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Exogenous application of Biostimulant augments on growth and yield of cotton genotypes

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Abstract : A field experiment was conducted during *kharif*, 2021 to study the effect of biostimulant on growth and development of *Bt* cotton at Cotton Research Area, CCS Haryana Agriculture University Hisar. The experiment was carried in factorial randomized block design (FRBD) with three replications. The treatments comprised of two cotton genotypes RCH 776 (*Bt*) and H 1098i (Non *Bt*) as one factor and four sprays of biostimulants *i.e.*, B_1: Biostimulant at 30,45 and 60 DAS, B_2: Biostimulant at 45,60 and 75 DAS, B_3: DMSO* spray 30,45,60 and 75 DAS and B_4: Control water spray-30,45,60 and 75 DAS as second factor. Cotton variety RCH 776 recorded significantly higher plant height as compared to H 1098i while plant height at harvest was not influenced due to spray of biostimulant and DMSO. The monopodia, sympodia and days to 50 per cent boll bursting were statistically *at par* with in all the treatments. Boll weight in RCH 776 was higher as compared to H 1098i whereas boll weight was not significantly affected by spray of biostimulant. Significantly higher bolls/plant and seed cotton yield was recorded with spray of Biostimulant B_2 (Bio stimulant at 45, 60 and 75 DAS) and B_1 (Biostimulant at 30, 45 and 60 DAS) as compared to rest of the treatments.

Keywords: Biostimulant, *Bt* cotton, seed cotton yield

Cotton (*Gossypium* spp) a natural fiber plant, produces excellent unicellular fiber comprised of a secondary cellulose wall, is a prominent cash crop that is grown commercially for agricultural and industrial purposes in more than 80 countries around the world with a major contribution from India (337.23 lakh bales of 170 kg).Cotton lint is woven into fabrics either alone or combined with other fibers. The seeds contain good percentage of edible oil and residual cake is rich in proteins and used as cattle feed. Cotton production, processing and trade provide livelihood and employment to millions of people. India is the only country in the world that can grow all four species of cotton under a diversity of agro-climatic conditions. India ranks first in terms of area among all cotton producing countries 12.96 million hectares.

Cotton area, production and productivity in Haryana are 7.37 lakh hectares, 25lakh bales and 576.66 kg/ha, respectively. Biotic and abiotic stress during cropping season are basically responsible for low productivity of cotton in Haryana and in India as a whole.

Biostimulants are natural or synthetic substances that can be applied to seeds, plants, and soil. These substances cause changes in vital and structural processes to influence plant growth through improved tolerance to abiotic stresses and increase seed and/or grain yield and quality. Biostimulants contain a variety of bioactive compounds that help to improve a variety of physiological processes, allowing for optimal growth and development of crop plants with efficient nutrient utilisation, reducing the use of inorganic fertilisers while maintaining crop quality and yield (Bulgari *et al.*, 2015). Biostimulants also play an important role in the care of plants, increasing their resistance to external influences because of global warming, environmental changes, sudden warming, low rainfall, drought, early spring or autumn, cool and cool weather. Application of biostimulants in cotton (*Gossypium hirsutum* L.) helps to balance vegetative and reproductive growth as well as boost seed yield and fiber quality.

Biostimulants includes a diverse collection of compounds, substances and microorganisms that are applied to plants to improve the crop yield, quality, and tolerance to biotic and abiotic stress.. Breaking dormancy, stimulating plant growth and development, increasing fruit size, promoting the root system and increasing the activities of photosynthetic and other vegetative tissues are all possible benefits of bio stimulants (Du Jardin, 2015) Field study was conducted to assess the role of bio-stimulant in the resource utilization efficiency of cotton cultivars at Cotton Research Area, CCS Haryana Agricultural University Hisar, during *kharif*, 2021.

Site description and experimental setup

The experiment was carried out at cotton research area of CCS HAU, Hisar during *kharif* 2021. It is situated in the sub tropics at longitude 75°46'E, latitude 29°10'N and altitude of 215.2 m above mean sea level in Haryana. The experimental design used was factorial randomized block design having two factors with different levels replicated thrice. Gross plot size was 7.0 x 9.0 m. Soil was sandy loam in texture (73.8% sand, 15.9% silt and 10.3% clay) with pH 7.9, low in soil organic carbon (SOC) (0.23%), low in available nitrogen (122 kg/ha), medium in available phosphorus (P) (14.8 kg/ha), available potassium (K) (256 kg/ha). The DTPA-extractable zinc (Zn) was 1.66 mg/kg.

Treatment details and crop management

The treatments comprised of two cotton genotypes RCH 776 (*Bt*) and H 1098i (Non *Bt*) as one factor and four sprays of bio stimulants *i.e.*, B_1: Biostimulant at 30,45 and 60 DAS, B_2: Biostimulant at 45,60 and 75 DAS, B_3: DMSO spray 30,45,60 and 75 DAS and B_4: Control water spray-30,45,60 and 75 DAS as second factor as factorial randomised block design was used to set up the experiment Cotton variety RCH 776 recorded significantly higher plant height as compared to H 1098i while plant height at harvest was not influenced due to spray of biostimulant and DMSO. All the treatments replicated three times. Pre sowing irrigation was given. At proper moisture condition, Seed bed was prepared by a primary harrowing tillage operation with tractor drawn disc harrow followed by cultivator and planking. Sowing was done by dibbling method on well prepared bed with row to row spacing of 100 cm and plant to plant spacing of 45cm. Thinning was done to keep the good crop stand. Recommended dose of fertilizer for *Bt* cotton was 175:60:60 kg/ha and 90:60:0 kg/ha for cotton variety H 1098i applied in the field. One third quantity of nitrogen, full amount of phosphorus and potassium is supplied through urea, DAP and murate of potash, respectively at the time of sowing. Remaining 2/3 quantity of nitrogen was top dressed in two equal splits: at first and second irrigation.

Biometric observations

Plants in each plot were selected randomly as true representative of the whole plot and labelled. The height of five tagged plants was measured periodically from each plot. Two plants were uprooted at ground level from each plot to measure the dry matter accumulation. The samples were first dried under sun and then in an oven at a temperature of 70°C till constant weight were obtained. For leaf area index, leaves of these plants were used for the measurement of leaf area by using LI-3000 Leaf Area Meter, LICOR Ltd., Nebraska, USA.

$$\text{LAI} = \frac{\text{Leaf area}}{\text{Ground area}}$$

Bolls/plant were counted from five tagged plants in each plot by adding the mean number of good and fully opened bolls picked/plant. Five completely opened bolls from tagged plants/plot were picked randomly, weighed and averaged to obtain boll weight (in grams). Monopodial branches in each plot were counted at maturity stage from the five tagged plants and mean was determined and expressed/plant basis. The sympodial branches are known as the reproductive branches and were counted at maturity stage from the five tagged plants in each plot and expressed as average sympodial branches/plant. After ginning weight of 100 cotton seeds taken randomly from each plot and it was expressed in grams. Total seed cotton harvested from two pickings/plot was registered and expressed as seed cotton yield in kg/ha.

Statistical analysis

The experimental data recorded for growth, yield and quality characters were subjected to statistical analysis in accordance with the help of "Analysis of Variance" Technique. The critical difference (CD) for the treatment comparisons were worked out wherever the variance ratio (t- test) was found significant at 5 per cent level of probability. The significance of treatment effects was tested with the help of "F" (variance ratio) test. Appropriate standard errors (SE) along with critical differences (CD at 5%) were worked out for differentiating the treatment effects from those of change effects.

$$CD = \sqrt{\frac{2\ \text{Error Variance}}{}} \times \text{t-value for error d.f. at 5 per cent level of significance}$$

Where,

CD = is the critical difference.

n = is number of observations of that factor for which CD is to be calculated.

t at 5 per cent = is the value of percentage point of 't' distribution for error degree of freedom at 5 per cent of significance.

Growth characters:

Growth characters which include plant height, dry matter accumulation and leaf area index at harvest are genetically controlled parameter. The result showed that *Bt* hybrid (RCH 776) produced significantly taller plants, more dry matter accumulation and lower leaf area index as compared to cotton variety (H 1098i). Significantly higher growth of *Bt* genotypes than non *Bt* cotton varieties as observed by Ali *et al.*, (2012) is in accordance with the present findings. It was recorded that foliar application of biostimulants had no significant effect on plant growth parameters, however plant height numerically reduced due to application of bio-stimulants when compared with control. Similar findings were observed by Veeraputhiran and Thiruvarasan (2021), Priyanka *et al.*, (2022). Alexander *et al.*, (2001) found that height to node ratio, mainstream nodes and node above white flower was reduced by the application of bio-stimulants and this could be the reasons for reduced plant height. Similar effect of reduction in plant height and decreased shoot length was also realized by Steve *et al.*, (2003) and Xiaming *et al.*, (2013). Application of biostimulants had no significant impact on the number of monopodial branches. Similar results were reported by Aksona and Aydin, 2019. Interaction of biostimulants with genotypes showed no significant difference on plant height, number of monopodia and sympodia (Table 1). However, application of water spray on *Bt* genotypes produced the taller plant (209 cm). Lowest monopodia (2.83) reported in *Bt* genotypes with biostimulant sprayed at 45, 60 and 75 DAS. Application of DMSO on *Bt* genotype recorded highest sympodia (18.13).

Yield and yield attributes

Significantly higher bolls/plant, boll

Table 1. Effect of cotton genotypes and foliar application of Biostimulant on plant height, monopodia and sympodia

Treatments	Plant height (cm)					Number of monopodia					Number of sympodia				
	B_1 (Biostim-ulant at 30,45 and 60 DAS)	**B_2** (Biostim-ulant at 45,60 and 75 DAS)	**B_3** (DMSO* spray 30, 45,60 and 75 DAS)	**B_4** (Controlwater spray- 30, 45, 60 and 75 DAS)	**Mean (Biostim-ulant)**	**B_1** (Biostim-ulant at 30,45 and 60 DAS)	**B_2** (Biostim-ulant at 45,60 and 75 DAS)	**B_3** (DMSO* spray 30, 45, 60 and 75 DAS)	**B_4** (Controlwater spray-30, 45, 60 and 75 DAS)	**Mean (Biostim-ulant)**	**B_1** (Biostim-ulant at 30,45 and 60 DAS)	**B_2** (Biostim-ulant at 45,60 and 75 DAS)	**B_3** (DMSO* spray 30, 45, 60 and 75 DAS)	**B_4** (Controlwater spray-30, 45, 60 and 75 DAS)	**Mean (Biostim ulant)**
Bt Hybrid RCH 776	195	197	197	209	**205**	3.08	2.83	3.08	3.33	**3.08**	17.17	17.75	18.13	17.6	**18.23**
H 1098i	166	174	172	167	**172**	3	3.08	3.17	3.5	**3.18**	17.58	17.34	17.13	17.62	**18.02**
Mean (Genotype)	**181**	**186**	**184**	**188**		**3.04**	**2.96**	**3.13**	**3.42**		**17.38**	**17.55**	**17.63**	**17.61**	
CD (P = 0.05)															
Genotype			14.17					NS					NS		
Bio stimulants			NS					NS					NS		
BXG			NS					NS					NS		

Table 2. Effect of cotton genotypes and foliar application of Biostimulant on dry matter accumulation and leaf area index

Treatments	Dry matter accumulation (g/plant)	Leaf Area Index (LAI)
Genotypes		
G_1 (RCH 776)	382.46	1.58
G_2 (H 1098i)	364.80	3.09
CD (P=0.05)	NS	0.62
Biostimulant		
B_1 (Biostimulant at 30, 45 and 60 DAS)	348.26	2.20
B_2 (Biostimulant at 45, 60 and 75 DAS)	378.68	2.41
B_3 (DMSO* spray 30, 45, 60 and 75 DAS)	366.14	2.30
B_4 (Control water spray-30, 45, 60 and 75 DAS)	401.46	2.42
CD (P = 0.05)	NS	NS

Table 3. Effect of cotton genotypes and foliar application of Biostimulant on bolls/plant and seed index

Treatments	Bolls/plant	Seed index (g)
Genotypes		
G_1 (RCH 776)	45.65	9.19
G_2 (H 1098i)	28.74	6.67
CD (P = 0.05)	5.09	0.45
Biostimulant		
B_1 (Biostimulant at 30, 45 and 60 DAS)	38.26	7.68
B_2 (Biostimulant at 45, 60 and 75 DAS)	39.40	7.87
B_3 (DMSO* spray 30, 45, 60 and 75 DAS)	36.44	8.13
B_4 (Control water spray-30, 45, 60 and 75 DAS)	34.67	8.03
CD (P = 0.05)	1.53	NS

weight and seed cotton yield (19-16% higher) were recorded with foliar application of Biostimulant at 45, 60 and 75 DAS or at 30, 45 and 60 DAS, respectively. Foliar application of biostimulants could result an increased flowers and boll formation, due to increased photosynthetic activity (Sawan *et al.*, 2006). In case of cotton genotypes RCH 776 recorded higher bolls/plant as compared to H 1098i. It might be due to difference in genetic potential of the genotype. Similar results were observed. Such enhancements in productivity are associated with higher bolls, regulation in source sink association and postponed the senescence. Foliar spray of biostimulant was used to regulate the vegetative and reproductive growth and sustaining internal hormonal balance, effective sink source relationship, which improved yield contributing parameters depending on the enhanced photosynthetic activity (Sawan *et al.*, 2006; Gwathmey and Clement, 2010). Foliar application of biostimulant three times (either at 30,45 and 60 or at 45,60 and 75 DAS) augments seed cotton yield of cotton genotypes over control. The results showed no significant difference of Interaction of biostimulants with genotypes on boll weight and seed cotton yield (Table 4). However, highest boll weight recorded in *Bt* genotype treated with biostimulant at 30, 45 and 60 DAS (4.37 g) followed by biostimulant at 45, 60 and 75 DAS (4.35 g). Maximum (2008 kg/ha) and minimum (1350 kg/ha) seed cotton yield obtained with *Bt* genotype treated with bio stimulant at 45, 60 and 75 DAS and non *Bt* genotype treated with DMSO spray at 30, 45, 60 and 75 DAS, respectively.

Table 4. Effect of cotton genotypes and foliar application of Biostimulant on Boll weight and seed cotton yield

Treatments	Boll weight (g)					Seed cotton yield (kg/ha^{-1})				
	B_1 (Biostimulant at 30,45 and 60 DAS)	**B_2** (Biostimulant at 45,60 and 75 DAS)	**B_3** (DMSO* spray 30,45,60 and 75 DAS)	**B_4** (Controlwater spray-30,45,60 and 75 DAS)	**Mean (Biostimulant) at 30,45 and 60 DAS)**	**B^1** (Biostimulant at 45,60 and 75 DAS)	**B^2** (Biostimulant spray 30,45,60 and 75 DAS)	**B^3** (DMSO* spray-30,45,60 and 75 DAS)	**B_4** (Controlwater	**Mean (Biostimulant)**
Bt Hybrid RCH 776	4.37	4.35	4.16	4.17	4.26	1959	2008	1531	1613	1778
H 1098i	3.05	3.14	3.05	3.21	3.18	1564	1630	1350	1482	1506
Mean (Genotype)	**3.71**	**3.75**	**3.61**	**3.69**		**1761**	**1819**	**1440**	**1547**	

CD (P=0.05)	Boll weight (g)	Seed cotton yield (kg/ha^{-1})
Genotype	0.24	NS
Bio stimulants	NS	265
BXG	NS	NS

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