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GENETIC COMPONENTS OF VARIATION IN WHITE JUTE (*CORCHORUS CAPSULARIS* L.)

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Abstract

A diallel set, involving ten varieties/accessions of white jute including reciprocals was utilized for studying the genetic architecture of the parents and mode of gene action in F_1 and F_2s. The estimates of D and H_1 indicated that both additive and dominance effect were significant for plant height, technical height, base diameter, number of nodes/plant, bark weight/plant, fibre weight/plant and stick weight/plant in F_1. In F_2 significant additive (D) and dominance (H_1) effects were observed for plant height, technical height, base diameter and fibre weight/plant. It appears that inheritance of these characters would likely to be more complex than the other. In F_1 generation the ratio of $[(H_1/D)]^{1/2}$ was more than unity for bark weight/plant, fibre weight/plant and stick weight/plant suggesting the presence of over dominance for these traits. In F_2 similar phenomenon was observed for plant height, technical height, base diameter and bark weight/plant. It was revealed that the inheritance of these traits was predominated by over dominance effect of genes. Fibre weight/plant indicated complete dominance. In F_1 and F_2 the value of $H_2/4H_1$ was smaller than 0.25 for all the characters indicating asymmetry of positive and negative genes at different loci showing dominance. In F_1 broad sense heritability was greater than narrow sense heritability for all the characters revealed that genotypic variation was controlled by non-additive gene action. In F_2 the narrow sense heritability was estimated to be higher for plant height, technical height and base diameter and moderately high for number of nodes/plant.

Introduction

Jute is the most important cash crop of Bangladesh. Its varietal improvement with respect to quality and yield is a necessity. Economically desirable characters of jute are mostly quantitative in nature. In formulating appropriate breeding procedures for varietal improvement of white jute, information about the pattern of inheritance of quantitative traits is essential. The knowledge of the components of genetic variation of quantitative characters would be useful to a plant breeder in order to determine their usefulness as selection criteria. A limited number of publications dealing with genetical studies of quantitative characters of jute have been reported. Rahman (1968), Joarder *et al.* (1969) and Basak *et al*. (1974) reported that both additive and dominance variation were involved in the inheritance of earliness and plant height, but in the case of fibre yield the contribution of dominance variation was found to be greater than additive effects. The present study was, therefore, undertaken to investigate the components of genetic variation of seven morpho-agronomic characters.

Materials and Methods

A diallel cross involving ten parental genotypes of *Corchorus capsularis* L. including reciprocals was used in this study. Of the ten parents seven were accessions *viz*. Accs. 3695, 1515, 1831, 1832, 1833, 2146, 4087 and three commercial varieties of white jute *viz.* CVL-1, A-38 and CC-45. The ten parents and their 90 F_1s were grown at the adjacent field of Bangladesh Jute Research Institute in a RCBD with three replications in 2001. For each entry the plot consisted of

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one single row of 3.0 m length. Spacing between rows and between plants within a row were 30 cm and 6 - 7 cm, respectively. Following the same fashion ten parents and 90 F_2 were grown at the Central Jute Agricultural Experiment Station, Manikganj in 2002. Data on ten randomly selected plants from each row were collected for seven characters *viz.* plant height, technical height, base diameter, number of nodes, bark weight, fibre weight and stick weigh on per plant basis. In F_1 the components of genetic variation and related genetic parameters were calculated according to Hayman (1954a,b, 1957) and Jinks (1954, 1956) using Mather's concept of D and H components of variation and in F_2 these were estimated by the formulae given by Jinks (1956), Hayman (1958) and Mather and Jinks (1971).

Results and Discussion

There were wide range of variations among the parents for seven characters in respect of mean values (Table 1). Variety CVL-1 scored the highest value for plant height, base diameter, number of nodes/plant, bark weight/plant, fibre weight/plant and stick weight/plant. Accession 4087 gave the highest technical height. Based on the parental values of the seven characters, the highest C.V. was observed for stick weight/plant followed by fibre weight/plant, bark weight/plant, technical height, base diameter, number of nodes/plant and plant height.

Table 1. Mean values of parents over two years for seven characters in *Corchorus capsularis*.

Parents	Plant height (m)	Technical height (m)	Base diameter (mm)	No. of nodes/ plant	Bark weight/ plant (g)	Fibre weight/ plant (g)	Stick weight/ plant (g)
CVL-1	3.59	2.81	24.04	58.50	54.56	25.38	79.53
3695	2.72	1.84	11.41	48.40	26.12	7.69	24.20
1515	2.44	2.09	12.37	32.57	24.98	8.30	25.36
1831	3.13	2.48	19.15	48.24	37.65	15.65	47.70
1832	2.26	1.38	15.70	40.72	16.89	6.35	18.48
1833	1.14	0.38	7.88	17.66	1.79	0.78	2.18
2146	3.06	2.19	18.24	56.87	32.90	10.97	34.86
4087	3.42	2.82	21.88	52.20	47.13	15.46	52.06
A-38	3.29	2.48	20.99	46.01	50.61	19.40	58.47
CC-45	3.06	2.41	18.16	53.11	32.51	12.38	42.40
Mean	2.81	2.09	16.98	45.43	32.51	12.24	38.52
CV	25.64	35.55	30.05	27.28	49.59	57.78	57.89

The genetic components of variation and their ratio of a ten parental diallel in *C. capsularis* for seven characters in the F_1 and F_2 generations are presented in Tables 2 and 3, respectively. The additive component D was highly significant for plant height, technical height, base diameter, number of nodes/plant, bark weight/plant fibre weight/plant and stick weight/plant in F_1 and F_2 revealing the importance of additive variation. In F_1 values of H_1 and H_2 showed significant results for all the characters whereas in F_2 similar phenomenon observed for plant height, technical height, and base diameter for H_1 and H_2 components and also fibre weight/plant for H_1 components which indicate dominance variation in the inheritance of these characters. Khanna *et al.* (1974) observed that a character showing both significant additive and dominance components were supposed to possess more complex genetic inheritance. Paria and Basak (1973) reported that both additive and non-additive effects were significant for different characters. Eunus

(1974) found that both D and H components were significant for earliness, plant height and fibre yield. According to Paul *et al.* (1978) the estimates D and H indicated that both additive and dominance effects were involved in the inheritance of fibre yield in jute. Jana (1972), Singh (1974) and Ghosh *et al.* (1979) also observed a preponderance of additive gene action for most of the yield contributing parameters of *capsularis* jute. Singh (1973) reported that both additive and non-additive gene effects were responsible for fibre yield in *capsularis* jute but base diameter was primarily controlled by non-additive gene effects. Srivastava *et al*. (1978, 1979) reported that additive genetic variation contributed more to the total variation for plant height but there was a preponderance of non-additive genetic variances for base diameter in white jute. Singh and Gupta (1985) also reported that the additive component D was found to be significant in *Capsularis* jute.

Table 2. Estimates of genetic components of seven characters of *Corchorus capsularis* in F_1.

Genetic component	Plant height (m)	Technical height (m)	Base diam. (mm)	No. of nodes/plant	Bark weight/ plant (g)	Fibre weight/ plant (g)	Stick weight/ plant (g)
	F_1	F_1	F_1	F_1	F_1	F_1	F_1
D	0.65** ± 0.01	0.83** ± 0.02	25.51** ± 1.27	271.85** ± 8.43	305.42** ± 0.00	76.37** ± 9.10	402..55** ± 65.73
H_1	0.46** ± 0.03	0.59** ± 0.04	19.34** ± 2.70	198.36** ± 17.93	343.67** ± 85.14	86.50** ± 19.38	511.00** ± 139.92
H_2	0.18** ± 0.03	0.23** ± 0.04	9.34** ± 2.30	69.75** ± 15.24	263.82** ± 72.36	57.15** ± 16.47	389.97** ± 118.91
h^2	0.36** ± 0.02	0.15** ± 0.02	16.42** ± 1.54	14.00 ± 10.20	548.71** ± 48.44	108.01** ± 11.02	700.87** ± 79.60
F	0.81** ± 0.03	0.99** ± 0.05	30.63** ± 2.93	346.04** ± 19.44	253.81** ± 92.29	68.15** ± 21.00	359.99* ± 151.66
E	0.03** ± 0.01	0.03** ± 0.01	2.22** ± 0.38	16.03** ± 2.54	86.00** ± 12.06	17.56** ± 2.74	102.85** ± 19.82
$(H_1/D)^{½}$	0.84	0.71	0.87	0.85	1.06	1.06	1.13
$H_2/4H_1$	0.10	0.10	0.12	0.09	0.19	0.16	0.19
$\frac{KD}{KR} = \frac{[(4DH_1)^{½} + F]}{KR\ [(4DH)^{½} - F]}$	6.51	5.90	5.44	6.84	2.29	2.44	2.31
h^2/H_2	1.96	0.66	1.76	0.20	2.08	1.89	1.80
h^2(ns)	0.46	0.52	0.35	0.45	0.30	0.37	0.29
h^2(bs)	0.80	0.83	0.68	0.73	0.60	0.65	0.63

* and ** represent significant at 5 and 1% levels, respectively.

In F_1 and F_2 significant values of h^2 for plant height, technical height, base diameter, fibre weight/plant and stick weight/plant except number of nodes/plant (F_1) and bark weight/plant (F_2) revealed the existence of dominance effect. The component F (interaction of additive × dominant effect) measured the relative frequency of dominant and recessive genes in the parents. Significant and positive estimates of F value were observed in F_1 for plant height, technical height, base diameter, number of nodes/plant, bark weight/plant, fibre weight/plant and stick weight/plant indicating the presence of an excess of dominant alleles in the parents than recessive alleles. In F_2 highly significant positive value of F for plant height, technical height, base diameter and number of nodes/plant and positive value for bark weight/plant, fibre weight/plant and stick weight/plant showed that the dominant genes were in excess than the recessive genes in the parents. In F_1 and F_2 generations the value of E revealed significant results for all the characters.

Table 3. Estimates of genetic components of seven characters of *Corchorus capsularis* in F_2.

Genetic component	Plant height (m)	Technical height (m)	Base diam. (mm)	No. of nodes/ plant	Bark weight/ plant (g)	Fibre weight/ plant (g)	Stick weight/ plant (g)
	F_2	F_2	F_2	F_2	F_2	F_2	F_2
D	0.39** ± 0.03	0.38** ± 0.04	19.68** ± 2.64	63.86** ± 7.32	116.95** ± 124.58	15.29** ± 3.08	458.48** ± 107.35
H_1	1.68** ± 0.26	1.61** ± 0.35	127.98** ± 22.45	106.72 ± 62.29	2152.81 ± 1060.75	61.50* ± 26.26	637.96 ± 914.02
H_2	0.83** ± 0.22	0.93* ± 0.30	76.60** ± 19.08	30.52 ± 52.94	1473.68 ± 901.52	35.20 ± 22.32	166.01 ± 776.82
h^2	2.95** ± 0.15	0.62* ± 0.20	274.80** ± 12.77	255.36** ± 35.44	1192.70 ± 603.44	216.05** ± 14.94	4023.57** ± 519.97
F	1.07** ± 0.14	0.74** ± 0.19	61.38** ± 12.15	179.00** ± 33.72	196.03 ± 574.19	14.43 ± 14.23	1064.91 ± 494.76
E	0.03* ± 0.01	0.03* ± 0.01	2.50* ± 0.79	29.96** ± 2.21	153.97** ± 37.56	8.00** ± 0.93	213.05** ± 32.37
$[1/4(H_1/D)]^{1/2}$	1.04	1.03	1.27	0.65	2.14	1.00	0.59
$H_2/4H_1$	0.12	0.14	0.15	-0.07	0.17	0.14	-0.06
$\frac{KD}{KR} = \frac{[1/4(4DH_1)^{1/2} + 1/2F]}{[1/4(4DH_1)^{1/2} - 1/2F]}$	-6.90	28.35	-9.97	-2.71	2.28	2.78	-3.06
h^2/H_2	3.54	0.66	3.59	8.37	0.81	6.14	-24.24
h^2(ns)	0.99	0.70	0.63	0.53	0.10	0.27	0.49

* and ** represent significant at 5 and 1% levels, respectively.

In F_1 the mean degree of dominance showed partial dominance for plant height, technical height, base diameter and number of nodes/plant and over dominance effect was observed for bark weight/plant, fibre weight/plant and stick weight/plant. In F_2 ratio $[1/4(H_1/D)]^{1/2}$ for plant height, technical height, base diameter and bark weight/plant indicating over dominance effect of these traits, fibre weight/plant revealed complete dominance and partial dominance was observed for number of nodes/plant and stick weight/plant.

The value of the ratio of $H_2/4H_1$ was found to be deviating from its expected value of 0.25 in F_1 and F_2 indicated the asymmetry of gene distribution at loci showing dominance for all the characters. In F_1 the estimated value of the ratio of dominant to recessive genes (KD/KR) was more than unity for plant height, technical height, base diameter, number of nodes/plant, bark weight/plant, fibre weight/plant and stick weight/plant while in F_2 it was observed for technical height, bark weight/plant indicating excess of dominant genes in the parents and positive value of F simultaneously provided the same information. For fibre yield/plant, presence of an excess of dominant alleles in the parents than the recessive alleles was observed in F_1 and F_2. The ratio of h^2/H_2 showed an estimate of gene groups exhibiting dominance for the all the characters studied except technical height and number of nodes/plant in F_1. Similarly in F_2 this value (h^2/H_2) indicated that plant height, base diameter, number of nodes/plant, fibre weight/plant were controlled by a number of gene or gene group and exhibited a dominance effect. In F_1 broad-sense heritability was greater than narrow-sense heritability for all the characters but in F_2 high narrow-sense heritability was observed for plant height (0.99), technical height (0.70) and base diameter (0.63) and moderately high for number of nodes/plant (0.53). So, improvement of fibre yield can be enhanced through pedigree selection based on plant height, technical height and base diameter of white jute.

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