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Development of Bt Cotton (*Gossypium hirsutum* L.) Hybrids Amenable for High Density Planting

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ABSTRACT

Breeding investigation was taken up to evolve and assess hybrids for high density planting in Bt cotton through Line X Tester mating design involving parents with diverse plant architecture. Randomized complete block design (RCBD) with three replicates was adopted to ascertain the performance of hybrids under conventional density (CDP) and high density planting (HDP) in the year 2015-16. Analaysis of variance (ANOVA) revealed significant differances among the genotypes, which includes nine parents and 20 test crosses for maturity, plant architecture, yield and yield attributing traits under both planting densities. Ideal ideotype of hybrid for high density planting (HDP) found to be of open to semi open plant architecture with determinant growth habit. Considering the parental status of most promising hybrid combinations, it is quite evident that to evolve most suitable hydrids for high density planting (HDP) at least one of the parents must be of open plant type with determinant plant growth habit, whereas second parent can be of varied plant type and growth pattern provided there is nice complementation with the first parent. Test cross combinations SC1104 X 1205, SC1134 X 1205 and SC1112 X 1205 have been identified as most suitable for high density planting (HDP).

Key words: *Line X Tester, Bt cotton, Ideotype, Plant architecture, High density planting*

INTRODUCTION

In India, Cotton (*Gossypium hirsutum* L.) is one of the most important industrial crop contributing significantly to economy directly and indirectly. As of 2015-16, India stood first with an area of 11.8 million hacters, and second in production with 34.6 million bales[1]. With large scale cultivation of hybrid cultivars from mid-90´s and adoption of boll worm insect resistance Bt technology since 2002 aided for achieving current average productivity of 520 kg of lint per hectare. But still our productivity is low compared to world average (765 kg lint per ha). In spite of introduction of improved hybrids over the years we have started witnessing the plateauing of yield levels. One of the alternative options to break this plateauing and to increase the productivity levels is through exploring higher density planting method of production.

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In countrys such as Brazil (1476 kg lint /ha), Turkey (1433 kg lint/ha) and China (1352 kg lint/ha) through the adoption of high density planting method with compact determinate plant architecture achieved the high productivity levels. On contrary, plant population with hybrid varieties in India ranges from 6000 to 15000 plants per hectare which is far below the planting densities countrys with the higher productivity. One of the limitations for the adoption of high density planting system of production is non availability suitable hybrids with suitable plant architecture. Majority of the hybrids being grown so far in India are with semi determinate growth habit and robust plant architecture. Development of short to medium duration hybrids with compact plant architecture offers opportunity for increasing the yield as well as land use efficiency. Such plant type may also favor the adoption of mechanization the various operations of production and harvesting. As per Aphalo *et. al.*[2], the classical crop response to increased plant density and crowding is expressed in a typical optimum curve. Population yield increases while yield per plant decreases to a given plant density of maximum yield, after which the continued reduction in yield per plant with the increased density begin to reduce population yield. Thus, maximum yield is achieved with a population of undersized stressed plants shape. Plants in a dense population try to avoid shading by investing energy and resources in modifying growth and shape.In the process of breeding hybrid cultivars selection of parental lines to achive desired combination of traits in hybrid is considered as most critical step. This involves careful selection of complementary parental lines along with knowledge on the nature of inheritance of traits under the consideration. Hence the present study was commissioned to evolve test hybrids involving diverse growth pattern and plant architecture so as to understand the complementation for component traits determining the plant type and to identify the most suitable ones for high density planting.

MATERIAL AND METHODS

Nine parental lines with varying plant architecture (Table. 1) with known breeding value were selected and sourced from M/S Sri Satya Agri Biotech Pvt. Ltd. Guntur germplasm. Twenty test hybrids were evolved in Line x Tester mating design proposed by Kempthrone (5) by considering five Bt transgenic lines as females and non Bt lines as males through conventional hand emasculation and pollination in the year 2015. For standard economic comparison, widely cultivated Bt cotton hybrid Mallika® with semi open plant architecture was included in the study.Field experiment was conducted in the year 2015-2016 at the research farm of department of Botany, Pratishthan Mahavidyalaya, Paithan, Aurangabad with deep black cotton soil, situated at latitude 19°44' N, longitude 73°59' E. The study consisted of 30 entries such as 20 test hybrids, nine corresponding parental lines and one standard commercial check hybrid. Randomized block design involving three replicates was adopted to evaluate the test material, wherein each plot consisted of two rows of six meter length.. To assess response of test hybrids with contrasting plant densities, paired trial was conducted with same design in higher density planting (HDP) and conventional density planting (CDP). Based on the previous studies, planting density of 37037 plants/ha @ 90X30 cm spacing with supplmentary sprays of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS + 90DAS and 18518 plants/ha @ 90x60cm spacing was considered as HDP and CDP respectively. The crop was raised under protected irrigation system with standard agronomic practices of the region.Data on key traits influencing maturity and plant architecture such as days to 50% flowering, days to first boll opening, plant height (cm), number of monopodial branches, number of sympodial branches, number of bolls per plant, boll weight (g) has been collected. Along with this seed cotton yield per hectare which is considered as economic yield was worked out by extrapolating the gross plot yield (kg) and subjected for the analysis. Analysis of variance for line x tester was done as suggested by Singh and Chaudhary[12] separately for conventional density planting (CDP) and high density planting (HDP) to assess the expression of test hybrids in contrasting planting densities.

RESULTS AND DISCUSSION

Analysis of variance (ANOVA):

Analysis of variance from both conventional density planting (CDP) and high density planting (HDP) system of planting found to be highly significant (Table.2) for genotypes (parents and crosses) for traits determining maturity viz., days to 50% flowering and days to first boll opening as well as plant architecture related traits such plant height (cm), number of monopodial branches, number of sympodial branches. And also, mean sum of squares (Table 3) were significant for seed cotton yield (Kg/ha) and yield attributing traits such as number of bolls per plant and boll weight. This indicates the presence of substantial genetic variability among genotypes for all the characters studied in contrasting planting densities, similar results were observed in Maize by Lamalakshmi Devi[6]. The mean squares due to crosses (test hybrids) as well as parents vs. crosses comparison for all the traits were found highly significant, indicating superiority and nice complementation in F1 crosses (test hybrids) over corresponding parents in the present investigation, which is in conformity with the studies of Gnanasekaran *et.al*.[3] and Monicashree *et. al*.[7] Mean performance acts as the main criterion in selecting better hybrids as it reveals their real value. Shimna and Ravikesavan[11] suggested that the per se performance of hybrids appeared to be a useful index in judging them. Hence mean performance of test hybrids has been considered criterion to assess the performance and to identify most suitable ones for high density planting.

Assessment of maturity traits:

In order to assess the growth pattern and maturity of test hybrids, data on traits such as days to 50% flowering (Table 4) and days to first boll opening (Table 5) was collected. Irrespective of planting densities significant differences among the test hybrids were observed for both the traits. Among the test hybrid combinations, SC1104 X 1206, SC1134 X 1206 and SC1132 X 1206 found be significantly earlier as compared to standard check, wherein male parent SC1206 with per se very early maturity imparted earliness to corresponding test hybrids. Present investigation for these maturity traits in agreement with the findings of Sawarkar *et. al*.[9] The early maturing hybrids are desirable to avoid the terminal stress during water limiting condition and amenable double cropping system.

Assessment of plant architecture traits:

Plant architecture in cotton is determined to great extent by traits such as number of monopodial branches, number of sympodial branches and plant height. Considering these three traits in combination Yellamanda Reddy and Shankar Reddy[14] broadly classified cotton plant type into two categories such as compact and robust types. As far as number of monopodial branches (Table 6) as concerned, significant differances were observed among the test hybrids. Test hybrids such as SC1134 X 1206, SC1132 X 1206 and SC1112 X 1206 found be having close to zero monopodial branches under high density planting (HDP). The suppression of monopodial branches coupled with shorter sympodial branches makes the plants amenable for high density planting. The same phenomenon was observed by Gunasekaran *et. al*.[4] while developing zero monopodia and short sympodial *G. hirsutum* cotton genotype. Assessment of test hybrids for number of sympodial (Table 7) branches revealed significant differences in both the planting densities. Cross combinations yielding consistantly higher seed cotton yield also recorded significantly higher number of sympodial branches under the conventional density planting. Whereas the same combinations recorded on par or significantly less number under high density planting exhibiting the versatility of the crosses to adapt for contrasting planting densities with sutle modification in plant architecture. The findings are in conformity with the work of Sekloka *et. al*.[10] Plant height is the trait one which determines the utilization of vertical space. In the present investigation test hybrids (Table 8) registered significant differences for the same, this could be largely attributed to status of corresponding parental lines. Dwarf and compact plant type is considered as desirable for high density planting; hence hybrids with lesser plant height coupled with shorter inter sympodial branching distance for the efficient explotation of three dimensional space. In this direction 17 out of 20 combinations found to be having lesser plant height as compared to the standard check, this is in agreement with the studies of Tamilselvam *et. al*[13].

Assessment of yield components and seed cotton yield:

Number of bolls per plant (Table 9) and boll weight (Table 10) are considered as major components of final commercial yield. For both the traits highly signicant differances were observed under both the planting densities. Average number of boll per plant for test hybrids was significantly reduced under high density planting as compared to conventional density planting; nevertheless it got compensated by relatively dense population plants leading to significantly higher seed cotton yield in test hybrids with compact plant types. On contrary boll weight of test hybrids got unaffected by increase in planting density, in fact there has been significant in boll weight of selected test hybrids owing to the chemical growth regulator sprays. The same phenomenon was observed by Prakash and Korekar[8] in the agronomic involving planting densities and chemical growth regulators. Cotton bolls with burst open fibers with seeds is considered as economic yield and referred as seed cotton yield or kapas yield, expressed as kilo grams per hectare of land. In this particular investigation (Table 11) significant differences were observed among test hybrids. Under high density planting 10 out 20 test hybrids found to be significantly superior than the standard check, this superiority could be attributed to the suitable plant architecture resulting from most complementary parental lines.

Suitable hybrids for high density planting:

Top three test crosses (SC1104 X 1205, SC1134 X 1205 and SC1112 X 1205) with significantly high seed cotton yield over commercial check had been selected for high density planting (HDP). In order to assess the complementation of parental in resulting test crosses, data on maturity, plant architecture and yield component traits were compared (Table 12). In order to achive compact plant architecture with minimum plant to plant competition under higher density planting (HDP) for plant height and number of monopodial branches as well as to achieve earliness interms of days to 50% flowering and days to first boll opening per se values in negative direction was considered to be favorable. Whereas, for number of sympodial branches, number of bolls and boll weight positive values was considered to be desirable. All the three selected test hybrids included common male parent (SC1205) with open plant type with determinate growth habit. As far as female parental line as concerned, it was varied from bushy to open plant type and indeterminate to determinate growth pattern. Considering the status of parental lines in the present investigation it is quite evident that to evolve suitable hydrids for high density planting (HDP) at least one of the parents must be of open plant type with determinant plant growth to achieve ideal ideotype. As far as second parent as concerned it can be of varied plant type and growth pattern provided there is nice complementation with the first parent.

Table 1: Salient features of parental lines used for the development of test crosses.

Sl.No.	Line/Tester	Name	Bt/Non Bt	Plant architecture/type	Growth pattern	Boll size
1	Line	SC1104	Bt	Bushy/Robust	Indeterminate (ID)	Big
2	Line	SC1112	Bt	Open/compact	Semi determinate (SD)	Medium
3	Line	SC1117	Bt	Semi open/ Semi compact	Semi determinate (SD)	Medium
4	Line	SC1132	Bt	Semi open/ Semi compact	Semi determinate (SD)	Big
5	Line	SC1134	Bt	Open/compact	Determinate (D)	Small
6	Tester	SC1115	Non Bt	Bushy/Robust	Indeterminate (ID)	Small
7	Tester	SC1133	Non Bt	Semi open/ Semi compact	Semi determinate (SD)	Big
8	Tester	SC1205	Non Bt	Open/compact	Determinate (D)	Medium
9	Tester	SC1206	Non Bt	Open/compact	Extremely Determinate (ED)	Small

Table 2: ANOVA for maturity and plant architecture traits

Traits		DFF		DFBO		NMB		NSB		PH	
Source of variation	df	CDP	HDP	CDP	HDP	CDP	HDP	CDP	HDP	CDP	HDP
Replicates	2	1.0	1.7	1.1	1.1	0.0	0	0.1	0.1	1.3	12.1**
Genotypes	28	36.4**	34.8**	73.1**	79.5**	2.5**	45.2**	2.7**	2.4**	125.7**	265.9**
Parents	8	69.0**	79.1**	94.2**	105.5**	3.9**	17.7**	1.1**	1.5**	176.1**	522.1**
Parents (Line/female)	4	30.9**	30.1**	25.4**	23.1**	3.7**	8.6**	1.8**	0.7**	217.5**	521.2**
Parents (Testers/male)	3	123.8**	132.1**	155.8**	180.1**	5.2**	8.7**	0.4**	2.1**	138.0**	523.5**
Parents (L vs T)	1	57.4**	116.7**	184.9**	211.6**	1.1**	0.3**	0.8**	2.7**	124.4**	521.6**
Parents vs Crosses	1	48.9**	17.1**	25.7**	21.0**	0.1*	0.4**	24.2**	0.6**	95.1**	42.5**
Crosses	19	22.0**	17.1**	66.6**	71.7**	2.1**	27.1**	2.3**	2.9**	106.0**	169.8**
Error	56	1.5	0.2	0.6	0.2	0.0	0.6	0.0	0	0.1	1.8
Total	86	12.9	11.5	24.2	26.0	0.8	45.7	0.9	0.8	41.0	88

**5% & **1% significance*, CDP: Conventional density planting, HDP: High density planting, DFF: Days to 50% flowering, DFBO: Days to first boll opening, NMB: Number of monopodial branches, NSB: Number of sympodial branches, PH: Plant height (cm)

Table 3: ANOVA for yield and yield component traits

Traits		NB		BW		SCY	
Source of variation	df	CDP	HDP	CDP	HDP	CDP	HDP
Replicates	2	2.0	3.1	0.0	0.0	7661	505
Genotypes	28	143.5**	174.2**	0.4**	0.8**	332718**	1174001**
Parents	8	89.8**	64.3**	0.5**	0.6**	157108**	309609**
Parents (Line/female)	4	97.1**	97.8**	0.5**	0.8**	38490**	86395**
Parents (Testers/male)	3	109.0**	41.0**	0.5**	0.1**	366312**	693540**
Parents (L vs T)	1	2.7*	0.6	1.5**	1.5**	3969	50673*
Parents vs Crosses	1	1764.8**	1070.8**	0.5**	0.6**	4749786**	18582916**
Crosses	19	80.8**	173.3**	0.4**	0.9**	174181**	621697**
Error	56	0.5	2.2	0.0	0.0	3661**	9825
Total	86	47.1	58.2	0.2	0.3	110889	388642

**5% & **1% significance*, CDP: Conventional density planting, HDP: High density planting, NB: Number of bolls BW: Boll weight (g), SCY: Seed cotton yield (kg/ha)

Table 4: Days to 50% flowering of test hybrids involving parents with varying plant architecture

Conventional density planting (CDP)						High density planting (HDP)					
Female/Male		SC1115	SC1133	SC1205	SC1206	Female/Male		SC1115	SC1133	SC1205	SC1206
	Per se	62.5	64.5	55.0	51.0		Per se	63.5	64.5	56.0	50.5
SC1104	64.5	62.5	65.0	60.0	54.5	SC1104	65.5	62.5	64.5	61.0	57.5
SC1112	59.5	64.0	64.5	61.0	60.0	SC1112	62.5	63.5	64.5	62.0	59.5
SC1117	63.5	63.5	64.5	61.5	60.0	SC1117	65.0	63.5	64.5	62.5	61.0
SC1132	61.5	64.0	61.5	61.0	59.0	SC1132	63.5	65.0	64.5	61.5	58.5
SC1134	56.5	64.5	62.0	59.5	57.5	SC1134	57.5	61.5	63.5	59.5	57.5
Check (Mallika)	65.0					Check (Mallika)	64.5				
CD (p=0.05)	2.0					CD (p=0.05)	0.8				
CD (p=0.01)	2.7					CD (p=0.01)	1.0				
Sem±	0.71					Sem±	0,27				

Table 5: Days to first boll opening of test hybrids involving parents with varying plant architecture

Conventional density planting (CDP)						High density planting (HDP)					
Female/Male		SC1115	SC1133	SC1205	SC1206	Female/Male		SC1115	SC1133	SC1205	SC1206
	Per se	124.5	126.0	115.5	111.0		Per se	125.0	125.5	114.5	110.0
SC1104	128.0	121.5	125.0	117.5	112.5	SC1104	127.5	122.5	125.0	116.5	111.5
SC1112	122.5	123.5	124.5	122.0	121.0	SC1112	121.5	124.0	124.5	122.5	119.5
SC1117	126.0	124.5	125.0	122.0	121.5	SC1117	126.5	125.0	123.5	122.0	119.5
SC1132	125.5	124.0	126.0	121.5	118.5	SC1132	124.5	124.5	126.0	120.0	117.5
SC1134	120.5	122.5	124.0	116.0	107.0	SC1134	121.5	123.5	125.0	116.0	107.5
Check (Mallika)	126.5					Check (Mallika)	125.5				
CD (p=0.05)	1.3					CD (p=0.05)	0.7				
CD (p=0.01)	1.7					CD (p=0.01)	1.0				
Sem±	0.45					Sem±	0.25				

Table 6: Number of monopodial branches of test hybrids involving parents with varying plant architecture

Conventional density planting (CDP)						High density planting (HDP)					
Female/Male		SC1115	SC1133	SC1205	SC1206	Female/Male		SC1115	SC1133	SC1205	SC1206
	Per se	2.0	3.8	1.4	0.7		Per se	1.5	2.3	0.8	0.0
SC1104	4.0	2.9	3.5	2.2	2.0	SC1104	2.5	2.0	2.7	1.5	1.3
SC1112	1.8	2.4	3.2	1.5	0.7	SC1112	0.9	1.5	2.0	1.4	0.7
SC1117	2.8	2.4	3.3	1.8	1.4	SC1117	1.7	1.7	2.2	1.0	0.9
SC1132	2.3	2.5	3.3	2.0	1.0	SC1132	1.5	1.7	2.5	1.0	0.5
SC1134	1.0	1.7	2.5	1.3	1.0	SC1134	0.3	1.0	1.8	0.8	0.0
Check (Mallika)	2.8					Check (Mallika)	1.7				
CD (p=0.05)	0.3					CD (p=0.05)	0.17				
CD (p=0.01)	0.32					CD (p=0.01)	0.22				
Sem±	0.27					Sem±	0.06				

Table 7: Number of sympodial branches of test hybrids involving parents with varying plant architecture

Conventional density planting (CDP)						High density planting (HDP)					
Female/Male		SC1115	SC1133	SC1205	SC1206	Female/Male		SC1115	SC1133	SC1205	SC1206
	Per se	15.7	16.3	16.4	16.5		Per se	14.9	14.2	14.8	16.2
SC1104	16.2	15.8	16.8	17.2	16.7	SC1104	14.9	12.6	15.8	14.2	13.3
SC1112	15.9	16.6	16.9	17.6	17.0	SC1112	14.0	15.3	14.8	15.2	14.0
SC1117	16.0	16.1	16.7	17.3	17.2	SC1117	14.9	14.8	15.6	14.2	13.4
SC1132	16.7	16.1	16.3	17.8	18.1	SC1132	13.9	13.3	14.9	13.2	16.2
SC1134	14.6	17.5	18.0	18.4	19.3	SC1134	14.2	14.6	13.9	14.5	15.5
Check (Mallika)	16.8					Check (Mallika)	15.1				
CD (p=0.05)	0.24					CD (p=0.05)	0.3				
CD (p=0.01)	0.4					CD (p=0.01)	0.4				
Sem±	0.10					Sem±	0.11				

Table 8: Plant height (cm) of test hybrids involving parents with varying plant architecture

Conventional density planting (CDP)						High density planting (HDP)					
Female/Male		SC1115	SC1133	SC1205	SC1206	Female/Male		SC1115	SC1133	SC1205	SC1206
	Per se	142.5	144.0	155.8	154.0		Per se	126.8	101.2	128.4	127.5
SC1104	144.2	143.5	156.3	154.8	148.8	SC1104	115.7	116.2	109.0	126.7	116.4
SC1112	154.5	147.5	154.5	157.0	158.8	SC1112	104.2	110.0	104.5	123.3	115.8
SC1117	164.0	151.5	147.8	156.0	163.5	SC1117	133.7	122.0	107.9	118.3	120.8
SC1132	145.5	153.5	151.5	162.9	148.0	SC1132	102.0	112.5	109.2	106.7	100.5
SC1134	158.8	149.8	148.3	154.6	166.0	SC1134	105.0	112.9	109.4	127.8	120.8
Check (Mallika)	154.8					Check (Mallika)	124.5				
CD (p=0.05)	0.6					CD (p=0.05)	2.2				
CD (p=0.01)	0.8					CD (p=0.01)	3.0				
Sem±	0.21					Sem±	0.78				

Table 9: Number of bolls per plant of test hybrids involving parents with varying plant architecture

Conventional density planting (CDP)						High density planting (HDP)					
Female/Male		SC1115	SC1133	SC1205	SC1206	Female/Male		SC1115	SC1133	SC1205	SC1206
	Per se	40.0	44.8	42.0	31.2		Per se	28.7	30.0	36.5	29.0
SC1104	42.5	48.0	48.0	57.0	51.0	SC1104	27.8	33.0	25.0	46.0	41.0
SC1112	35.0	42.0	52.0	52.0	43.0	SC1112	27.3	34.5	41.0	46.0	38.5
SC1117	41.0	54.0	47.0	46.0	47.0	SC1117	34.7	43.5	27.8	37.5	40.5
SC1132	31.0	40.0	44.7	43.0	47.2	SC1132	25.5	29.0	27.2	34.8	41.0
SC1134	44.8	51.0	51.0	60.5	53.2	SC1134	39.0	43.5	38.0	53.0	49.5
Check (Mallika)	48.0					Check (Mallika)	39.0				
CD (p=0.05)	1.1					CD (p=0.05)	0.2				
CD (p=0.01)	1.5					CD (p=0.01)	0.3				
Sem±	0.63					Sem±	0.08				

Table 10: Boll weight (g) of test hybrids involving parents with varying plant architecture

Conventional density planting (CDP)						High density planting (HDP)					
Female/Male		SC1115	SC1133	SC1205	SC1206	Female/Male		SC1115	SC1133	SC1205	SC1206
	Per se	5.02	4.47	4.90	4.72		Per se	5.38	4.99	5.24	5.04
SC1104	5.30	5.56	4.80	5.42	5.05	SC1104	5.83	6.35	5.31	6.24	5.64
SC1112	4.99	5.49	4.65	5.07	5.03	SC1112	5.32	6.22	4.99	4.93	5.30
SC1117	5.18	5.30	4.63	5.19	4.96	SC1117	5.48	5.73	5.08	5.91	5.39
SC1132	5.83	5.77	5.44	5.77	5.37	SC1132	6.40	6.62	5.90	6.25	5.82
SC1134	4.77	5.05	4.73	5.07	4.55	SC1134	5.12	5.36	5.17	5.23	4.56
Check (Mallika)	5.35					Check (Mallika)	5.95				
CD (p=0.05)	0.03					CD (p=0.05)	0.22				
CD (p=0.01)	0.04					CD (p=0.01)	0.29				
Sem±	0.01					Sem±	0.08				

Table 11: Seed cotton yield (kg/ha) of test hybrids involving parents with varying plant architecture

Conventional density planting (CDP)						High density planting (HDP)					
Female/Male		SC1115	SC1133	SC1205	SC1206	Female/Male		SC1115	SC1133	SC1205	SC1206
	Per se	2433	2388	2099	1673		Per se	3649	3606	3224	2610
SC1104	2139	2770	2438	3108	3095	SC1104	3205	3940	3825	4835	4499
SC1112	2023	2738	2871	2487	2484	SC1112	3034	4266	4168	4666	4342
SC1117	2194	2746	3056	2637	2563	SC1117	3290	4140	3511	4433	4401
SC1132	2266	2545	2436	2625	2609	SC1132	3399	3890	2895	4395	4509
SC1134	1998	2508	2455	2277	2284	SC1134	2997	4062	4343	4767	4570
Check (Mallika)	2766					Check (Mallika)	4036				
CD (p=0.05)	98.7					CD (p=0.05)	161.9				
CD (p=0.01)	132.4					CD (p=0.01)	216.9				
Sem±	34.9					Sem±	57.2				

Table 12: Maturity, plant architecture, yield and yield component traits of top three hybrids amenable for high density planting

Details			Description		Traits							
Rank	Entry	Code	Plant type/ architecture	Growth habit	DFF	DFBO	NMB	NSB	PH	NB	BW	SCY
1	Female	SC1104	Bushy (Robust)	Indeterminate	65,5	127.5	2.5	14.9	115.7	27.8	5.83	3205
	Male	SC1205	Open (Compact)	Determinate	56.0	114.5	0.8	14.8	128.4	36.5	5.24	3224
	Hybrid	SC1104 X 1205	Semi open (Semi compact)	Determinate to Semi determinate	61	116.5	1.5	14.2	126.7	46.0	6.24	4835
2	Female	SC1134	Open	Determinate	57.5	121.5	0.3	14.2	105.0	39.0	5.12	2997
	Male	SC1205	Open	Determinate	56.0	114.5	0.8	14.8	128.4	36.5	5.24	3224
	Hybrid	SC1134 X 1205	Open	Determinate	59.5	116.0	0.8	14.5	127.8	53.0	5.23	4767
3	Female	SC1112	Semi open (Semi compact)	Semi determinate	62.5	121.5	0.9	14.0	104.2	27.3	5.32	3034
	Male	SC1205	Open	Determinate	56.0	114.5	0.8	14.8	128.4	36.5	5.24	3224
	Hybrid	SC1112 X 1205	Semi open (Semi compact)	Semi determinate	62.0	122.5	1.4	15.2	123.3	46.0	4.93	4666
Check		Mallika	Semi open (Semi compact)	Semi determinate	64.5	125.5	1.7	15.1	124.5	39.0	5.95	4036

DFF: Days to 50% flowering, DFBO: Days to first boll opening, NMB: Number of monopodial branches, NSB: Number of sympodial branches, PH: Plant height (cm), NB: Number of bolls, BW: Boll weight (g), SCY: Seed cotton yield (Kg/ha)

CONCLUSION

The present study unveiled the ideal ideotype interms of plant type and growth habit along with the type of parental lines to be considered in the breeding hybrids for high density planting. Test cross combinations SC1104 X 1205, SC1134 X 1205 and SC1112 X 1205 have been identified as most suitable combination for economic yield and other essential traits for high density planting and proposed for commercial explotation through large scale trials in varied agro climatic regions.

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