Indian Journal of Agronomy **58** (4): 588–591 (December 2013)

Research Paper

Assessing the performance of transgenic Bt cottons through mother and baby trial

T. SUDHA[1], RAMESH BABU[2], D.P. BIRADAR[3] AND V.C. PATIL[4]

University of Agricultural Sciences, Dharwad, Karnataka 580 005

Received : December 2012; Revised accepted : September 2013

ABSTRACT

The performance of different Bt cotton *(Gossypium* species*)* hybrids were compared in mother and baby trial design to assess the potentiality of the hybrids under scientifically managed (mother) vs farmer growing practices (baby trial) in red soil under rainfed condition. The field experiment (mother trial) was conducted in farmer field during 2008–09 and 2009–10. In evaluation of different genotypes in red soil, Bt cotton 'MRC 6918' recorded significantly higher seed-cotton yield (2.26 t/ha) than all other cotton genotypes and found on par with 'Bunny BG II' (2.20 t/ha) and 'RCH 2 BG II' (2.09 t/ha). The significantly higher gross returns of ₹89,131/ha and net returns of ₹64,917/ha was obtained in 'MRC 6918' as compared to all other genotypes. The higher uptake of nutrients (N,P,K) was recorded with 'MRC 6918' at 120 days after sowing. 'DHH 11' non Bt recorded higher fibre fineness (4.60 micronaire) and fibre maturity (0.76) than other genotypes. Higher yield (1.73 t/ha) was recorded in baby trial with 'Bunny BG II' and differed significantly with mother trial (2.20 t/ha)

Key words *:* Bt cotton genotypes, Fibre quality, Mother and baby trial design, Seed cotton yield

Cotton is a major crop of India. India ranks first in area in global scenario with about 33% of the world's cotton area. The production increased from 2.8 m bales in 1947–48 to 17.6 m bales in 1996–97 and a record of 35.3 m bales was recorded during 2011–12 upland cotton (*Gossypium hirsutum* L.) represents more than 90% of the hybrid cotton production in India. *Gossypium hirsutum* is grown in an area of 89% (9.8 m ha) and reached a remarkably high proportion in a fairly short period of 8 years (2002 to 2009) with unprecedented 168–fold increase. The multiple gene Bt cotton hybrids were planted for the first time in India during 2009 and now it occupies (57%) as compared to (43%) by single gene Bt cotton hybrids. Multiple gene Bt cotton hybrids provide additional protection against bollworm and spodptera, increases efficacy of protection and higher profit through savings with fewer sprays, which inturn increased the yield by 8 to 10% over single gene Bt hybrids (Singh *et al*., 2003). Therefore to realize the utility of BG II cotton for enhanced yield in comparison with Bt and non-Bt cotton in red soil, a study was undertaken in farmer's field in participatory mode of research with mother and baby trial design at Budarkatti village of Bailhonagal Taluk, Belgaum district, Karnataka, India.

MATERIALS AND METHODS

Cotton is grown both in red and black soil generally. A field trail was conducted during 2008–09 and 2009–10 in the farmer field in red soil. The soil of the study site was sandy clay loam, neutral in pH (6.81), low in available N (234 kg/ha), medium in available P (21.6 kg/ha), and high in available K (283 kg/ha). The entire experiment was conducted under the rainfed condition using a randomized complete-block design with 3 replications. Gross plot size was 10.8 m × 7.8 m. The treatments consisted of 'RCH 2' Bt, 'RCH 2 BG II' Bt, 'Bunny BG II' Bt, 'JK 99' Bt, 'Mallika' Bt, 'MRC 6918' Bt, 'Brahma' Bt, 'RCH 708' Bt, 'Bunny' Bt, and 'DHH 11'. Recommended levels of nutrients (100 kg N, 50 kg P_2O_5 and 50 kg k_2O/ha) were applied to all the treatments. Nitrogen was applied in 2 equal splits, first at the time of sowing and remaining at 30 days after sowing (DAS). Sowing was done during the fourth week of June in both the years by hand dibbling method with 90 cm × 60 cm spacing. Growth parameters were recorded from 5 randomly selected plants. Growth and yield parameters were recorded at harvest during both the years. The N, P, K contents in the plant samples were estimated from 5 randomly selected plants at different

[1]**Corresponding author Email:** sudhagron@gmail.com

[1]Associate Professor (Agronomy), [2]Professor of Agronomy, UAS Dharwad, [3]Registrar, UAS, Raichur, Karnataka; [4]Precision Agriculture Research Chair, King Saud University, Riyadh, Saudi Arabia

days after sowing following standard methods (Jackson, 1973; Subbaiah and Asija, 1956).

The N, P, K were calculated by multiplying dry matter yield/ha with corresponding concentration of nutrients and dividing by 100. The economics was worked out on the basis of prevailing rates of inputs and produce. Fibre quality parameters such as 2.5% span length, fineness, maturity ratio and bundle strength were analyzed using the HVI machine (Statex – HVI model) at Regional Centre, CIRCOT, Dharwad, Karnataka.

RESULTS AND DISCUSSION

Growth attributes

The growth parameters like number of sympodial branches/plant, total dry-matter accumulation and leaf-area index were varied significantly with different cotton genotypes in the pooled data (Table 1). The higher number of sympodials were observed in 'MRC 6918' Bt, followed by 'Mallika' Bt. Total dry-matter accumulation was recorded significantly highest in 'MRC 6918' Bt and it was found on par with 'RCH 708' Bt, 'JK 99' Bt, 'Bunny BG-II' Bt and 'Brahma Bt'. The higher number of sympodial branches and more height resulted in more dry-matter accumulation in 'MRC 6918' Bt. The results confirm the findings of Giri *et al.* (2008).

The genotype 'Bunny BG-II' Bt gave the highest leaf-area index followed by 'JK 99' Bt, 'MRC 6918' Bt and 'Bunny' Bt. The accumulation rate and leaf area and number of sympodial branches/plant were high, as also noticed by Prasad Joshi *et al.* (2011).

Yield attributes

The yield parameters, viz. total number of bolls/plant and boll weight differed significantly with different cotton genotypes in pooled data (Table 1). The highest total number of bolls/plant was recorded in 'MRC 6918' Bt, followed by 'RCH 708' Bt and differed significantly with non-Bt hybrid 'DHH 11'. Bt cotton hybrids were more efficient in mobilizing photosynthates to reproductive sink and also in retaining more bolls/plant (Sunitha *et al*., 2010). Similarly, the boll weight was highest in 'MRC 6918' Bt, followed by 'Mallika' Bt, 'Bunny' Bt and 'RCH 2 BG II' Bt and it differed significantly from non-Bt hybrid 'DHH 11' (Table 1). The higher values of yield attributes is the result of better growth and more translocation of photosynthates from source to sink. The higher number of bolls and boll weight were observed in 'MECH 184' Bt hybrid, as also noticed by Ramamurthy and Venugopalan (2009).

Economics

The gross returns, net returns and net benefit: cost ratio were influenced significantly by the Bt cotton genotypes (Table 1). The higher gross returns and net returns were obtained in 'MRC 6918' Bt and differed significantly from all the other cotton genotypes, indicating lower total cost of cultivation and higher economic yield associated with this hybrid. This result was also observed by Manjunath *et al*. (2010).

Nutrient uptake

Nutrient uptake differed significantly with different cotton genotypes (Table 2). The nutrient uptake increased with increased growth of the crop. Higher uptake of nitrogen, phosphorus and potassium was observed in 'MRC 6918' Bt at different stages of crop growth. The significant variation in uptake of nutrients is due to significant variation in dry-matter accumulation of plant and soil available

Table 1. Growth, yield attributes and economics of Bt Cotton genotypes (pooled data over 2 years)

Treatment	Sympodia/ plant	Leaf-area index	Bolls/ plant	Boll weight (g/boll)	Total dry-matter accumulation (g/plant)	Harvest index	Gross returns (× 10^3₹/ha)	Net returns (× 10^3₹/ha)	Benefit: cost ratio
'RCH 2 Bt'	16.5	2.51	28.5	4.6	256.9	0.29	61.5	37.3	1:2.54
'RCH 2 BG II'	17.4	2.60	26.9	4.8	270.4	0.29	65.8	42.2	1:2.80
'Bunny BG II'	17.6	2.98	26.0	5.1	274.6	0.31	69.1	45.6	1:2.94
'JK 99 Bt'	18.4	2.87	30.8	4.2	275.6	0.25	54.7	30.4	1:2.26
'Mallika Bt'	18.9	2.59	22.7	5.5	271.1	0.27	58.7	34.4	1:2.42
'MRC 6918 Bt'	20.6	2.83	34.6	5.5	295.7	0.29	89.1	64.9	1:3.68
'Brahma Bt'	18.5	2.42	27.5	4.5	274.3	0.24	52.0	27.6	1:2.14
'RCH 708 Bt'	19.1	2.63	34.5	4.1	279.2	0.28	80.0	55.7	1:3.30
'Bunny Bt'	16.8	2.83	23.9	5.1	259.7	0.29	62.8	38.5	1:2.60
'DHH 11'	15.4	2.64	26.1	4.3	249.4	0.24	47.1	21.0	1:1.81
SEm+	0.65	0.08	1.00	0.27	7.79	0.01	1724.82	1926.18	0.06
CD (P=0.05)	1.94	0.25	2.98	0.80	23.15	0.02	5124.65	5722.93	0.18

nutrient status. The uptake of nutrients increased significantly from 60 days after sowing to 120 days after sowing in all the genotypes which was mainly attributed to meet the needs of developing branches, leaves, flower and bolls.

The increase in uptake of nutrients attributed to cultivar improvement and better agronomic management (Rochester, 2007)

Fibre quality parameters

The cotton genotypes exhibited significant variation for 2.5% span length fibre fineness, fibre maturity ratio and bundle strength (Table 3). The highest 2.5% span length was observed in 'RCH 708' Bt, followed by 'Brahma' Bt and 'MRC 6918' Bt. The highest fibre fineness and fibre maturity were noticed in non Bt hybrid 'DHH 11'.

The bundle strength was the highest in 'MRC 6918' Bt and differed significantly with other cotton genotypes. Bt cotton hybrids depicted wide range of ginning outturn ranged from 28.17 to 39.22% and 2.5% span length ranged from 23.59 mm to long 34.72 mm micronaire value between fine 2.9 to medium 4.78 was observed by Sarang *et al*. (2010).

Seed yield in mother and baby trials

The seed-cotton yield differed significantly with different cotton genotypes (Table 4). The highest seed-cotton yield was recorded in 'MRC 6918' Bt, and differed significantly with other Bt cotton genotypes and non Bt cotton hybrid 'DHH 11'. The results indicated the superiority of Bt-cotton hybrids with higher retention of bolls with practically very little damage by bollworms and higher level of physiological efficiency during the grand growth phase of the crop. The results support the findings of Bhalerao *et al.* (2008), who reported higher seed cotton yield with 'Brahma BG' over that of non-Bt-hybrid.

The performance of different Bt cotton genotypes were compared in mother and baby trail mode to assess the potentiality under scientifically managed vs farmer growing practices. The study is first of its kind in cotton and was aimed at harnessing the complete potential of popular Bt

Table 2. Nitrogen, phosphorus and potassium uptake (kg/ha) of different cotton genotype (pooled data over 2 years)

Treatment	Nitrogen			Phosphorus			Potassium		
	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS
'RCH 2 Bt'	23.6	67.34	104.2	4.2	12.4	19.6	23.6	61.10	101.6
'RCH 2 BG II'	27.8	66.78	110.4	5.1	12.6	20.4	27.0	64.7	107.5
'Bunny BG II'	28.5	70.0	115.6	5.4	13.1	21.8	27.8	66.3	112.3
'JK 99 Bt'	27.2	71.7	117.9	5.0	13.1	22.1	29.4	73.4	118.1
'Mallika Bt'	24.5	73.9	121.4	4.8	13.9	22.4	28.8	73.3	120.1
'MRC 6918 Bt'	31.4	79.9	129.0	6.0	15.1	24.2	33.5	78.9	126.4
'Brahma Bt'	26.9	68.9	109.6	4.6	13.1	21.8	26.6	64.0	105.5
'RCH 708 Bt'	28.8	72.7	114.1	5.1	13.1	21.5	28.7	70.5	113.2
'Bunny Bt'	24.4	63.9	106.9	4.5	11.9	19.8	23.0	60.0	99.0
'DHH 11'	22.0	63.3	98.55	4.9	12.1	19.1	23.9	64.8	102.0
SEm±	1.05	1.99	3.58	0.28	0.34	0.79	0.93	2.27	4.06
CD (P=0.05)	3.12	5.92	10.63	0.84	1.01	2.34	2.75	6.75	12.05

DAS, Days after sowing

Table 3. Fibre quality parameters of cotton genotypes (pooled data over 2 years)

Treatment	2.5% span length (mm)	Fibre fineness (micronaire)	Fibre maturity (maturity ratio)	Bundle strength (g/tex)
'RCH 2 Bt'	31.85	4.05	0.71	23.15
'RCH 2 BG II'	32.15	4.25	0.75	22.90
'Bunny BG II'	34.70	3.40	0.64	23.50
'JK 99 Bt'	30.90	4.25	0.72	23.25
'Mallika Bt'	32.05	4.05	0.71	23.35
'MRC 6918 Bt'	35.65	3.45	0.66	27.35
'Brahma Bt'	36.15	3.65	0.66	23.10
'RCH 708 Bt'	36.40	3.70	0.68	24.40
'Bunny Bt'	32.85	4.05	0.73	23.60
'DHH 11'	29.00	4.60	0.76	23.70
SEm±	0.42	0.05	0.06	0.45
CD (P=0.05)	1.24	0.14	0.01	1.34

Table 4. Seed-cotton yield of different genotypes in mother and baby trial (pooled data over 2 years)

Treatment (genotypes)	Yield (t/ha)		Caclc. 't' value	Significance
	Mother trial	Baby trial		
'RCH 2 Bt'	1.99	1.67	3.01	NS
'RCH 2 BG II'	2.09	1.69	5.10	*
'Bunny BG II'	2.20	1.73	8.90	*
'JK 99 Bt'	1.74	1.59	2.39	NS
'Mallika Bt'	1.87	1.65	7.15	*
'MRC 6918 Bt'	2.26	1.59	4.95	*
'Brahma Bt'	1.65	1.58	2.98	NS
'RCH 708 Bt'	2.03	1.71	4.40	*
'Bunny Bt'	1.99	1.62	14.5	**
'DHH 11'	1.50	1.27	2.35	NS

Table 't' value – 4.03; NS, non-significant; *significant at 5% level, **significant at 1% level

cotton transgenic hybrids. 'RCH 2' Bt, 'JK 99' Bt, 'DHH 11' and 'Brahma' Bt were found at par with respective mother trail. These genotypes have reached the maximum potentiality in both scientifically managed (mother trial) and under farmer's practice (baby trials.)

The harvest index varied from 0.24 to 0.31. (Table 1), being highest in 'Bunny BG II', followed by 'MRC 6918' Bt and 'RCH 2 BG-II' Bt. The Bt cotton hybrids were more efficient in mobilizing photosynthates to reproductive sink resulting in higher harvest index Hebbar *et al.* (2007).

It was concluded that 'MRC 6918' Bt recorded the higher seed-cotton yield and, gross returns under rainfed condition. 'RCH 2' Bt, 'JK 99' Bt, 'DHH 11' and 'Brahma' Bt have reached the maximum genetic potentiality in both mother and baby trial.

REFERENCES

Bhalerao, P.D. and Gaikwad, G.S. 2010. Productivity and profitability of Bt cotton (*Gossypium hirsutum)* under various plant geometry and fertilizer levels. *Indian Journal of Agronomy* **55**(1): 60–63.

Giri, A.N., Aundhekhar, R.L. Kapse, P.S. and Suryavanshi, S.B., 2008. Response of Bt cotton hybrids to plant densities and fertilizer levels. *Journal of Cotton Research and Development* **22**(1): 45–47.

Hebbar, K.B., Rao, M.R.K. and Khadi, B.M. 2007. Synchronized boll development of Bt cotton hybrids and their physiological consequences. *Current Science* **93**: 693–95.

Jackson, M.C., 1973. *Soil Chemical Analysis,* Prentice Hall of India Pvt. Ltd, New Delhi. pp. 187.

Manjunath, M.J., Halepyati, A.S., Koppalkar, B.G. and Pujar, B.T. 2010. Yield and yield components, uptake of nutrients, quality parameters and economics of Bt cotton (*Gossypium hirsutunm*) genotypes as influenced by different plant densities. *Karnataka Journal of Agricultural Sciences* **23**(3): 423–25.

Prasad, Joshi, Biradar, D.P., Patil, V.C., Janagoudar, B.S., Patil, B.R. and Udikeri, S.S. 2011. Evaluation of commercially available Bt cotton genotypes for their agronomic performance and economic returns. *Karnataka Journal of Agricultural Sciences* **24**(3): 277–79.

Rochester, I.J. 2007, Nutrient uptake and export from an Australian cotton field. *Nutrient Cycling Agro-ecosystem* **77**: 213–23.

Ramamurthy, V. and Venugopalan, M.V. 2009. Performance of Bt cotton (*Gossypium hirsutunl*) hybrid on shrink swells soils of Central India. *Indian Journal of Agricultural Sciences* **79**(12): 1026–29.

Subbiah, B.V. and Asija, G.L., 1956. Rapid procedure for estimation of available nitrogen in soil. *Current Science* **25**: 259–60.

Sunitha, V., Chandrashekhar, K. and Veeraraghavaiah. 2010. Performance of Bt cotton hybrids at different nitrogen levels. *Journal of Cotton Research* and *Development* **24**(1): 52–55.

Sarang, D.H., Bhatade, S.S. and Deosarkar, D.B. 2010. Evaluation of some new Bt cotton hybrids for seed cotton yield and fibre quality traits under rainfed condition. *Journal of Cotton Research and Development* **24**(2): 149–54.

Singh, J., Blaise, D., Rao, M.R.K., Mayee, C.D. and Deshmukh, M.S. 2003, Assessment of agronomic efficacy of Bt cotton in raifed vetisole. *Journal of Indian Society of Cotton Improvement* **28**: 185–90.