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Research Article

HETEROSIS STUDIES FOR HIGH GINNING OUTTURN PERCENT AND RELATED TRAITS IN *G. Hirsutum* COTTON

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Abstract: Twenty seven parents of *Gossypium hirsutum* cotton were used as female parent (13 cultivars + 7 indigenous collections +7 exotic collection) and 13 recombinant inbred lines of cross SA977 x SA112 are possessing high ginning outturn percent (GOT%) ≥ 40 were used as male to attempt crosses during 2013-14 *Kharif* crop season. 178 F_1 hybrids obtained were evaluated in 2014-15 crop season for the traits, seed cotton yield (Kg/ha), boll no/plant, boll weight (g), GOT%, the number of monopod and sympod. As many as 133 hybrids gave positive heterosis over male parent for seed cotton yield trait. For GOT% 15 hybrids gave heterosis higher than high GOT% male parents, for boll no/plant positive heterosis was obtained for eight and two hybrids over the best female and male parent, respectively. Nine and 27 hybrids exhibited positive heterosis over the best female and male parent for the trait boll weight.

Keywords: Ginning outturn percent, heterosis, *Gossypium hirsutum*

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Introduction

Cotton (*Gossypium* sp.) is a major crop of global importance and has high commercial value. It is a principle fibre crop, as well as an important source of edible oil throughout the world. Demand for higher fibre quality in upland cotton (*Gossypium hirsutum* L.) has been increasing due to the rapid development of new technology in the textile industry. Delinking of negatively associated desirable (high yield) and undesirable (poor fibre quality) traits had been a breeding challenge in cotton. Joshi and his students could address this problem by indigenous breeding/selection strategies. Cotton varieties known as JK series (J stands for Joshi and K for Kadappa, student of Joshi and well-known cotton breeder in Karnataka, India) combining high ginning outturn and high fibre strength and fineness in high-yield backgrounds are the outcome of this effort. It was his belief that yield stagnation at low levels for long in cotton could be breached by exploitation of hybrid vigour. Cotton ginning outturn is the percentage of ginned lint obtained from seed cotton and is used for measurement of ginning, cotton production and marketing. Achieving higher ginning outturn is an important goal for breeding programmes. Thus selecting parental lines with wide genetic diversity and evaluating these lines in their hybrid form become an essential practice for making progress in attaining high ginning outurn. Earlier studies showed that heterotic potential in cotton for improving yield and fibre quality were ranged from 10 to 20%. Both F_1 and F_2 hybrids can provide significantly higher yields than commercial cultivars [1, 2, 3, 4]. Therefore, the aim of this research study was to estimate the amount of heterosis for high ginning outturn per cent among twenty seven different cotton genotypes and to determine appropriate parents and crosses for the other investigated traits contributing the production and ginning outturn. Twenty seven parents (H 1098, F 1861, F1378 9C, LH-2107, LH-2108, F-2164, F-846, LH-1134, CSH-3129, H 1226, IC 359508, IC 358382, IC 357203, IC 357671, IC 356665, IC 358479, SA-1231, IC 357726, EC359059, EC357032, SA-668, SA-524, Biyani 161, F2383, Biyani-251, SA 112 and SA 977) with GOT% ranging between 33 and 35% were used as female parent (13 cultivars + 7 indigenous collections + 7 exotic collection) and 13 recombinant inbred lines of cross SA977 x SA112 possessing high ginning outturn (GOT%) ≥ 40 to identify F_1 hybrids with superiority over the best male and female for the traits, seed cotton yield (Kg/ha), boll no/plant, boll weight (g), GOT%, number of monopod and sympod.

Materials and methods

The research work was conducted at the experimental farm of ICAR-Central Institute for Cotton Research, Regional Station, Sirsa (*Haryana*) India to estimate the heterosis of F_1 hybrids. Twenty seven (H 1098, F 1861, F1378, LH-2107, LH-2108, F-2164, F-846, LH-1134, CSH-3129, H 1226, IC 359508, IC 358382, IC 357203, IC 357671, IC 356665, IC 358479, SA-1231, IC 357726, EC359059, EC357032, SA-668, SA-524, Biyani 161, F2383, B-251, SA 112 and SA 977 (13 cultivars + 7 indigenous collections +7 exotic collection as per details given in Table-1) were used as female and 13 recombinant inbred lines of cross SA977 x SA112 are possessing high ginning outturn (GOT%) ≥ 40 were used as male parent and total 178 crosses were attempted during 2013-14 crop season. During 2014-15 *Kharif* (May month) crop season F_1 population of 178 crosses along with 27 females and 13 male parents were raised in a replicated experimental trial with three rows of each. Row to row spacing of 67.5cm and plant to plant spacing of 30 cm with row length of 5.4 meters accommodating 18 plants per row were maintained. Recommended agronomic practices were followed for raising the crop. Data were recorded from 10 plants for each of the crosses and the parents of the traits, number of monopods, number of sympods per plant, number of bolls per plant, and the average was calculated for analysis of heterosis. Twenty random bolls of each of the crosses and the parent plants were collected, they were subjected for weighing and the average was calculated for analysis of heterosis for boll weight (g). Ginning outturn percent (GOT %) was estimated by weighing the percent amount of lint obtained from 100 gram of seed cotton. Seed cotton yield per hectare of each cross and parent was calculated from the weight of seed cotton yield obtained from three rows of individual cross and the parent. The magnitude of the heterosis in terms of percentage of increase or decrease of F_1 hybrids over the best female and best male for each character was computed according to Hallauer and Miranda [5].

$$Heterosis = \frac{F1 - BP}{BP} \times 100$$

Table-1 $F_{1's}$ attempted between 27 agronomically superior varieties and 13 high ginning outturn (GOT) percent recombinant lines (male and female parents of crosses attempted in 2013-14)

SN	Female Parents	SN	Male Parents (High GOT% 37 to 41%)
	Cultivars	1	SA-977 x SA-112 P7
1	H 1098	2	SA-977 x SA-112 P32
2	F 1861	3	SA-977 x SA-112 P44
3	F1378	4	SA-977 x SA-112 P68
4	LH-2107	5	SA-977 x SA-112 P69
5	LH-2108	6	SA-977 x SA-112 P70
6	F-2164	7	SA-977 x SA-112 P79
7	F-846	8	SA-977 x SA-112 P84
8	LH-1134,	9	SA-977 x SA-112 P86
9	CSH-3129	10	SA-977 x SA-112 P139
10	H 1226	11	SA-977 x SA-112 P164
11	Biyani 161	12	SA-977 x SA-112 P174
12	F2383	13	SA-977 x SA-112 P184
13	Biyani-251		
	Indigenous Collections		
14	IC 359508		
15	IC 358382		
16	IC 357203		
17	IC 357671		
18	IC 356665		
19	IC 358479		
20	IC 357726		
	Exotic Collections		
21	EC359059		
22	EC357032		
23	SA-1231		
24	SA-668		
25	SA-524		
26	SA-112		
27	SA-977		

Results and discussion

Results of 178 F_1 populations

Of the 178 F_1 populations of the crosses of 27 agronomically high yielding female parents and 13 recombinant inbred lines male parents under evaluation, the seed cotton yield kg/hectare ranged from 731.25 to 4478.73, number of bolls per/plant from 5.50 to 30.20, boll weight (g) 1.40 to 3.90, ginning outturn percent from 25.0 to 44.73, number of monopodia branches/plant 0.20 to 9.0 and number of sympodia branches/plant from 4.0 to17.0. Respective values of the best female parent and male parent in the breeding material evaluated for different traits were selected viz. for seed cotton yield kg/hectare Biyani-251 (3819.81) and SA-977 x SA-112 P69 (1661.78), for number of bolls per/plant LH-2107 (23.75) and SA-977 x SA-112 P70 (26.0), for boll weight(g) EC359059 (3.50g) and SA-977 x SA-112 P86 (3.20g), for ginning outturn percent EC359059 (42.48%) and SA-977 x SA-112 P86 (42.20%), for number of monopodia branches/plant IC 357203 (6.33) and SA-977 x SA-112 P 139 (26.0) and for number of sympodia branches LH-1134 (9.50) and SA-977 x SA-112 P 174 (12.13).Out of 178 F_1 populations of the crosses of 27 female parents and 13 male parents under evaluation heterosis percent over the best female parent for seed cotton yield kg/hectare varied from -86 to 17.25, number of bolls per/plant from -76.80 to 27.16, boll weight (g) -60.0 to 11.43, ginning outturn percent from -42.15 to 5.30, number of monopodia branches/plant -96.84 to 42.18 and number of sympodia branches/plant from -57.89 to78.95. Over the best male parent, heterosis percent ranged for seed cotton yield kg/hectare from -51.52 to 260.52, number of bolls per/plant from -79.55 to 12.27, boll weight (g) from -56.25 to 21.68, ginning outturn percent from -40.76 to 6.00, number of monopodia branches/plant from-87.35 to 51.27 and number of sympodia branches/plant from -67.07 to 40.15. Heterosis range was higher over the best female parent for the traits, number of bolls per/plant and number of sympodia branches/plant, whereas over the best male parent for the traits, seed cotton yield kg/hectare, boll weight (g), ginning outturn percent and number of monopodia branches/plant. For seed cotton yield as many as 133 hybrids gave positive heterosis over the best male parent SA-977 x SA112 P69. In the present study the best female parent EC-359059 possessed the boll weight of 3.50 grams and 9 intra-specific hybrids exhibited positive heterosis over the best female. In case of number of bolls per plant only 2 hybrids exhibited positive heterosis over the best male parent SA-97 7x SA 112 P70 (26.90 bolls per plant) while 8 hybrids had shown positive heterosis over best female LH-2107 (23.75 bolls). For GOT%, as many as 15 hybrids gave positive heterosis over the best male parent SA-977 x SA112 P86 (GOT 42.20%). For the character monopod, 17 hybrids have shown positive heterosis over the best male SA-977 x SA 122 P139 (5.93 monopods per plant).

Results of top five F_1 populations

Among 178 F_1 hybrids of the crosses of 27 female parents and 13 male parents evaluated top five hybrid in respect of seed cotton yield kg/hectare were: Biyani 251 x (SA-977 x SA 112 P86), F 1861 x (SA-977 x SA 112 P70), EC359059 x (SA-977 x SA 112 P174), LH-2108 x (SA-977 x SA 112 P68) and Biyani 251 x (SA-977 x SA 112 P139) and their respective heterosis per cent over the best male parent (SA-977 x SA-112 P69) (1661.78) was 269.52, 203.03, 203.0, 184.64 and 180.01, respectively. Over the best female parent Biyani-251 (3819.81) only one of the hybrid Biyani 251 x (SA-977 x SA 112 P86) among top five possessed 17.25% heterosis Top five F_1 hybrids for heterosis of the trait ginning outturn per cent were; LH-2108 x (SA-977 x SA 112 P184), F-2383 x (SA 112 x SA-977), IC357333 x (SA-977 x SA 112 P164), IC 357671 x (SA-977 x SA 112 P70) and F 1861 x (SA-977 x SA 112 P70) and their respective positive heterosis percent over the best female parent EC359059 (42.48%) was 5.30, 3.33, 3.11, 2.78 and 2.28 and on the best male parent SA-977 x SA112 P86 (42.20%) respective percent heterosis was 6.00, 4.02, 3.79, 3.46 and 2.96. In the studies of Islam *et al*. [4] heterosis was found to be highly heterotic for seed cotton yield, number of sympodia, number of bolls per plant and ginning outturn. Respective heterosis percent for boll weight (g) in top five F_1 hybrids Biyani 161 x (SA-977 x SA 112 P139), LH-2107 x (SA-977 x SA 112 P70), H 1098 x (SA 112), F 1861 x (SA-977 x SA 112 P79) and F-846 x (SA-977 x SA 112 P70) over the best female parent EC359059 (3.50g) was 11.43, 10.0, 10.0, 7.14 and 7.14 and over the best male parent SA-977 x SA-112 P86 (3.20g) it was 21.88, 20.31, 20.31, 17.19 and 17.19. Top five F_1 hybrids for number of bolls/plant were Biyani 251 x (SA-977 x SA 112 P7), IC 358479 x (SA-977 x SA 112 P184), SA524 x (SA-977 x SA 112 P139), EC357072 x (SA-977 x SA 112 P68) and IC 358382 x (SA-977 x SA 112 P69) and their respective heterosis percent were 27.16, 22.11, 9.47, 5.26 and 5.26 in comparison to the best female parent LH-2107 (23.75). Number of bolls/plant in the best male parent (SA-977 x SA-112 P70) (26.0) and corresponding positive heterosis percent over it for top F_1s was 12.27 and 7.81, respectively. For number of monopods/plant the best female parent and male parents were IC 357203 (6.33) and SA-977 x SA-112 (P 139)(26.0) and the top five F_1 hybrids were IC 358479 x (SA-977 x SA 112 P184), LH-2108 x (SA-977 x SA 112 P139), F-2164 x (SA-977 x SA 112 P32), H-1226 x (SA-977 x SA 112 P86) and EC357072 x (SA-977 x SA 112 P84). The corresponding positive heterosis percent over the best female parent for these top five hybrids was 42.18, 10.58, 10.58,10.58 and 10.58, and over the best male parent, it was 51.77, 18.04, 18.04, 18.04 and 18.04. Heterosis was also recorded for this trait by Gwathmey and Clement in 2010 [6]. Number of sympods/plant for the best female parent LH-1134 and the best male parent SA-977 x SA-112 P 174) were 9.50 and 12.13. In the top five F_1 hybrids H 1098 x (SA 112 x 977 P64), H 1098 x (SA 112), CSH-3129 x (SA 112), CSH-3129 x (SA 112 x 977P64) and F-2383 x (SA-977 x SA 112 P67) positive heterosis over the best female parent was 78.95, 28.42, 26.12, 10.55 and 10.55 and over the best male parent was 40.15 and 0.58. Studies on top five hybrids indicated that same top five hybrids showed positive heterosis over both the best female and the male parents for the traits: ginning outturn percent, boll weight (g) and number of monopods/plant. Whereas, top five hybrids exhibiting positive heterosis over the best female and the best male were different for the traits: seed cotton yield kg/hectare, number of bolls/plant and number of sympods/plant.

Table-2 Heterotic performance of top 5 F_1 hybrids, range of heterosis and the trait in replicated evaluation of 178 F_1 hybrids along with parents

Top five hybrids among 178 hybrids	Range of heterosis (%)over the best[a]	
Seed cotton yield kg/ha		
	Best female parent (Biyani-251(3819.81)	Best male parent (SA-977 x SA-112 P69)(1661.78)
	Range (Heterosis)	Range (Heterosis)
	731.25 to 4478.73 (-86.76 to17.25)	731.25 to 4478.73 (-51.52 to260.52)
1. Biyani 251x(SA-977XSA 112 P86)	17.25	269.52
2. F 1861x(SA-977XSA 112 P70)	-	203.03
3. EC359059x(SA-977XSA 112 P174)	+	203.03
4 . LH-2108x(SA-977XSA 112 P68)	-	184.64
5.Biyani 251x(SA-977XSA 112 P139)	-	180.01
Ginning outturn%		
	Best female parent EC359059 (42.48%)	Best male parent SA-977 x SA-112 P86 (42.20%)
	Range (GOT%, heterosis)	Range (GOT% , heterosis)
	25.00 to 44.73 (-42.15 to5.30)	25.00 to 44.73 (-40.76 to 6.0)
1. LH-2108x(SA-977XSA 112 P184)	5.30	6.00
2. F-2383x(SA 112x977)	3.33	4.02
3. IC357333x(SA-977xSA 112 P164)	3.11	3.79
4 . IC 357671x(SA-977xSA 112 P70)	2.78	3.46
5. F 1861x(SA-977xSA 112 P70)	2.28	2.96
Boll weight(g)		
	Best female parent EC359059 (3.50g)	Best male parent SA-977 x SA-112 P86 (3.20g)
	Range (Boll weight heterosis)	Range (Boll weight heterosis)
	1.40 to 3.90g, (-60.0 to11.43)	1.40 to 3.90g (-56.25 to 21.68)
1. Biyani 161x (SA-977xSA 112 P139)	11.43	21.88
2. LH-2107x(SA-977xSA 112 P70)	10.0	20.31
3. H 1098x(SA 112)	10.0	20.31
4. F 1861x (SA-977xSA 112 P79)	7.14	17.19
5. F-846x(SA-977xSA 112 P70)	7.14	17.19
Number of bolls/plant		
	Best female parent LH-2107 (23.75)	Best male parent (SA-977xSA-112 P70)(26.0)
	Range (Heterosis)	Range (Heterosis)
	5.50 to 30.20 (-76.84 to27.16)	5.50 to 30.20 (-79.55 to12.27)
1. Biyani 251X(SA-977xSA 112 P7)	27.16	12.27
2. IC 358479 x(SA-977xSA 112 P184)	22.11	7.81
3. SA524x(SA-977xSA 112 P139)	9.47	-
4. EC357072 x(SA-977xSA 112 P68)	5.26	*
5. IC 358382 x(SA-977xSA 112 P69)	5.26	-
Number of Monopos/plant		
	Best female parent IC 357203(6.33)	Best male parent (SA-977xSA-112 P 139)(26.0)
	Range (Heterosis)	Range (Heterosis)
	0.20 to9.00 (-96.84 to 42.18)	0.20 to 9.00 (-87.35 to51.77)
1. IC 358479 x(SA-977xSA 112 P184)	42.18	51.77
2. LH-2108x(SA-977xSA 112 P139)	10.58	18.04
3. F-2164x(SA-977xSA 112 P32)	10.58	18.04
4. H-1226 x(SA-977xSA 112 P86)	10.58	18.04
5. EC357072 x(SA-977xSA 112 P84)	10.58	18.04
Number of sympods/plant		
	Best female parent LH-1134 (9.50)	Best male parent (SA-977xSA-112 P 174)(12.13)
	Range (Heterosis)	Range (Heterosis)
	4.00 to17.00 (-57.89 to 78.95)	4.00 to 17.00 (-67.02 to40.15)
1. H 1098x(SA 112x977 P64)	78.95	40.15
2. H 1098x(SA 112)	28.42	0.58
3. CSH-3129x(SA 112)	26.12	-
4. CSH-3129x(SA 112x977P64)	10.55	
5. F-2383x(SA-977xSA 112 P67)	9.47	

[a] GOT: ginning outturn

Delinking of negatively associated desirable (high yield) and undesirable (poor fibre quality) traits had been a breeding challenge in cotton. Joshi and his students could address this problem by indigenous breeding/selection strategies. Cotton varieties known as JK series (J stands for Joshi and K for Kadappa, student of Joshi and well-known cotton breeder in Karnataka) combining high ginning outturn and high fibre strength and fineness in high-yield backgrounds are the outcome of this research effort. It was his belief that yield stagnation at low levels for long in cotton could be breached by exploitation of hybrid vigour [7]. Solanki, *et al*.[8] found that number of sympodia per plant, number of bolls per plant, boll weight and lint yield per plant were the main contributors towards increase in heterotic effects for seed cotton yield per plant.

Application of research: The superior hybrids can further be utilized in cotton production improvement programmes by the breeders.

Research Category: Cotton Research

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