2.43	2.37	2.40	2437.41	1948.90	2193.1522	2918.67	2416.02	2667.35
	2013	2014	2013	2014	2013	2014												
	Sem			CD			CV			Sem			CD			CV		
Varieties (V)	0.036	0.22	5.76	0.047	0.29	7.52	0.049	0.30	12.93	0.046	0.28	12.94	46.431	282.53	14.20	53.543	325.80	13.47
Spraying of growth regulators and nutrients (T)	0.105	0.30	6.08	0.077	0.22	4.54	0.106	0.30	10.22	0.091	0.26	9.26	72.356	204.98	8.08	81.164	229.94	7.45
T at the same V	0.148	0.42		0.110	0.31		0.149	0.42		0.128	0.36		102.326	289.89		114.783	325.18	
V at the same or different T	0.148	0.45		0.116	0.39		0.152	0.48		0.132	0.43		109.217	373.60		123.141	424.56	
T0 (control)	7.13	8.00	7.57	8.20	7.53	7.87	5.60	5.60	5.60	6.33	5.73	6.03	2109.50	1666.20	1887.85	2548.30	2096.00	2322.15

CONCLUSIONS

In terms of genotypic performance Bhaskara hybrid showed better performance compared to Bunny BG II. Growth parameters like CGR, RGR and NAR differed significantly among the treatments.. The results indicated that the growth characteristics like CGR, RGR and NAR increased with the spray of GA3 and NAA combined with macro nutrients (Urea, DAP, KNO_3) due to increment in the leaf area and total dry matter production.

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