



E-ISSN: 2278-4136

P-ISSN: 2349-8234

www.phytojournal.com

JPP 2020; 9(5): 1952-1958

Received: 30-06-2020

Accepted: 28-08-2020

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Response of Bt cotton to high density planting and nitrogen levels through fertigation

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Abstract

An experiment during *kharif-rabi* season of 2016-17 to 2018-19. The experiment was laid out in a split plot design with three replication. The results revealed that significantly maximum seed cotton yield and stalk yield were recorded when sowing of crop at narrow row spacing of S₁ (30-60-30 cm x 30 cm) over wider row spacing during individual years and on pooled data basis, which was found statistically at par with S₂ (i.e. 30-90-30 cm x 30 cm) during individual years as well as in pooled results. Significantly maximum plant population and plant height were noted when crop was sown at closer paired row spacing of S₁ (30-60-30 cm x 30 cm) during individual years and in pooled results, accordingly. Bt cotton sown at wider spacing of 120cm x 45cm (S₄) recorded maximum sympodial branches, Least number of monopodial branches per plant, maximum number of bolls and boll weight during individual years and on pooled data basis Fertilizing the crop with 125% RDN through fertigation (N₃) in eight equal splits at 15 days interval produced significantly superior in all growth, yield attributes and yield parameters.

Keywords: Bt cotton, high density planting, nitrogen levels

Introduction

Cotton the “White gold” is one of the most important commercial crop of India and accounts for the largest area 12.6 million hectare under cultivation. With the introduction of Bt cotton in cultivation, resulting in quantum jump in production from 16 million bales to 33.0 million bales with productivity of 454 kg ha⁻¹ (Anonymous, 2019) [1].

Water and fertilizer are the main limiting factors affecting the agricultural production in arid and semi-arid regions. Application of fertilizers with irrigation water has several advantages. By fertigation, the time and rate of fertilizer applied can be regulated precisely. Fertigation is the most efficient method of fertilizers application, as it ensures application of water and fertilizers directly to the plant roots leading to greater efficiency of application (Rajput and Patel, 2006) [4]. Fertigation can save fertilizers by 50% and may increase the crop yield by 20-30%. Dingre *et al.* (2012) [2] showed that drip fertigation resulted into 12 to 74% increase in the productivity of onion seed as compared to conventional method. It has been reported that efficiency of nitrogenous fertilizers is 95% under drip fertigation compared to 30-50% under soil application. The fertilizer use efficiency with fertigation can be increased to 95% for nitrogen, 45% for phosphorus and 80% for potash.

Further improvement in cotton yields is possible only through change in agronomic management and cropping system with Bt cotton. Cotton is grown at wider spacing of 120 x 120 cm to 90 x 90 cm with only 6944 to 12356 plants per hectare, which limit yields. Bt cotton virtue of built in resistance to bollworms, retain higher number of bolls from early stages of crop growth. Due to mobilization of nutrients to the developing bolls the vegetative growth is restricted and the canopy size reduced, offering scope for planting cotton at higher planting density with some genotypes. There is a positive relationship between plant population and seed cotton yield. Optimum plant population is one of the factors for improving the yield per unit area. Adoption of HDP along with good fertilizer management is a viable approach to break the current trend of stagnating yields. The application of 100% nitrogen through drip recorded significantly higher cotton yield. However, 75% nitrogen through drip and 100% nitrogen through conventional method with surface irrigation recorded on par with saving 25% nitrogen. Fertigation ensures saving in fertilizer (40-60%), due to better fertilizer use efficiency and reduction in leaching (Kumar and Singh, 2002) [3]. Keeping this in view, an experiment was planned to study the response of Bt cotton to high density planting and nitrogen levels through fertigation at Micro Irrigation Project, Instructional Farm, COA, JAU, Junagadh.

Material and Methods

The field experiment was carried out during *Kharif-Rabi* seasons of 2016-17 to 2018-19 at Micro Irrigation Research Project, Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat). The area is situated in southern part of Gujarat, which falls under South Saurashtra agro-climatic zone. It lies between the parallels of 20°51' N latitudes and 70°31' E longitudes with an average elevation of 83 meters above mean sea level.

The field experiment was carried out to study the Response of Bt cotton to high density planting and nitrogen levels through fertigation. The soil of experimental field was medium black in texture, medium in available nitrogen, phosphorus and potassium with slightly alkaline in reaction (pH 7.38). The net plot area of 4.50 m x 3.60 m. Twelve treatment combinations consisted of four spacing *viz.*, S₁: 30-60-30 cm x 30 cm, S₂:30-90-30 cm x 30 cm, S₃:90 cm x 30 cm, S₄:120 cm x 45 cm in paired row and three levels of nitrogen *viz.*, N₁: 75% RDN, N₂: 100% RDN and N₃: 125% RDN were tested under split plot design with three replications. Bt cotton variety (Gujarat Cotton Hybrid-8 BG-II) was raised as per recommended package of practices. During the experimental period, no infestation of serious pests and diseases were observed. The recommended dose of fertilizer (RDF) for Bt cotton is @ 240-50-120 kg NPK/ha respectively. Phosphorus and potash were applied through soil application as per RDF. Nitrogen was given in 8 equal splits as basal and at 15 days interval through fertigation. After cessation of rainfall irrigation was applied before sowing and at 0.8 PFF through drip. FYM 10 t/ha and phosphorus and potassium fertilizers as per treatments were applied.

Result and Discussion

Effect of spacing

❖ Seed cotton and stalk yields

The data furnished in Table-1 showed that different spacing had significant effect on seed cotton and stalk yields. Significantly maximum seed cotton yield of 2358, 1934, 2074 and 2122 kg/ha was recorded when Bt cotton was sown at closer paired row spacing of 30-60-30cm x 30cm (S₁) during 2016-17, 2017-18, 2018-19 and on pooled data basis, respectively which was found statistically at par with S₂ (i.e. 30-90-30 cm x 30 cm) during individual years as well as in pooled results except seed cotton yield during 2018-19 and in pooled results. The per cent increase in seed cotton yield at closer spacing of 30-60-30 cm x 30cm (S₁) was to the tune of 40.8, 58.5, 44.7 and 47.1% during individual years and in pooled results, accordingly over wider row spacing of 120 cm x 45cm (S₄). Stalk yield of cotton also significantly influenced by various row spacing. Sowing of Bt cotton at closer row spacing of 30-60-30cm x 30cm (S₁) produced significantly higher stalk yield of 3631, 2225, 3475 and 3111 kg/ha during 2016-17, 2017-18, 2018-19 and in pooled results, respectively and it was remained on same bar with S₂ (i.e. 30-90-30 cm x 30 cm). Increase in stalk yield with narrow row spacing of 30-60-30 cm x 30 cm over wider row spacing of 120-cm x 45cm was to the tune of 30.6, 67.2, 35.5 and 39.8% during 2016-17, 2017-18, 2018-19 and in pooled results, respectively.

Higher seed cotton yield per hectare was recorded under closer spacing of 30-60-30 cm x 30cm as compared to wider spacing. This might be due to higher values of yield attributes and ultimately produce more seed cotton yield and stalk yield. These findings corroborates the results of Sarkar and Malik

(2004) ^[18], Nehra *et al.* (2004) ^[19], Buttar and Singh (2006) ^[20], Singh *et al.* (2007) ^[21] and Giri *et al.* (2008) ^[22].

❖ Growth and yield attributes

Results presented in Table-3 revealed that growth attributes *viz.*, plant population and plant height were significantly influenced by different row spacing. Closer paired row spacing of 30-60-30 cm x 30 cm (S₁) noted significantly maximum plant population of 64421, 63917, 64029 and 64122 during 2016-17, 2017-18, 2018-19 and in pooled results, respectively. In closer spacing increased plant population per unit area there may be competition for light nutrients spaces and congestion in the growing induced more vertical growth through nodal elongation that restricted lateral branching these results are in conformity with Dahipale *et al.* (2012) ^[5], Deotalu *et al.* (2013) ^[6], Parlawar *et al.* (2017) ^[7]. Significantly maximum plant height of 102.8, 73.6, 86.6 and 87.7 cm was recorded when Bt cotton was sown at closer paired row spacing of 30-60-30 cm x 30 cm during individual years and in pooled results, accordingly. The increase in height at close row spacing could be due to competition for solar radiation, water and nutrient uptake among the plants from their the lower height recorded at 30-60-30 cm x 30 cm might be due to suppression of apical dominance as against closer spacing. These results are in agreement with Ganvir *et al.* (2013) ^[8] and Munir *et al.* (2015) ^[9, 12]. Data presented in Table-5 indicated that number of monopodial and sympodial branches were significantly influenced by various sowing spacing. Bt cotton sown at wider spacing of 120cm x 45cm (S₄) recorded maximum sympodial branches of 11.7, 11.1, 11.3 and 11.4 during 2016-17, 2017-18, 2018-19 and in pooled results, respectively and it was found statistically on same bar with S₃ (i.e. 90cm x 30cm) during 2016-17 and 2017-18 Availability of more space for lateral expansion of branches and chance to enhance auxiliary buds of plant as compared to closer planted crops resulted in maximum sympodial branches under wider spaced plants. These observations are in conformity with Bhalerao *et al.* (2008) ^[10] and Kalaichelvi (2009) ^[11]. Least number of monopodial branches per plant was observed under wider spacing of 120cm x 45cm (S₄) and 90cm x 30cm (S₃). Data given in Table-6 indicated that different row spacing significantly affect the number of bolls and boll weight during individual years and on pooled data basis. Significantly maximum number of bolls 22.8, 12.3, 15.4 and 16.8 was recorded under wider row spacing of 120 cm x 45 cm during 2016-17, 2017-18, 2018-19 and in pooled results, respectively. Corresponding values of boll weight was 3.30, 3.35, 3.24 and 3.30g. More number of bolls plant⁻¹ in wider spacings, because of substantial space available for growth, more photosynthetic efficiency, frequent availability of water and nutrients, less humidity for efficient control of insect pest attack and boll saving from rotting, which resulted in increase in fruiting points, fruiting period, fruit retention and ultimately more bolls plant⁻¹ (Munir *et al.*, 2015) ^[9, 12]. Similar result reported by Narayana *et al.* (2007) ^[13], Reddy and Gopinath (2008) ^[14] and Venugopalan *et al.* (2011) ^[15] are in agreement with the present results. A significant increase in boll weight with increasing row spacing was reported by Devraj *et al.* (2011) ^[16]. This might be due to the higher interception of solar radiation, better utilization of available nutrients, lesser competition for moisture which resulted in higher photosynthetic activity as reported by Sharma and Dunganwal (2003) ^[17].

Effect of nitrogen levels

❖ Seed cotton and stalk yields

Seed cotton and stalk yields of Bt cotton were significantly influenced by nitrogen levels during individual years as well as in pooled results (Table-1). Fertilizing the crop with 125% RDN through fertigation (N_3) in eight equal splits at 15 days interval produced significantly maximum seed cotton yield of 2287, 1716, 1848 and 1950 kg ha⁻¹ during 2016-17, 2017-18, 2018-19 and in pooled results, respectively which was closely followed by N_2 (i.e. 100% RDN) and found statistically on same bar during 2017-18 and 2018-19. The per cent increase in seed cotton yield with the application of 125% of RDN over 75% RDN was to the tune of 24.6, 16.6, 18.9 and 20.4% during 2016-17, 2017-18, 2018-19 and in pooled results, accordingly. Similarly, significantly higher stalk yield of 3589, 1979, 3264 and 2944 kg ha⁻¹ was produced when Bt cotton was fertilized with 125% RDN through fertigation (N_3) through fertigation in eight equal splits at 15 days interval and which remained statistically at par with N_2 (i.e. 100% RDN) during 2018-19. Per cent increase in stalk yield with 125% RDN through fertigation over 75% RDN was to the tune of 37.2, 26.2, 12.9 and 24.8% during 2016-17, 2017-18, 2018-19 in pooled results, respectively.

Application of fertilizer nutrients through irrigation systems (fertigation) has been found to increase seed and stalk yields of cotton and nutrient uptake by researchers in Syria (Janat and Somi, 2001; Janat, 2004) [26, 25], Texas (Enciso-Medina *et al.*, 2007) [27] and India (Thind *et al.*, 2008) [28]. Irrigation systems permit multiple small dose fertilizer injections at different intervals, reducing the risk of leaching compared to fertilizers applied in a single application

Growth and yield attributes

The data furnished in Table-3 indicated that different nitrogen levels that growth attributes *viz.*, plant population and plant height were significantly influenced by different nitrogen levels. 125% RDN through fertigation (N_3) noted significantly maximum plant population of 43569, 43537, 44008 and 43705 during 2016-17, 2017-18, 2018-19 and in pooled results, respectively. Significantly maximum plant height of 101.7, 73.8, 82.2 and 85.9cm was noted when Bt cotton was fertilized with 125% of RDN through fertigation in eight equal splits at 15days interval during 2016-17, 2017-18, 2018-19 and on pooled results basis, respectively and which was on same bar with N_2 (i.e. 100% RDN) during 2018-19. The increase in plant height was associated with increased internodes length. Jat *et al.* (2014) reported similar results. Number of monopodial and sympodia branches per plant were significantly influenced by nitrogen levels (Table-5). Significantly minimum monopodial branches and maximum sympodial branches per plant were observed when Bt cotton was fertilized with 125% RDN through fertigation (N_3) during each individual years and in pooled results. Number of bolls and boll weight were significantly influenced by nitrogen levels (Table-6). Maximum number of bolls of 21.3, 12.4, 14.5 and 16.0 were produced when Bt cotton was fertilized with 125% of RDN through fertigation in eight equal splits at 15 days interval during individual years and in pooled results, respectively and it was remained statistically at par with N_2 (i.e. 100% RDN) during 2017-18 and 2018-19. Significantly maximum boll weight of 3.43, 3.38, 3.25 and 3.35g during 2016-17, 2017-18, 2018-19 and in pooled results, respectively were noted when Bt cotton fertilized with 125% RDN through

fertigation (N_3). The better performance of Bt cottons were ascribed to maximum number of bolls and maximum boll weight. Similar differences among Bt and non-Bt cotton hybrids were also reported from India by Nehra *et al.* (2004) [19], Singh *et al.* (2007) [21] and Yudhveer Singh *et al.* (2010) [24].

Quality parameters

Data on quality parameters are furnished in Table-8 revealed that various quality parameters *viz.*, upper half mean length (UHML), uniformity index (UI), micro naire (MIC MV), tenacity and fibre elongation were not significantly influenced by sowing spacing and nitrogen levels except, micro naire which was maximum under wider sowing spacing of 120 cm x 45 cm (S_4).

Interaction effect

Interaction effect between spacing and nitrogen levels found significant for seed cotton yield during 2018-19 and stalk yield during 2016-17 and 2017-18 (Table-2). Maximum seed cotton yield of 2271 kg/ha during 2018-19 and stalk yield of 4530 and 2350 kg/ha during 2016-17 and 2017-18, respectively was recorded when Bt cotton was sown at closer spacing of 30-60-30cm x 30cm along with the application of 125% RDN through fertigation (S_1N_3) and it was remained statistically at par with S_1N_2 for seed cotton yield and S_1N_2 and S_2N_3 for stalk yield during 2017-18. Data given in Table-4 revealed that interaction between spacing and nitrogen level was also found significant for plant height during 2017-18 and in pooled results. Significantly tallest plant was produced when Bt cotton was sown at closer spacing of 30-60-30cm x 30cm and crop was fertilized with 125% RDN through fertigation (S_1N_3). Results presented in Table-7 showed that interaction effect between spacing and nitrogen was also found significant for number of bolls during 2018-19 and boll weight during 2018-19 and on pooled basis. Significantly higher number of bolls and boll weight were recorded when crop was sown at wider spacing of 120cm x 45cm along with the application of 125% RDN (S_4N_3) and it was comparable with S_4N_2 , S_3N_3 and S_2N_3 .

Economics

Economics was worked out by using current market prices of produce and inputs used (Table-9). The mean data of three years indicated that maximum gross (Rs. 101696/ha) and net returns (Rs. 60132/ha) with B:C ratio of 2.45, were obtained when Bt cotton was sown at closer spacing of 30-60-30cm x 30cm (S_1) which was closely followed by S_2 (i.e. 30-90-30cm x 30cm) with recording gross and net returns of Rs. 90679 and Rs. 52805/ha along with B:C ratio of 2.39, accordingly. Fertilizing the Bt cotton with 125% RDN (i.e. N_3 -300kg N/ha) gave maximum gross (Rs. 93627/ha) and net returns (Rs. 54819/ha) along with B:C ratio of 2.41, which was followed by N_2 (i.e. 100% RDN).

Conclusion

On the basis of the results obtained from the present three-year field study, it could be concluded that significantly higher seed cotton yield of Bt cotton with higher net return can be obtained by growing Bt cotton at 30-60-30 cm x 30 cm paired row spacing and fertilized with 125% RDN through drip fertigation on medium black calcareous soil of South Saurashtra Agro-climatic Zone of Gujarat.

Table 1: Influence of spacing and nitrogen on seed cotton and stalk yields of Bt cotton

Treatments	Seed cotton Yield (kg/ha)				Stalk yield (kg/ha)			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
Spacing								
S ₁ - 30-60-30 cm x 30cm	2358	1934	2074	2122	3631	2225	3475	3111
S ₂ -30-90-30cm x 30cm	2188	1667	1805	1887	3292	2104	3295	2897
S ₃ -90cm x 30cm	2011	1507	1602	1707	2827	1500	3064	2463
S ₄ -120cm x 45cm	1674	1220	1433	1443	2779	1331	2565	2225
S.Em. ±	80.28	82.72	59.83	37.49	178.05	62.87	116.6	64.06
CD at 5%	277.79	286.26	207.06	128.63	616.15	217.6	403.4	219.78
CV%	11.70	15.69	10.39	12.57	17.05	10.54	11.28	14.37
Nitrogen levels								
N ₁ -75% RDN	1836	1471	1554	1620	2616	1568	2891	2358
N ₂ -100% RDN	2050	1560	1783	1798	3191	1823	3144	2719
N ₃ -125% RDN	2287	1716	1848	1950	3589	1979	3264	2944
S.Em.±	59.59	55.84	46.12	31.26	75.51	39.84	99.58	43.72
CD at 5%	178.66	167.41	138.26	88.90	226.37	119.5	298.6	124.33
CV %	10.03	12.23	9.24	10.48	8.35	7.71	11.13	9.81
S x N interaction								
S.Em. ±	119.19	111.68	92.24	62.53	151.02	79.68	199.17	87.45
CD at 5%	NS	NS	276.52	NS	452.75	238.9	NS	NS

Table 2: Interaction effect of spacing and nitrogen on seed cotton and stalk yield of cotton

S x N	Seed cotton yield 2018-19 (kg/ha)				Stalk yield 2016-17 (kg/ha)				Stalk yield 2017-18 (kg/ha)			
	S ₁	S ₂	S ₃	S ₄	S ₁	S ₂	S ₃	S ₄	S ₁	S ₂	S ₃	S ₄
N ₁	1768	1856	1301	1293	2910	2817	2415	2322	2059	2006	1041	1165
N ₂	2183	1644	1756	1551	3454	3339	2969	3004	2267	2177	1443	1404
N ₃	2271	1916	1749	1455	4530	3720	3098	3011	2350	2128	2016	1423
S.Em. ±				92.24				151.0				79.7
CD at 5%				276.5				452.7				238.9

Table 3: Influence of spacing and nitrogen on plant population and plant height of Bt cotton

Treatments	Plant population				Plant height (cm)			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
Spacing								
S ₁ - 30-60-30 cm x 30cm	64421	63917	64029	64122	102.8	73.6	86.6	87.7
S ₂ -30-90-30cm x 30cm	48599	48795	49309	48901	95.4	70.8	80.1	82.1
S ₃ -90cm x 30cm	32796	32432	32628	32619	94.0	68.4	76.2	79.5
S ₄ -120cm x 45cm	24809	24498	24538	24615	91.3	64.4	73.5	76.4
S.Em. ±	162	256	404	146	2.20	1.66	2.01	0.98
CD at 5%	559	884	1399	500	7.62	5.75	6.95	3.38
CV%	1.14	1.81	2.85	2.05	6.89	7.19	7.62	7.26
Nitrogen levels								
N ₁ -75% RDN	41859	41097	40965	41307	89.2	67.0	75.5	77.2
N ₂ -100% RDN	42541	42597	42905	42681	96.8	67.2	79.6	81.2
N ₃ -125% RDN	43569	43537	44008	43705	101.7	73.8	82.2	85.9
S.Em.±	232	220	196	125	1.12	1.52	1.45	0.79
CD at 5%	695	659	589	355	3.35	4.57	4.35	2.26
CV %	1.88	1.79	1.60	1.76	4.04	7.62	6.35	5.85
S x N interaction								
S.Em. ±	463	439	393	250	2.23	3.05	2.90	1.59
CD at 5%	NS	NS	NS	NS	NS	9.14	NS	4.52

Table 4: Interaction effect of spacing and nitrogen on plant height of cotton during 2017-18 and on pooled basis

S x N	Plant height- 2017-18 (cm)				Plant height –Pooled basis (cm)			
	S ₁	S ₂	S ₃	S ₄	S ₁	S ₂	S ₃	S ₄
N ₁	64.8	69.7	66.0	67.5	80.1	81.6	82.1	82.1
N ₂	70.0	68.5	67.3	63.0	85.8	86.4	74.4	74.4
N ₃	86.1	74.3	72.0	62.8	97.1	76.1	76.9	76.9
S.Em. ±				3.05				1.59
CD at 5%				9.14				4.52

Table 5: Influence of spacing and nitrogen on no. of monopodia and sympodia of Bt cotton

Treatments	No. of monopodia				No. of sympodia			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
Spacing								
S ₁ - 30-60-30 cm x 30cm	2.7	2.6	2.4	2.6	9.8	8.6	9.4	9.2
S ₂ -30-90-30cm x 30cm	2.4	2.5	2.1	2.3	10.1	9.9	9.5	9.8
S ₃ -90cm x 30cm	2.2	2.1	1.9	2.0	11.6	10.0	10.4	10.7
S ₄ -120cm x 45cm	2.2	1.9	2.0	2.0	11.7	11.1	11.3	11.4
S.Em. ±	0.18	0.16	0.13	0.08	0.40	0.30	0.17	0.15
CD at 5%	NS	NS	NS	0.27	1.37	1.03	0.60	0.52
CV%	22.34	21.46	19.11	21.20	11.01	9.02	5.11	8.83
Nitrogen levels								
N ₁ -75% RDN	2.9	2.7	2.5	2.7	9.7	9.3	9.4	9.5
N ₂ -100% RDN	2.4	2.2	2.0	2.2	10.5	9.8	10.1	10.2
N ₃ -125% RDN	1.9	2.0	1.7	1.9	12.1	10.6	10.9	11.2
S.Em.±	0.13	0.07	0.11	0.06	0.28	0.12	0.11	0.11
CD at 5%	0.40	0.20	0.34	0.18	0.85	0.37	0.33	0.31
CV %	19.58	10.14	18.69	16.70	9.15	4.37	3.80	6.43
S x N interaction								
S.Em. ±	0.27	0.13	0.22	0.13	0.57	0.25	0.22	0.22
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 6: Influence of spacing and nitrogen on no. of bolls and boll weight of Bt cotton on

Treatments	No. of bolls plant ⁻¹				Boll weight (g)			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
Spacing								
S ₁ - 30-60-30 cm x 30cm	16.6	9.9	9.9	12.2	2.77	2.83	2.89	2.83
S ₂ -30-90-30cm x 30cm	16.8	9.2	12.0	12.7	3.09	3.23	3.08	3.13
S ₃ -90cm x 30cm	21.7	11.7	12.3	15.2	3.16	3.29	3.19	3.21
S ₄ -120cm x 45cm	22.8	12.3	15.4	16.8	3.30	3.35	3.24	3.30
S.Em. ±	1.41	0.59	0.53	0.47	0.10	0.70	0.70	0.04
CD at 5%	4.88	2.03	1.84	1.60	0.34	0.24	0.24	0.14
CV%	21.75	16.33	12.83	19.70	9.67	6.68	6.84	7.83
Nitrogen levels								
N ₁ -75% RDN	18.0	9.0	10.5	12.5	2.77	2.96	2.96	2.90
N ₂ -100% RDN	19.2	11.0	12.2	14.1	3.04	3.18	3.08	3.10
N ₃ -125% RDN	21.3	12.4	14.5	16.0	3.43	3.38	3.25	3.35
S.Em.±	0.82	0.48	0.38	0.34	0.06	0.05	0.05	0.03
CD at 5%	2.45	1.42	1.13	0.97	0.19	0.15	0.14	0.09
CV %	14.57	15.25	10.50	14.32	7.13	5.54	5.29	6.03
S x N interaction								
S.Em. ±	1.64	0.95	0.75	0.68	0.13	0.10	0.09	0.06
CD at 5%	NS	NS	2.26	NS	NS	NS	0.28	0.18

Table 7: Interaction effect of spacing and nitrogen on no. of bolls and boll weight

S x N	No. of bolls (2018-19)				Boll weight (2018-19) (g)				Boll weight (Pooled basis) (g)			
	S ₁	S ₂	S ₃	S ₄	S ₁	S ₂	S ₃	S ₄	S ₁	S ₂	S ₃	S ₄
N ₁	7.7	11.1	10.1	13.3	2.51	3.04	3.18	3.14	2.46	3.11	3.41	3.41
N ₂	8.5	12.6	11.8	15.9	3.06	2.99	3.18	3.10	2.96	3.32	3.06	3.06
N ₃	13.5	12.4	15.1	17.0	3.10	3.21	3.21	3.49	3.07	3.11	3.20	3.20
S.Em. ±				0.75				0.09				0.06
CD at 5%				2.26				0.28				0.18

Table 8: Influence of spacing and nitrogen on quality parameters of Bt cotton

Treatments	Upper half mean length (mm)	Uniformity index (%)	MIC MV (micro naire) (µg/inch)	Tenacity (g/tex)	Elongation
Spacing					
S ₁ - 30-60-30 cm x 30cm	26.31	85.33	4.52	24.73	5.34
S ₂ -30-90-30cm x 30cm	26.67	85.11	4.29	24.97	5.32
S ₃ -90cm x 30cm	26.63	84.67	4.46	25.14	5.29
S ₄ -120cm x 45cm	26.32	84.33	4.48	24.50	5.23
S.Em. ±	0.17	0.54	0.04	0.33	0.10
CD at 5%	NS	NS	0.15	NS	NS
CV%	1.98	1.89	3.03	3.99	5.73
Nitrogen levels					
N ₁ -75% RDN	26.44	85.17	4.48	24.69	5.29

N2-100% RDN	26.43	84.17	4.43	24.73	5.28
N3-125% RDN	26.58	85.25	4.39	25.08	5.32
S.Em.±	0.27	0.68	0.07	0.24	0.05
CD at 5%	NS	NS	NS	NS	NS
CV %	3.59	2.79	5.10	3.31	3.15
S x N interaction					
S.Em. ±	0.55	1.37	0.13	0.48	0.10
CD at 5%	NS	NS	NS	NS	NS

Table 9: Economics of different treatments in Bt cotton (Average of three years)

Treatments	Seed cotton Yield (kg/ha)	Gross Realization (Rs./ha)	Total cost of Cultivation (Rs./ha)	Net realization (Rs./ha)	B:C ratio
Spacing					
S ₁	2122	101696	41564	60132	2.45
S ₂	1887	90679	37874	52805	2.39
S ₃	1707	81711	38986	42725	2.10
S ₄	1443	69355	35296	34059	1.96
S.Em.±	37.49				
CD at 5%	128.63				
Nitrogen levels					
N ₁	1620	77628	38052	39576	2.04
N ₂	1798	86327	38430	47897	2.25
N ₃	1950	93627	38808	54819	2.41
S.Em.±	31.26				
CD at 5%	88.90				

Selling price: Seed cotton Rs. 45.0/kg, Stalk Rs.2.0/kg

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