

Original Research Article

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Evaluation of Advance Generation Populations of Cotton (*Gossypium hirsutum* L.) for High Ginning Out Turn Percent and Yield

S.L. Ahuja*, D. Monga, Rishi Kumar and S.K. Sain

Indian Council for Agricultural Research-Central Institute for Cotton Research Regional
Station, Sirsa, Haryana-125055, India

*Corresponding author

ABSTRACT

Keywords

Advance generation population, *Gossypium hirsutum*, Ginning out turn percent, Lint yield kg/hectare

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Nineteen F₅ individual populations selected from two crosses involving two *Gossypium hirsutum* cotton varieties RS875 and F1861 with South American germplasm lines SA524 and SA668 were evaluated in randomized block design with three replications in the Kharif season of 2016-17. The objective of study was to develop high yielding (>20quintals/hectare) and high ginning out turn per cent (>35) cultures/ varieties. Out of 19 advance generation, three advance generation individual populations RS875xSA524 P12, F1861xSA668 P15, RS875xSA524 P4 had significantly higher seed cotton yield in comparison to both the check varieties H1226 (1717.37±292.3) and (F1861 1751.09 ±292.3) and possessed GOT% of 40.6, 38.5 and 39.0 and lint yield 935.6, 848.0 and 772.4kg/ hectare, respectively. The present study reveals good scope for isolation of pure lines from the advance generation progenies of heterotic F₁^s for high seed cotton yield and high ginning out turn

Introduction

Historically, cotton breeders have focused on seed cotton yield, quality, maturity and host plant resistant traits. Advances in breeding for increased lint yield have slowed down perhaps because of its relatively low heritability and high environmental interaction. Approaches to enhance lint yield by increasing ginning out turn percent (GOT%) (presently around 35% in India) should help breeder to break the productivity barriers in response to global competition.

Number of seeds per boll, ginning out turn per cent and lint index exhibit high narrow sense

heritability (h² n.s.) due to the presence of additive gene action, whereas seed weight per boll, seed index and lint yield possess low heritability. The genetic analysis suggested that number of seeds per boll, and lint index could be upgraded through full-or half-sib family, pedigree and progeny selection, ginning out turn per cent while exploitation of hybrid vigour would probably be the way to achieve the genetic progress in seed weight per boll, seed index and lint yield.

Workers who achieved hybrid vigour for ginning out turn per cent (Ansari *et al.*, 1989, Yuan *et al.*, 2001, 2002; Wei *et al.*, 2002 Panhwar *et al.*, 2008; Iqbal, 2003).

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 effort. It was his belief that yield stagnation at low levels for long in cotton could be breached by exploitation of hybrid vigour (Siddiq, 2010).

The present study has helped in developing material with broad genetic base, superior donor lines and development of parents with high productivity. Taking into average seed cotton yield as 25q/ha every 1% increase in ginning out turn per cent will result 25 Kg lint yield/ha increase and targeted 5-7% shall result 125 to 175 Kg/ha lint yield increase in addition to enhancement in seed cotton yield.

Materials and Methods

Genetic materials

Eleven agronomical high yielding varieties (H1098, F 1861, F1378 9C, LH2107, LH-108, F2164, F846, LH1134, CSH3129, H 1226 and RS875) of India were used as female parent, IC 359508, IC 358382, IC 357203, IC 357671, IC 356665, IC 358479, SA1237, IC 357726, EC356785, EC359059, EC358002, SA668 and SA524 (IC=Indigenous collections and others were EC= exotic collections) high ginning out turn (GOT%) \geq 40 male parents were crossed in 2011-12 Kharif crop season (Table 1) to identify high yielding F₁ hybrids possessing ginning out turn (GOT%) \geq 40 in 2012-13 crop season (Table 2). In the crop season 2013-14, higher yielding (in comparison to agronomically superior parent)

approximately 200 plants of two crosses (RS-875xSA-524, F-1861xSA-668) F₂s (selfed) and out of 16 crosses of each variety with GOT% hybrid vigour \geq 40% were selected raised in the next season. In the crop season 2014-15, 200 plants in the F₃ generation were raised and selfed seeds of these two selected crosses were ginned and higher yielding plants with GOT% \geq 40%. In 2015-16 and 2016-17 crop season higher yielding F₄ plants and F₅ plants (about 200) of two crosses with GOT% \geq 40% were raised and selfed and plants with GOT% \geq 40% were selected. Nineteen F₅ populations selected from these two crosses involving *G.hirsutum* cotton varieties R875 and F-861 with South American germplasm lines SA524 and SA668 were evaluated in randomized block design with three replications in the Kharif season of 2016-17 along two check varieties H1226 and F1861 at ICAR-Central Institute for Cotton Research Regional Station, Sirsa, Haryana-125055 (India)

Details of experiment

The field experiment was started in 2016-17 cropping season with the dated of sowing was 28 April 2016 with the spacing of 67.5 x 30cm. Number of F₅ populations were 19 (of Crosses of RS-875xSA-524 and F1861xSA-668). For each population three replications were maintained in three rows in each replication. The single plot area per replication was 10.33sqm. The two checks (H1226 and F1861) were also sown for control. The agronomic practices were implemented as per the recommendations. The final picking was done on 11 November 2016.

Experimentation and data recording

Recommended agronomic practices were followed to raise the crop. The data were recorded on 10 random plants for the traits number of bolls /plant, monopodial

branches/plant, sympodial branches/plant, plant height (cm), boll weight (g) and seed cotton yield of three rows in each replication of each of the advance generation population and the two checks. Ginning out turn percent was estimated by weighing the percent amount of lint obtained from 100 gm of seed cotton. Lint yield was calculated as a multiple of seed cotton yield kg/hectare and ginning outturn per cent and division by 100.

Disease and insect pest data recording

Number of jassids, thrips, whitefly and leaf hoppers were counted in the first week of September on three leaves (one each of upper, middle and lower portion of the plant) of three random plants in each replication and were averaged for each replication. For cotton leaf curl diseases (CLCuD) symptom was graded (at 120 days, the total plants as on that date, including the previous ones were also graded) according to standard 0-6 rating scale for CLCuD (Monga, 2014). PDI (Per cent disease index) for leaf curl disease CLCuD was calculated as (overall mean grades of the three replications infected plants with the disease/ 6) x100.

Fibre quality data

Fibre quality traits 2.5% span length (mm), fibre strength gram/tex, micronaire value and uniformity ratio were estimated through HVI (high volume instrument) by Central Institute for Research on Cotton Technology unit at CICR, Regional Station, Sirsa, Haryana, India

Data analysis

The analysis of variance was done following the method of Panse and Sukhatme (1978). In order to compare significance of particular variety from the other critical difference was calculated following Singh and Chaudhary (1985).

Results and Discussion

Analysis of variance

The analysis of variance revealed significant differences among the 19 F₅ individual plant progenies of the two crosses viz; RS875xSA524 and F1861xSA668) and two check varieties H1226 and F1861 for all the eight traits viz., seed cotton yield kg/hectare, lint yield kg/hectare number of bolls per/plant, boll weight (g), number of monopodia branches/plant, number of sympodia/plant, plant height (cm) including ginning out turn percent. Information is given in Table 4, 5 and 6.

Results of 19 advance generation F₅ populations

In the 19 advance generation populations of the two crosses (RS875xSA524 and F1861xSA668) under evaluation seed cotton yield kg/hectare ranged from 897.70 to 2304.52, lint yield kg/hectare 364 to 935.60, number of bolls per/plant from 18.5 to 29.3, boll weight (g) 2.57 to 3.63, ginning out turn percent from 32.73 to 40.60, plant height (cm) 85.23 to 136.33, number of monopodia branches/plant 0.0 to 1.6 and number of sympodia branches/plant from 11.73 to 18.73. For fibre property traits viz. 2.5% span length (mm) from 24.4 to 27.9, fibre strength (g/tex) from 24.1 to 26.6, micronaire value from 4.2 to 5.5. Respective average values in the material evaluated were seed cotton yield kg/hectare (1441), lint yield kg/hectare (548.72), number of bolls per/plant (24.13), boll weight (g) (2.93), ginning out turn percent (38.25), plant height (cm) (110.40), number of monopodia branches/plant (0.67) and number of sympodia branches (15.90). There were two check varieties viz., H-122 6 (from Haryana State and F-1861 (from Punjab State). Seed cotton yield kg/hectare of these varieties was 1712.37 ± 291.29 and 1751.09 ± 291.29 The later

variety check had significantly higher seed cotton yield kg/hectare than average (1441 ± 291.29) suggesting that some of the 19 advance generation populations of the two crosses had significantly lesser seed cotton yield kg/hectare. The two check varieties had lint yield kg/hectare 592.49 ± 80.69 and 593.40 ± 80.69 and the average lint yield kg/hectare was 548.72 ± 80.69 which was statically at par with both of the check varieties. Ginning out turn percent of the two check varieties was 34.50 ± 1.01 and 34.0 ± 1.01 and was significantly lower than overall average 38.25 ± 1.01 . Information on this trait therefore, also suggested that ginning out turn percent of 19 advance generation populations of the two crosses was significantly higher than the two check varieties. The two check varieties H-1226 and F-1861 had boll weight (g) of 2.80 ± 0.25 and 2.90 ± 0.25 and overall average boll weight of the evaluated material was 2.93 ± 0.25 .

This showed that advance generation material evaluated possessed statically at par with the boll weight (g) of both of the checks. The two check varieties possessed number of bolls per/plant as 19.10 ± 3.93 and 17.67 ± 3.93 and the overall average of the material evaluated was 24.13 ± 3.93 . Observations recorded on number of bolls per/plant revealed that the 19 advance generation populations of the two crosses had significantly higher number of bolls per plant than the two check varieties. Plant height (cm) of the two check varieties was 136.33 ± 19.43 and 133.0 ± 19.43 and overall average of 19 advance generation populations of the two crosses and two checks was 110.42 ± 19.43 . Number of monopodia branches per plant possessed by the check variety H-1226 and F-1861 were 1.2 ± 0.64 and 1.17 ± 0.64 respectively, whereas overall average was 0.67 ± 0.64 . Number of sympod branches/plant of the two check varieties was 12.33 ± 2.13 and 12.0 ± 2.13 and the average was 15.91 ± 2.13 revealing that 19 advance

generation populations of the two crosses had significantly higher fruit bearing branches than the two check varieties. This information further supported the observation that the 19 advance generation populations of the two crosses had significantly higher number of bolls per/plant than the two check varieties. Information on fibre traits has been given in Table 5. 2.5% span length (mm) of the check varieties H-1226 and F-1861 was; 27.7 ± 0.40 and 27.9 ± 0.40 , respectively and average was 25.5 ± 0.40 which was significantly lower than both of the check varieties. However, in respect of fibre strength values were at par with check variety H-1226 only (Table 5).

Results of top 5 advance generation F₅ populations

Among 19 F₅ individual plant progenies of the two crosses viz; RS-875xSA-524 and F-1861xSA-668 top five advance generation populations in respect of seed cotton yield kg/hectare were; RS875xSA524 P12, F1861xSA668 P15, RS875xSA524 P4, F1861xSA668 P57 and F1861xSA668 P6 and their respective seed cotton yield in kg/hectare were; 2304.52, 2202.85, 2198.01, 1931.73 and 1849.42. First three advance generation populations RS875xSA524 P12, F1861xSA668 P15, RS875xSA524 P4, had significantly higher seed cotton yield in comparison to both the check varieties H1226 (1717.37 ± 292.3) and (F1861) (1751.09 ± 292.3) and last two generation advance populations F1861xSA668 P57 and F1861xSA668 were spastically at par with the two check varieties.

Lint yield kg/hectare of the top five advance generation populations was; 935.60, 848.00, 857.22, 772.4 and 730.5. All the top five advance generation populations had significantly higher lint yield kg/hectare in comparison to both the check varieties; 592.49 ± 80.69 and 593.40 ± 80.69 .

Table.1 F₁'s attempted between 11 agronomically superior varieties and high GOT germplasm lines (Male and Female parents of crosses attempted in 2012-13)

Sr. No.	Female Parents	Sr. No.	Male Parents (High GOT% 37 to 41%)
1	H1098	1	I-359508
2	F1861	2	IC357333
3	F-1378	3	IC358382
4	LH2107	4	IC357203
5	LH2108	5	IC357631
6	F2164	6	IC356665
7	F846	7	IC358479
8	LH1134	8	SA1237
9	CSH3129	9	IC357726
10	H1226	10	EC356785
11	RS875	11	EC359059
		12	EC358002
		13	EC357032
		14	EC359044
		15	SA668
		16	SA524

Table.2 Performance of 176 F₁'s of 11 Agronomically superior females and high GOT% 16 germplasm lines

No. of parents		No. of crosses	No. of F ₁ s with seed cotton yield/ plant (g)		Highest seed cotton yield/ plant of F ₁ (g)	Highest seed cotton yield/ plant of parent (g)	Heterosis for yield over the best parent
Female	Male		>100	50-100			
11	16	176	70	106	215.9	162.6	-100 to 132%
GOT% range			No. of crosses more than 35% GOT %			No. of crosses more than 40% GOT	
29.2 to 39.1			16			-----	

Table.3 Evaluation of F₂ population of 2 selected crosses attempted during 2011-12 for estimation of GOT%

Sr. No.	Name of the cross	No. of plants	GOT% range	Seed cotton yield/ plant (g)	No. of plants more than 35% GOT	No. of plants more than 40% GOT
1	RS-875xSA-524	172	30.5 to 44.2	10 to 75	11	13
2	F-1861xSA-668	168	29.3 to 45.2	10 to 100	48	24

Table.4 Top 5 genotypes in replicated evaluation of 19 F₅ selections of selected crosses

Genotype/ Population	Seed Cotton Yield (kg/ha)	Lint yield (kg/ha)	Ginni ng out turn per cent	Boll weight (g)	Boll No. /plant	Plant height (cm)	No. of Mon opod	No. of Sympods
RS875xSA524 P12	2304.52	935.60	40.60	3.02	23.90	115.00	0.33	13.93
F1861xSA668 P15	2202.85	848.00	38.50	2.65	22.20	125.00	0.57	13.38
RS875xSA524 P4	2198.01	857.22	39.00	2.85	20.37	112.00	0.80	13.13
F1861xSA668 P57	1931.73	772.4	40.00	2.83	22.90	144.20	1.57	11.73
F1861xSA668 P6	1849.42	730..5	39.50	2.58	27.90	148.17	1.13	16.80
H 1226 (Check)	1717.37	59249	34.50	2.80	19.10	136.33	1.20	12.33
F1861 (Check)	1751.09	593.40	34.00	2.90	17.67	133.50	1.17	12.00
CD	292.21	80.69	1.01	0.25	3.93	19.43	0.64	2.13
CV (5%)	14.63	29.54	5.95	5.38	11.07	9.61	12.28	10.15
Overall average	1,441	548.72	38.25	2.93	24.13	110.42	0.67	15.91
Over all range	897.70 to 2304.52	364.4 to 935.6	32.73 to 40.6	2.57 to 3.63	18.5 to 29.23	85.23 to 136.33	0.0 to 1.6	11.73 to 18.73

Table.5 Fibre properties of Top 5 genotypes in evaluation of 19 F₅ selections of selected crosses

Genotype/Population	Span length (mm)	Uniformity ratio	Fibre strength(g/tex)	Micronare value
RS875xSA524 P12	26.8	81	25.2	4.5
F1861xSA668 P15	26.9	82	26.1	4.7
RS875xSA524 P4	26.7	82	25.1	4.3
F1861xSA668 P57	27.3	82	26.4	4.4
F1861xSA668 P6	26.8	82	26.5	4.7
H 1226 (Check)	27.7	82	25.8	4.5
F1861 (Check)	27.9	82	26.6	4.4
CD	0.40	-	0.34	0.16
CV	3.51	-	3.10	7.73
Average	26.59	81.86	25.54	4.78
Range	24.4 to 27.9	81 to 82	24.1 to 26.6	4.2 to 5.5

Table.6 Insect pest and CLCuD data of top 5 genotypes in replicated evaluation of 19 F₅ progenies of selected crosses

Entry	Jassid Grade	Sucking Pests /3 Leaves			PDI (Per cent Disease Index) CLUCD
		Leaf hopper / 3leaf	White Fly / 3leaf	Thrips	
F1861xSA668 P15	1	1.30	9.53	2.90	23.89
RS875xSA524 P12	1	0.80	9.47	3.03	22.22
RS875xSA524 P4	1	9.40	10.2	2.70	21.11
F1861xSA668 P57	1	1.23	9.93	3.53	30.00
RS875xSA524 P15	1	1.17	10.53	2.60	23.33
H 1226 (Check)	1	1.57	13.87	2.73	20.56
F1861 (Check)	1	1.57	12.33	3.57	22.22
Average	1	2.43	10.84	3.0	23.33
Range	1 to1	0.8 to 9.40	9.47 to 13.87	2.6 to3.57	20.56 to30.0

This was due to significantly higher ginning out turn percent of 19 advance generation populations of the two crosses in comparison to both the check varieties (as lint yield is the product of seed cotton yield and ginning out turn per cent). Significantly higher ginning out turn per cent (38.5 to 40.60±1.01) was obtained for all the top five entries which was significantly higher than both the check varieties H-1226 34.5 ±1.01 and F-1861 34.0±1.01. Boll weight (g) and boll number/plant were at par with both the checks in top five advance generation populations. RS875xSA524 P12 115 ±1.01cm and RS875xSA524 P4 112.0±1.01cm were dwarf and are suitable for mechanical picking in comparison to both the checks (136.33±1.01cm and 133.50±1.01cm). Number of monopodia branches /plant among the top five high yielding advance generation populations RS875xSA524 P12 F1861xSA668 P15 and RS875xSA524 P4 was less than unity indicating these populations were suitable for mechanical picking. Results are given in Table 4. Top five advance generation populations RS875xSA524 P12, F1861xSA668 P15,

RS875xSA524 P4, F1861xSA668 P57 and F1861xSA668 P6 had fibre properties comparable with the both the checks (Table 5). F1861x SA668 P15, RS875xSA524 P12 and RS875xSA524 P4 had PDI (Per cent disease index) for leaf curl disease CLCuD was 23.89, 22.22 and 21.11 for three populations, respectively, which was equivalent to the highest yielder local check F1861(22.22). Jassid grade injury was recorded as one in these high GOT% populations as for both the checks (Table 6).

Observance of significant differences among 19 advance generations and two check varieties for all the eight traits viz., seed cotton yield kg/hectare, lint yield kg/hectare number of bolls per/plant, boll weight (g), number of monopodia branches/plant, number of sympodia/plant, plant height (cm) including ginning out turn percent indicated that the breeding material possessed sufficient genotypic variability and suggested possibility of selection from them. 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 effort. It was his belief that yield stagnation at low levels for long in cotton could be breached by exploitation of hybrid vigour (Siddiq, 2010).

Over all evaluation of the experimental material indicated that the two check varieties had lint yield kg/hectare 592.49 ± 80.69 and 593.40 ± 80.69 and the average lint yield kg/hectare was 548.72 ± 80.69 which was statically at par with both of the check varieties indicating that though the seed cotton yield of 19 advance generation populations of the two crosses had significantly lesser seed cotton yield kg/hectare in comparison to the check variety F-1861. This was due to significantly higher ginning out turn percent of 19 advance generation populations of the two crosses in comparison to both the check varieties (as lint yield is the product of seed cotton yield and ginning out turn per cent). Solanki *et al.*, (2014) 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.

Overall average plant height (cm) of 19 advance generation populations of the two crosses and two checks was 110.42 ± 19.43 and that of the two check varieties was 136.33 ± 19.43 and 133.0 ± 19.43 , this suggested that advance generation material had dwarfed populations suitable for mechanical picking. Number of monopodia branches/plant possessed by the check variety H-1226 and F-1861 were 1.2 ± 0.64 Number of monopodia branches/plant possessed by the

check variety H-1226 and F-1861 were 1.2 ± 0.64 and $1.1.17 \pm 0.64$ respectively, whereas overall average was 0.67 ± 0.64 This observation suggested that the breeding material evaluated possessed populations which had less than average 0.67 number of monopodia branches/plant and were suitable for mechanical picking (Gwathmey and Clement, 2010).

Out of top five three advance generation populations RS875xSA524 P12, F1861xSA668 P15, RS875xSA524 P4, had significantly higher seed cotton yield and lint yield kg/hectare in comparison to both the check varieties H1226 (1717.37 ± 292.3 and 592.49 ± 80.69 and F1861 (1751.09 ± 292.3 and 593.40 ± 80.69). Geddam *et al.*, 2011 and Chaudhary *et al.*, (2015) also found yield increase in F₂ generation is quite satisfactory. Their encouraging results suggest there is sufficient scope to use F₂ hybrids and advance generation material with increased yield on commercial scale. High heterosis was found to be highly heterotic for seed cotton yield, number of sympodia, number of bolls per plant and ginning out turn (Zia *et al.*, 2001). Less than one monopod and lesser plant height in comparison to both the check varieties suggest suitability of high yielder and high ginning out turn top five advance generation material. The present study reveals good scope for the isolation of pure lines from the progenies of heterotic F₁s for high seed cotton yield and high ginning out turn. More so, these populations have comparable less disease and insect pest tolerance and fibre properties

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