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Determining path of productivity in double cross F_1 populations belonging to within and between heterotic group crosses in cotton (*Gossypium hirsutum* L.)

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Abstract: The study was initiated to exploit heterotic groups for varietal development in cotton. The Single cross F_1s representing different heterotic groups *viz.*, stay green (SG), robust (ROB), RGR and compact (COM) were used as parents in diallel (half) mating programme to get within and between double cross F_1 populations. The main objective of this study was identify the possible role of all characters contributing towards seed cotton yield along with assessing superiority and inferiority of genotypes by comparing their performance of most and least productive double cross F_1 populations. Top five potential double cross F_1 populations as well as bottom five double cross F_1 populations were considered for calculating the per cent deviation of genotypes from group mean. Top five potential double crosses had positive value for seed cotton yield, number of bolls per plant, lint yield, number of monopodia per plant, sympodial length at 50 per cent height, reproductive points on sympodia, seed index, lint index and inter branch distance. This information on path of productivity helps to understand the yield traits associated with high and low productivity and helps to achieve desired level of productivity.

Key words: Compact, Cotton, Robust, Stay green

Introduction

Cotton is the most precious gift of nature to mankind. Right from earliest phase of human civilization when it helped to differentiate man from animals clothing from cotton has shown direct impact on culture and growth of human civilization. India is hub of cotton and it achieved first position in cotton production in world.

Cotton as a crop is unique with respect to dynamic nature of its ecosystem. The decade of successful Bt cotton cultivation witnessed the popularisation of Bt cotton hybrids especially by private sectors, the recent development in the form of pink boll worm acquiring resistance to Bt gene and consistently increasing labour cost has brought back focus on varietal development (Mohan *et al.,* 2015). This change in focus marked by empowering farmer to reuse his seeds and there by helps in reducing cost of cotton cultivation.

Concept of development of heterotic groups has played important role in hybrid development of maize. Heterotic groups basically helps in identifying genetically diverse varieties or inbreds based on performance of hybrids. The diversity existing between heterotic groups has been exploited to get better hybrids and many schemes of population improvement have been used that facilitate to enhance the diversity and thereby get more potential hybrids, this concept can be extended to self pollinated crops because the need of diversity enhances heterosis same irrespective of whether a crop is self or cross pollinated (Ajjappa *et al.,* 2009).

The crossing between the two heterotic groups which increased recombination in populations can lead to novel rearrangements of alleles and greater genotypic diversity. In cotton heterotic group like stay green, robust, RGR and compact are inter-crossed to develop best heterotic F_1, it can also be utilized for development of varieties. The multiple inter crosses are made between heterotic groups and these multi-crossed F_1 populations (double cross F_1 populations) were evaluated for genetic potentiality for development variety.

In the present study, top five potential double cross F_1 populations as well as bottom five double cross F_1 populations were considered for calculating the per cent deviation of genotypes from group mean. With the help of this, it is possible to identify the role of different traits contributing to the superiority and inferiority of genotypes

Material and methods

Initially the material was generated for exploiting opposite heterotic groups by development of potential hybrids. These heterotic groups are found to be highly potential and diverse. Single cross F_1s was developed by crossing within group potential genotypes. These single cross F_1s used as parents in Diallel mating design to obtain within and between group double crosses. The potentialities of double cross populations were compared.

During 2014-15 seven single cross F_1s *viz.,* SG 79- 6 x SG 35, SG 79-6 X SG 95-6, RGR 257-2 X RGR 370, RGR 20 X RGR 90, ROB 8 X ROB 50-1, DSC 75-8 X DSC 27-4 and DSC 7 X DSC 19 were crossed in all possible combinations (half diallel method)

Parents		Heterotic group
RGR 257-2	RGR 370	RGR
RGR 20	RGR 90	RGR
DSC 75-8	DSC 27-4	COM
SG 79-6	SG 35	SG
ROB 8	ROB50-1	ROB
SG 79-6	SG95-6	SG
DSC 7	DSC 19	COM

to develop double cross F_1s. These crosses were sown in *kharif,* 2014-15 at Agricultural Research Station, Dharwad.

Twenty one double cross F_1s and their seven parents (single cross F_1s) were sown under rain fed condition during *kharif,* 2015 in a randomized block design (RBD) with two replications each row was sown at a spacing of 90 cm between the rows and 45 cm spacing given between two plants within a row and row length of 4.80 m was maintained. Observations were recorded on 15 randomly selected plants of each entry. 14 different quantitative characters were studied in these double crosses.

Out of 21 double crosses top 5 potential double cross F_1 populations as well as bottom five double cross F_1 populations were considered for calculating the per cent deviation of genotypes from group mean. The per cent deviation of the traits observed in these potential genotypes were calculated by using the following formula (Kencharaddi *et al.,* 2015)

$$\text{Per cent deviation} = \frac{\text{Genotypic - Group mean}}{\text{Group mean}} \times 100$$

Results and discussion

The superiority of potential genotypes were depends on their performances with mean of all genotypes and expressed as deviation from this group mean. These per cent deviation values gives crucial information regarding important yield contributing traits responsible for superior yield or productivity seen in the group as well as in superior genotypes. This approach helps to identify diverse genotypes.

In the present study, top five potential double crosses populations as well as bottom five double crosses populations were considered for calculating the per cent deviation of parents (single cross F_1s representing different heterotic groups) from group mean. With the help of this study, efforts were made to identify the possible role of different traits contributing to the superiority and inferiority of double cross populations belonging to different heterotic groups.

Per cent mean deviation of the top five and least five double cross F_1 populations performance from the group mean are shown in Table 1 and 2 respectively. The top five performing double cross F_1 population showed positive value for seed cotton yield (23.94%), number of bolls per plant (22.61%), lint yield (17.23%), number of monopodia per plant (5.70%), sympodial length at 50 per cent height (2.49%), reproductive points on sympodia (3.46%), seed index (4.66%), lint index (2.35%) and inter branch distance (1.01%) The double cross F_1 populations showed negative per cent deviation for number of sympodia per plant (-6.22%), ginning outturn (-1.18%), inter boll distance (-0.82%), plant height (-3.35%) and boll weight (-0.45%). In case of percent deviation from parental mean, the top five performing double cross F_1 population showed positive value for most of characters except reproductive points on sympodia (-18.36%), number of sympodia per plant (-12.41%) and ginning outturn (-0.73%).

Table 1. Path of productivity of top five potential double cross hybrids among 21 double cross hybrids

Crosses	Seed cotton yield ($q\ ha^{-1}$)	Lint yield ($q\ ha^{-1}$)	Plant height (cm)	No.of mono podia per plant	No. of Sympodia per plant	Reproductive points on sympodia	Sympodial length at 50% height (cm)	Inter boll distance (cm)	Inter branch distance (cm)	Boll weight (g)	Ginning outturn (%)	Seed index (g)	Lint index (g)	Number of bolls per plant
1x3	21.09	7.07	110.85	2.28	17.77	5.93	38.72	6.63	7.97	3.92	33.87	6.61	3.55	27.40
2x4	20.40	7.23	127.00	2.08	16.69	6.41	61.16	9.60	7.39	3.07	36.24	8.51	4.85	33.86
2x5	18.34	5.28	119.07	2.34	17.78	5.21	45.89	8.86	9.29	4.04	34.61	8.55	4.53	19.06
3x6	16.88	6.01	111.67	2.44	15.67	5.40	37.34	6.94	8.89	3.67	35.67	7.67	4.25	23.27
3x4	15.93	5.67	122.00	2.25	15.05	6.89	35.67	5.18	7.12	4.02	35.68	7.82	4.35	20.05
Top 5 mean	18.53	6.25	118.12	2.28	16.59	5.96	43.76	7.44	8.13	3.74	35.21	7.83	4.30	24.73
Overall mean	14.95	5.33	122.21	2.15	17.69	5.76	42.65	7.50	8.05	3.76	35.89	7.48	4.21	20.17
Percent deviation	23.94	17.23	-3.35	5.70	-6.22	3.46	2.60	-0.82	1.01	-0.45	-1.88	4.66	2.35	22.61
Parental mean	12.22	4.38	125.76	2.24	18.94	7.3	41.83	5.94	5.94	3.6	35.47	7.19	4.07	17.26
Percent deviation from parental mean	51.64	42.69	-6.08	1.79	-12.41	-18.36	4.61	25.25	36.87	3.89	-0.73	8.90	5.65	43.28

Table 2. Path of productivity of bottom five double cross hybrids among 21 double cross hybrids

Crosses	Seed cotton yield (q ha^{-1})	Lint yield (q ha^{-1})	Plant height (cm)	No.of mono podia per plant	No. of Sympodia per plant	Reproductive points on sympodia	Sympodial length at 50% height (cm)	Inter boll distance (cm)	Inter branch distance (cm)	Boll weight (g)	Ginning outturn (%)	Seed index (g)	Lint index (g)	Number of bolls per plant
6x7	12.93	4.69	124.89	1.62	18.40	7.01	48.62	6.94	7.83	3.50	36.34	7.29	4.17	18.93
5x7	12.86	4.97	141.67	2.04	17.50	5.32	50.40	9.47	8.26	4.55	37.53	7.37	4.43	14.38
2x6	12.58	4.54	138.84	1.68	20.58	6.73	42.96	6.39	8.47	4.03	36.41	7.72	4.46	15.85
1x2	11.20	3.84	133.24	2.46	16.02	4.96	43.15	8.70	8.79	3.78	35.02	7.62	4.17	15.06
4x5	10.91	4.37	123.13	1.92	21.00	5.28	43.49	8.23	8.97	4.24	38.68	6.80	4.36	13.10
Bottom 5 mean	12.10	4.48	132.35	1.94	18.70	5.86	45.73	7.95	8.46	4.02	36.79	7.36	4.32	15.46
Overall mean	14.95	5.33	122.21	2.15	17.69	5.76	42.65	7.50	8.05	3.76	35.89	7.48	4.21	20.17
Percent deviation	-19.08	-15.97	8.30	-9.89	5.71	1.66	7.22	5.90	5.15	6.82	2.53	-1.68	2.74	-23.32
Parental mean	12.22	4.38	125.76	2.24	18.94	7.3	41.83	5.94	5.94	3.6	35.47	7.19	4.07	17.26
Percent deviation from parental mean	-0.98	2.28	5.24	-13.39	-1.27	-19.73	9.32	33.84	42.42	11.67	3.72	2.36	6.14	-10.43

The top five performing double cross F_1s showed the highest positive value for seed cotton yield, number of bolls per plant, lint yield, number of monopodia per plant, sympodial length at 50 per cent height, reproductive points on sympodia, seed index, lint index and inter branch distance, whereas negative values were observed in case of reproductive points on the sympodia and ginning outturn (%). These negative deviations for number of sympodia per plant, ginning outturn, inter boll distance, plant height and boll weight observed but this minor variation did not affect yield of potential crosses. Negative deviations for inter boll distance represents compactness or good packaging of bolls is desirable than loose packing of bolls. Similarly Ranganatha and Patil (2015) reported that compact packages of bolls increases the seed cotton yield. Similar results were noticed by Deepak (2002) for plant height, ginning out turn.

The least potential double cross F_1 populations showed negative values for seed cotton yield (-19.08%), number of bolls per plant (-23.32%), lint yield (-15.97%), number of monopodia per plant (-9.89%) and seed index (-1.68%). Double cross F_1 populations showed positive per cent deviation for plant height (8.30%), sympodial length at 50 per cent height (7.22%), inter boll distance (7.22%), boll weight (6.82%), inter branch distance (5.15%), number of sympodia per plant (5.71%), lint index (2.74%), ginning outturn (2.53%) and reproductive points on sympodia (1.66%), In case of percent deviation from parental mean, the top five performing double cross F_1 population showed positive value for most of characters except number of reproductive points on sympodia (-19.73%), number of monopodia per plant (-13.39%), number of bolls per plant (-10.43%), number of sympodia per plant (-1.27%), seed cotton yield (-0.98%) and ginning outturn (-0.73%).

This negative deviation for yield influencing traits like number of bolls per plant and lint yield were strong factors for reduced seed cotton yield in these double crosses populations. Double crosses showed positive per cent deviation for number of sympodia per plant, seed index, lint index, plant height, sympodial length at 50 per cent height, inter boll distance, boll weight, inter branch distance and ginning outturn. Similar results observed by Kenchreddi *et al.* (2015) seed cotton yield, number of bolls per plant, lint yield and lint index. Altaher and Singh (2003), Sharma *et al.* (2006), Ahuja *et al.* (2008) and Dothi *et al.* (2008) observed in case of plant height.

Path of productivity has indicated that best double cross F_1 populations belonging to different within and between heterotic group crosses and also showed potentiality of these double crosses over parents. Hence present study helps to understand role of different traits on seed cotton yield. For example Negative deviations for inter boll distance represents compactness or good packaging of bolls and positive deviations for number of bolls per plant indicates increase in number of bolls per plant favourable to increase seed cotton yield. This gives crucial information for further breeding programme.

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