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Analysis of quantitative variation and selection criteria for yield improvement in exotic germplasm of tossa jute (*Chorchorus olitorius* L.)

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ABSTRACT

The genetic variability, heritability, genetic advance, correlation coefficient and path analysis were estimated for fibre yield and its attributing traits in fifty two germplasm lines of Jute (Corchorus olitorius L.) at Rahuri (M.S.) during kharif season of 2020. Higher magnitude of variance was recorded in plant height followed by days to 50% flowering, days to initiation of flowering and fibre yield per plant. The genotype OIN-136 recorded the highest fibre yield per plant along with higher green weight and basal diameter. The highest genotypic and phenotypic variance was for plant height, days to 50% flowering, days to initiation of flowering, fibre yield and basal diameter and the lowest genotypic and phenotypic variance was that of green weight. High values for PCV and GCV were recorded for green weight and fibre weight. High values of heritability were recorded for basal diameter, days to 50% flowering, days to initiation of flowering and plant height and moderate values of heritability were recorded for green weight and fibre yield. The genetic advance was highest for plant height and lowest for base diameter. The high heritability with moderate to high genetic advance over percentage of mean was observed in plant height, days to 50% flowering and days to initiation of flowering which indicate preponderance of additive genetic action. The high heritability with low genetic advance over percentage of mean was observed in basal diameter. Low heritability with low genetic advance over percentage of mean was observed in green weight and fibre yield indicated the presence of both additive and non additive gene effects. The magnitude of genotypic correlation was higher than the phenotypic correlation indicating that elimination of environmental effects led to strengthen genetic association. The correlation analysis revealed that there was a nonsignificant association of initiation of flowering with green weight and fibre yield at phenotypic level, plant height with green weight at phenotypic level and plant height with fibre yield at genotypic and phenotypic level. Green weight/ plant had highest positive direct effect on fibre yield per plant at genotypic and phenotypic level, days to 50% flowering at phenotypic and initiation of flowering at genotypic level. Therefore direct selection based on these characters would be feasible. Days to initiation of flowering at phenotypic, days to 50% flowering at genotypic, plant height at genotypic and phenotypic and basal diameter per plant at genotypic exhibited high and negative direct effects towards fibre yield. Significant positive correlations with fibre yield per plant indicated that the indirect selection could be made for high yielding jute genotypes through most of the characters having positive indirect effects.

Keywords: Mean performance, variability, PCV, GCV, heritability, genetic advance, path coefficient, quality aspects, variance

INTRODUCTION

Jute is a natural fiber crop and is second in the world after cotton in terms of global production, consumption and availability. In India, West Bengal occupies foremost place both in respect of area (73.5%) and production (82.26%) of jute. The fibre (bast fibre) is obtaining from the bark of two cultivated species of the genus namely *Corchorus capsularis* L. and *Corchorus olitorius* L. which are widely cultivated throughout the tropical and sub-tropical regions of the world, particularly in Asia, Africa and Latin America. The bast fibres of jute are not only important to textile and paper industries but also make us free from being worried of population hazards as it is biodegradable. The present threatening of undegradable particle reminds us that there is no other alternative for fibre crops like jute. (Senapati *et al*., 2006). Jute fibre has high tensile strength, low extensibility and ensures better breathability of fibre, therefore, it has proved its importance in packaging of agricultural commodity, textiles and non-textiles industries and construction work. Raw jute along with manufactured jute products formed an important source of earning for foreign exchange

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in India. Unfortunately, there is limited scope for further improvement of cultivated variety of jute in the absence of required variability and genetic diversity. The association of commercially important quantitative characters that are statistically determined by correlation coefficient has been quite helpful as a basis of selection. Selection pressure can be more easily exerted on any of the characters which reflect close association with yield. Correlation studies measure only mutual association between two traits and path analysis for the cause and effect of relationship. (Kumar *et al*., 2013a; Reddy *et al*., 2013). Thus, the estimation of correlation and path analysis give a clear picture about the association between two characters and partitioning of the relationship into direct and indirect effects showing the relative contribution of each of the causal factors towards the yield. (Pervin *et al.*, 2012) In this regards, a good number of research works in jute has been reported by many workers (Alam *et al*., 2011). Hence, present experiment was under taken to study the correlation and path coefficient between yield and its attributing traits and to find out the extent of direct and indirect effects of fibre yield components.

MATERIALS AND METHODS

Fifty two germplasm lines of tossa jute (*Corchorus olitorius* L.) were collected from AINP jute and allied fibres via Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore, West Bengal were evaluated in randomized block design (RBD) with two replications having plot size of 4.5 m × 0.60 m for each genotype at the Cotton Improvement Project, MPKV, Rahuri during kharif, 2020. The recommended agronomic practices were followed to obtain optimum fibre yield. Observations were recorded on days to initiation of flowering, days to 50% flowering, plant height (cm), basal diameter (cm), green weight per plant (kg) and fibre yield per plant (g) from each genotype from each replication. The analysis of variance (ANOVA) for RBD was estimated according to Panse and Sukhtame (1989). The genotypic and phenotypic variances were calculated according to Johnson *et al.* (1955) and Comstock and Robinson (1952). Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated by the method suggested by Singh and Chaudhary (1985) whereas heritability in broad sense for yield and its components were worked out by using formula suggested by Hanson *et al.* (1956). Genetic advance (GA) was calculated by the method suggested by Johnson *et al.* (1955). Genotypic and phenotypic correlations were partitioned using the technique outlined by Dewey and Lu (1959).

RESULT AND DISCUSSION

The analysis of variance showed significant differences among the genotypes for all the characters indicating presence of considerable variability (Table 1). Higher magnitude of variance was recorded in plant height followed by days to 50% flowering, days to initiation of flowering and fibre yield per plant.

Table 1: Analysis of variance (ANOVA) for fibre yield and yield contributing traits

Source of variation	DF	Mean sum of squares					
		Initiation of flowering (days)	50% flowering (days)	Plant height (cm)	Basal diameter (cm)	Green weight plant (kg)	Fibre yield/ plant (g)
Replication	1	16.163	33.471	5.552	0.001	0.005	0.758
Treatment	51	32.311**	49.785**	409.981**	0.035**	0.006**	4.870**
Error	51	1.516	1.589	20.024	0.001	0.001	1.395

The genotype JRO 502 showed highest values (65.50) while genotype OIN-142, OIN-157, OIN-167 and OIN-182 showed lowest means (48.00) for days to initiation of flowering. The genotype OIN-185 and JRO 204 (73.50) were late, whereas, OIN-182 was earlier for days to 50% flowering. In case of plant height genotype OIN-185 showed the highest mean values (353.33 cm) whereas OIN-165 was lowest (284.17 cm) for plant height. Highest basal diameter (2.11 cm) found in genotype OIN-136 followed by lowest basal diameter (1.25 cm) in OIN-165. The genotype OIN-136 produced highest green weight per plant (0.41 kg) while OIN-165 recorded the lowest green weight per plant (0.18 kg). The highest and the lowest fibre yield produced by OIN-136 (16.17 g) and OIN-179 (8.51 g), respectively (Table 2).

Table 2: Mean performance of fibre yield and yield attributing traits

Sl. No.	Genotype	Initiation of flowering (days)	50% flowering (days)	Plant height (cm)	Basal diameter (cm)	Green weight/ plant (kg)	Fibre yield/ plant (g)
1	OIN-136	56.00	67.00	312.50	2.11	0.41	16.17
2	OIN-137	56.50	67.00	308.34	1.82	0.34	13.23
3	OIN-138	54.50	66.50	319.17	1.81	0.35	12.37
4	OIN-139	51.00	57.50	307.50	1.70	0.34	11.86
5	OIN-140	49.50	55.50	299.17	1.86	0.31	11.30
6	OIN-141	49.50	55.50	300.00	1.67	0.21	9.39
7	OIN-142	48.00	54.50	324.17	1.74	0.25	10.46
8	OIN-143	53.00	58.50	313.34	1.85	0.25	11.60
9	OIN-144	53.00	61.00	307.50	1.75	0.30	11.57
10	OIN-145	51.00	57.50	313.33	1.77	0.25	11.46
11	OIN-146	52.50	58.00	309.17	1.71	0.26	10.38
12	OIN-147	53.50	59.00	316.67	1.64	0.29	11.70
13	OIN-148	52.00	59.00	307.50	1.73	0.34	13.39
14	OIN-149	50.00	55.50	305.00	1.82	0.37	14.12
15	OIN-150	55.00	59.00	305.84	1.69	0.32	11.53
16	OIN-151	55.00	61.00	300.00	1.66	0.26	10.14
17	OIN-152	50.00	56.50	326.67	1.82	0.35	12.23
18	OIN-153	51.00	59.00	310.00	1.73	0.28	11.48
19	OIN-154	53.00	60.50	323.34	1.60	0.35	10.86
20	OIN-155	54.50	61.00	312.50	1.68	0.27	10.40
21	OIN-156	53.50	61.50	314.17	1.88	0.34	12.17
22	OIN-157	48.00	54.00	319.17	1.66	0.28	11.40
23	OIN-158	51.50	56.50	323.34	1.73	0.41	13.51
24	OIN-159	52.00	57.50	325.84	1.68	0.26	9.89
25	OIN-160	49.50	55.00	290.83	1.54	0.25	9.00
26	OIN-161	50.50	57.00	310.84	1.87	0.35	13.43
27	OIN-162	55.00	61.50	318.34	1.65	0.22	9.45
28	OIN-163	53.00	58.00	290.84	1.66	0.20	8.72
29	OIN-164	50.00	56.00	291.67	1.68	0.25	11.24
30	OIN-165	50.00	57.00	284.17	1.25	0.18	11.27
31	OIN-166	49.50	55.00	310.00	1.72	0.25	11.91
32	OIN-167	48.00	53.00	290.34	1.52	0.22	9.09
33	OIN-168	49.00	54.00	307.50	1.64	0.26	11.36
34	OIN-169	49.00	55.50	310.84	1.65	0.24	10.90
35	OIN-170	50.00	55.00	325.00	1.85	0.26	11.80
36	OIN-171	51.00	55.00	313.34	1.70	0.26	11.06
37	OIN-172	50.50	57.00	325.84	1.93	0.25	10.80
38	OIN-173	50.00	57.00	302.50	1.93	0.34	12.73
39	OIN-174	52.50	57.50	305.84	1.66	0.27	10.96
40	OIN-175	52.50	59.00	303.34	1.73	0.36	13.52
41	OIN-176	48.00	53.00	303.34	1.71	0.19	7.75
42	OIN-177	51.50	58.50	310.83	1.65	0.24	10.10
43	OIN-178	54.00	60.00	320.00	1.75	0.22	8.95
44	OIN-179	48.50	53.00	317.50	1.64	0.21	8.51
45	OIN-180	50.50	57.00	327.50	1.70	0.25	9.76
46	OIN-181	52.00	57.00	315.84	1.82	0.26	10.26
47	OIN-182	48.00	52.00	311.67	1.82	0.28	11.34
48	OIN-183	49.00	53.50	291.67	1.67	0.22	9.97
49	OIN-184	49.00	53.50	341.67	1.85	0.29	11.63
50	OIN-185	65.00	73.50	353.33	1.92	0.26	10.88
51	JRO 524	66.00	73.00	342.50	1.96	0.29	11.71
52	JRO 502	65.50	73.50	349.17	1.86	0.29	12.26

Estimation of different genetic variability parameters are given in Table 3. There was substantial variability in terms of range for all the characters. Results showed that the highest genotypic and phenotypic variance was for plant height (389.96 & 409.98) followed by days to 50% flowering (48.20 & 49.79) days to initiation of flowering (30.79 & 32.31), fibre yield (3.48 & 4.87), base diameter (0.03 & 0.04) and the lowest genotypic and phenotypic variance was that of green weight (0.01). The phenotypic coefficient of variability (PCV) was higher than genotypic coefficient of variability (GCV) in all the cases revealed the characters mainly influenced by environment. This result corroborated with Kumar *et al*. (2013 a.), Mehandi *et al*. (2013), and Tejbir *et al*. (2009). But the difference between GCV and PCV was little in days to initiation of flowering, days to 50% flowering, plant height and basal diameter. This finding was corroborated with Senapati *et al*. (2006). This indicated that these characters were less influenced by environment whereas the other characters, Fibre yield and green weight exhibited higher degree of environmental influences. High values for PCV and GCV were recorded for green weight (21.30, 17.36) and fibre weight (15.79, 11.76). The plant height exhibited low value for GCV (4.46) and PCV (4.69). Similar result were reported by Singh *et al*. (2013), Anandrao *et al*. (2011), Paul *et al*. (2011), Singh *et al*. (2011) and Quatadah *et al*. (2012). High values of heritability were recorded for basal diameter (94.89%), days to 50% flowering (93.82%), days to initiation of flowering (91.04%) and plant height (90.69%), while moderate values of heritability were recorded for green weight (66.41%) and fibre weight (55.47%). Similar result were reported by Nayak *et al*. (2007) and Kumar *et al*. (2013b.). Thus, these characters contain good amount of additive genetic components which can be easily utilized for further crop improvement.

The high genetic advance was highest for plant height (27.39) and lowest for base diameter (0.26). Johnson *et al*. (1955) suggested that for a more reliable conclusion, heritability and genetic advance should be considered together. The high heritability with moderate to high genetic advance over percentage of mean was observed in plant height (90.69%, 27.39), days to 50% flowering (93.82%, 9.80) and days to initiation of flowering (91.04%, 7.71) which indicate preponderance of additive genetic action. Similar result was reported by Senapati *et al*. (2006). The high heritability with low genetic advance over percentage of mean was observed in basal diameter (94.89%, 0.26). This result is corroborated by Nayak *et al*. (2007). Low heritability with low genetic advance over percentage of mean was observed in green weight (66.41%, 0.08) and fibre yield (55.47%, 2.02) indicated the presence of both additive and non additive gene effects.

Table 3: Range, Mean, Variability, heritability and other genetic parameters

Character	Range	GV	PV	GCV	PCV	H^2	GA	%GA
Initiation of flowering (days)	48.00-65.50	30.79	32.31	7.53	7.89	91.04	7.71	14.80
50% flowering (days)	52.00-73.50	48.20	49.79	8.40	8.67	93.82	9.80	16.76
Plant height (cm)	290.34-353.33	389.96	409.98	4.46	4.69	90.69	27.39	8.76
Basal diameter (cm)	1.25-2.11	0.03	0.04	7.48	7.68	94.89	0.26	15.02
Green weight/ plant (kg)	0.18-0.41	0.01	0.01	17.36	21.30	66.41	0.08	29.14
Fibre yield/ plant (g)	7.75-16.17	3.48	4.87	11.76	15.79	55.47	2.02	18.04

Estimates of phenotypic and genotypic correlation coefficients between each pair of characters are given in Table 4. The results showed that the magnitude of genotypic correlation is higher than the phenotypic correlation indicating that elimination of environmental effects led to strengthen genetic association. The correlation analysis revealed that there was a non-significant association of initiation of flowering with green weight and fibre yield at phenotypic level, plant height with green weight at phenotypic level and plant height with fibre yield at genotypic and phenotypic level. Rest of the characters showed positive and significant association with each other. Similar result was obtained by Singh *et al*. (2013) and Nayak *et al*. (2008).

Table 4: Phenotypic (P) and Genotypic (G) correlation coefficient among different yield component characters

Character		Initiation of flowering (days)	50% flowering (days)	Plant height (cm)	Basal diameter (cm)	Green weight/ plant (kg)
50% flowering (days)	G	0.970**				
	P	0.944**				
Plant height (cm)	G	0.557**	0.510**			
	P	0.534**	0.501**			
Basal diameter (cm)	G	0.388**	0.427**	0.525**		
	P	0.372**	0.411**	0.510**		
Green weight/ plant (kg)	G	0.225*	0.332**	0.210*	0.602**	
	P	0.167NS	0.267**	0.192NS	0.466**	
Fibre yield/ plant (g)	G	0.285**	0.394**	0.177NS	0.619**	1.070**
	P	0.150NS	0.261**	0.123NS	0.442**	0.717**

Green weight /plant had highest positive direct effect on fibre yield per plant at genotypic (1.0996) as well as phenotypic level (0.6063) followed by 50% flowering (0.3874) at phenotypic and initiation of flowering (0.2640) at genotypic level (Table 5). Therefore direct selection based on these characters would be feasible. Days to initiation of flowering at phenotypic (0.3289), days to 50% flowering at genotypic (0.1640), plant height at genotypic (0.1066) and phenotypic ((0.0994) and basal diameter per plant at genotypic (0.0197) exhibited high and negative direct effects towards fibre yield. Similar findings were reported by Pervin *et al*. (2012). But its significant positive correlations with fibre yield per plant indicated that the indirect selection could be made for high yielding jute genotypes through most of the characters having positive indirect effects. The residual effect (R) at are -0.15644 (Genotypic) and 0.44954 (Phenotypic), indicating there was also some other characters which although not studied but influenced the yield of fibre per plant. The green weight per plant of the present study had higher values of direct effects even than their respective correlation coefficients indicating their prime importance in fibre yield.

Table 5: Path coefficient (genotypic) analysis showing direct (bold) and indirect effects of component traits in jute

Character		Initiation of flowering (days)	50% flowering (days)	Plant height (cm)	Basal diameter (cm)	Green weight /plant (kg)	Correlation with fibre yield
Initiation of flowering	G	**0.2640**	-0.1591	-0.0593	-0.0076	0.2474	0.285**
(days)	P	**-0.3289**	0.3656	-0.0531	0.0644	0.1015	0.150NS
50% flowering	G	0.2561	**-0.1640**	-0.0544	-0.0084	0.3652	0.394**
(days)	P	-0.3105	**0.3874**	-0.0498	0.0712	0.1622	0.261**
Plant height (cm)	G	0.1470	-0.0837	**-0.1066**	-0.0103	0.2309	0.177NS
	P	-0.1757	0.1940	**-0.0994**	0.0883	0.1162	0.123NS
Basal diameter (cm)	G	0.1024	-0.0701	-0.0560	**-0.0197**	0.6621	0.619**
	P	-0.1223	0.1594	-0.0507	**0.1731**	0.2826	0.442**
Green weight/ plant	G	0.0594	0.0545	0.0224	0.0118	**1.0996**	1.070**
(kg)	P	-0.0551	0.1036	-0.0190	0.0807	**0.6063**	0.717**

Residual effects are -0.15644 (Genotypic) and 0.44954 (Phenotypic)

Genetic variation is an essential character for the development of new variety. Identification of potential gene/s is important for the breeding programmes. In the present research, 52 tossa jute accessions were analyzed in respect of morphological characters and genetic variation. Phenotypic variation was more prominent than the genetic variation in the jute accessions. Moreover, it showed the origin of the jute accessions which were highly diverse in genetic components. Based on that breeding programme it can be undertaken to maximize the jute yield. Thus, the result of this investigation suggested that plant height, basal diameter, green weight would be the selection parameters to produce kenaf varieties with acceptable yield.

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