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Effect of Biostimulants on Yield and Quality Parameters of Irrigated Transgenic Cotton (Gossypium Hirsutum L.)

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Abstract: *A field investigation was carried out during kharif season of 2013-2014 to study the effect of biostimulants such as microbial consortia, L-aminoacid complex and chitin in different combinations on yield and quality parameters of transgenic cotton. The experiment was laid out in randomized block design with five treatments and four replications. The highest seed cotton yield of 3968 kg ha^{-1} was recorded by the application of microbial consortia, L-aminoacid complex and chitin as soil drenching with activation and foliar sprays without activation. Quality parameters like seed index, ginning percentage, 2.5% span length, uniformity ratio, micronaire value and fibre elongation percent were not highly influenced by different treatments whereas lint index was significantly increased by application of biostimulants in different combinations.*

Key words: *Transgenic cotton, yield, fibre quality parameters, biostimulants*

INTRODUCTION

India is historically considered as the native home of cotton and center of finest textile industry in the world. About 60 million people in India are involved in cotton cultivation, textile industry and trade. Cotton 'the king of apparel fibres' is an important cash crop and supplies a major share of raw material for the textile industry. India is one of the largest producers as well as exporters of cotton yarn. During 2012-13, India had about 11.77 million hectares under cotton cultivation and produced 34 million bales of cotton, making it the second largest producer of cotton worldwide. The states of Gujarat, Maharashtra, Andhra Pradesh, Haryana, Punjab, Madhya Pradesh, Rajasthan, Karnataka and Tamil Nadu are the major cotton producers in India. India accounted for about 4.72 per cent of global textiles and clothing trade in 2013 (CCS, 2014).

The nutrient management in cotton is a complex phenomenon due to its simultaneous production of vegetative and reproductive structures during the active growth phase. Cotton requires sufficient quantity of macro and micro nutrients to achieve the maximum seed cotton yield. Nutrients deficiency in cotton increases abscission of boll and finally affects the yield of cotton and are directly related to physiological processes in plant and help in increasing the production by improving the reproduction phase (Dubey *et al*., 2000).

Agricultural biostimulants include diverse formulations of compounds, substances and other products that are applied to plants or soils to regulate and enhance the crop physiological processes, thus making them more efficient. Biostimulants act on plant physiology through different pathways to improve crop vigour, yields and quality and post-harvest shelf life/conservation (Calvo *et al*., 2014). In this direction, a detailed research on combined effect of fertilizers with microbial consortia, L-aminoacid complex and chitin was conducted to study its effect on yield and quality of irrigated transgenic cotton (*Gossypium hirsutum* L.).

MATERIALS AND METHODS

The field experiment for cotton (Transgenic cotton Jackspot BG II) was conducted at farmers holding in Dasampalayam, Annur block, Coimbatore district, Tamil Nadu during August 2013 to February 2014 with five treatments and four replications. The treatment details are presented in table 1. Among the treatments HYT indicates high yield technology and HYT A, HYT B and HYT C represents microbial

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Table 1
Details of treatments

	Treatments	*Method of application*
T_1	HYT A @ one lit ha^{-1} + Activator (molasses) @ two lit ha^{-1} (Ready for application only after 12hrs. activation)	Soil drenching in the stem base on 7-15 days after sowing
	HYT B @ one lit ha^{-1}	Foliar spray on 30-35 & 60-65 days after sowing
T_2	HYT A @ one lit ha^{-1} + HYT B @ two lit ha^{-1} (Ready for application only after 72hrs. activation)	Soil drenching in the stem base on 7-15 days after sowing
	HYT B @ 1lit ha^{-1}	Foliar spray on 30-35 & 60-65 days after sowing
T_3	HYT A @ one lit ha^{-1} + HYT B @ one lit ha^{-1} + HYT C @ one kg ha^{-1} (without activation)	Soil drenching in the stem base on 7-15 days after sowing and foliar spray on 30-35 & 60-65 days after sowing
T_4	HYT A @ one lit ha^{-1} + HYT B @ one lit ha^{-1} + Chitin @ one kg ha^{-1} (Ready for application only after 72hrs. activation)	Soil drenching in the stem base on 7-15 days after sowing
	HYT A @ one lit ha^{-1} + HYT B @ one lit ha^{-1} + HYT C @ one kg ha^{-1}	Foliar spray on 30-35 & 60-65 days after sowing
T_5	Standard Check	

*In all the above treatments STCR based fertilizer recommendation was followed

consortia, L-aminoacid complex and micronized chitin respectively. The design adopted was randomized block design (RBD). The soil type of the experimental field belongs to periyanaikenpalayam series (Vertic Ustropept). The experiment was laid out in 0.27 acre area. The topography of experimental field was fairly uniform, ploughed well, leveled and ridges and furrows were formed at a distance of 120 cm. The field was divided in to plots of 7.8 x 6 m^2. The soil samples were taken at random all over the experimental area. A composite sample of about 1 kg from gross samples were prepared and analysed for various physico-chemical properties. The analysed data are presented in Table 2. The soil of experimental plot was non-saline and slightly alkaline in reaction. The initial soil fertility status showed medium organic carbon and available phosphorus, low available nitrogen and very high available potash. The micronutrients (Fe, Mn, Zn and Cu) were sufficient. Based on soil test values, the fertilizer doses were calculated for macronutrients using Soil Test Crop Response (STCR) equation. The calculated fertilizer dose is 200:75: 37.5 kg of N, P_2O_5 and K_2O per ha.

Table 2
Physico- chemical properties of the soil experimental site

S.No.	*Particulras*	
1.	Texture	Clay loam
2.	Soil reaction (pH)	8.41
3.	Electrical conductivity (dSm^{-1})	0.10
4.	Organic carbon (%)	0.42
5.	Available nitrogen (kg ha^{-1})	151
6.	Available phosphorus (kg ha^{-1})	16.0
7.	Available potassium (kg ha^{-1})	908
8.	Exchangeable Ca (mg kg^{-1})	40.8
9.	Exchangeable Mg (mg kg^{-1})	15.24
10.	Available S (mg kg^{-1})	59.05
11.	DTPA-Fe (mg kg^{-1})	6.035
12.	DTPA- Mn (mg kg^{-1})	19.21
13.	DTPA-Zn (mg kg^{-1})	1.196
14.	DTPA-Cu (mg kg^{-1})	1.387

Seed cotton yield

Five pickings were done, seed cotton yield per plot was recorded and expressed in kg ha^{-1}

Quality parameters

For quality parameter estimation, the seed cotton samples from five plants from each replication were pooled, ginned and the seeds were acid delinted and the lint index, seed index and ginning percentage was calculated. The lint obtained was assessed for the following fibre quality traits *viz*., 2.5% span length, uniformity ratio, bundle strength, micronarie value and elongation percentage. These traits were estimated by High Volume Instrument 900 classic installed at Cotton Breeding Station, Tamil Nadu Agricultural University, Coimbatore.

RESULTS

Seed cotton yield

The application of different treatments significantly influenced the seed cotton yield. Wide variation from 3310 to 3968 kg ha^{-1} was noticed. In the treatments, the highest seed cotton yield (3968 kg ha^{-1}) was obtained with soil application of HYT A+ HYT B + HYT C as drenching with activation and foliar spray

without activation, followed by application of HYT A+ HYT B + HYT C as soil drenching and foliar spray without activation (3890 kg ha^{-1}), while the control recorded the lowest yield of 3310 kg ha^{-1}.

Quality parameters By the year 2050, the global demand for fibre will increase to the tune of four to five fold. These demands will also largely be for better fibre quality viz., stable length, strength and maturity. Advanced spinning technologies and related improvements in textile processing led to increased demand for high strength cotton fibre (Elangovan and Chandrasekaran, 2014). In present study, the results of the statistically analysed data were discussed here under.

Seed index

The variation in seed index values among different treatments failed to attain statistical significance. However, it ranges from 10.7 (Standard check) to 11 (soil application of HYT A+ HYT B + HYT C as drenching with activation and foliar spray without activation).

Lint index

The application of different combinations of microbial consortia, aminoacids and chitin significantly altered the lint index of cotton (Table 3). Amongst the application of HYT A + HYT B + HYT C as soil drenching with activation and foliar spray without activation registered the highest lint index (6.9 g), while the lowest index was registered in standard check (5.6 g).

Ginning percentage

The ginning percentage values in different treatments did not differ significantly. It varied between 32.5 (standard check) to 34.1 ((soil application of HYT A+ HYT B + HYT C as drenching with activation and foliar spray without activation).

2.5 per cent span length

The different treatments failed to alter the 2.5 per cent span length significantly. However, the highest value (11.0 mm) was observed in T_4 and the lowest (10.7 mm) in standard check.

Uniformity ratio

The variation in uniformity ratio among the treatments failed to attain statistical significance. However, it was found to vary between (49.0 per cent) standard check and 50.8 per cent (T_4).

Micronaire value

The micronaire value was found to range from 4.70 to 4.83 µg/inch, the highest being recorded in T_4 and the lowest in standard check. However, it failed to differ significantly.

Bundle strength

The different treatments failed to exert significant influence on bundle strength. The highest value (24.2 g/t) was registered in T_4 and the lowest (23.1 g/t) in control.

Elongation percentage

Elongation percentage values varied between 5.18 to 5.33 per cent. But, the variation among the treatments failed to attain the level of significance.

Even though, the variation was not significant in seed index, ginning percentage and other quality parameters like 2.5 per cent span length, uniformity ratio, micronaire value, bundle strength and elongation percentage by different treatments, numerically higher values were recorded in the treatment T_4 when compared to other treatments and the marginal increase in quality was observed in all the treatments over the standard check.

Table 3
Effect of treatments on seed cotton yield (kg ha^{-1}) of transgenic cotton

Treatments	*Seed cotton yield (kg ha^{-1})*
T_1: HYT A 1lit ha^{-1} + Molasses 2lit ha^{-1} (WA) + HYT B 1lit ha^{-1}	3600
T_2: HYT A 1lit ha^{-1} + HYT B 2lit ha^{-1} (WA) + HYT B 1lit ha^{-1}	3730
T_3: HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1}	3890
T_4: HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1} (WA) + HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1}	3968
T_5: Standard check	3310
SEd	55.39
CD (P=0.05)	120.69

Table 4
Effect of treatments on seed index (g), lint index and ginning percentage of transgenic cotton

Treatments	*Seed index (g)*	*Lint index*	*Ginning percentage*
T_1: HYT A 1lit ha^{-1} + Molasses 2lit ha^{-1} (WA) + HYT B 1lit ha^{-1}	10.80	5.90	33.00
T_2: HYT A 1lit ha^{-1} + HYT B 2lit ha^{-1} (WA) + HYT B 1lit ha^{-1}	10.80	6.10	33.60
T_3: HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1}	10.88	6.40	33.80
T_4: HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1} (WA) + HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1}	11.03	6.90	34.10
T_5: Standard check	10.68	5.60	32.50
SEdCD(P=0.05)	0.16NS	0.070.16	0.33NS

Table 5
Effect of treatments on 2.5% span length (mm), uniformity ratio (%) and micronarie value (µg/inch) of transgenic cotton

Treatments	*2.5% span length(mm)*	*Uniformity ratio (%)*	*Micronarie value (µg/inch)*
T_1: HYT A 1lit ha^{-1} + Molasses 2lit ha^{-1} (WA)+HYT B 1lit ha^{-1}	32.10	49.10	4.73
T_2: HYT A 1lit ha^{-1} + HYT B 2lit ha^{-1} (WA) + HYT B 1lit ha^{-1}	32.30	49.60	4.78
T_3: HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1}	32.40	50.30	4.80
T_4: HYT A 1lit ha^{-1}+ HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1} (WA) + HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1}	32.50	50.80	4.83
T_5: Standard check	31.70	49.00	4.70
SEdCD(P=0.05)	0.44NS	1.02NS	0.07NS

Table 6
Effect of treatments on of bundle strength 1/8" (g/t) and elongation percentage of transgenic cotton

Treatments	*Bundle strength 1/8" (g/t)*	*Elongation (%)*
T_1: HYT A 1lit ha^{-1} +Molasses 2lit ha^{-1} (WA)+HYT B 1lit ha^{-1}	23.20	5.23
T_2: HYT A 1lit ha^{-1} + HYT B 2lit ha^{-1} (WA) + HYT B 1lit ha^{-1}	23.50	5.25
T_3: HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1}	23.90	5.30
T_4: HYT A 1lit ha^{-1}+ HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1} (WA) + HYT A 1lit ha^{-1} + HYT B 1lit ha^{-1} + HYT C 1lit ha^{-1}	24.20	5.33
T_5: Standard check	23.10	5.18
SEdCD	0.45	0.08
(P=0.05)	NS	NS

DISCUSSION

The results of this study revealed that soil drenching and foliar spray with combination of biostimulants increased yield and quality parameters in cotton. The increase in yield might be due to the higher nutrient uptake and subsequent greater production of photosynthates by the combined application of different treatment combination. The plant growth promoting bacteria present in HYT A helps in promoting plant growth by increasing the availability of primary nutrients to the host plant through N_2 fixation and stimulation of nutrient uptake. Klopper and Beauchamp (1992) have been shown that wheat yield increased upto 30% in seed priming with PGPR. Mirzakhani *et al.*2009 reported that Azotobacter increased available nitrogen in soil which could enhance the grain yield in safflower. The L-aminoacid present in HYT B enhances the metabolism processes in plant tissues. Commercially available aminoacid stimulants can improve fertilizer assimilation, increase uptake of nutrients and water, and enhance the photosynthetic rate and dry matter partitioning resulting in increased crop yield (Papenfus *et al.,* 2013). The micronized chitin in HYT C stimulates plant defence mechanism against pests and diseases. But results obtained by the combined application of microbial consortia, L-amino acid complex and chitin are yet to be seen.

The quality parameters of seed cotton are largely controlled by the genetic make up of plant rather than the applied source of biostimulants and nutrient status of the soil (Padole *et al*. 1998). However, environmental and crop management practices can influence the quality parameters to some extent. Maximum improvement in all the quality parameters were observed by the application of HYT A @ one

litre per hectare + HYT B @ one litre per hectare + HYT C @ one kg per hectare as soil drenching with activation and foliar spray without activation.

Cotton plant being a heavy feeder requires adequate supply of nutrients to optimize the seed cotton yield and quality in cotton production. It can be achieved through application of fertilizer based on soil test values and soil application of HYT A @ one litre per hectare + HYT B @ one litre per hectare + HYT C @ one kg per hectare with activation and foliar spray without activation is one of the most efficient ways of supplying the essential nutrients to the crop at appropriate stage and protect the plant from abiotic stresses and pest and diseases.

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