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Effect of plant spacing on yield and economics of extra long staple (ELS) *Bt* cotton hybrid

S.DIVYA*, P.SARAVANAN, J.KATHIRAVAN AND P.VENKATESAN
Krishi Vigyan Kendra, Hans Roever Campus, Perambalur - 621 115.
*****E-mail: kvkpblr@rediffmail.com and divya_ento@rediffmail.com*

ABSTRACT : The experiment was laid out to study the effect of spacing with improved production technologies in extra long staple (ELS) *Bt* cotton hybrid in farmers field of Perambalur district, Tamil Nadu, India during *kharif* 2013-2014 under rainfed condition. The experiment had 6 treatments (spacing) with 5 replications. The spacings adopted were 150 × 45, 150 × 60, 120 × 45, 120 × 60 and 120 × 90 cm. A control plot was maintained as farmers practice with the spacing of 120 × 90 cm. The results revealed that among the plant spacing, 120 × 45 cm with improved production technologies recorded highest seed cotton yield (4226 kg/ha) which was significantly superior over plant spacing 120 × 90, 150 × 60 followed by 120 × 60 cm and also *on par* with spacing of 150 × 45 cm along with improved production technologies. As the same, adoption of 120 × 45 cm spacing in ELS *Bt* hybrid cultivation with improved production technologies were recorded the highest gross return (‘ 2,83,142/ha), net return (‘ 2,27,392/ha) and Benefit Cost Ratio (5.07) compared to other spacings and farmers practice. The optimal spacing for ELS *Bt* hybrid with improved production technologies in terms of yield and economics were 120 × 45 and 150 × 45 cm.

Key words : *Bt* cotton, economics, ELS, improved production technology, spacing, yield

Cotton (*Gossypium* sp.) is the most important commercial crop of India, often referred as the ‘White Gold’ providing employment to about 60 million people. It is cultivated on an area of 11.1 m ha and out of which the area under *Bt* cotton has already crossed 90 per cent. Among the cotton pests, American bollworms alone cause a yield reduction of 40 to 70 per cent under severe infestation. An alternate strategy to circumvent this problem was followed by cloning and transferring the genes encoding the toxic crystal ä-endo toxin protein from the soil bacterium *Bacillus thuringiensis* var *kurstaki* to cotton. The *Bt* transgenic cotton (Bollgard of Monsanto) was developed successfully in USA, having the ability to control the bollworms during crop growth effectively. With the introduction of *Bt* cotton hybrids, there has been a significant change in the cotton cultivation scenario of India. However, the average production is very low when compared to world’s average. This is mainly because 70 per cent of cotton area is under rainfed condition. Lack of knowledge about important agronomical practices could also be another reason. Among the various agronomical practices influencing the production of *Bt* cotton hybrids, spacing play a very significant role. Maximum yield potential of *Bt* cotton can be realized by adopting new and high yielding *Bt* cotton hybrids with suitable agronomic practices, namely optimum plant spacing and fertilizer management. Establishment of an acceptable population of cotton seedling is paramount to obtain high yield.

Extra long staple (ELS) cotton typically denotes a cotton fiber of extraordinary fiber length. As per the CIRCOT, Mumbai classification, staple length of more than 32.5 mm is considered as ELS category. In India, ELS cotton production for the year 2008-2009 was reported as 5.0 lakh bales from 2.30 lakh ha. The current estimates of National demand for ELS cotton is about 15 lakh bales and projections for the year 2015 will be 25 lakh bales. The textile mills are therefore compelled to import ELS cotton from countries like USA, Egypt, Sudan or Common Wealth of Independent states (CIS) countries. ELS cotton represent only about 2 per cent of the entire world's cotton production due to its specific characters like long crop duration, less suitable for rainfed condition, need of different weather condition (hot days and cool nights), higher production cost etc., In South zone (highly conducive for ELS cotton) comprising of Andhra Pradesh, Tamil Nadu and Karnataka, The maximum temperature during the cotton season varies from 32-40°C and the minimum temperature ranges from 8-20°C. The rainfall varies from 500 mm to 1250 mm, primarily through the south west monsoon. Tamil Nadu and parts of Karnataka receive rains from north east monsoon from September to December particularly benefiting the crop performance (Sankaranarayanan *et al.,* 2010). Recently, the area under ELS *Bt* cotton (*G.hirsutum* x *G.barbadense*) hybrids has got increased in Perambalur district of Tamil Nadu from 2008 due to its bimodal rainfall conditions, complete black cotton soil, suitable weather conditions during cropping season, highest market value and net profit. But the production and productivity was in decreasing trend due to the poor adoption of emerging technologies for cotton production. Wide adoption of ELS *Bt* transgenic cotton need to decide the optimum plant spacing for each type of hybrid. However, very few studies have been conducted to investigate the effects of spacing on yield and economics of ELS *Bt* transgenic cotton hybrid. Keeping in view the above facts, the present investigation was planned to find out the optimum plant spacing with improved production technologies to achieve higher seed cotton yield and economics of ELS *Bt* cotton.

A field Experiment was conducted during 2013-2014 under rainfed condition in farmers field of Perambalur district. Perambalur is situated between 10°54' and 11°30' N latitude and 78°40' and 79°30' E longitude at an altitude of about 148 m above mean sea level. It has a semi arid and sub tropical climate with hot dry summers and moderate cold winters. The temperature ranges from 17.7°C to 41.62° C with a mean annual rainfall about 811 mm. The soil of the experimental plots is a fertile black cotton soil with sandy loam type having pH 8.2. The experiment was conducted in 2013-2014 to compare the various plant spacing with Improved Production Technologies (IPT) and production, economics of Extra Long Staple *Bt* cotton Hybrid, MRC 7918 BG II *Bt* (*G.hirsutum* x *G.barbadense*) under rainfed condition. The experiment was laid out in randomized block design with 5 replications. The treatments comprised of dibbling of cotton seeds in 150 × 45, 150 × 60, 120 × 45, 120 × 60 and 120 × 90 cm. All the treatment plots were adopted with IPT like soil test based fertilizer application, basal application of MN mixture @ 12.5 kg/ha, soil application of *Trichoderma viride* @ 2.5 kg/ha for disease management, Foliar spraying of NSKE (5%) for sucking pest management, need based foliar spraying of chemical insecticides for sucking pest management in above ETL, need based application of chemical fungicides for foliar disease management, foliar spraying of TNAU cotton plus @ 6.5 kg/ha and nipping the tip @ 21st node. Dibbling of the same ELS *Bt* hybrid seed with the spacing of 120 x 90 cm along with farmers practiced production technologies were imposed as control plot. The trial plots were periodically visited and monitored throughout the cropping season. The seed cotton yield (kg/ha), cost of cultivation (' /ha), gross return (' /ha), net return (' /ha) and BCR were recorded in each treatment. The statistical analysis of the data was performed.

The outcome of the experiment revealed that the plant population (plants /ha) seed cotton yield (kg/ha), gross return (' /ha), net return ('/ ha) and BCR were found significantly increased in all treatments over control (Table 1). ELS *Bt* cotton spaced with 120 × 45 cm (S_3) + IPT produced significantly more seed cotton yield (4226 kg/

ha) over 150 × 60 cm (2842 kg/ha), 120 × 90 cm (2356 kg/ha) and control (2062 kg/ha). However, it was *on par* with 150 × 45 cm and 120 × 60 cm spacing along with IPT 3660 kg/ha, 3200 kg/ha respectively. The seed cotton yield obtained in 120 × 45 cm spacing with IPT registered 51.19 per cent higher over farmers practice and 44.26 per cent over 120 × 90 cm with IPT. This is because of higher population density when compared with other spacing treatments. The results corroborate with the findings of Patel *et al.,* 2012, who reported that spacing of 120 × 45 cm in *Bt* cotton gave the highest seed cotton yield (2841 kg/ha) as compared to narrow or wider spacing. Plants under closer spacing produced significantly more leaf area index, seed cotton yield, crop profitability and crop productivity over wider plant spacing (Shukla *et al.*, 2013, Raut *et al.*, 2005 and Sisodia and Khamparia, 2007). It was mainly due to higher plant population accommodated per unit area *i.e.*, 18,518.51 plants /ha (120 × 45 cm) and 14,814.81 plants / ha (150 × 45 cm). Manjunatha *et al.,* 2010 reported that increasing the plant density/unit land area increased the interplant competition within the plot for natural resources and because of higher competition between plants contribution of yield components/plant with 60 × 30 and 90 × 20 cm was lower when compared to 90 × 60 and 75 × 30 cm spacing but the loss in yield attributes/plant was compensated through higher plant population/ha and it also lead to the higher nutrients uptake by the plants. With respect to economics, significantly higher gross return (‘ 2,83,142 /ha), net return (‘ 2,27,392 / ha) and BCR (5.07) were obtained with the spacing of 120 × 45 cm + IPT when compared to control and 120 × 90 cm+ IPT but it was *on par* with the spacings of 150 × 45 cm and 120 × 60 cm along with IPT. Patel *et al.,* 2012 reported that spacing of 120 x45cm in *Bt* cotton gave highest return and BCR as compared to narrow or wider spacing.

Cotton producers are currently faced problems with rising production costs and static or declining return for their commodity. To combat these challenges, producers are continually searching for new alternatives to optimize their profit. Using promising varieties like *Bt* transgenic cotton may be a favorable choice. Containing the gene for Cry 1Ac or Cry 1ab, *Bt* cotton provides a fairly high degree of resistance to *Lepidopterous* pests and is thus widely adopted in both developed and developing countries (Qaim and Zilberman, 2003). Considerable research efforts have been ongoing for the last 100 years to determine the optimum

Table 1. Yield and economics of ELS *Bt* cotton due to the adoption of different plant spacing along with improved production technologies under rainfed condition

Treatments	Plants/ha	Seed cotton yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross return # (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio
S_1 -150×45 cm +IPT	14814.81	3660	55275	245220	189945	4.43
S_2 -150×60 cm +IPT	11111.11	2842	55000	190414	135414	3.46
S_3 -120×45 cm +IPT	18518.51	4226	55750	283142	227392	5.07
S_4 -120×60 cm +IPT	13888.88	3200	55100	214400	159300	3.89
S_5 -120×90 cm +IPT	9259.00	2356	54800	157852	103052	2.88
S_6 - farmers practice (120×90 cm)	9259.00	2062	59758	138154	78396	2.31
SEd		112.44	645.22	7534.12	7820.91	0.15
CD (p=0.05)		234.56	1345.90	15715.95	16314.17	0.32

S- Spacing (cm)
IPT-Improved Production Technology
(Calculation based on an average market sold Price of seed cotton @ ‘ 67.00/kg)

plant population for maximum yield and quality in upland cotton. Additionally, the influence of plant population on cotton growth and development has also been investigated with inconsistent or conflicting results. Several researchers have reported no significant difference in total seed cotton yield due to changes in plant density, while others have reported yield decreases with excessive or deficient plant populations.

Thus, from this study, it could be concluded that the maximum seed cotton yield and economics were obtained which dibbling the ELS *Bt* cotton hybrid seed with 120 × 45 along with IPT followed by 150 × 45 cm.

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