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Genetic analysis of seed cotton yield and yield components in intra specific diploid cotton

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ABSTRACT : Six generations *viz.*, P_1, P_2, F_1, F_2, BC_1 and BC_2 derived from AKA 7 x Dh 2 were sown in randomized block design (RBD) with three replications. Observations on 12 yield contributing characters and 4 fibre traits were recorded on 15 random plants in each parent and F_1 plants, 30 plants in BC_1 and BC_2 and 60 plants in F_2 generation. The scaling test indicated either scale A, B, C or all the three scales deviated from zero for all the characters except monopodia/plant, boll weight, ginning percentage, 2.5 per cent span length, uniformity ratio, micronaire and fibre strength, indicating presence of epistasis due to inter allelic interactions. Joint scaling test also resulted into significant chi square value indicating inadequacy of the three parameter model for these characters. The dominant component (h) found significant for boll weight, ginning percentage and higher in monopodia/plant, whereas, additive component (d) found significant for fibre strength and micronaire value and higher in uniformity ratio. Duplicate type of gene action was involved in the expression of majority traits except 100 seed weight. These observations implies the use of biparental approach in early segregating generations for improvement in seed cotton yield.

Key words: Diploid cotton, fibre quality, genetic analysis, seed cotton yield

Cotton is an important commercial crop and played a vital role in Indian economy and is primarily grown for fibre which is the most important raw material for textile industry. In spite of severe competition from synthetic fibres in recent years it is still occupying a premier position in textile industry. The picture is completely reversed today and at the invent of *Bt* cotton hybrids, Indian *desi* cotton varieties were edged out. However, now a days short staple cotton is in great demand, particularly in fabrics like denim and upholstery. The short staple coarse cotton is also facing a acute shortage today which is mainly used for production of absorbent cotton in medical industry (Kranthi, 2011). The erratic rainfall and emerging biotic and abiotic stresses declined the cotton yield in India in spite of *Bt*. The *desi* cotton is able to withstand the rigours of nature like drought and pests and also has lesser cost and production. Hence, the breeder has to think seriously again for *desi* cotton cultivation and reorient his breeding programme accordingly. Knowledge on genetic contribution of yield and yield components besides fibre quality traits is essential to formulate effective breeding programme for crop improvement. The importance of additive as well as non additive gene effects has been earlier reported by Pradeep *et al.* (2007), Pradeep and Sulamini (2008). Hence, the attempt has been made to estimate gene effects for yield and fibre traits using six generations of intra specific cross of *G. arboreum.*

The present investigation was carried out at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri during 2010-2011. Six generations *viz.*, P_1, P_2, F_1, F_2, BC_1 and BC_2 derived from AKA 7 x Dh 2 were sown in randomized block design with 3 replications. The number of rows assigned to P_1, P_2, F_1, F_2, BC_1 and BC_2 were 1, 1, 2, 8, 3 and 3 with a spacing 45 x 22.5 cm with 18 plants in each row. Observations on 12 yield contributing characters and 4 fibre traits *viz.*, plant height (cm), monopodia/plant, sympodia/plant, days to 50 per cent flowering, days to boll bursting, days to maturity, bolls/plant, boll weight (g), 100 seed weight (g), lint yield/plant (g), ginning outturn, seed cotton yield/plant (g), fibre length, micronaire, uniformity ratio and fibre strength were recorded on 15 random plants in each parent and F_1 plants, 30 plants in BC_1 and BC_2 and 60 plants in F_2 generation. The mean values were computed for each generation overall the replication. The adequacy of simple additive dominance model for the data was tested utilizing scaling test and joint scaling test. In the absence of epistasis, the three parameter model was used to analyze (m), (d) and (h) components. In the presence of epistasis, the six parameter model is used to estimate mean (m), additive (d), dominance (h) and non allelic interaction components (i, j and l).

The mean performance of 6 generations *viz.*, P_1, P_2, F_1, F_2, BC_1 and BC_2 of the cross (AKA 7 x Dh 2) exhibited substantial variability in the material for different characters under study (Table 1). The parents showed wide divergence for plant height (cm), sympodia/plant, days to 50 per cent flowering, days to boll bursting, days to maturity, bolls/plant, 100 seed weight (g), lint yield/plant (g), ginning outturn, seed cotton yield/plant (g). In general, F_1 performance was better than either of the parents for sympodia and bolls/plant, boll weight, 100 seed weight, lint yield/plant, ginning percentage and seed cotton yield/plant. Superiority of F_1 performance over the parents in sympodia and bolls/plant, 100 seed weight, lint yield/plant, ginning percentage, seed cotton yield/plant may be due to contribution from P_2 for these traits. P_1 seemed to be contributing in micronaire and fibre strength but not reflected in F_1. Intermediate values of F_1 for plant height, days to 50 per cent flowering, days to boll bursting, days to maturity, 2.5 per cent span length, micronaire value and fibre strength showed presence of partial dominance.

Decline in the performance of F_2 for days to boll bursting, days to maturity, sympodia/plant, 100 seed weight, lint yield/plant, ginning percentage, seed cotton yield and 2.5 per cent span length suggested the presence of dominance and epistatic interactions in expression of these traits. Similar results were also obtained by Mehetre *et al.,* (2003). The F_2 mean tended towards F_1 in boll weight, days to maturity, lint yield/plant, 2.5 per cent span length, uniformity ratio and micronaire which might be due to linkage or complementary factors or both (Mehetre *et al.*, 2003). Significant increase in plant height in F_2, showed presence of transgressive segregant in F_2 population indicating importance of additive gene action for plant height. Decrease in F_1 performance was observed in uniformity ratio. This may be due to preponderance of non allelic interaction as compared to main effects.

Table 1. Mean performance for various characters in six generation of AKA 7 x Dh 2 in cotton

Character	Generations					
	P_1	P_2	F_1	F_2	B_1	B_2
Plant height (cm)						
Mean	116.33	175.87	165.07	178.00	167.87	181.50
S E+	1.365	0.989	1.263	3.463	4.343	4.349
Monopodia/plant						
Mean	1.07	1.07	1.07	1.17	1.10	1.20
S E+	0.06	0.06	0.06	0.05	0.06	0.07
Sympodia/plant						
Mean	6.933	10.533	11.933	10.867	11.967	12.333
S E+	0.228	0.322	0.206	0.491	0.552	0.578
Days to 50 per cent flowering						
Mean	78.93	86.47	82.33	83.75	84.23	85.37
S E+	0.43	0.40	0.35	0.53	0.62	0.64
Days to first boll bursting						
Mean	110.80	121.73	119.67	116.95	117.17	119.67
S E+	0.38	0.37	0.45	0.61	0.75	0.48
Days to maturity						
Mean	140.67	151.47	149.40	146.78	146.47	149.60
S E+	0.347	0.215	0.388	0.578	0.761	0.520
Bolls/plant						
Mean	8.87	13.93	17.07	15.88	17.33	16.73
S E+	0.22	0.32	0.33	0.79	0.78	0.91
Boll weight (g)						
Mean	2.302	2.257	2.597	2.498	2.537	2.505
S E+	0.012	0.026	0.014	0.045	0.062	0.047
Hundred seed weight (g)						
Mean	5.597	6.560	6.572	6.042	5.830	6.09
S E+	0.026	0.053	0.020	0.095	0.130	0.122
Lint yield/plant (g)						
Mean	7.02	10.31	14.52	13.07	13.79	13.72
S E+	0.24	0.46	0.30	0.72	0.63	0.79
Ginning (%)						
Mean	35.79	35.90	37.22	36.84	36.96	37.22
S E+	0.44	0.52	0.51	0.39	0.49	0.47
Seed cotton yield/plant (g)						
Mean	19.63	28.72	39.03	35.35	37.88	36.93
S E+	0.67	1.20	0.61	1.87	1.78	1.99
2.5 Per cent span length (mm)						
Mean	25.63	25.97	25.90	25.80	25.34	25.45
S E+	0.19	0.27	0.42	0.11	0.16	0.18
Uniformity ratio (%)						
Mean	49.67	49.67	49.33	49.43	49.58	49.00
S E+	0.33	0.33	0.67	0.14	0.23	0.17
Mironaire (µg/inch)						
Mean	4.60	4.27	4.33	4.35	4.39	4.21
S E+	0.27	0.03	0.13	0.05	0.07	0.12
Fibre strength (g/tex)						
Mean	21.33	20.30	20.87	20.58	20.55	20.24
S E+	0.42	0.23	0.58	0.19	0.21	0.20

Scaling test : The scaling test (Table 2) indicated either scale A, B, C or all the three scales deviated from zero for most of all the characters, indicating presence of epistasis due to inter allelic interactions. Joint scaling test also resulted into significant chi square value indicating inadequacy of the three parameter model. Scaling test and joint scaling test agreed closely with each other except 2.5 per cent span

Table 2. Scaling tests and joint scaling test for various characters for 6 generations of AKA 7 x Dh 2 in cotton

Character	AKA 7 x Dh 2			
	A	B	C	$\times^2$
Plant height (cm)	54.33**	22.07*	89.67**	79.14**
Monopodia/plant	0.07	0.27	0.40	3.86(NS)
Sympodia/plant	5.07**	2.20	2.13	22.79**
Days to 50 per cent flowering	7.20**	1.93	4.93*	31.22**
Days to first boll burst	3.86**	-2.07	-4.07	13.42**
Days to maturity	4.87**	-1.67	-3.80	15.12**
Bolls/plant	8.73*	2.47	6.33*	33.07**
Boll weight (g)	0.18	0.16	0.24	7.29 (NS)
Hundred seed weight (g)	-0.51	-0.96**	-1.14**	25.99**
Lint yield/ plant (g)	6.04**	2.61	5.91*	25.31**
Ginning (%)	0.92	1.31	1.22	1.72 (NS)
Seed cotton yield/plant (g)	17.09**	6.09	14.97*	26.11**
2.5per cent span length (mm)	-0.85	-0.97	-0.21	8.57*
Uniformity ratio (%)	0.17	-1.00	-0.28	7.48(NS)
Micronaire (µg/inch)	-0.16	-0.19	-0.14	1.13(NS)
Fibre strength (g/tex)	-1.09	-0.68	-1.05	2.67(NS)

** Significant at 1 per cent level of significance, * Significant at 5 per cent level of significance

length. For 2.5 per cent span length, joint scaling test was in significant and scaling test was in significant. In the characters *viz.,* monopodia/ plant, boll weight (g), ginning outturn, uniformity ratio, fibre strength and micronaire both scaling test and X^2 value from joint scaling test found insignificant indicating adequacy of additive dominance model for these characters.

Gene effects for interacting characters (Six parameter model) : Gene effects of various characters are given in Table 3. Amongst 16 characters studied, dominant component 'h' was significant and higher in desirable direction than additive component 'd' for sympodia, bolls/ plant, lint yield and seed cotton yield/plant indicating importance of dominance. Additive component was significantly higher in desirable direction only for plant height, days to boll bursting and maturity.

When interaction components (i+j+l) put together against main effects (d+h), main effects was larger for sympodia/plant, lint weight/plant, seed cotton yield/plant, days to boll bursting and days to maturity. The interaction component is higher for plant height, 50 per cent flowering, 100 seed weight and 2.5 per cent span length. Negative sign of 'i' in plant height indicated that there would be decrease in expression of the plant height in successive generations.

The 'h' and 'l' were in opposite direction, indicating duplicate type of interaction for most of all the characters except 100 seed weight. Duplicate type of gene interaction tends to reduce the heterosis effect as such it is not desirable while, complimentary epistasis increases the heterosis. Keeping in the view, the presence of both fixable and non-fixable genetic components as well as duplicate type of epistasis, it appears worthwhile to intermate the selects in segregating generations, which would result into the accumulation of favourable genes for seed cotton yield and its majority components. Hence, biparental mating or few cycles of recurrent selection followed by pedigree method of selection is suggested for the improvement in seed cotton yield in this cross.

Gene effects for interacting characters (Three parameter model) : When epitasis is insignificant the main effects, account for the phenotypic mean performance of the cross. The dominant component (h) found significant for boll weight, ginning percentage and higher in monopodia/plant. The cause of heterosis may be over dominance. These characters can be improved by heterosis breeding; while, additive component (d) found significant for fibre strength and micronaire value and higher in uniformity ratio. These characters can be improved by selection.

Table 3. Gene effects for various characters in AKA 7 x Dh 2

Characters	Gene effects						Type of epistasis
	M	d	h	i	j	l	
Plant height (cm)	178.00**	-13.63*	5.70	-13.27	16.13**	-63.13*	Duplicate
Monopodia/plant	1.07**	0.00	0.27	—-	—-	—-	—-
Sympodia/plant	10.87**	-0.37	8.33**	5.13*	1.43	-12.40**	Duplicate
Days to 50 per cent flowering	83.75**	-1.13	3.83	4.2	2.6**	-13.33**	Duplicate
Days to first boll burst	116.95**	-2.50**	9.26**	5.87*	2.97**	-7.67	Duplicate
Days to maturity	146.78**	-2.13*	10.33**	7.00*	3.27**	-10.20*	Duplicate
Bolls/plant	15.82**	0.60	10.53**	4.87	3.13*	-16.07**	Duplicate
Boll weight (g)	2.29**	0.02	0.32*	0.09	0.01	-0.42	———-
Hundred seed weight (g)	6.04**	-0.26	0.16	-0.33	0.22	1.79*	Complimentary
Lint yield/plant (g)	13.07**	0.07	8.60**	2.74	1.71	-11.38*	Duplicate
Ginning (%)	36.01*	-0.13	1.57**	—-	—-	—-	———-
Seed cotton yield/ plant (g)	35.35**	0.95	23.07*	8.21	5.50*	-31.40*	Duplicate
2.5per cent span length (mm)	25.80**	-0.11	-1.51	-1.61*	0.06	3.44*	Duplicate
Uniformity ratio (%)	49.63*	0.27	-0.57	—-	—-	—-	——-
Micronaire (µg/inch)	4.39*	0.13*	-0.11	—-	—-	—-	——-
Fibre strength (g/tex)	20.69*	0.41*	-0.37	—-	—-	—-	———

** Significant at 1 per cent level of significance, * Significant at 5 per cent level of significance

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