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Website: www.aarf.asia Email : editor@aarf.asia , editoraarf@gmail.com

PRODUCTIVITY AND QUALITY OF BT COTTON (*GOSSYPIUM HIRSUTUM)* AS INFLUENCED BY PLANT GEOMETRY AND FERTILIZER LEVELS

E. Aruna
Acharya N.G. Ranga Agricultural University
Regional Agricultural Research Station, Nandyal , Andhra Pradesh -518 502

ABSTRACT

A field experiment was conducted at Regional Agricultural Research Station, Nandyal, kurnool district, Andhra Pradesh during kharif seasons of 2008 to 2010 for three years on vertisols to find out optimum spacing and fertilizer level to Bt cotton (Gossypium hirsutum). The experiment was laid out in double split plot design with plant geometry of 120 cm x 60 cm and 90 cm x 45 cm as main plots, hybrids bunny Bt and bunny non Bt as sub plots and fertilizer levels 120-60-60,150-60-60 and 180-60-60 kg N-P-K / ha as sub sub plots and replicated thrice. From pooled analysis of 3 years data, it was observed that, closer spacing of 90 cm x 45cm for Bt cotton recorded 15-19 % increase in kapas yield compared to wider spacing of 120 cm x 60 cm. Bunny Bt hybrid recorded 70 % increased seed cotton yield compared to its non Bt counterpart. Regarding fertilizers, higher fertilizer levels (150-60-60 and 180-60-60 kg N-P-K / ha) did not significantly improve the kapas yield. Fibre quality characters were not significantly influenced by plant geometry or Bt gene or fertilizer. Closer spacing of 90cm x 45cm and recommended dose of fertilizer (120-60-60 kg N-P-K / ha) for non Bt were found suitable for bunny Bt cotton under rainfed conditions.

Key words: Bt cotton, Fertilizer, Plant geometry, Productivity, Quality.

Introduction

Cotton (*Gossypium hirsutum*) crop assumes a place of special significance in Indian economy. India is the only country in the world which grows four types of cultivated species of cotton. During the last decade, a decline in seed cotton yield was observed due to severe incidence of boll worms which resulted in decrease in cotton area. However, after the introduction of Bt cotton which resists the boll worm attack in 2002, the technology has been widely accepted by Indians and the area under cotton increased to 11.64 million ha with a production of 33.4 million bales with productivity of 489 kg / ha in 2012-13 (Anonymous, 2013). Now 90 per cent of cotton area was occupied by Bt cotton. Till date, there is confusion in the farming community that whether Bt crop needs same plant geometry and nutrient requirement as that of non Bt cotton. Vegetative growth in Bt cotton is restricted due to 100% setting of fruiting bodies on the plant, which requires closer spacing for better yields. Chen *et al*. (2004) specified the need to develop agronomic management practices as there are changes in vegetative and reproductive characteristics of Bt cotton. Keeping this in view the present study was carried out to find the optimum spacing and nitrogen requirement for Bt cotton in the scarce rain fall zone of Andhra Pradesh under rainfed conditions.

Material and Methods

A field study was carried out during kharif seasons of 2008 to 2010 at the Research farm of Regional Agricultural Research Station, Nandyal, Andhra Pradesh. The soil was deep black, low in available nitrogen (139 kg/ha), high in available phosphorus (87 kg /ha) and potassium (590 kg /ha) with P^H 8.67 and EC 0.08 dS m^{-1}. The experiment was laid out in double split plot design with plant geometry as main plots, hybrids as sub plots and fertilizer levels as sub sub plots and replicated thrice. The plot size was 7.2 m x 5.4 m. The main plot treatments consisted of two plant geometries viz., 120 cm x 60 cm and 90 cm x 45 cm. The two sub plots were bunny Bt hybrid and isogenic non Bt hybrid. Three N-P-K levels 120-60-60, 150-60-60 and 180-60-60 kg / ha were allocated in sub sub plots. Entire phosphorus (60 kg/ha) and half potassium (30 kg / ha) were applied as basal. Nitrogen was applied in three splits at 30, 60 and 90 DAS. Remaining half potassium (30 kg / ha) was applied along with last split of nitrogen. Sowing was done on 31 July, 28 August and 3 August respectively in 2008, 2009 and 2010 by dibbling method. All other recommended package of practices was followed during the crop season. A total of 661.7 mm, 497.8 mm and 529.4 mm rain fall was received in 2008, 2009 and 2010 respectively during the crop period. The data on growth and yield parameters was collected at harvest by selecting five random plants in the plot. Seed cotton collected from each plot (200g / plot) was ginned in Lilliput ginning machine and the samples were sent to CIRCOT lab, Guntur for quality analysis. The seed after acid treatment was sent for oil analysis. Economics was worked out based on present market price.

Results and discussion

Effect of spacing

Plant geometry has no significant influence on mean plant height, number of monopodia and sympodia per plant. Reddy and Gopinath (2008) and parminder kaur *et al*. (2010) also reported no significant difference in number of monopodia as well as sympodia and length of sympodial branches with different plant geometries. Yield parameters, the number of bolls per plant and boll weight were not significantly influenced by plant geometry. Kapas yield was also not influenced significantly by plant geometry. But, in interaction (Table 3) of Bt versus non Bt and spacing, it was indicated that there was 15-17% improvement in kapas yield in Bt cotton with narrow spacing (90 cm x 45 cm) compared to wider spacing (120 cm x 60 cm) at different fertilizer levels. Where as in non Bt cotton the effect of plant geometry was inconsistent. Bhalerao and Godavari (2010), Parminder kaur *et al*. (2010) also recorded higher seed cotton yields with closer plant geometry in Bt hybrids. The reason might be that Bt cotton hybrids with short branches and determinate growth may be requiring less plant space when compared to conventional hybrids.

Quality characters like mean staple length, strength, uniformity ratio and micronaire were not significantly influenced by plant geometry. Constable and Hearn (1981) reported that most of the quality parameters are genetically governed but minor improvement could possibly be made by modifying the plant environments. Ginning percentage and seed oil percentage were also not affected by spacing. Higher benefit cost ratio (2.34) was recorded with narrow spacing (90 cm x 45 cm) compared to wider spacing i.e 120 cm x 60 cm (2.21).

Effect of Bt gene

Plant height, number of monopodia and sympodia per plant were not influenced by Bt gene. But, Sunitha *et al*. (2010) reported more sympodia in Bt cotton. Mean number of bolls per plant was significantly superior in Bt cotton. Boll weight was not significantly influenced by Bt gene. Mean kapas yield was increased significantly in Bt cotton compared to its non Bt counterpart. Pooled data also reflected the superiority of Bt cotton with 70% increase in seed cotton yield (Table 3). The superior performance of Bt hybrids might be due to inbuilt resistance to boll worms conferred by Bt gene which in turn might have caused Bt hybrids to move in to reproductive phase early by curtailing vegetative growth and helped to produce higher seed cotton yield.

Ginning percentage, seed oil percentage and fibre quality characters were not significantly influenced by Bt gene (Table2). Higher benefit cost ratio (3.00) was observed with Bt cotton hybrids.

Effect of fertilizers

Plant height, number of monopodia and sympodia were not significantly influenced by fertilizer levels. Yield attributing characters like number of bolls per plant and boll weight were not significantly influenced by fertilizer levels. Mean data indicated no significant improvement in kapas yield with higher dose of fertilizers in cotton. Excessive fertilization may result in excessive vegetative growth imbalancing source and sink causing poor seed cotton yield. Reddy and Kumar (2010) and Bhalerao and Godavari (2010) also recorded insignificant influence of fertilizers on boll number and seed cotton yield. They also reported a decline of 7.4 % and 15.2 % yield with higher nitrogen levels of 200 and 250 kg / ha) . In contrast, sunitha *et al.* (2010) reported significant improvement in number of bolls per plant and seed cotton yield up to 240 kg N /ha.

Mean ginning percentage, seed oil percentage and fibre quality characters were not significantly influenced by nitrogen. But, sunitha *et al.* (2010) reported increased span length with increasing nitrogen. The gross, net returns and benefit cost ratio were improved with increasing fertilizer levels from 120-60-60 to 150-60-60 kg N-P-K / ha. Same trend was not observed with further increase in fertilizer levels. The differences in mean kapas yield over the years (Table 3) were attributed to amount and distribution of rainfall.

It can be concluded that for Bt cotton sowing at 90 cm x 45cm and recommended dose of fertilizer of non Bt (120-60-60 kg N-P-K / ha) were found suitable for bunny Bt also under rain fed conditions in the scarce rain fall zone of Andhra Pradesh.

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Table 1. Growth and yield of cotton as influenced by plant geometry and fertilizer levels

Treatment	Plant height (cm)	No. of Monopodia	No. of Sympodia	No. of bolls/plant	Boll weight (g)	Kapas yield (t/ha)	Ginning out turn(%)	Seed oil percentage
Spacing (cm)								
120 x 60	96.9	2.20	18.0	39.1	4.5	1.38	33.1	19.07
90 x 45	96.7	2.10	16.8	33.5	4.2	1.56	33.9	19.05
SEm $\pm$	0.93	0.20	1.11	1.94	0.13	0.07	0.58	0.12
C.D (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Hybrids								
Bunny Bt	96.7	1.93	18.6	41.3	4.3	1.87	33.6	18.99
Bunny non Bt	95.7	2.25	16.2	31.8	4.4	1.08	33.3	19.08
SE m$\pm$	1.16	0.11	0.55	1.26	0.13	0.05	0.5	0.07
C.D (P = 0.05)	NS	NS	NS	4.05	NS	0.21	NS	NS
NPK levels(kg/ha)								
120-60-60	97.8	2.23	16.8	35.5	4.2	1.43	33.1	19.19
150-60-60	97.4	2.06	18.0	37.0	4.4	1.51	33.3	18.85
180-60-60	95.2	2.12	17.4	36.4	4.5	1.47	33.8	19.14
SEm $\pm$	1.79	0.12	0.42	1.32	0.13	0.04	0.37	0.11
C.D (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV	3.24	17.29	9.12	12.72	7.35	12.8	4.14	2.0

Table 2. Quality and economics of cotton as influenced by plant geometry and fertilizer levels

Treatment	**Staple length (mm)**	**Strength (g/tex)**	**Uniformity ratio (%)**	**Micronaire (10^6 g /inch)**	**Gross returns (x 10^3 ₹ /ha)**	**Net returns (x 10^3 ₹ /ha)**	**B.C ratio**
Spacing (cm)							
120 x 60	30.5	22.7	46.0	3.68	6.21	3.41	2.21
90 x 45	31.0	22.8	46.0	3.65	7.02	4.02	2.34
SEm±	0.2	0.24	0.23	0.05	-	-	-
C.D (P= 0.05)	NS	NS	NS	NS	-	-	-
Hybrids							
Bunny Bt	30.2	22.8	46.3	3.66	8.41	5.61	3.00
Bunny non Bt	30.8	22.4	45.8	3.71	4.86	2.86	2.43
SEm±	0.15	0.23	0.24	0.09	-	-	
C.D (P=0.05)	NS	NS	NS	NS	-	-	
NPK levels(kg/ha)							
120-60-60	30.6	22.7	46.0	3.75	6.43	3.63	2.29
150-60-60	30.7	23.2	46.1	3.56	6.79	3.97	2.40
180-60-60	30.7	22.7	45.7	3.68	6.61	3.77	2.32
SEm ±	0.26	0.32	0.44	0.09	-	-	-
C.D (P=0.05)	NS	NS	NS	NS	-	-	-
CV	3.50	5.20	3.58	9.72	-	-	-

Table 3. Seed cotton yield as affected by spacing, fertilizer level and Bt gene over three years

Treatments	Bt cotton	Non Bt cotton
120cm x 60 cm , 120-60-60 kg N-P-K /ha	1769	975
120cm x 60 cm , 150-60-60 kg N-P-K /ha	1745	1104
120cm x 60 cm , 180-60-60 kg N-P-K /ha	1660	1201
90cm x 45 cm , 120-60-60 kg N-P-K /ha	2042	1005
90cm x 45 cm , 150-60-60 kg N-P-K /ha	2093	1178
90cm x 45 cm , 180-60-60 kg N-P-K /ha	1952	1156
Mean	1876	1103
SEm±	65	
CD (P= 0.05)	184	

Treatments	2008	2009	2010
120cm x 60 cm , 120-60-60 kg N-P-K /ha	1507	1449	1159
120cm x 60 cm , 150-60-60 kg N-P-K /ha	1510	1552	1211
120cm x 60 cm , 180-60-60 kg N-P-K /ha	1455	1639	1196
90cm x 45 cm , 120-60-60 kg N-P-K /ha	1760	1481	1328
90cm x 45 cm , 150-60-60 kg N-P-K /ha	1668	1757	1481
90cm x 45 cm , 180-60-60 kg N-P-K /ha	1722	1571	1368
Mean	1604	1575	1290
SEm ±	80		
CD (P= 0.05)	226		