Inheritance Studies of Quantitative Characters in Upland Cotton (*Gossypium hirsutum* L.)

A. Kapoor
Department of Botany, Govt. P. G. Girls College,
Sri Ganga Nagar-335001, Rajasthan, India

ABSTRACT

Before any efficient breeding methodology can be developed it is necessary to analyze the genetic architecture of quantitatively inherited characters like yield and its components. Understanding the nature of gene action involved in the expression of a character is helpful in deciding the breeding procedure to be used for improvement of that character. Genetic analysis was performed through sequential model fitting to analyze the variation among generations derived from a cross of two diverse parents, MU-2 and Rs-453, for seed cotton yield per plant, number of bolls per plant, boll weight, ginning out turn and lint index. The analysis indicated the presence of both additive and non-additive genetic effect. Epistasis was found to be important in controlling the genetic effect for most characters. The magnitude of non-additive genetic component was found to be significant for number of bolls per plant, ginning outturn and lint index. Performing bi-parental mating in early segregating populations would facilitate simultaneous exploitation of additive and non-additive gene effects to achieve improvement in the characters.

Introduction

Development of superior high yielding varieties and hybrids would be effective only when genetic variability exists and efficient methodology to utilize that genetic variability is known. In cotton several economic characters including yield are polygenically controlled. It is of prime importance to study their inheritance in term of variance. The nature and magnitude of different components of variations help to elucidate the type of gene effects operative for a particular trait and thus to formulate an appropriate breeding methodology. For initiating a successful breeding program it is essential to know the genetic architecture of quantitatively inherited characters. Besides the role of additive and dominance effects, the importance of epistasis has been established in cotton. However their relative importance varied from character to character over different studies. The preponderance of additive and non additive genetic components for seed cotton yield, boll number, boll weight, seed index, ginning out turn and lint index was reported by Kalsy *et al.* (1988) and Sri Vastva *et al.* (1991) In the present study genetic analysis was performed to analyze the variation among various generations derived from crosses of two diverse parents, through sequential model fittings.

Material and Methods

The experimental material in the present study consisted of genetically diverse parents, MU-2 and indigenous variety Rs-453. A basic set of twelve generations i.e. P_1, P_2, F_1, F_2, first back cross generations B1 and B2 , second back cross generations, B_{11}, B_{12}, B_{21}, B_{22} along with B1S and B2S derived by selfing B_1 and B_2 populations were generated.

The experiment was grown during kharif 1989-90 in a randomized block design, with three replications. The observations were recorded on seed cotton yield, number of bolls per plant, boll weight, seed index, ginning out turn and lint index. The statistical analysis on generation means were computed following the procedures outlined by Jinks and Perkins (1969). Epistasis was detected by applying the joint scaling test of Cavalli (1952).

Results and Discussion

The mean values, scaling tests and the estimates of gene effects in the best fitting model for various characters are given in Table 1, 2 and 3 respectively. The F_1 mean observed was more than the better parent in all the characters studied showing over dominance, whereas the F_2 mean was lower than its corresponding F_1mean. All of the simple scaling tests A, B and C showed significant deviation from zero, indicating the presence of epistasis in all the characters. Further joint scaling test indicted the inadequacy of the additive dominance, six parameter model based on linked digenic interaction. Fitting the trigenic epistatic parameter model reduced the chi-square values considerably, showing adequacy of this model to explain inheritance in all characters. The results indicated the presence of both additive and non-additive genetic components.

The higher magnitude of the non-additive genetic component than the additive component was observed

Proceedings of the World Cotton Research Conference-2. Athens, Greece, September 6-12, 1998. pp.211-213.

in all the characters though the additive component was found significant for number of bolls per plant, ginning out-turn and lint index. Sri Vastva *et al.* (1991) reported similar results. For number of bolls per plant Jagtap *et al.* (1992) also observed similar results. Regarding the type of epistasis, the relative signs of parameters (h), (l) and (z), which are not effected by degree of association 'r" showed the presence of duplicate epistasis at the three gene level. However definite conclusions regarding the type of epistasis could not be drawn for seed index and ginning out turn as (h) was non-significant. After considering signs and internal cancellation epistatic effects were more than the main effects suggesting their major role in the expression of characters. Kalsy *et al.* (1981), Jagtap (1986) and Randawa *et al.* (1991) obtained the same results. The results indicated the prevalence of both additive and non additive genetic effects. Since dominance component was also significant for most of the traits except ginning outturn, simple selection may not be very effective in the early segregating generations, selection should be delayed so that dominance variance may not get dissipated and progeny testing will be desirable for better gains through selection. Inter-mating the desirable segregants followed by selfing and selecting superior genotypes, enables the release of concealed variability and will mop-up the additive genetic variance and break up unfavourable linkage occurring in the repulsion phase. This procedure will ensure full utilization of additive and non-additive genetic variance and ultimately lead to fixation of character at desired level.

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Table 1. Generation means and standard errors for different characters.

Generations	Yield of SC per plant (g)	Bolls per Plant No.	Bolls weight (g)	Seed index (g)	GOT (%)	Lint Index
P1(MU-2)	100.05±5.15	48.40±2.34	2.15± 0.09	6.60± 0.11	35.17± 0.29	3.56± 0.02
P2(RS453)	104.79 ±1.64	48.73 ±0.10	2.09 ± 0.05	7.40 ±0.06	33.37 ±0.13	3.79 ±0.02
F1	105.50 ±3.18	49.60 ± 0.72	2.68 ± 0.06	7.87 ±0.15	36.87±0.32	4.27±0.04
F2	100.43 ±3.08	47.47 ±0.76	2.35 ± 0.04	7.34 ± 0.30	34.50±0.25	3.88±0.18
B1	93.23 ±3.37	48.47 ± 0.61	2.11 ± 0.05	6.90 ±0.25	35.85±0.20	3.88±0.13
B2	96.62 ± 3.72	47.93± 0.09	2.17 ± 0.02	7.13 ± 0.05	34.93±0.41	3.82±0.08
B11	105.46 ±2.20	57.40 ±0.99	2.32 ±0.01	7.04 ±0.26	36.18±0.24	4.00±0.16
B12	118.88 ±2.76	58.77±0.97	2.26 ±0.07	7.40 ±0.14	35.17 ±0.18	4.00±0.04
B21	116.53±4.38	56.20 ±2.78	2.27 ±0.07	7.09 ± 0.14	36.17±0.17	3.84±0.13
B22	88.72 ±1.14	44.57 ± 0.49	2.17 ±0.02	6.85 ±0.04	34.88 ±0.37	3.68±0.05
B1S	90.66 ±4.93	45.97 ±0.55	1.90 ±0.08	6.84 ±0.14	34.98 ±0.53	3.71±0.01
B2S	87.67 ±6.41	54.73 ±0.28	1.88 ±0.05	7.33 ±0.18	36.05 ±0.13	4.15±0.1

Table 2. Scaling test and their standard errors for various characters.

Scaling test	SC Yield per Plant (g)	Bolls per Plant No.	Boll weight (g)	Seed index (g)	Ginning Outturn	lint index
A	19.09 ±90.05	-6.06 ±2.73	0.61 ±0.14	0.67 ±0.52	-0.33 ± 0.59	-0.06 ±0.25
B	-14.04 ± 7.61	-7.46 ± 1.16	0.55 ±0.06	1.01 ± 0.10	-0.36 ±0.89	-0.42 ± 0.14
C	-8.11 ± 7.94	-16.46 ± 4.19	0.20 ± 0.22	0.38 ±1.24	-4.26 ±1.23	-0.37 ± 0.72
X^2 for joint scaling test[1]						
Additive dominance	134.06 (9)	835.42 (9)	102.13 (9)	26.67 (9)	242.91 (9)	65.82 (9)
Digenic interaction	63.85 (6)	533.73 (6)	74.07 (6)	9.84 (6)	155.35 (6)	29.57 (6)
linked digenics	44.09 (2)	325.10 (2)	50.78 (2)	2.97 (2)	94.62 (2)	10.90 (2)
Trigenic interactions	15.73(2)	84.84(2)	17.89(2)	0.35 (2)	6.04 (2)	0.88 (2)

P<0.05

[1] Figures in parenthesis indicate degrees of freedom

Table 3. Weighted least square estimates and their standard errors of the best fitting model for various characters.

Parameter	SC yield per plant	Bolls per Plant	Boll weight (g)	Seed index (g)	GOT	Lint Index
m	1362 ± 30.22	37.90 ± 4.45	-1.51 ± 0.37	6.16 ± 1.48	34.69 ± 2.20	3.66 ± 0.86
[d]	4.94 ±27.41	-41.94 ± 2.85	-0.18 ± 0.32	-1.92 ± 1.84	-3.07 ± 1.09	-2.02 ± 0.49
[h]	358.17 ±137.59	27.07 ±13.05	12.09 ± 1.79	5.99 ± 8.21	4.47 ± 10.47	2.36 ± 0.83
[i]	89.30 ±30.28	12.65 ±4.57	2.68 ±0.37	0.83 ±1.48	-0.43 ±2.21	-3.16 ±0.86
[j]	35.76 ±63.76	116.54 ±10.16	0.77 ±0.81	5.78 ±2.45	4.05 ±4.40	4.74 ±1.49
[l]	-30.90 ±194.06	-104.09 ±39.01	-15.94 ±2.68	-7.75 ±3.32	-17.07 ±5.37	-2.04 ±7.23
[w]	-7.21 ±27.33	41.69 ±2.82	0.24 ±0.32	1.51 ±0.84	3.94 ±1.89	1.95 ±0.49
[x]	-161.54 ±74.02	-15.77 ±14.02	-16.31 ±0.93	-4.09 ±5.08	10.55 ±5.73	0.12 ±3.00
[y]	-145.65 ±17.11	-102.19 ±11.4	-0.75 ±0.75	-6.22 ±2.19	0.13 ±3.65	-5.39 ±1.32
[z]	203.51 ±88.23	114.86 ±19.17	6.39 ±1.29	4.87 ±2.10	14.82 ±7.27	4.27 ±3.27

p<0.05