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Productivity and nutrient uptake of *Bt* cotton (*Gossypium hirsutum* L) under different spacing and nutrient levels

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ABSTRACT : The experiment was conducted in split plot design with 3 replications during *kharif,* 2010 at Research Area of Department of Agronomy, CCS Haryana Agricultural University, Hisar. The combination of three spacing and two time of N fertilizer application were kept in main plots while three nutrient levels were kept in subplots. Seed cotton yield (kg/ha) was highest in closer spacing (100 x 40 cm), respectively. Plant spacing had a significant effect on N and K uptake but non significant effect was noticed on phosphorus uptake. For total NPK uptake cotton seed was highest in S_1 with a significant difference with S_2. Nitrogen uptake was non significant. Total uptake of NPK by cotton crop under $F_1$and F_3 fertilizer doses did not differ significantly. Maximum potassium uptake was recorded in T_2 followed by T_1. The time of N fertilizer application did not differ in N, P and K uptake by cotton seed as well as total uptake by crop. Seed cotton, cotton seed and lint yields (kg/ha) were highest at closer spacing (100 x 40 cm) as compared to 100 x50 cm and 100 x 60 cm spacings, respectively. Time of N fertilizer application influenced significantly the seed cotton, cotton seed and lint yields (kg/ha). Maximum seed cotton, cotton seed and lint yields (kg/ha) were recorded with 3 splits applications of N fertilizer as compared to 2 splits. Maximum seed cotton, cotton seed and lint yields (kg/ha) were recorded with 100 per cent RDF followed by 125 per cent RDF. Plant spacing had a significant effect on available N, P and K content of soil after harvest of crop. Maximum N, P and K content in soil were observed with 100 x 60 cm spacing as compared to other spacings. The maximum available N, P and K in soil was observed with 2 split doses of N application as compared to 3 split doses of N application. Significantly higher available N, P and K in soil after harvest of crop was found with 125 per cent RDF, which is significantly superior over 75 per cent RDF and 100 per cent RDF.

Key words: *Bt* cotton, productivity, spacing, nutrient

The country is the fifth largest grower of genetically modified (GM) crops by area. Productivity of cotton can be considerably improved by cultivation of *Bt* hybrids with suitable agronomic practices *e.g.,* proper spacing, method of planting and nutrient management. Spacing affects plant growth and fruiting through its effects on the microclimate of the crop. Response of cotton to applied nutrients is governed by environment and cultural factors. Most of the cotton growing soils are deficient in N and P. Balanced fertilization of cotton is very essential for achieving high yields. Effect of nutrients may differ with spacing because of their profound impact on canopy structure, phonological behavior and fruiting pattern. It is, therefore, necessary to study the interacting influence of nutrients with spacing.

The experiment during kharif 2010 was conducted at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar, situated in the semi arid, sub tropical region of north western India, in the state of Haryana at 29^0102 N latitude, 75^0462 E longitude and at an altitude of 215.2 m above mean sea level. The experiment was laid out in split plot design with three replications. The main plots treatments were spacing (cm) *viz.,* S_1:100 x 40, S_2:100 x 50 and S_3:100 x 60 time of N fertilizer application T_1: (50% at flowering and 50% at square formation) andT_2:(25% at basal, 37.5% at flowering and 37.5%) at square formation. Sub plots treatments were three nutrient levels (NPK) F_1: 75 per cent RDF, F_2 :100 per cent RDF and F_3 : 125 per cent RDF replicated thrice in split plot design. The soil of the experimental field was normal with respect to electrical conductivity, slightly high in pH, low in organic carbon and available nitrogen, medium in available phosphorus and high available potash. The rainfall was highly erratic. The weather showed that 709.3 mm rain was received during the crop season and the max and min temp during the crop season varied from 45.2 to 27.7^0 C and 12.2 to 28.3^0 C,

respectively. The mean weekly pan evaporation values varied between 2.1 to 11.2 mm/day with a total of 544.8 mm during the crop growing season. Results were analyzed statistically and presented in tables.

Effect of spacing : The closer spacing 100x40 cm gave highest seed cotton yield (3695 kg/ha) as compared to 100x50 cm (3290 kg/ha) and 100x60 cm (3185 kg/ha) spacings and resulted in 16 per cent higher seed cotton yield (kg/ha) over 100x60 cm spacing (Table 1). This increase in seed cotton yield may be due to higher plant population over closer spacing. Similar results were found by Nehra and Kumawat (2003) who reported that wider spacing of 75x15 cm gave significantly higher seed cotton yield (1411 kg/ha) than other two wider spacings of 75x22 cm (1240 kg/ha) and 75 x 30 cm (1264 kg/ha). The closer spacing 100x40 cm gave higher cotton seed yield (2744 kg/ha) as compared to 100x50 cm (2456 kg/ha) and 100x60 cm (2385 kg/ha) and resulted in 15 per cent more cotton seed yield over 100x60 cm spacing (Table 1). Similar results were found by Narkhede *et al.*, (2000). The closer spacing 100x40 cm gave higher lint yield (905 kg/ha) as compared to 100x50 cm (785 kg/ha) and 100x60 cm (763 kg/ha) and resulted in 18.6 per cent higher in lint yield over 100x60 cm spacing (Table 1).

Available N, P and K in soil after harvest of crop were significantly influenced by plant geometry. The 100x60 cm spacing (S_3) exhibited significantly higher available N, P and K in soil (136:16:301 kg/ha) than closer spacings. Next best treatment was 100x50 cm (S_2) which was significantly superior to closer spacing of 100x40 cm (S_3). This might be due to higher seed cotton yield under 100x40 cm which removed more nutrient than other spacing (Table 2).

Effect of time of N fertilizer application : The seed cotton, cotton seed and lint yields recorded with three split dose of N fertilizer application were significantly higher over two splits of N fertilizer application (Table 1). Difference in available N, P and K in soil after harvest of crop due to split doses of N fertilizer was also significant. Max available N, P and K in soil (132:15:296 kg/ha) was observed with 2 split doses of N application (T_1) as compared to 3 split doses of N application (T_2) (Table 2).

Effect of fertilizer : Seed cotton yield (kg/ha) was higher with 100 per cent RDF (3515 kg/ha) followed by 125 per cent RDF (3345 kg/ha) and 75 per cent RDF (3155 kg/ha). Resulted in 11.41 per cent higher in seed cotton yield over 75 per cent RDF. It might be due to more photosynthetic activity which resulted in more dry matter accumulation with increasing amount of fertilizer (Table 1). Similar results were obtained by Srinivasulu *et al.,* (2006) who reported that application of 150 kg N /ha recorded higher yield (1545 kg/ha) over 120 kg N /ha (1500 kg/ha). Cotton seed yield (kg/ha) was maximum at 100 per cent RDF (2638 kg/ha) followed by 125 per cent of recommended dose of fertilizer (2542 kg/ha) and 75 per cent RDF (2404 kg/ha). Results showed that 100 per cent RDF resulted in 9.73 per cent higher cotton seed yield over the 75 per cent recommended dose of fertilizer. It might be due to more photosynthesis and ultimately

Table 1. Yield of seed cotton, cotton seed and lint yield of *Bt* cotton (*Gossypium hirsutum* L) under different spacing and nutrient levels

Treatments	Seed cotton yield (g/ha)	Cotton seed yield (kg/ha)	Lint yield (kg/ha)
Spacing (cm)			
S_1: 100x40	3695	2744	905
S_2: 100x50	3290	2456	785
S_3: 100x60	3185	2385	763
SE m+	70	14.81	5.50
P=0.05	276	43.23	16.17
Time of N fertilizer application			
T_1: At flowering (50%) and at square formation (50%)	3180	2413	748
T_2: At sowing (25%), at flowering (37.5%) and at square formation (37.5%)	3590	2643	872
SE m+	48	12.21	3.21
P=0.05	140	35.41	9.05
Fertilizers levels			
F_1: RDF* (75%)	3155	2404	697
F_2: RDF (100%)	3515	2638	844
F_3: RDF (125%)	3345	2542	762
SE m+	59	10.81	5.82
P=0.05	172	31.43	17.13

Table 2. Effect of different plant spacings, time of N application and nutrient levels on available nitrogen, phosphorus and potassium content (kg/ha) in soil after harvest of crop

Treatments	Nitro-gen	Phos-phorus	Pota-ssium
Spacing (cm)			
S_1 : 100x40	122	13	285
S_2 : 100x50	126	14	288
S_3: 100x60	136	16	30
SE m±	0.31	0.04	10.22
P=0.05	0.90	0.12	0.65
Time of N fertilizer application			
T_1 : At flowering (50%) and at square formation (50%)	132	15	296
T_2 : At sowing (25%) and at flowering (37.5%) and at square formation (37.5%)	124	13	287
SE m±	0.25	0.03	0.18
P=0.05	0.72	0.10	0.53
Nutrient levels			
F_1 : RDF* (75%)	128	14	291
F_2 : RDF 100%)	121	13	285
F_3 : RDF (125%)	134	15	299
SE m±	0.19	0.08	0.21
P=0.05	0.55	0.24	0.60

*RDF = Recommended dose of fertilizers RDF 175: 60: 60 (kg NPK/ha)
*Available NPK (152:19:315) before sowing in soil (kg/ha)

increase in dry matter with an increased amount of fertilizer (Table 1). Similar results were obtained by Srinivasulu *et al.,* (2006) who reported that application of 150 kg N /ha recorded higher yield (1545 kg/ha) than 120 N kg/ha (1500 kg/ha). Lint yield increased with increasing dose of fertilizer from 75 per cent RDF (697 kg/ha) to 100 per cent RDFs (844 kg/ha). Results showed that 100 per cent RDF resulted in 21.09 per cent higher seed cotton yield over 75 per cent RDF (Table 1). Similar results were obtained by Srinivasulu *et al.,* (2006) and reported that application of 150 kg N /ha recorded higher yield (1545 kg/ha) than 120 kg N /ha (1500 kg/ha).

Significantly, higher available N, P and K in soil after harvest of crop was found with 125 per cent RDF, which is significantly superior over 75 per cent RDF and 100 per cent RDF (Table 2). The above results are also corroborated by the findings of Katkar *et al.,* (2002).

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