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RESEARCH PAPER

Evalution of Bt cotton to different sowing windows and plant spacing under rainfed vertisol conditions

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Abstract : The field experiments were conducted during 2010-11, 2011-12 and 2012-13 in *Rabi* season (Sep - Feb) at Agricultural Research station, Kovilpatti to study the response of Bt cotton to different dates of sowing under varying spacing. Experiments were laid out in split-plot design with three replications. The treatment combinations comprised of three dates of sowing, *viz.*, 39th, 41st and 43rd standard weeks (pre-monsoon, monsoon and post-monsoon sowing, respectively) in main plot with four different spacing of 90 x 60, 90 x 45, 75 x 60, 75 x 45 in the sub plot. The results of the experiment revealed that, pre-monsoon sowing of cotton (NCS 145) registered increased growth and yield parameters *viz.*, plant height, DMP, LAI, number of bolls/plant, boll weight, which reflected on increased yield of cotton kapas (1434, 2430 and 347 kg ha^{-1}) in 2011, 2012 and 2013, respectively. Similarly among the spacing tried, 75 x 45 cm (S_4) registered increased plant height, dry matter production, LAI and number of symbodial branches which reflected on increased kapas yield which was followed by spacing of 90 x 45 cm. Interaction result shows that, 39th standard week (pre-monsoon) sowing with narrow spacing of 75 x 45 cm registered increased kapas yield under rain-fed condition.

Key Words : Cotton, Growth, Spacing, Sowing window, Yield

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INTRODUCTION

Cotton (*Gossypium* sp.) is one of the major cash crops in many tropical and sub-tropical countries of the world. Bt cotton occupies 40 per cent area in India and 82 per cent area in Tamil Nadu. High levels of cotton production require favourable combinations of climate, soil and cultural practices. Cotton requires four to five months of warm temperature (about 32°C) during the growing season. Although cotton is grown on wide range of annual precipitation, the distribution of rainfall is a controlling yield factor. Planting geometry has greater role in optimizing yield of Bt cotton (Bhalerao *et al.*, 2008). Some earlier workers reported different results with regards to plant spacing and date of sowing *i.e.* Soomro *et al.* (2000) recorded 15th May as optimum sowing time with 30 cm spacing, Arian *et al.* (2001) reported that maximum seed cotton yield was produced when cotton was sown on first May followed by April 15th. The contradictory results reported by these workers may be due to different breeding material, sowing dates, cultural practices and also studied under various environmental conditions. However, no sufficient

research reports are available especially for Bt cotton (NCS 145) under rainfed vertisal condition of southern districts of Tamil Nadu. It is essential to find out suitable plant density and time of sowing for recently released Bt cotton hybrid to realize the maximum yield potential under rainfed vertisol condition. Hence, the present study was undertaken to find out the effect of spacing and sowing date on productivity of Bt cotton hybrid (NCS 145).

MATERIAL AND METHODS

A field experiment was conducted during 2010-11, 2011-12 and 2012-13 in *Rabi* season (September-February) at the Agricultural Research Station, Tamil Nadu Agricultural University, Kovilpatti, Tamil Nadu. Experiment was laid out in split plot design replicated thrice with dates of sowing in main plots and spacing in sub plots. The plot size was 5 x 4 m. The soil was clay in texture with sub angular blocky in structure with WHC of 65 per cent, EC: 0.32 dSm^{-1}, pH: 8.45, available N: 140 kg/ha, available P: 15.5 kg/ha, available K: 340 kg/ha. The treatment combinations comprised of four different spacing of 90 x 60 cm, 90 x 45 cm, 75 x 60 cm, 75 x 45 cm in the sub plot and different dates of sowing (D_1: 39th standard week - 24 to 30 'Sep (pre- monsoon), D_2: 41st standard week - 8 to 14 'Oct (monsoon), D_3: 43rd standard week - 22 to 28' Oct (post- monsoon) in main plot. Data on plant height, LAI, DMP, number of monopodial and sympodial branches, number of bolls per plant, boll weight and seed cotton yield were recorded and statistically analyzed. Meteorological data regarding rainfall, temperature, RH, wind speed and sunshine hours were collected from meteorological observatory located near crop field at Agricultural Research Station, Kovilpatti.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Weather data:

Total rainfall during crop growing period was D_1-602.2, D_2- 557.4, D_3- 524.8 mm during 2010-11, D_1-554.2, D_2-483.6 and D_3-367.0 mm during 2011-12 and D_1-259.5, D_2-259.5 and D_3-158.8 mm during 2012-13, respectively. The pre- monsoon sown crop received higher amount of AGDD, AHTU than other dates of sowing during all the three years of study. During 3rd year, because of the rainfall which was received at 10th October 2012, the pre-monsoon and monsoon sown crop received same amount of rainfall, AGDD and AHTU and that germinate at same time.

Growth parameters:

The effect of sowing date and spacing on some

Table 1: Effect of treatment on growth and symbodia branches at physiological maturity

Treatments	Plant ht (cm)			DMP (kg/ha)			LAI			Monobodia branches (Nos.)			Symbodia branches (Nos.)		
	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
D_1	117.2	114.6	51.8	3784	3706	1382	1.91	1.88	0.89	2.0	0.9	1.5	17.2	14.9	10.2
D_2	111.1	108.6	51.7	3358	3280	1362	1.76	1.80	0.89	2.0	1.0	1.6	16.9	13.1	10.2
D_3	95.0	93.1	40.1	2340	2254	926	1.54	1.52	0.68	2.0	1.1	1.5	14.4	12.7	8.7
S.E.±	5.9	5.0	2.4	157.7	154.3	62.6	0.09	0.082	0.04	0.1	0.0	0.1	0.8	0.57	0.48
C.D.(P=0.05)	16.4	14.0	5.0	437.8	428.2	130.3	0.24	0.226	0.08	NS	0.1	NS	2.2	1.58	0.98
S_1	105.6	97.5	47.7	2901	2821	1070	1.47	1.32	0.76	2.0	1.0	1.5	15.9	12.6	8.8
S_2	110.3	110.0	47.1	3309	3228	1275	1.92	1.94	0.86	2.0	1.0	1.6	16.8	14.0	10.1
S_3	99.7	100.9	48.7	2778	2697	1137	1.47	1.52	0.77	2.0	1.0	1.5	14.3	13.2	9.3
S_4	115.5	113.4	47.8	3654	3574	1413	2.08	2.16	0.89	2.0	1.0	1.5	17.6	14.6	10.7
S.E.±	5.2	5.6	2.3	154.7	150.2	59.2	0.08	0.088	0.04	0.1	0.1	0.1	0.7	0.68	0.49
C.D.(P=0.05)	10.9	11.8	NS	325.1	315.6	118.0	0.17	0.185	0.08	NS	NS	NS	1.5	1.42	1.00
M at S SEd	9.7	9.8	3.9	280.6	273.1	103.8	0.15	0.155	0.69	0.2	0.1	0.1	1.3	1.16	0.83
C.D.(P=0.05)	NS	NS	NS	649.3	632.5	NS	0.35	NS	NS	NS	NS	NS	3.1	NS	NS
S at M SEd	8.9	9.8	3.8	268.0	260.2	97.3	0.14	0.152	0.67	0.2	0.1	0.1	1.2	1.17	0.84
C.D.(P=0.05)	NS	NS	NS	563.0	546.6	NS	0.29	NS	NS	NS	NS	NS	2.6	NS	NS

NS= Non-significant

plant characters are presented in Table 1. Plant height being a physiological parameter was affected significantly (P<0.05) by different dates of sowing and different plant spacing. The tallest plants were recorded in plots sown on 39th standard week with spacing of 75 x 45 cm; the reason seems the elongated inter-nodes in an attempt to reach exposed solar energy at upper canopy levels (Jat and Nanwal, 2013). The results are in confirmation with Barman *et al.* (2013). The shorter plants were observed in the plots with plant spacing of 75 x 60 cm and 90 x 60 cm during three year of study period. It is worth mentioning here that the plants with lesser height had very spreading and increased canopy which indicates that the plants had an opportunity to spread rather than elongate. Similarly the other growth factor such as dry matter production, leaf area index and sympodial branches were significantly higher in crop sown during pre monsoon period (39th standard week) with the closer spacing of 75 X 45 cm compared to other delayed date of sowing and spacing during all the years. Early sowing helped the plants to achieve higher LAI as compared to delayed sowing. The highest LAI was observed under closer spacing of 75 x 45 cm was due to more number of leaves per unit area which in turn was due to increased number of plants per unit area (Sivagamy and Ram Mohan, 2012). Higher DMP was due to higher LAI might have helped the plants in harvesting higher amount of solar energy and accumulation in the tissues. Generally, delaying the sowing date significantly reduced all growth and yield components.

Yield parameters:

Number of bolls:

Among the spacing tried, the number of bolls plant^{-1} was significantly higher in wider spacing with the values of 20.8, 40.4 and 12.7 during 1st, 2nd and 3rd year, respectively (Table 2). When cotton plants were grown wide apart, due to availability of more nutrients and ample space it is a common feature to have more number of bolls (Bhalerao *et al*., 2012). The number of bolls plant^{-1} was significantly higher in pre-monsoon sowing crop during all the years. Sowing crop few days earlier get the higher benefits of soil moisture, nutrient and intercepted radiation due to little bit extension in growing season of cotton crop.

Boll weight:

Significantly increased boll weight was recorded by pre-monsoon sown crop in all three years of study period which was followed by monsoon sown cotton. Timely planting of Bt hybrid produced significantly higher yield and associated traits than late planting (Sankaranarayanan *et al*., 2011). Delay in sowing date reduced the size of the boll. Among the spacing tried, heavier bolls were produced by wider spaced crop than the close spaced crop. Wider spacing significantly improved the number of bolls/plant and boll weight as compared to closer spacings (Jagdish Kumar *et al.*, 2010).

Seed cotton yield:

The results revealed that spacing of 75 x 45 cm

Table 2: Effect of treatment on yield attributes and yield of cotton

Treatments	No. of bolls plant^{-1}			Boll wt (g)			Seed cotton yield (kg ha^{-1})		
	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
D_1	20.5	46.5	14.2	4.7	4.4	3.3	1433	2430	347
D_2	19.9	39.9	14.2	4.5	4.1	3.3	1281	1905	338
D_3	15.0	25.4	7.5	4.1	3.7	2.7	941	1398	220
S.E.±	0.89	1.79	0.62	0.23	0.18	0.16	59.1	90.5	17
C.D.(P=0.05)	2.47	4.97	1.25	NS	0.49	0.34	164.1	251.3	35
S_1	20.8	40.4	12.7	4.6	4.2	3.1	1169	1841	220
S_2	17.3	35.1	11.8	4.4	4.0	3.0	1271	1964	320
S_3	18.5	38.2	12.0	4.4	4.1	3.1	1000	1769	283
S_4	17.2	35.4	11.5	4.3	3.9	3.0	1434	2070	384
S.E.±	0.92	1.62	0.60	0.21	0.19	0.15	60.7	87.79	14.6
C.D.(P=0.05)	1.92	3.39	NS	NS	NS	NS	127.5	184.45	30.7
M at S SEd	1.64	3.01	0.97	0.39	0.33	0.25	108.5	159.81	28.0
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	249.8	370.38	56.1
S at M SEd	1.59	2.80	0.87	0.37	0.33	0.25	105.1	152.0	25.3
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	220.8	319.48	50.2

NS= Non-significant

(S_4) recorded significantly higher yield than wider spacing (Table 2). The higher seed cotton yield at 75 x 45 cm spacing might be due to more number of bolls per unit area as compared to wider spacing. Nehra and Yadav (2012) and Shekar *et al.* (2012) also reported higher seed cotton yield in Bt cotton with closer spacing as compared to wider spacing. Lowest seed cotton yield at wider spacing was mainly due to decrease in population. This decrease in population could not make up for the individual increase in growth and yield parameters and yield (Krishnasamy *et al.*, 2013). Planting cotton at 39th standard week (pre- monsoon sowing) recorded the highest kapas yield in all the three years of study period. This could be due to more rainfall amount and longer distribution that might be improved the yield. Early sowing increased plant height and number of branches. Consequently, the number of bolls/plant, boll weight and resulting in higher yield of seed cotton. These results are in agreement with the findings of Sankaranarayanan *et al.* (2011). Higher seed yield in early sowing might be due to prevailing favourable climatic conditions in early monsoon sowing (Dudhat and Asodaria, 2012). The results revealed that as we delay the sowing, the seed cotton yield decreases drastically. There was a clear trend towards reduced yields with delayed sowing. The results of the study are in line with the findings of Bharathi *et al.* (2012).

Conclusion:

It can be concluded from this study that for getting maximum seed cotton yield, the crop should be sown on 39th standard week (pre-monsoon sowing) with plant spacing of 75 x 45 cm under rainfed vertisol condition of southern agroclimatic zone of Tamil Nadu.

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