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Performance of *Bt* cotton hybrids under varying plant spacing's and nutrient levels

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ABSTRACT : A field experiment was conducted during *kharif* season of 2014 and 2015 at Agriculture Research Station (MPUAT), Borwat Farm, Banswara to evaluate the response of *Bt* cotton hybrids under different plant spacings and nutrient levels. The treatments comprised of three *Bt* cotton hybrids (PCH 888, Paras Brahma and Jai *Bt*) in main plot, two plant spacings (S_1: 90 x 45cm and S_2: 90 x 60cm) in sub and three nutrient levels (N_1: 100% recommended RDF of 120+60+30kgNPK/ha) (N_2: 125% RDF) and (N_3:150% RDF) in sub-sub plots of split plot design with three replications. The results revealed that *Bt* hybrid PCH 888 planted at 90x45cm spacing with (150%) RDF produced seed cotton yield (4900 kg/ha) in response of plant growth and bolls/plant over other interactions. The maximum nutrient use efficiency in the term of partial factor productivity (PFP) was significantly recorded in PCH 888 with closer plant density (90x45cm) at RDF. Monitory returns shown increasing trend with intra row spacing and fertility levels which varying with *Bt.* hybrids. The maximum net return (Rs 1, 57194/ha) was obtained with the interaction of PCH 888 at closer spacing and higher nutrient level. However, maximum B:C ratio (4.05) was calculated with interaction of PCH 888 at closer spacing and (150%) RDF followed by (125%) RDF and it found significantly higher over rest interaction effects. Overall, it is concluded that *Bt* hybrid PCH-888 was found more productive and profitable at 90x 45cm spacing with (125%) RDF under humid condition of southern Rajasthan.

Key words : B: C ratio, *Bt* hybrid, net return, nutrient, seed cotton yield, spacing

Cotton is known as **"White Gold"** is grown mainly for fiber,the plant also produces large quantities of seeds which is an important sources of oil and cottonseed meal is used as livestock feed (Desrochers and Szurmark, 2017). *Bt* cotton is introduced with inherent resistance to American bollworm (*Heliocoverpa armigera* Hubner), in 2002 (Bollgard I) and American bollworm and tobacco caterpillar (*Spodoptera litura* Fabricius) in 2006 (Bollgard II) in India led to tremendous changes in cotton production (Blaze *et al.*, 2014). Area under *Bt* Cotton was 29,000 ha in 2002-2003 (0.38 per cent of total cotton area) increased to about 11.84 m ha in 2014-2015 (92% of total cotton area). Presently, India is the second largest producer, consumer and exporter of cotton in the world (Anonymous 2015-2016). However, average cotton productivity of India is lower compared to other countries. The productivity and profitability/unit area depends upon two major factors *viz.,* the genetic potential of a plant and its environment such as plant density and supply of inputs. The newly released *Bt* cotton hybrids have more yield potential and input use efficiency than non *Bt* cotton and local hybrids because, its plant is modified according to produce maximum economical yield due to effective control of three types of bollworms, *viz.*, American,spotted and pink bollworms and lesser flower/boll dropping. As a result, maximum bolls are converted into

yield. Cotton crop is exhaustive crop as evident to remove 43.2-29.3-53.3kg of N-P-K/t of economic product (Hussain *et al.*, 2014).The information on suitable crop geometry and fertilization of new cotton hybrid is lacking at present and will be very useful for exploiting its full potentiality to boost up the yield level. Effect of nutrients may differ with spacing because their profound impact on canopy structure, phonological behavour and fruiting pattern (Shukla *et al.,* 2013). It is therefore, necessary to study the interacting response of *Bt* cotton hybrids at spacing with nutrient levels. The present investigation was planned to study the evaluation of *Bt* cotton hybrids under different plant spacing and nutrient levels with the objective to find out and determine the effect of spacings and nutrient levels on growth, yield and economics of cotton hybrids under humid condition of southern Rajasthan.

MATERIALS AND METHODS

A field experiments was conducted during two consecutive rainy season (June-October) of 2014 and 2015 at Agricultural Research Station (MPUAT), Banswara (Rajasthan) located at 23^0 33' N latitude, 74^0 27'E longitude, and altitude of 220M above Mean Sea Level. It is covered under humid southern plain agro climatic zone of Rajasthan. The soil of experimental field was clay loam in texture, slightly alkaline in reaction with low in organic carbon (0.45%), low in available nitrogen (238kg/ha), medium in available (18kg P_2O_5/ha) and high in available (384 kg K_2O_5/ha). The treatments comprised of three *Bt* cotton hybrids (PCH 888, Paras Brahma and Jai *Bt*) in main plot, two plant spacings (S_1: 90 x 45cm and S_2: 90 x 60cm) in sub and three nutrient levels (N_1: 100% recommended dose of 120+60+30 kg NPK/ha), N_2: (125%) RDF and N_3:(150%) RDF in sub sub plots were randomized in split plot design with three replications. *Bt* cotton hybrids were sown on first fortnight of June by dibbling at different plant spacing of both nutrient levels. Fertilizers were applied as per treatments. The full dose of P and K and half dose of N was applied as basal before sowing and remaining dose of N was applied in two equal splits at square formation and boll development stages. Pendimethalin, pre emergence (PE) herbicide was applied just after sowing with a knapsack sprayer fitted with a flat fan nozzle using a spray volume of 500 l water/ha and one hoeing and weeding was done at 25 DAS for weed management. Data of plant growth and yield attributes were recorded from five randomly selected plant in each plot. Whereas, seed cotton yield was recorded from whole plot area of each picking and and expressed in kg/ha. Nutrient use efficiency was calculated in the term of partial factor productivity (kg economic yield/ kg applied nutrient) computed through formula given by Dobermann (2007) to study the response of fertilizer to produced economic yield per unit investment of nutrient. Economics calculated based on market price of seed cotton and cost of cultivation. The data were subjected to analysis of variance technique as per the statistical procedure and the treatment pooled means were compared at 5 per cent level of significance.

RESULTS AND DISCUSSION

Effects of *Bt* cotton hybrids : The Pooled data of two years (Table 1) indicated that tested *Bt* cotton hybrids expressed significantly their characters like plant height, bolls/plant, boll weight, seed cotton yield, lint yield as well as net return and B:C ratio. PCH 888 exhibited significantly higher plant height (187.33cm), bolls (64.92/plant) and seed cotton yield (4282kg/ha), lint yield (1509kg/

Table 1. Effect of plant spacing and nutrient levels on growth, yield attributes, yield and economics of *Bt* hybrids (Pooled data of 2014 and 2015)

Treatment	Plant height (cm)	Bolls/ plant	Boll weight (g)	Seed cotton yield (kg/ha)	Lint yield (kg/ha)	Net return (Rs/ha)	B:C ratio
***Bt* cotton hybrids**							
PCH 888	187.33	64.92	4.65	4282	1509	133267	3.50
Paras Brahma	160.47	43.14	4.51	3058	1029	84300	2.21
Jai *Bt*	153.81	53.84	4.66	3710	1228	11074	2.90
CD (p=0.05)	3.19	2.08	0.11	115	26.33	3098	0.08
Plant spacing (cm)							
90 x 45	170.21	51.86	4.58	3976	1357	121022	3.18
90 x 60	164.19	56.07	4.63	3391	1154	97606	2.56
CD (p=0.05)	2.61	1.70	0.07	93.50	21.50	2530	0.07
Nutrient level (NPK)							
RDF (100%)	157.61	49.56	4.54	3298	1129	94709	2.55
RDF (125%)	167.25	54.59	4.63	3776	1285	113008	2.97
RDF (150%)	176.75	57.75	4.66	3976	1351	120224	3.10
CD (p=0.05)	3.17	2.08	0.09	94.09	21.76	2757	0.07

ha), net return (Rs 1,33,267/ha) and B:C ratio (3.50) as compared to Paras Brahma and Jai *Bt*. However, Paras Brahma obtained higher boll weight (4.66g/boll) followed by PCH 888 and significantly superior over Jai *Bt* PCH 888 recorded significantly better yield by 28.60 and 13.37 per cent over Paras Brahma and Jai *Bt*, respectively. Owing to improved bolls/plant values which in turn helped in capturing of significantly highest yield and economics. Similar resultsreported by Biradar *et al.,* (2010). The maximum partial factor productivity of N, P and K (Table 2) was recorded with PCH 888 which was found significantly superior over over Paras Brahma and Jai *Bt*. Partial factor productivity of nutrients recorded higher in PCH 888 might be due to tall and vigorous growing habit that obtained high biomass production as compared to rest hybrids.

Effect of plant spacing : Pooled data (Table1) revealed that plant spacings were significantly influenced the plant growth, yield attributes and seed cotton yield, lint yield and economics. Maximum plant height (170.21cm) was obtained at 90x45cm that recorded significantly 3.54 per cent higher over 90x60cm. The increase in plant height was associated with increased internodes length. Jat *et al.,* (2014) reported similar results. However, bolls/plant was significantly higher (56.07/plant) in wider spacing than closer spacing (51.86/plant). Singh *et al.*, (2014) also observed significantly higher bolls/plant with wider plant geometry (67.5 x 90cm) as compared to closer one (67.5 x 75cm). The higher bolls/plant in wider spacing might be due to lesser competition among the plants for available resources. There was non significant effect of plant spacing on the boll weight. The closer spacing 90x45 cm gave significantly higher seed cotton yield (3976kg/ ha) as compared to wider spacing (3391kg/ha). The enhancement in seed cotton yield may be due to higher plant density. Manjunatha *et al.,* (2010) reported the similar results. The closer spacing 90x45cm gave higher lint yield (1357kg/

Table 2. Effect of nutrient and plant geometry on partial factor productivity (PFP) of *Bt* cottonhybrids (Pooled data of 2014 and 2015)

Treatment	Partial factor productivity (kg seed cotton yield/kg applied nutrient)		
	N	P_2O_5	K_2O
Bt cotton hybrids			
PCH 888	29.01	58.02	116.04
Paras Brahma	20.63	41.26	82.52
Jai *Bt*	25.1025.26	50.20	100.39
CD (p=0.05)	1.11	2.25	4.50
Plant spacing (cm)			
90 x 45	26.88	53.77	107.54
90 x 60	22.94	45.88	91.76
CD (p=0.05)	0.90	1.82	3.65
Nutrient level (NPK)			
RDF (100%)	27.48	54.96	109.92
RDF (125%)	25.17	50.34	100.67
RDF (150%)	22.09	44.17	88.35
CD (p=0.05)	0.97	1.97	3.95

ha) as compared to wider spacing (1154kg). Closer spacing obtained significantly higher net return (Rs 1, 21022/ha) and B:C ratio (3.18) than net return (Rs 97606/ha) and B:C ratio (2.56) at wider spacing, respectively. Partial factor productivity (PFP) of nutrients (Table 2) was significantly higher with closer spacing compared to wider spacing. It might be possible due higher production with high plant density

Effect of nutrient levels : Pooled data of both years (Table 1) revealed that plant growth, yield attributes and seed cotton yield, lint yield and economics influenced with nutrient levels. The higher nutrient level (150% RDF) resulted higher in plant height over 100 and 125 per cent recommended dose of fertilizer.Bolls/plant increased with increasing nutrients levels on upto 150 per cent recommended dose of fertilizer. Sunitha *et al.,* (2010) reported similar results. However, maximum boll weight (4.66g) was recorded with 150 per cent RDF followed by 125 per cent RDF and significantly superior over 100 per cent RDF. Seed cotton yield (3976kg/ha) and lint yield (1351kg/ha) were significantly superior with 150 per cent RDF over 125 per cent RDF and 100 per cent RDF. Higher seed cotton yield and lint yield may be due to more number of bolls per plant under elevated levels of nutrient reported by Sunitha *et al.,* (2010) and Bhalerao *et al.*, (2010). These similar results were conformed with findings of Biradar *et al.,* (2010) The maximum net return (Rs 1,20,224/ha) and B:C ratio (3.10) recorded at 150 per cent RDF which were significantly higher than 125 per cent RDF and 100 per cent RDF. It may be due to get higher yield at 150 per cent RDF than lower

Table 3. Interaction of plant spacing and nutrient levels on seed cotton yield and economics of *Bt* hybrids (Pooled data of 2014 and 2015)

Interaction	Seed cotton yield (kg/ha)			Net return (Rs/ha)			B:C ratio		
Spacing and fertility	PCH 888	Paras Brahma	Jai *Bt*	PCH 888	Paras Brahma	Jai *Bt*	PCH 888	Paras Brahma	Jai *Bt*
S_1N_1	4127	3031	3490	127891	84051	102382	3.44	2.26	2.75
S_1N_2	4644	3464	4139	147760	100556	127554	3.89	2.65	3.36
S_1N_3	4900	3670	4316	157194	107987	133820	4.05	2.78	3.45
S_2N_1	3645	2339	3154	108609	56360	88963	2.92	1.52	2.39
S_2N_2	4122	2786	3497	126875	73426	101875	3.34	1.93	2.68
S_2N_3	4252	3056	3661	131275	83419	107652	3.38	2.15	2.77
CD (p=0.05%)	190	7589	0.21						

S=Plant spacing and N= Nutrient level

nutrient level. Similar, finding were reported by Singh *et al.*, 2014 and Bharathi *et al.*, 2014. Partial factor productivity (Table 2) was significantly higher recorded with 100 per cent RDF compared to higher dose of nutrient.It might be conformed that partial factor productivity increased to lower nutrient levels because yield is divided by dose of nutrients.

Interaction effect of hybrid, spacing and nutrient : The interaction effect of hybrids, spacing and nutrient levels was observed on seed cotton yield, net return and B:C ratio (Table 3) indicated that maximum seed cotton yield (4900kg/ha) and net return (Rs 1,57,194/ ha) obtained with interaction of *Bt* hybrid PCH 888 with closer plant spacing (90x45cm) at 150 per cent RDF which was found significantly superior over rest interaction. However, maximum B:C ratio (4.05) was recorded with the interaction of *Bt* hybrid PCH 888 with closer spacing at 150 per cent RDF followed by interaction of PCH 888 with closer spacing at 125 per cent RDF which was significantly higher than rest interactions. It indicated that yield, net return and B:C ratio might be increased through yield potential of hybrids at optimum spacing and economical nutrient level.

CONCLUSION

Based on two years study, it can be concluded that high yielding *Bt* cotton hybrid responded higher to closer spacing (90x45cm) and higher nutrient level (125% RDF) as compared to wider spacing and lower levels to produce higher yield and profit/unit area under humid condition of Southern Rajasthan and similar agro-ecological condition.

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