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Enhancing the productivity of irrigated *Bt* cotton (*Gossypium hirsutum*) by transplanting technique and planting geometry

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ABSTRACT

A field experiment was conducted during 2007–09 in Upper Krishna Project command area at Agricultural Research Station, Bheemarayanagudi, Karnataka to study the comparative performance of *Bt*-cotton (*Gossypium hirsutum* L.) under in transplanting and dibbling methods at different planting geometry. Significantly higher seed cotton yield was obtained from the transplanting of seedlings (3.86 to 4.26 tonnes/ha) than the farmers' practice of dibbling (3.27 tonnes/ha).Transplanting increased the cotton yield by 17 to 25% and net returns by 12 to 32% compared to dibbling. Potential yield of *Bt* cotton both under normal and delayed sowing conditions could be enhanced by transplanting which resulted in better establishment, early vigour, early flowering and increased yield attributes. Leaf reddening in transplanted *Bt* cotton was reduced (7.8 to 9.2%) compared to dibbled cotton (19%). Among the transplanting geometry, spacing of 90cm×90cm recorded the highest seed cotton yield and it was at par with spacing's of 120cm×90cm and 120cm×60cm.Yield attributes, like sympodial branches, bolls/plant, and boll weight were significantly higher in different transplanting geometry than in farmer's practice of hand dibbling. Transplanting at 90cm×90cm, 120cm×90cm and 120cm×60cm geometries were at par with each other in respect of yield components and yield, but superior over the other transplanting spacings and hand dibbling practice.

Key words: *Bt* cotton, Cotton yield, Dibbling, Geometry, Planting, Transplanting

There is much scope to increase to cotton (*Gossypium hirsutum* L.)yield by increasing the productivity through optimization and adoption of appropriate agro-techniques. Planting geometry and time of planting have greater role in boosting yield of cotton. Plant population has direct influence on cotton yield. Planting geometry has greater role in optimizing yield of *Bt* cotton (Bhalerao *et al*. 2008).

The cotton area in command area will increase further in coming years with popularization of *Bt* cotton. The actual yield levels are low compared to the potential productivities. Some of the reasons for low productivity are delayed sowing by dibbling method due to late release of water and poor germination and establishment due to poor soil condition caused by accumulation of salts. Irrigation coupled with high rainfall during July and August would lead to water stagnation, which results in stunted growth, rotting and poor vigour of seedlings. Further, many times farmers have to wait for optimum soil condition, which again delays the sowing time. Therefore novel technology of raising hybrid cotton seedlings in poly bag well in advance of planting has been suggested (Rajakumar and Gurumurthy 2008).

High cost of *Bt* cotton seeds coupled with poor germination and establishment under above soil situation paved the ways for current study of contingency plan with main objective of evaluation of performance of transplanted *Bt* cotton *visa-a vis* normal dibbled *Bt* cotton under different planting geometry.

MATERIALS AND METHODS

The field experiment was conducted in Upper Krishna Project command area at Agricultural Research Station, Bheemarayanagudi, Gulbarga, Dist. Karnataka for two years during 2007–08 and 2008–09 on clay loam soil with *p*H of 7.5, EC,0.4 dS/m. The available N, P and K in the soil were 295, 13.5 and 340 kg/ha, respectively.

The experiment was laid out in a randomized block design with three replications. There were eight treatments which include seven transplanting treatments (T_1:120 cm×90 cm, T_2:120 cm×60 cm, T_3:120 cm×30 cm, T_4:90 cm×30 cm, T_5:90 cm×60 cm, T_6:90 cm×90 cm, T_7:75 cm×60 cm) and one treatment of farmer's practice (T_8: seed dibbling at 90 cm×60 cm). During June, *Bt* cotton seedlings were raised in black polyethylene bags of 20 cm height and 7.5 cm width.

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These poly bags were filled with red soil and compost in 3:1 ratio. Soil was moistened to field capacity. Seeds of *Bt* cotton were dibbled at the rate of 1 seed/poly bag at a depth of 5 cm in the centre. Soil moisture in the poly bag was maintained by watering regularly. They were exposed to direct sunlight during last week in the main field. During both the years around 20–25 days old seedlings were transplanted to main field on 17 July as per the treatment details. Treatment consisting of dibbling of seeds (farmer's practices) was also done on the same day of transplanting of seedlings. Normally farmers wait for release of canal water for sowing of cotton seeds and it will occur only during last week of July.

The recommended dose of 150:75:75 N,P and K kg/ha respectively were applied to the soil in the form of urea (326 kg/ha), diammonium phosphate (156 kg/ha) and muriate of potash (125 kg/ha). Farmyard manure was applied two weeks before treatment imposition, 50 %N and entire P and K were applied were applied at dibbling/ transplanting. Remaining 50% N was applied in three equal splits at 50, 80 and 110 days after transplanting. Total seven irrigations were provided at the interval of 15–20 days. Sucking pests were controlled by spraying imidacloprid 0.5 ml/litre of water at initial growth stage. The data on plant height, number of sympodial branches were recorded at flowering. Yield attributes and yield were recorded at harvest. Leaf reddening per cent was calculated by counting number of healthy leaves in a plant and divided it by number of leaves affected by reddening.

RESULTS AND DISCUSSION

Influence of planting methods

Mean yield of two years revealed that significantly higher seed cotton yield was obtained in the seedlings transplanted plots (3.86 to 4.26 tonnes/ha) than farmer's practice of hand dibbling (3.27 tonnes/ha) (Table 4). The increase in seed cotton yield in transplanted plots was due to significantly more number of sympodial branches and bolls / plant. The weight of bolls and seed cotton yield / plant were also significantly higher in transplanted plots compared to dibbled plot which contributed to greater extent for increased yield in the former (Tables 3,4). Early vigour and robust growth of plants were noticed in transplanted plots as evidenced by

Table 1 Growth of transplanted and dibbled *Bt* cotton after 60 and 120 days after planting (pooled data of two years)

Treatment	Plant height (cm)		Squares and fruiting structures/plant		Stem girth (cm)	
	60 DAT	120 DAT	60 DAT	120 DAT	60 DAT	120 DAT
T_1 :120 cm×90 cm TP	75.4	115.3	15.8	96.9	2.8	5.34
T_2 :120 cm×60 cm TP	78.5	113.9	15.9	96.6	2.9	5.20
T_3 :120 cm×30 cm TP	75.6	108.9	15.4	94.5	2.8	5.22
T_4 :90 cm×30 cm TP	76.5	104.2	15.9	89.5	2.7	5.14
T_5 :90 cm×60 cm TP	77.1	107.2	15.5	83.2	2.7	5.21
T_6 :90 cm×90 cm TP	75.5	105.1	16.5	90.2	2.9	5.29
T_7 :75 cm×60 cm TP	75.8	107.8	16.2	88.3	2.7	5.19
T_8 :90 cm×60 cm dibbling	61.5	101.0	NIL	60.1	1.9	4.25
CD (*P*=0.05)	5.84	7.71		9.76	0.19	0.13
CV (%)	15.7	13.3		9.3	7.4	11.7

TP, Transplanted

Table 2 Yield components of transplanted and dibbled *Bt* cotton at first harvest

Treatment	Sympodials/plant			Bolls/plant			Boll weight (g)		
	2007	2008	Mean	2007	2008	Mean	2007	2008	Mean
T_1 :120 cm×90 cm TP	49.5	39.5	44.5	107.5	86.3	96.9	3.92	3.75	3.83
T_2 :120 cm×60 cm TP	44.7	41.6	43.1	102.9	90.4	96.6	3.67	3.75	3.71
T_3 :120 cm×30 cm TP	44.2	42.3	43.3	102.1	86.9	94.5	3.71	3.72	3.71
T_4 :90 cm×30 cm TP	46.5	38.3	41.4	102.3	76.8	89.5	3.60	3.63	3.61
T_5 :90 cm×60 cm TP	38.5	33.5	39.0	80.3	80.0	83.2	3.57	3.55	3.56
T_6 :90 cm×90 cm TP	44.8	36.0	40.4	96.8	83.5	90.2	3.95	3.82	3.88
T_7 :75 cm×60 cm TP	49.7	41.3	45.5	94.4	82.1	88.3	3.85	3.52	3.68
T_8 :90 cm×60 cm dibbling	34.5	31.5	33.0	71.9	48.3	60.1	3.15	3.35	3.25
CD (*P*=0.05)	4.51	3.93	4.02	8.54	11.41	9.76	0.15	0.12	0.13
CV (%)	10.3	7.5	8.0	10.9	12.5	9.34	12.1	10.3	11.8

TP, Transplanted

Table 3 Leaf reddening at 120 days after planting in transplanted and dibbled *Bt* cotton

Treatment	Leaf reddening (per cent of leaves affected by visible red leaf spots)		
	2007	2008	Mean
T_1 :120 cm×90 cm TP	7.00	8.90	7.9
T_2 :120 cm×60 cm TP	7.10	8.50	7.8
T_3 :120 cm×30 cm TP	7.70	9.00	8.3
T_4 :90 cm×30 cm TP	8.50	9.05	8.7
T_5 :90 cm×60 cm TP	8.60	9.55	9.0
T_6 :90 cm×90 cm TP	6.35	7.20	7.7
T_7 :75 cm×60 cm TP	8.45	9.95	9.2
T_8 :90 cm×60 cm dibbling	17.7	20.50	19.1
CD (*P*=0.05)	1.62	1.50	1.17
CV (%)	15.8	14.2	13.1

significantly taller plants, more number of branches and stem girth (Tables 1, 2). There was 15 to 16 fruiting bodies/plant at 60 days after transplanting. While in plants raised from seed dibbling have yet to bloom during same time. Dong *et al*. (2005) noticed the peak blooming five days earlier in transplanting system than in normal planting system. And also blooming period was extended by five weeks longer in transplanted plants. The number of bolls retained per unit area in transplanting system was significantly higher than those in normal planting system (Dong *et al.* 2005). At first picking plants in farmers practice (dibbling) attained similar height at par with transplanted plants, but they did not achieve similar stem girth and sympodial branches which have enabled to retain more number of flowers and ultimately bolls. The number of early-season flowers and number of bolls retained per unit area in transplanting system were significantly higher than those in normal planting system in china (LiS Ji C *et al.* 2000). In Indian situation also, direct seeding gave less number of bolls/plant than transplanting of poly bag seedlings (Rajakumar and Gurumurthy 2008). The increased boll production in transplanted cotton could be due to the efficient photosynthetic source, as a result of optimal leaf area-index (Kuppusamy 1993). Reddening of more number of leaves (19%) have further reduced efficiency of photosynthesis in plants raised from hand dibbling maintained The increased yield in transplanted plots over farmer's practice was 17 to 30% under irrigated condition; whereas in rainfed situation, increased yield advantage in transplanted crop was due to many reasons, such as plants gets stored soil moisture almost four months instead of 2-3 months in dibbled cotton. Leaf reddening a major physiological disorder in cotton was reduced to 7.2% in transplanted cotton compared to dibbling which recorded the highest (19%). Crop stage at commencement of winter season, temperature, nutrients balance in plant system, sucking pest incidence and nutrient uptake influence the severity of reddening. Transplanted crop escape heavy build-up of pests compared to hand dibbled cotton (Nagarajan 2003). Another advantage of transplanting under rainfed condition is that the date of planting is advanced by 1–2 months, so that farmers get an early peak harvest. Under dibbled condition development of bolls take place under drought / stress during later in the season resulting in poor yield. Transplanting of seedlings is an effective seed-saving technique in China (Hezhong Dong *et al.* 2004).

Influence of transplanting geometry

Among the different transplanting geometry, significantly higher seed cotton yield was obtained in the spacing of 90 cm×90 cm (4.26 tonnes/ha) and it was at par with 120 cm × 60 cm (4.12 tonnes/ha). The increased yield in these two spacing was due to optimum plant population, where yield attributes like sympodial branches, bolls / plant and weight of bolls were statistically on par with those in plant density obtained in 120 cm×90 cm. Seed cotton yield in remaining plant densities was at par with each other, but all these transplanted densities were significantly superior over farmer's practices of hand dibbling at 90 cm×60 cm due to more number of sympodial branches, bolls/plant, boll weight and yield/plant. Bolls/plant and seed cotton yield/plant have decreased with increased plant density and they were the highest in the spacing of 120 cm×90 cm.

Table 4 Seed cotton yield of transplanted and hand dibbled *Bt* cotton

Treatment	Seed cotton yield (g/plant)			Seed cotton yield (tonnes/ha)			Per cent increase over dibbling		
	2007	2008	Mean	2007	2008	Mean	2007	2008	Mean
T_1 :120 cm×90 cm TP	171.8	168.5	170.1	4.03	4.10	4.07	15.5	18.5	24.2
T_2 :120 cm×60 cm TP	167.0	170.0	168.5	4.22	4.05	4.11	20.9	15.6	25.6
T_3 :120 cm×30 cm TP	170.7	157.6	164.2	4.05	3.88	3.96	15.9	12	20.9
T_4 :90 cm×30 cm TP	159.1	157.0	158.0	3.90	3.78	3.84	11.6	9.2	17.2
T_5 :90 cm×60 cm TP	160.0	151.5	155.7	3.75	3.90	3.83	7.5	12.6	16.8
T_7 :75 cm×60 cm TP	182.0	179.0	180.5	4.44	4.09	4.26	7.2	18.1	30.2
T_7 :75 cm×60 cm TP	166.0	155.0	160.5	3.87	3.85	3.86	10.8	11.3	17.8
T_8 :90 cm×60 cm dibbling	120.6	124.5	122.5	3.49	3.46	3.27			
CD (*P*=0.05)	28.5	35.2	31.0	0.25	0.1	0.18			
CV (%)	12.3	15.1	13.4	13.5	19.5	11.8			

similar results were also obtained by Rajakumar and Gurumurthy (2008). On the contrary Srinivasan (2006) did not notice the influence of spacings on boll weight and number of bolls/plant. Under rainfed situation spacing of 90 cm×60 cm recorded higher yield and yield attributes than closer spacing (Bhalerao *et al*. 2008). Optimum spacing / plant density depend on fertility of soil and time of planting. Generally wider spacing advantage is noticed in fertile soil and when time of sowing is optimum. But under poor soil and late sowing condition higher plant densities are preferred to minimize reduction of yield.

Hence, the potential yield of *Bt* cotton both under normal and delayed sowing conditions could be enhanced by transplanting which resulted in better establishment, early vigour, early flowering, increased yield attributes and seed cotton yield. Leaf reddening was increasing important problem in *Bt* cotton-growing areas of India. And leaf reddening in transplanted *Bt* cotton was reduced (7.8 to 9.2%) compared to dibbled cotton (19%). Among the transplanting geometry, 90 cm×90 cm, 120 cm×90 cm and 120 cm×60 cm geometries were at par with each other with respect yield components and yield, but superior over both other transplanting spacings and farmer's practice of hand dibbling.

REFERENCES

Bhalerao P D, Gawande P P, Ghatol P V and Patil B R. 2008. Performance of Bt cotton hybrids for various spacing under rainfed condition. *Agricultural Science Digest* **28**(1) : 54–6.

Dong H Z, Tang W J, Liw Li Z H and Zhang D M. 2004. Increased yield and revenue with a seedling transplanting system for hybrid seed production in *Bt* cotton. *Journal of Agronomy and crop science* **191** (2): 116–24.

Hezhong Dong, Weijiang Li, Wei Tang and Dongmei Zhang. 2004. Development of hybrid *Bt* cotton in China-A successful integration of transgenic technology and conventional techniques. *Current Science* **86** (6): 778–82.

LiS Ji C, Chen X J in J, He X and Shou L. 2000. Technique to reach 100 kg/mu of cotton transplanting in Jiangsu province. *China Cotton* **27**(6): 6–8.

Nagarajan S. 2003. High yield of rainfed cotton through transplanting. *Current Science* **85** (2): 122–3.

Srinivasan G. 2006. Agronomic evaluation of *Bt* cotton hybrids in summer irrigated tract of southern Tamil Nadu**.** *Journal of Cotton Research Development* **20** (2): 224–5.

Rajakumar D and Gurumurthy S. 2008. Effect of plant density and nutrient spray on the yield attributed and yield of direct sown and polybag seedling planted hybrid cotton. *Agricultural Science Digest* **28**(3): 174–7.