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RESEARCH ARTICLE

Performance of Bt cotton hybrids under various crop geometries and nutrient levels in Humid Southern Plain Zone of Rajasthan

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SUMMARY

A field experiment comprised of three Bt hybrids (Leo cott, Paras Brahma and Jai Bt) with two plant geometries (90 x 45 cm and 90 x 60 cm) and three levels of NPK (100% RDF,125% RDF and 150% RDF) was conducted during *Kharif* 2012 and 2013 at ARS, Banswara in Split Plot Design with four replications. The Bt hybrid of Leo cott gave higher seed cotton yield (2242 kg ha^{-1}) as compared to Jai Bt and Paras Brahma (1809 and1755 kg ha^{-1}), respectively. The closer spacing 90 x 45 cm was recorded significantly higher seed cotton yield (2240 kg ha^{-1}) over 90 x 60 cm (1752 kg ha^{-1}). Increasing levels of fertilizer from 100% RDF to150% RDF of NPK ha^{-1} significantly increase seed cotton. Application of 125 % RDF gave significantly higher seed cotton yield (2249 kg ha^{-1}) over 100% RDF (1815 kg ha^{-1}), but it was found at par with application of 150% RDF (2304 kg ha^{-1}) in the pooled analysis.

Key Words : Leo cott, Plant geometry, Seed cotton yield, NPK levels

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Cotton, *Gossypium hirsutum* L., is one of the most important fibre crops playing a key role in economic and social affairs of the world. It is a soft fibre that grows around the seeds of the cotton plant *Gossypium* spp., a shrub native to tropical and subtropical regions around the world, including the Americas, India, and Africa. The fibre is most often spun into thread and used to make a soft, breathable textile, which is the most widely used natural-fibre cloth in clothing today. It is generally believed that the first cultivation of cotton was in India, though it grew wild in several locations around the world. People living in Egypt's Nile Valley and across the world in Peru were also familiar with cotton (Deng *et al*., 2004).

The reasons for decreasing productivity are due to

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decreasing soil fertility especially micronutrients, imbalanced use of fertilizer and occurrences of physiological disorders like square dropping, square drying, leaf reddening *etc*. Among these, imbalanced use of major and micro nutrients is the major problem (Hebbar *et al*., 2007). To overcome these constraints, additional nutrition through foliar feeding is required over and above the normal fertilizer recommendation. This is one of the most efficient ways of supplying essential nutrients to a growing crop. Newly released, high yielding transgenic cotton cultivars are said to have a higher nutrient demand during the boll development period (between flowering and maturity) due to their higher boll retention rate and larger boll load than conventional cultivars (Sawan *et al*., 2008).

The manipulation of row spacing, plant density and the spatial arrangements of cotton plants, for obtaining higher yield have been attempted by agronomists for several decades in many countries. The maximum exploitation of these genotypes can be achieved only after determining their optimum planting densities in comparison to recommended cotton varieties. In general, it was observed that lower plant densities produces high values of growth and yield attributes per plant, but yield per unit area was higher with higher plant densities (Sharma *et al*., 2001). However, it may happen that moderate increase in plant densities may not increase the yield but decrease due to competition between plants for nutrients, water, space and light (Nehra and Kumawat, 2003).

Yield of cotton crop is influenced by improved production technology and water management practices (Sharma *et al*., 2007). Declining availability of irrigation water, needs sustainability in crop production and increasing demand of food can be achieved through adoption of improved irrigation water management technology (Kang *et al*., 2002). To improve water use efficiency on the basis of increasing crop yields there must be a proper irrigation scheduling strategy. Scheduling irrigation have been well studied and widely practiced for improving crop yield and/or increasing irrigation water use efficiency (Wang *et al*., 2002).Water use efficiency has been reported to be decreasing with increasing in irrigation times and amount of irrigation water applied per growing season (Qui *et al*., 2008).

MATERIAL AND METHODS

An experiment was conducted for two consecutive crop season *Kharif* 2012 and 2013 at Agricultural Research Station, Borwat Farm, Banswara. The eighteen treatment combinations comprised of three Bt cotton hybrids (Leo cott, Jai Bt and Paras Brahma) in main plot, two plant geometries (90 x 45 and 90 x 60 cm) in sub plot and three nutrient levels (100,125 and 150 % RDF) in sub-sub plot under split plot design with four replications. Experimental field was well prepared by two ploughing followed by harrowing and cultivator and one planking for uniform levelling were performed for sowing of cotton. The soil was medium in available nitrogen (245 and 250 kg/ha) and phosphorus (50 and 50.2 kg/ha) and high in available potassium (325 and 326 kg/ha) during both the years. The crop was sown in first week of June by dibbling of 2-3 seeds per hills and full dose of phosphorus and potash were applied before sowing, while nitrogen dose was given in two splits *i.e.* first half at the time of thinning and remaining half at flowering stage. All production and protection measures were applied as per package of the zone IV b.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth:

It is evident from pooled data (Table 1) show that the sowing of Leo cott Bt cotton hybrid gave significantly higher plant height (117.86), monopodial branches plant^{-1} (1.38) and sympodial branches plant^{-1} (22.59) as compared to Jai Bt plant height (109.42), monopodial branches plant^{-1} (1.29) and sympodial branches plant^{-1}(20.32) and Paras Brahma plant height (108.42), monopodial branches plant^{-1} (1.27) and sympodial branches plant^{-1}(19.66), respectively. The closer spacing 90 x 60 cm was recorded significantly higher plant height (118.75), monopodial branches plant^{-1} (1.34) and sympodial branches plant^{-1}(19.62) over 90 x 45 cm plant height (111.12), monopodial branches plant^{-1} (1.25) and sympodial branches plant^{-1}(16.87).Increasing levels of fertilizer from 100% RDF to150% RDF of NPK ha^{-1} significantly increase seed cotton. Application of 125 % RDF gave significantly higher plant height (115.32), monopodial branches plant^{-1} (1.38) and sympodial branches plant^{-1} (20.81) over 100% RDF plant height (108.48), monopodial branches plant^{-1} (1.24) and sympodial branches plant^{-1} (17.38), but it was found at

par with application of 150% RDF plant height (117.15) , monopodial branches plant^{-1} (1.40) and sympodial branches plant^{-1} (21.52) in the pooled analysis. Similar results were observed by Kang *et al*. (2002) and Buttar and Singh (2007).

Yield attributes:

Pooled data shows that (Table 2) the sowing of Bt cotton hybrids significantly influence yield attributes. The maximum boll plant^{-1} (29.81) and boll weight (4.27 g) were recorded under Bt cotton hybrid of Leo cott over sowing of Jai Bt boll plant^{-1} (24.09) and boll weight (3.99 g) and Paras Brahma boll plant^{-1} (23.30) and boll weight (3.93 g), respectively. Sowing of Bt cotton hybrids at wider plant spacing 90 x 60 cm gave significantly higher boll plant^{-1} (28.61) and boll weight (4.14 g) over 90 x 45 cm boll plant^{-1} (23.68) and boll weight (3.91 g). Increasing levels of fertilizer from 100% RDF to150% RDF of NPK

Table 1 : Effect of nutrient levels and crop geometries on growth parameters of Bt cotton hybrid

Treatments	Plant height (cm)			Monopodial branches / plant			Sympodial branches/plant		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
Bt cotton hybrids									
Jai Bt.	108.64	110.20	109.42	1.27	1.30	1.29	19.80	20.85	20.32
Leo cott	115.69	120.04	117.86	1.36	1.40	1.38	22.00	23.19	22.59
Paras Brahma	107.83	109.01	108.42	1.26	1.28	1.27	19.14	20.18	19.66
S.E.±	1.69	1.91	1.66	0.03	0.03	0.2	0.40	0.44	0.38
C.D. (P=0.05)	5.09	5.82	4.98	0.08	0.09	0.08	1.18	1.29	1.16
Plant spacing									
90 x 45 cm	109.18	113.06	111.12	1.25	1.26	1.25	16.23	17.50	16.87
90 x 60 cm	116.26	121.24	118.75	1.33	1.35	1.34	19.05	20.18	19.62
S.E.±	1.38	1.86	1.49	0.02	0.03	0.02	0.36	0.41	0.35
C.D. (P=0.05)	4.16	5.42	4.50	0.06	0.08	0.07	1.07	1.23	1.07
Nutrient level (NPK)									
100% RDF	108.31	108.65	108.48	1.23	1.26	1.24	16.76	18.00	17.38
125% RDF	114.65	115.99	115.32	1.36	1.40	1.38	20.04	21.58	20.81
150% RDF	116.21	118.10	117.15	1.39	1.41	1.40	21.01	22.04	21.52
S.E.±	1.64	2.01	1.70	0.04	0.04	0.03	0.38	0.36	0.34
C.D. (P=0.05)	4.72	5.97	5.04	0.12	0.12	0.11	1.14	1.08	1.03

Table 2 : Effect of nutrient levels and crop geometries on yield attributes and seed cotton yield of Bt cotton hybrid

Treatments	Bolls plant^{-1}			Boll weight (g)			Seed cotton yield (kgha^{-1})		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
Bt cotton hybrids									
Jai Bt.	23.14	25.03	24.09	3.96	4.01	3.99	1785	1832	1809
Leo cott	29.63	29.98	29.81	4.25	4.29	4.27	2206	2278	2242
Paras Brahma	22.20	24.40	23.30	3.91	3.95	3.93	1724	1786	1755
S.E.±	1.52	1.12	1.21	0.09	0.08	0.08	124	109	107
C.D. (P=0.05)	4.60	3.39	3.65	0.28	0.25	0.23	370	325	322
Plant spacing									
90 x 45 cm	23.50	23.85	23.68	3.87	3.94	3.91	2176	2303	2240
90 x 60 cm	28.19	29.02	28.61	4.08	4.20	4.14	1689	1815	1752
S.E.±	1.04	1.60	1.21	0.06	0.07	0.05	115	121	109
C.D. (P=0.05)	3.06	4.76	3.62	0.18	0.20	0.17	339	359	326
Nutrient level (NPK)									
100% RDF	21.23	22.00	21.62	3.78	3.85	3.82	1760	1870	1815
125% RDF	26.78	27.76	27.27	4.02	4.08	4.05	2209	2289	2249
150% RDF	29.12	29.49	29.31	4.10	4.15	4.13	2270	2337	2304
S.E.±	0.98	1.35	1.07	0.05	0.06	0.05	120	130	115
C.D. (P=0.05)	2.90	3.98	3.22	0.16	0.17	0.15	358	386	348

ha^{-1} significantly increase seed cotton. Application of 125 % RDF gave significantly higher boll plant^{-1} (27.27) and boll weight (4.05 g) over 100% RDF boll plant^{-1} (21.62) and boll weight (3.82 g), but it was found at par with application of 150 % RDF boll plant^{-1} (29.31) and boll weight (4.13 g) in the pooled analysis. Similar results observed by Sharma *et al.* (2007) and *Deng et al*. (2004).

Seed cotton yield:

Two years pooled data shows that (Table 2) the Bt cotton hybrid of Leo cott gave higher seed cotton yield (2242 kg ha^{-1}) as compared to Jai Bt and Paras Brahma (1809 and1755 kg ha^{-1}) in the pooled analysis. The closer plant spacing 90 x 45 cm was recorded significantly higher seed cotton yield (2240 kg ha^{-1}) over wider plant spacing 90 x 60 cm (1752 kg ha^{-1}). Increasing levels of fertilizer from 100% RDF to150% RDF of NPK ha^{-1} significantly increase seed cotton. Application of 125 % RDF gave significantly higher seed cotton yield (2249 kg ha^{-1}) over 100% RDF (1815 kg ha^{-1}), but it was found at par with application of 150 % RDF (2304 kg ha^{-1}) during both the years and as well as in pooled analysis. The increase in seed cotton yield per plant was observed in plant geometries. This might be due to better aeration, adequate interception of light and lesser competition for available nutrient and moisture, which have resulted in synthesis of higher photosynthates and in turn helped to produce higher seed cotton yield per plant under wider intra row spacing. Similar results were reported by Sankarnarayanan *et al*. (2004) and Buttar and Singh (2007).

Water use efficiency:

It is evident from pooled data of two years shows that (Table 3) the under Bt cotton hybrid of Leo cott was recorded significantly higher water use efficiency (30.51 kg ha/cm) as compared to Jai Bt and Paras Brahma (24.61 and 23.88 kg ha/cm), respectively. The closer spacing 90 x 45 cm was recorded significantly higher water use efficiency (30.46 kg ha/cm) over 90 x 60 cm water use efficiency (23.83 kg ha/cm).Increasing levels of fertilizer from 100% RDF to150% RDF of NPK ha^{-1} significantly increase seed cotton. Application of 125 % RDF gave significantly higher water use efficiency (30.60 kg ha/cm) over 100% RDF water use efficiency (24.69 kg ha/cm), but it was found at par with application of 150% RDF water use efficiency (31.34 kg ha/cm) in the pooled analysis (Deng *et al.*, 2004) and Sankarnarayanan *et al.*, 2004).

Economics:

Pooled data shows that (Table 3) the sowing of Bt cotton hybrids significantly influence net return and B:C. The maximum net return (Rs. 58470/ha) and B:C (2.92) were recorded under Bt cotton hybrid of Leo cott over sowing of Jai Bt net return (Rs. 43298/ha) and B:C (2.16)

Table 3 : Effect of nutrient levels and crop geometries on WUE and economics of Bt cotton hybrid

Treatments	Water use efficiency (kg ha/cm)			Net return (Rs./ha)			B:C		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
Bt cotton hybrids									
Jai Bt.	24.79	24.43	24.61	42475	44120	43298	2.12	2.21	2.16
Leo cott	30.64	30.37	30.51	57210	59730	58470	2.86	2.99	2.92
Paras Brahma	23.94	23.81	23.88	40340	42510	41425	2.02	2.13	2.07
S.E.±	1.34	1.39	1.25	2750	2876	2588	0.19	0.22	0.18
C.D. (P=0.05)	4.01	4.40	3.72	8082	8462	7762	0.56	0.64	0.56
Plant spacing									
90 x 45 cm	30.22	30.71	30.46	56160	60605	58383	2.81	3.03	2.92
90 x 60 cm	23.46	24.20	23.83	39865	44275	42070	2.07	2.30	2.19
S.E.±	1.56	1.74	1.52	3245	3504	3105	0.16	0.20	0.17
C.D. (P=0.05)	4.60	5.16	4.55	9702	10509	9310	0.52	0.57	0.49
Nutrient level (NPK)									
100% RDF	24.44	24.93	24.69	42600	46450	44525	2.24	2.44	2.34
125% RDF	30.6	30.52	30.60	57315	60115	58715	2.87	3.01	2.94
150% RDF	31.53	31.16	31.34	58450	60795	59623	2.78	2.90	2.84
S.E.±	1.87	1.63	1.61	2845	2903	2644	0.14	0.16	0.13
C.D. (P=0.05)	5.60	4.88	4.80	8522	8700	7928	0.44	0.50	0.41

and Paras Brahma net return (Rs. 41425/ha) and B:C (2.07) in the pooled analysis. Sowing of Bt cotton hybrids at plant spacing 90 x 45 cm gave significantly higher net return (Rs.58383/ha) and B:C (2.92) over sowing at wider plant spacing 90 x 45 cm net return (Rs. 42070/ha) and B:C (2.19).Increasing levels of fertilizer from 100% RDF to150% RDF of NPK ha^{-1} significantly increase seed cotton. Application of 125 % RDF gave significantly higher net return (Rs. 58715/ha) and B:C (2.94) over 100% RDF net return (Rs. 44525/ha) and B:C (2.34), but it was found at par with application of 150 % RDF net return (Rs. 59623/ha) and B:C (2.84) in the pooled analysis. Similar results observed by Deng *et al*. (2004) and Buttar and Singh (2007).

Conclusion:

It could be concluded that the significantly higher seed cotton yield. The Bt hybrid of Leo cott gave higher seed cotton yield and the closer spacing 90 x 45 cm was recorded significantly higher seed cotton yield. Application of 125 % RDF gave significantly higher seed cotton yield. It was proposed to initiate further studies on agronomic management of crop geometry, NPK level and irrigation scheduling as it will be a promising higher remunerative crop of South East Rajasthan.

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