SIMPLIFIED TRIPLE TEST CROSS ANALYSIS FOR YIELD, YIELD CONTRIBUTING AND FIBRE TRAITS IN COTTON (Gossypium hirsutum L.)

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Abstract:

An experiment to study the additive, dominance and epistasis components of genetic variation was conducted during kharif 2007-08 at Botany Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Two genotypes with extreme phenotypic selections viz., AKH-84635 (L1) and AKH-023B (L2) were used as female parents (testers) and were crossed to each of ten genotypes viz., AKH-081, AKH-053B, AKH-9312, AKH-976, AKH-9913, BBP-9, AKH-1174 , LRK-516, 8660B, AKH-8828 used as male lines and obtained 20 F1's. Observations were recorded on days to 50 % flowering, plant height (cm), chlorophyll content (mg g-1), number of bolls plant-1, seed cotton yield plant-1, lint yield plant-1 (g), ginning out turn (%), 2.5% span length (mm), Micronaire value (mg inch-1), Fibre strength (g tex-1), uniformity ratio (%), maturity co-efficient and oil content (%). The test of epistasis indicated its presence for all characters. The maximum epistatic variation was contributed by the parents viz., AKH-053B, AKH-1174, 8660B, AKH-9913, AKH-976 and LRK-516. The mean squares due to sums and differences were significant for all the characters studied. Both additive and dominance component were observed for all the characters, any how the additive component were predominant for all the characters under study. The parents BBP-9, AKH-9312, LRK-516, AKH-1174, 8660B, AKH-9913 were identified for exploitation of additive genetic component and the parents AKH-081 and AKH-8828 for dominance genetic components.

Keywords:

Simplified triple test cross, epistasis, Gossypium hirsutum L.

Introduction:

Progress in the genetic improvement of yield in any crop depends upon the genetic information available on inheritance of quantitative traits i.e. yield and yield component characters. Therefore, knowledge of magnitude and type of genetic variance has a great importance for cotton breeders dealing with simultaneous improvement of fibre quality and lint yield. Various biometrical methods have been used in the past for estimating various types of gene actions. In most of the mating designs, it is assumed that non-allelic interactions are absent where as the fact is often contrary to this assumption. The triple test cross analysis and the simplified triple test cross are considered as significant methods to estimate non allelic intraction from the plant breeders view point. The appropriate analysis of triple test cross and simplified triple test cross yields information on epistasis as well as additive and dominance components. Hence, an attempt was made in this study to adopt simplified triple test analysis method to estimate the epistasis, additive and dominance type of genetic component.

Material and Method:

Two genotypes with extreme phenotypic selections viz., AKH-84635 (Rajat) (L1) and AKH-023B (L2) were used as female parents and as testers which were crossed to each of ten genotypes viz., AKH-081, AKH-053B, AKH-9312, AKH-976, AKH-9913, BBP-9, AKH-1174 , LRK-516, 8660B and AKH-8828 used as male lines and obtained 20 F1's. The crosses along with their respective parents were sown in randomized complete block design replicated thrice at the Farm of Department of Agricultural Botany, PGI, Dr.P.D.K.V. Akola during kharif, 2006 and 2007. Data were recorded on days to 50 % flowering, plant height (cm), chlorophyll content (mg g-1), number of bolls plant-1, seed cotton yield plant-1, lint yield plant-1 (g), ginning out turn (%), 2.5% span length (mm), Micronaire value (mg inch-1), Fibre strength (g tex-1), uniformity ratio (%), maturity co-efficient and oil content (%). Oil content in seeds was estimated by Soxhlet method as suggested by Sankaran (1966), and the total chlorophyll content of leaves was estimated by DMSO method as suggested by Arnon (1949). The statistical analysis were performed for simplified triple test cross as per the methodology suggested by Jinks et al. (1969).

Result and Discussion:

The data regarding test of epistasis for different characters are presented in the Table-1 indicating the presence of epistasis for all characters. Epistasis (L1i + L2i – Pi) is an important component in the inheritance of quantitative traits in cotton for all traits under study. Epistasis for yield and its components were also reported in cotton by Mehetre et al. (2003) and Singh et al. (2009). Estimates of individual line contribution to the epistasis comparison (L1i + L2i – Pi) are given in Table 2. The parent AKH-9312 contributed maximum epistatic variation for days to 50% flowering and oil content. The parent AKH-053B showed maximum epistatic variation for plant height and chlorophyll content. AKH-1174 recorded maximum epistatic variation for number of bolls plant-1, ginning out turn, seed cotton yield and lint yield. For micronaire value 8660B showed maximum epistatic variation. AKH-9913 exhibited maximum epistatic variation for 2.5% span length and uniformity ratio. The parent AKH-976 recorded maximum epistatic variation for fibre strength and uniformity ratio. LRK-516 showed maximum epistatic interaction for maturity co-efficient. According to Cockerham (1961) it is difficult to determine the most efficient breeding procedures when epistasis is operative. Standard hybridization and selection procedures should take the advantage of epistasis if it is of the additive and additive x additive types of epistasis. Other types of epistasis (additive x dominance, dominance x dominance etc.) are not fixable by selection under self fertilization and therefore, would not be favourable for developing pure line cultivators but useful in the development of hybrid varieties. The mean squares due to sums (L1i + L2i) and due to difference (L1i - L2i) were significant for all the characters studied (Table 3 and 4 respectively). The additive (D) and dominance (H) components presented in table 5 showed the predominance of additive component for all the thirteen characters studied. The predominance of additive component for different economic characters were also reported by Basal and Turgut (2005) and Singh et al. (2009). The data regarding estimates of individual line contribution to the additive and dominance components are presented in table 6 and 7 respectively. The maximum additive genetic variance was contributed by the parent BBP-9 for days to 50% flowering, seed cotton yield and lint yield and dominance genetic variance for 2.5% span length, fibre strength and oil content. AKH-9312 showed additive genetic variation for plant height, 2.5% span length, maturity co-efficient and oil content and showed dominance genetic variation for uniformity ratio. LRK-516 exhibited additive genetic variation for number of bolls plant-1 and maturity co-efficient which also exhibited dominance genetic variation for seed cotton yield and lint yield. The parent AKH-1174 showed maximum additive genetic variation for ginning out turn and dominance genetic variation for days to 50% flowering, ginning out turn and chlorophyll content. The parent 8660B recorded maximum additive genetic variation for micronaire value and maturity co-efficient and the same parent also recorded dominance genetic component for plant height. The parent AKH-9913 exhibited maximum additive genetic variation for fibre strength and uniformity ratio and AKH-053B for chlorophyll content. Similarly AKH-081 showed maximum dominance genetic component for maturity co-efficient and AKH-8828 for micronaire value. The parents with high additive genetic variation may be utilized in cotton breeding programme on the basis of general combining ability effects, and the parents with dominance genetic variation may be utilized in cotton hybrid breeding programme on the basis of specific combining ability and heterosis.

Table 1. Test of epistasis for different characters

Sources	d.f.	Mean squares												
		Plant height (cm)	**No. of bolls plant^{-1}**	**Seed cotton yield plant^{-1} (g)**	**Lint yield plant^{-1} (g)**	**Chlorophyll content (mg g^{-1})**	**Days to 50% flowering**	**Ginning out turn (%)**	**2.5 % span length (mm)**	**Micronaire value (µg inch^{-1})**	**Fibre strength (g tex^{-1})**	**Uniformity ratio (%)**	**Maturity co-efficient**	**Oil content (%)**
Epistasis $\overline{L}_{1i} + L_{2i} - P_i$	9	26.40*	9.58**	35.59*	22.28**	0.30**	7.6**	20.85**	4.70**	0.56**	4.03**	10.09**	0.0004**	0.60**
Error	18	10.38	2.48	13.32	1.68	0.0003	0.21	0.90	0.46	0.004	0.05	0.61	0.00002	0.03

Note : *Significant at 5% ** Significant at 1%

Table 2. Estimation of individual line (P_i) contribution to the epistatsis comparison $\overline{L_{1i}} + \overline{L_{2i}} - P_i$

Sr. No.	Parents	Plant height (cm)	No. of bolls plant^{-1}	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)	Chlorophyll content (mg g^{-1})	Days to 50% flowering	Ginning out turn (%)	2.5 % span length (mm)	Micronaire value (µg inch^{-1})	Fibre strength (g tex^{-1})	Uniformity ratio (%)	Maturity co-efficient	Oil content (%)
1.	AKH - 081	98.00	20.67	51.82	18.87	1.94	59.33	37.63	24.90	2.77	19.47	43.00	0.83	22.47
2.	AKH - 053B	109.00	16.67	44.02	17.03	2.98	58.33	42.05	27.53	3.50	19.77	44.67	0.84	22.36
3.	AKH - 9312	107.33	17.67	43.44	11.53	2.70	66.33	38.83	31.07	3.60	21.80	45.00	0.85	23.27
4.	AKH - 976	95.00	20.00	57.81	22.54	2.22	64.33	40.99	30.50	3.63	26.37	51.33	0.85	21.77
5.	AKH - 9913	104.67	16.67	55.56	23.41	2.73	62.00	42.75	31.27	1.90	23.27	51.33	0.81	22.69
6.	BBP - 9	102.00	20.67	50.45	22.58	2.11	63.33	38.10	26.73	4.10	21.80	50.00	0.83	22.64
7.	AKH - 1174	104.00	24.33	60.25	28.03	2.38	60.00	46.23	30.40	4.27	22.60	44.67	0.82	20.38
8.	LRK - 516	96.00	22.33	51.51	23.72	2.04	58.00	42.36	30.90	2.93	22.67	48.33	0.87	22.65
9.	8660 B	99.00	21.00	55.15	26.00	1.48	59.33	43.10	28.93	4.33	21.23	47.67	0.86	22.58
10.	AKH - 8828	108.33	14.00	44.28	20.77	1.26	61.67	29.48	28.03	3.50	20.33	43.67	0.83	22.49

Table 3. Analysis of variance for the sums ($\overline{L_{1i}} + \overline{L_{2i}}$) for different characters

Sources	d. f.	Mean squares					
		Plant height (cm)	No. of bolls plant^{-1}	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)	Chlorophyll content (mg g^{-1})	Days to 50% flowering
Sum (M_s) $\overline{L_{1i}} + \overline{L_{2i}}$	9	544769.4**	16759.29**	108255**	19357.3**	290.57**	244302.1**
Error (M_w)	18	27.74	24.57	122.42	50.73	0.001	5.46

Sources	d. f.	Mean squares						
		Ginning out turn (%)	2.5% span length (mm)	Micronaire value (µg inch^{-1})	Fibre strength (g tex^{-1})	Uniformity ratio (%)	Maturity co-efficient	Oil content (%)
Sum (M_s) $\overline{L_{1i}} + \overline{L_{2i}}$	9	97036.7**	51138.81**	826.81**	31388.9**	150007.2**	45.61**	31163.98**
Error (M_w)	18	0.62	0.56	0.007	0.20	2.54	0.0001	0.02

Note : *Significant at 5% ** Significant at 1%

Table 4. Analysis of variance for the difference $(\overline{L_{1i}} - \overline{L_{2i}})$ for different characters

Sources	d. f.	Mean squares: Plant height (cm)	No. of bolls plant^{-1}	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)	Chlorophyll content (mg g^{-1})	Days to 50% flowering
Difference (M_d) $\overline{L_{1i}} - \overline{L_{2i}}$	9	38.57**	6.56**	12.63	11.21**	0.23**	12.38**
Error (M_w)	18	7.07	2.50	5.10	1.75	0.0003	0.28

Sources	d. f.	Mean squares: Ginning out turn (%)	2.5% span length (mm)	Micronaire value (µg inch^{-1})	Fibre strength (g tex^{-1})	Uniformity ratio (%)	Maturity coefficient	Oil content (%)
Sum (M_d) $\overline{L_{1i}} - \overline{L_{2i}}$	9	11.77**	6.66**	0.31**	1.34**	5.62**	0.0002**	0.54**
Error (M_w)	18	0.10	0.37	0.005	0.04	0.62	0.00001	0.006

Note : *Significant at 5% ** Significant at 1%

Table 5. Components of genetic variation

Sources of variation	Plant height (cm)	No. of bolls plant^{-1}	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)	Chlorophyll content (mg g^{-1})	Days to 50% flowering
D	363161.11	11156.48	72088.39	12871.05	193.71	162864.43
H_1	21	2.71	0.29	6.31	0.153	8.07
$\sqrt{H1/D}$	0.0076	0.016	0.002	0.022	0.028	0.007

Sources of variation	Ginning out turn (%)	2.5% span length (mm)	Micronaire value (µg inch^{-1})	Fibre strength (g tex^{-1})	Uniformity ratio (%)	Maturity coefficient	Oil content (%)
D	64690.72	34092.17	551.20	20925.8	100003.11	30.41	20775.97
H_1	7.78	4.19	0.20	0.87	3.33	0.00013	0.356
$\sqrt{H1/D}$	0.011	0.011	0.019	0.0064	0.0058	0.0021	0.0041

Table 6. Estimation of individual line (Pi) contribution to the additive comparison $\overline{L_{1i}} + \overline{L_{2i}}$ for different characters

Sr. No.	Parents	Plant height (cm)	No. of bolls plant^{-1}	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)	Chlorophyll content (mg g^{-1})	Days to 50% flowering
1.	AKH - 081	164.33	31.67	78.87	28.73	3.84	120.00
2.	AKH - 053B	182.00	29.67	75.67	28.90	5.10	118.00
3.	AKH - 9312	193.00	28.33	71.21	25.07	4.72	123.33
4.	AKH - 976	182.00	28.00	76.53	30.85	4.01	124.67
5.	AKH - 9913	186.67	30.00	84.72	36.77	4.55	122.00
6.	BBP - 9	185.67	35.00	86.13	39.28	4.22	127.33
7.	AKH - 1174	165.67	34.00	85.54	36.77	4.42	117.00
8.	LRK - 516	170.33	35.67	82.46	37.42	3.95	118.00
9.	8660B	187.67	33.33	85.44	39.27	3.38	119.00
10.	AKH - 8828	190.33	31.33	79.20	37.40	3.54	121.33

Sr. No.	Parents	Ginning out turn (%)	2.5% span length (mm)	Micronaire value (µg inch^{-1})	Fibre strength (g tex^{-1})	Uniformity ratio (%)	Maturity coefficient	Oil content (%)
1.	AKH - 081	75.08	53.33	6.57	41.17	92.67	1.64	42.74
2.	AKH - 053B	76.70	55.03	7.10	42.60	93.00	1.64	41.89
3.	AKH - 9312	69.95	60.53	6.67	43.73	91.00	1.68	45.06
4.	AKH - 976	77.27	58.90	6.37	44.17	96.00	1.66	43.22
5.	AKH - 9913	79.97	57.37	6.43	44.73	100.33	1.62	43.85
6.	BBP - 9	72.06	53.67	7.23	42.93	97.33	1.67	44.06
7.	AKH - 1174	81.07	52.87	8.27	43.83	92.67	1.61	39.48
8.	LRK - 516	79.74	55.43	6.53	44.17	97.67	1.68	44.19
9.	8660B	77.43	53.23	8.33	42.83	94.33	1.68	44.33
10.	AKH - 8828	73.69	53.50	6.90	42.80	93.67	1.66	43.57

Table 7. Estimation of individual line (Pi) contribution to the dominance comparison $\overline{L_{1i}}$ - $\overline{L_{2i}}$ for different characters

Sr. No.	Parents	Plant height (cm)	No. of bolls plant^{-1}	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)	Chlorophyll content (mg g^{-1})	Days to 50% flowering
1.	AKH - 081	-2.33	-1.00	3.03	-0.20	-0.50	-0.67
2.	AKH - 053B	12.67	-0.33	3.02	0.70	0.29	0.67
3.	AKH - 9312	5.00	-0.33	0.84	2.93	0.47	-4.00
4.	AKH - 976	6.00	-4.00	-3.60	-2.32	0.42	-4.00
5.	AKH - 9913	2.00	-4.00	3.19	2.17	0.22	-6.67
6.	BBP - 9	1.67	1.00	1.97	3.48	0.59	0.00
7.	AKH - 1174	5.67	-2.67	1.95	1.63	0.99	1.67
8.	LRK - 516	9.00	1.00	7.23	6.18	0.29	1.33
9.	8660B	13.00	2.00	5.00	5.93	0.16	-2.33
10.	AKH - 8828	11.00	0.00	5.00	5.00	0.00	-4.67

Sr. No.	Parents	Ginning out turn (%)	2.5% span length (mm)	Micronaire value (µg inch^{-1})	Fibre strength (g tex^{-1})	Uniformity ratio (%)	Maturity coefficient	Oil content (%)
1.	AKH - 081	1.66	-0.87	0.30	0.63	-2.00	0.01	-0.58
2.	AKH - 053B	5.59	-2.37	-0.17	-0.40	0.33	-0.02	-0.27
3.	AKH - 9312	3.99	-6.00	0.40	0.00	1.67	0.00	-0.03
4.	AKH - 976	0.45	-4.57	0.70	0.30	-2.67	-0.01	0.41
5.	AKH - 9913	2.06	-6.43	0.83	-0.73	-1.00	-0.02	-1.02
6.	BBP - 9	2.88	0.07	0.23	1.13	0.67	0.00	0.50
7.	AKH - 1174	8.67	-2.73	0.13	-0.37	-4.00	-0.01	0.34
8.	LRK - 516	2.38	-1.97	0.80	-0.30	-3.67	-0.02	-0.61
9.	8660B	-0.92	-3.90	-0.13	-2.30	-0.33	0.00	-0.70
10.	AKH - 8828	5.53	-4.10	1.23	-1.00	0.33	0.00	-1.50

Conclusion:

In the present study, both additive (D) and dominance (H) component of genetic variation played an important role in the inheritance of characters under study. Therefore, it is suggested that both additive and dominance genetic variation can be exploited. For capitalizing the additive genetic variation, selective intermating in F2 generation should be followed and further segregating material should be carried by single seed descent method to obtain superior recombinant lines. The parents with maximum additive genetic variation were BBP-9, AKH-9312, LRK-516, AKH-1174, 8660B, AKH-9913 for economic traits like seed cotton yield, lint yield, number of bolls plant-1 etc. and hence, may be utilized in hybridization programme. Similarly, the maximum dominance genetic variation were contributed by the parents AKH-081 and AKH-8828 for fibre quality character and hence, will be exploited for heterosis breeding programme.

Reference:

Aronon, D. I. 1949. Copper enzymes in isolated chlorophyll polyphenaloxidases in Beta vulgaris. Plant Physio. 24:1-15.

Basal, H. and I. Turgut, 2005. Genetic analysis yield components and fibre strength in Upland cotton (G. hirsutum L.). Asian J. Plant Sci. 4 (3) : 293-298.

Chahal, G. S. and T. H. Singh, 1974. Application of different mating designs to determine gene action in G. arborium L. I. diallel vs. STTC. Crop Improv., 1 (1 and 2) : 61-71.

Cockerham, C. C. 1961. Partitions of heredity variance for various genetic models. Genetics, 44 : 1141-1148.

Jinks, J. L., J. M. Perkins and E. L. Breese, 1969. A General method of detecting additive, dominance and epistatic variation for metrical traits. II Application to inbred lines. Heridity, 24 : 115-117.

Mehetre, S. S., H. J. Rajput and G. C. Shinde, 2003. Genetic analysis for seed cotton yield and its Components in G. hirsutum. J. Cotton Res. Dev. 17 (2) : 119-122.

Sankaran, A. 1966. Laboratory manual for agriculture chemistry. Asia Publishing House. pp. 258.

Singh, Paramjit, G. S. Chahal, V. P. Mittal and K. S. Brar, 2009. Gene effects for yield components and fibre quality characters in upland cotton. J. Indian Soc. Cotton Improv., 34 (1) : 42-46.

Virk, D. S. and J. L. Jinks, 1977. The consequences of using inadequate testers in the STTC. Heredity, 38: 237-257.