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Effect of *Bt* biozyme and rejoice growth regulators on growth, yield and economics of *Bt* cotton (*Gossypium hirsutum* L.)

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Abstract : An experiment was conducted at Agricultural Research Sub Station, Aklera (Jhalawar) during *kharif* 2019. Seven treatment combinations were comparised in randomized block design with three replications. Results shows that the application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS as basal fb *Bt* Biozyme @ 625 ml/ha at 45 DAS as foliar spray fb two foliar spray of Rejoice WG at flower initiation and boll formation stage @ 500 g/ha gave significantly higher bolls/plant (25.4), boll weight (3.66 g), seed cotton yield (2052 kg/ha), net return (Rs. 67900/ha) and B:C ratio (1.96) over rest of treatments. However, it was found *at par* with application of *Bt* Biozyme G @ 20 kg ha-1 at 30 DAS as basal fb *Bt* Biozyme @ 625 ml/ha at 45 DAS as foliar spray fb two applications of Rejoice WG at flower initiation stage and boll formation stage as a foliar spray @ 400 g/ha and BT Biozyme G @ 20 kg/ha at 30 DAS as basal fb *Bt* Biozyme @ 500 ml/ha at 45 DAS as foliar spray fb two applications of Rejoice WG at flower initiation stage and boll formation stage as a foliar spray @ 400 g/ha.

Keywords : *Bt* Cotton, *Bt*. Biozyme, growth regulator, Rejoice and seed cotton yield.

Cotton (*Gossypium hirsutum* L.), also known as "White Gold" is one of the most important commercial cash crop of semi arid regions of the world. The top three cotton producing countries are India, China and USA. India has been a traditional home of cotton and cotton textile industries. Cotton is an international crop grown by about 80 countries across the world and on average, cotton is planted in an area of 34.5 m ha in the world. India accounts about 33 per cent global cotton area which is largest in the world (Anonymous, 2020). The area, production and productivity of cotton in India is 12.76 million ha, 36.1 million bales and 466 kg/ha respectively (Anonymous, 2020). Though India is having largest area under cotton cultivation globally, but production and productivity of country is low in comparison to other countries like Australia, China, USA etc. The major constraints in cotton production in our country are competition with other more economical crops, cultivation under rainfed condition, non availability of critical inputs, weed infestation, attack of various insect pests and diseases, costly and time consuming harvesting by hand picking etc. Among all practices, management of inputs are very important to increase the yield of crop. In India, cotton occupied approximately 65 per cent on dryland and 35 per cent on irrigated, the percentage of irrigated area is lower in the central zone, 23 per cent and south zone, 40 per cent. The central zone (Maharashtra, Madhya Pradesh, Gujarat and Southern Rajasthan) contributes more than 68 per cent to the total production and is characterized by rampant proliferation of *Bt* cotton hybrids. Under the rainfed growing condition, rainfall ranges from 400 to 1000 mm coupled with aberrant precipitation patterns over the years leading to large fluctuations in production.

An area, production and productivity of cotton in Rajasthan is 7.6 lakh ha, 27.9 lakh bales and 623 kg ha, respectively (Agriculture Statistics, 2020).The consistent and perceptible increase in cotton production and productivity during the last decade is partially attributed to higher rate of adoption (more than 95%) of *Bt* cotton in the Rajasthan. The average production is very low particularly in dryland areas due to low and erratic distribution of rainfall. Any increase or decrease in temperature may alter

days required to initiate square, onset of flowering, boll opening and maturation. There is evidence that plant growth regulators could be used to partially counteract environmental stresses and improve crop productivity. Under rainfed condition, cotton crop can better withstand without moisture stress by using growth regulators. The foliar spray of growth regulators enhanced drought tolerance by mitigating harmful effects by increasing translocation and by maintaining of water balance. Which is also participates in the regulation of physiological processes in order to mitigating the stress and enhanced physiological reactions and a series of growth processes leading to greater main stem node and sympodial branches, squares, bolls and enhance seed cotton yield. These results are in conformity with earlier works of Nawalkar *et al.*, (2014), Kumari and George (2012). Keeping these facts in mind, the present investigation was carried out the effect of *Bt*. biozyme and Rejoice growth regulators on growth, yield and economics of *Bt* cotton (*Gossypium hirsutum* L.).

MATERIALS AND METHODS

An experiment was carried out at Agricultural Research Sub Station, Aklera, Jhalawar (Rajasthan). The research station is situated in Agro-Climatic Zone V (Humid south-eastern plain zone) of Rajasthan. It is located between 25013´ N latitude and 750 25´ E longitudes at an altitude of 258 M above MSL. The average rainfall of research station was 1373 mm during crop growing season. The experiment was laidout in randomized block design with three replications. The total seven treatments consisted (T_1 control, T_2 *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme G @ 20 kg/ha at 45 DAS fb *Bt* Biozyme L. @ 625 ml/ha at flower initiation, T_3 *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 500 ml/ha at 45 DAS fb *Bt* Biozyme L. @ 500 ml/ha at flower initiation fb *Bt* Biozyme L. @ 500 ml/ha at boll formation, T_4 *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb *Bt* Biozyme L. @ 625 ml/ha at flower initiation fb *Bt* Biozyme L. @ 625 ml/ha at boll formation,T_5 *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 500 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage fb Rejoice WG @ 400 g/ha at boll formation stage, T_6 *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage fb Rejoice WG@ 400 g/ha at boll formation stage and T_7 *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 500 g/ha at flower initiation stage fb Rejoice WG@ 500 g/ha at boll formation stage.

The soil of the experimental field was clay loam with a pH of 7.7 and organic carbon 0.57 per cent. The available nutrient medium nitrogen and phosphorus and high potash status of the soil was 285 kg/ha, 24 kg/ha and 290 kg/ha, respectively. The recommended dose of nitrogen, phosphorus and potash i.e. 150:60:40 kg/ha was given in the form of urea, signal super phosphate and murate of potash. Full dose of phosphorus, potash and half nitrogen were drilled just before sowing and remaining half dose of nitrogen was applied in two equal split doses as per recommendation. The RCH-812 BG II *Bt* cotton hybrid was sown in the experiment. All other agronomic practices were carried out uniformly in all the treatments as per requirement of cotton crop. Observations on growth, yield parameters and seed cotton yield were recorded treatment wise. Ten plants were randomly selected in each plot of each replication and were tagged for the purpose of recording observations. The statistical method as proposed by Gomez and Gomez (2010) was used to analyse the data. The biometric observation on plant height, yield attributes and seed cotton yield were recorded and economics were also worked out.

*RDF = Recommended dose of fertilizer,
G = Granule, L. = Liquid, DAS = Days after sowing

Table 1. Effect of *Bt* Biozyme and Rejoice growth regulator on growth parameters of *Bt* cotton hybrid.

Treatments	Plant population/ ha		Plant height (cm)		Branches/Plant (120 DAS)	
	20 DAS	Harvest	60 DAS	90 DAS	Monopodial	Sympodial
T1 Control	23981	23192	51.90	85.42	1.61	11.10
T2 *Bt* Biozyme G @ 20 kg/ha at 30 & 45 DAS f/b foliar spray of *Bt* Biozyme L @ 625 ml/ha at flower initiation	23980	23245	53.34	90.30	1.69	12.42
T3 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of B*T* Biozyme L @ 500 ml/ha at 45 DAS, flower initiation and boll formation stage	23985	23298	54.42	94.00	1.73	12.60
T4 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of *Bt* Biozyme L @ 625 ml/ha at 45 DAS, flower initiation and boll formation stage	23991	23351	56.30	99.52	1.77	13.75
T5 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of *Bt* Biozyme L @ 500 ml/ha at 45 DAS and foliar spray of Rejoice WG @ 400 g/ha at flower initiation and boll formation stage	23989	23359	57.84	98.62	1.84	14.38
T6 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of *Bt* Biozyme L @ 625 ml/ha at 45 DAS and foliar spray of Rejoice WG @ 400 g/ha at flower initiation and boll formation stage	23983	23364	58.56	102.50	1.86	14.63
T7 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of *Bt* Biozyme L @ 625 ml/ha at 45 DAS and foliar spray of Rejoice WG @ 500 g/ha at flower initiation and boll formation stage	23987	23369	58.90	102.87	1.87	14.71
Sem+	16.00	92.00	0.47	0.72	0.02	0.16
CD (0.05)	NS	NS	1.42	2.14	0.07	0.47

*G: Granule *L: Liquid *WG: Wettable Granule (Sale price of seed cotton Rs.45/kg, Picking labour rate Rs.225/ day, Rental value of land Rs. 15, 000/-)

RESULTS AND DISCUSSION

Growth attributes: Application of *Bt* Biozyme G, *Bt* Biozyme L and Rejoice WG on different stages of *Bt* cotton hybrid significantly influenced the plant height, monopodial and sympodial branches. Data showed that the significantly higher plant height (58.90 cm) at 60 DAS, monopodial branches (1.87/plant) and sympodial branches (14.71/plant) of *Bt* cotton hybrid were recorded in treatment T_7 where the application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 500 g/ha at flower initiation stage fb Rejoice WG@ 500 g/ha at boll formation stage, which was significantly superior over rest of the treatments. However, it was found at par with application of T_6 *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage fb Rejoice WG@ 400 g/ha at boll formation stage plant height (58.56 cm) at 60 DAS, monopodial branches (1.86/plant) and sympodial branches (14.63/plant) and T_5 *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 500 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage fb Rejoice WG@ 400 g/ha at boll formation stage plant height (57.84 cm) at 60 DAS, monopodial branches 1.84/plant and sympodial branches 14.38/plant. Application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 500 g/ha at flower initiation stage fb Rejoice WG @ 500 g/ha at boll formation stage gave significantly higher plant height (102.87 cm) at 90 DAS over rest of the treatments. However, it was found *at par* with application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb

Table 2. Effect of BT Biozyme and Rejoice growth regulator on yield attributes, seed cotton yield and economics of *Bt* cotton hybrid.

Treatments	Bolls/ plant	Boll weight (g)	Seed cotton yield (g/plant)	Seed cotton yield (kg/ha)	Seed index (g)	Net returns (Rs./ha)	B:C ratio
T1 Control	18.9	3.10	58.6	1406	7.40	42300	1.51
T2 *Bt* Biozyme G @ 20 kg/ha at 30 & 45 DAS f/b foliar spray of *Bt* Biozyme L @ 625 ml/ha at flower initiation	20.5	3.35	64.6	1640	7.87	44100	1.34
T3 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of *Bt* Biozyme L @ 500 ml/ha at 45 DAS, flower initiation and boll formation stage	21.9	3.37	70.7	1697	7.93	51450	1.54
T4 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of *Bt* Biozyme L @ 625 ml/ha at 45 DAS, flower initiation and boll formation stage	23.1	3.39	74.1	1808	8.07	55200	1.64
T5 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of *Bt* Biozyme L @ 500 ml/ha at 45 DAS and foliar spray of Rejoice WG @ 400 g/ha at flower initiation and boll formation stage	23.7	3.41	80.8	1939	8.43	62750	1.83
T6 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of *Bt* Biozyme L @ 625 ml/ha at 45 DAS and foliar spray of Rejoice WG @ 400 g/ha at flower initiation and boll formation stage	24.0	3.50	84.0	2016	8.48	66500	1.94
T7 *Bt* Biozyme G @ 20 kg/ha at 30 DAS f/b foliar spray of *Bt* Biozyme L @ 625 ml/ha at 45 DAS and foliar spray of Rejoice WG @ 500 g/ha at flower initiation and boll formation stage	25.4	3.66	84.8	2052	8.52	67900	1.96
Sem+	0.59	0.09	1.42	53	0.12	1780	0.05
CD 5 (b=0.05)	1.73	0.26	4.05	160	0.39	5302	0.16

Rejoice WG @ 400 g/ha at flower initiation stage fb Rejoice WG@ 400 g/ha at boll formation stage plant height (102.50 cm) at 90 DAS (Table 1). Increase in number of branches and its length, these results are conformity with findings of Kataria *et al.*, (2017).

Yield attributes: Application of *Bt* Biozyme and Rejoice WG at different stages of hybrid cotton significantly influenced the yield contributing parameters of *Bt* cotton hybrid (Table 2). Significantly the maximum boll/plant (25.4), boll weight (3.66 g) and seed cotton yield/plant (84.8 g) of *Bt* cotton hybrid were recorded in treatment T_7 where application of (*Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L @ 625 ml/ha at 45 DAS fb Rejoice WG @ 500 g/ha at flower initiation stage fb Rejoice WG@ 500 g/ha at boll formation stage) which was significantly superior over rest of the treatments. However, it was found *at par* with the application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage fb Rejoice WG@ 400 g/ha at boll formation stage, bolls/plant (24.0), boll weight (3.50 g) and seed cotton yield/plant (84.0 g) and application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L @ 500 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage fb Rejoice WG@ 400 g/ha at boll formation stage where number of bolls/plant (23.7), boll weight (3.41 g) and seed cotton yield/plant (80.8 g). Due to foliar spray of growth regulators substantial increase in various yield attributes and its subsequent translocation towards sink and finally it improve the yield attributing characters. Similar observation reported by Aruna and Reddy (2009).

Seed cotton yield: Application of *Bt* Biozyme and Rejoice WG at different stages of *Bt* cotton hybrid significantly influenced the seed cotton yield. Significantly higher seed cotton yield (2052 kg/ha) and seed index (8.52) of hybrid cotton were recorded with the application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt*

Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 500 g/ha at flower initiation and boll formation stage. However, it was found at par where the application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage fb Rejoice WG @ 400 g/ha at boll formation stage seed cotton yield (2016 kg/ha) and seed index (8.48) and application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 500 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage and boll formation stage seed cotton yield (1939 kg/ha) and seed index (8.43). Whereas lowest seed cotton yield (1406 kg/ha) and seed index (7.40) was recorded under control (Table 2). Spraying of growth regulators gave beneficial effect on seed cotton yield was conformity with the findings of Virdia (2011).

Economics: Application of *Bt* Biozyme and Rejoice WG at different stages of *Bt* cotton hybrid significantly influenced the monetary return of *Bt* cotton hybrid (Table 2). The maximum net return (Rs. 67900/ha) and B:C ratio (1.96) were recorded with application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 500 g/ha at flower initiation and boll formation stage. However, it was found at par with application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 625 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage fb Rejoice WG @ 400 g/ha at boll formation stage net return (Rs. 66500/ha) and B:C ratio (1.94) and application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS fb *Bt* Biozyme L. @ 500 ml/ha at 45 DAS fb Rejoice WG @ 400 g/ha at flower initiation stage and boll formation stage net return (Rs. 62750/ ha) and B:C ratio (1.83).

Summary table of labour cost, rental value of land and price of seed cotton.

S. No.	Particulars	Price/kg(Rs.)	Labour rate/day (Rs.)	Rental value of land (Rs./ha)
1.	Seed cotton yield	50.0	-	-
2.	Picking rate	-	225.0	-
3.	Rental value of land	-	-	15000.0

CONCLUSION

It is concluded that the significantly higher seed cotton yield (2052 kg/ha) was recorded with the application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS as basal fb foliar spray of *Bt* Biozyme L @ 625 ml/ha at 45 DAS fb two foliar spray of Rejoice WG @ 500 g/ha at flower initiation and boll formation stage over control (1406 kg/ha) seed cotton yield. However, it was found at par with the application of *Bt* Biozyme G @ 20 kg/ha at 30 DAS as basal fb *Bt* Biozyme @ 625 ml/ha at 45 DAS as foliar spray fb two foliar spray of Rejoice WG @ 400 g/ha at flower initiation and boll formation stage (2016 kg/ha) seed cotton yield and *Bt* Biozyme G @ 20 kg/ha at 30 DAS as basal fb foliar spray of *Bt* Biozyme L @ 500 ml/ha at 45 DAS fb two foliar spray of Rejoice WG @ 400 g/ha at flower initiation and boll formation stage (1939 kg/ha) seed cotton yield.

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