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A Non-destructive Selection Criterion for Fibre Content in Jute

II. Regression Approach

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Summary. An experiment with ten populations of jute, comprising varieties and mutants of the two species *Corchorus olitorius* and *C. capsularis* was conducted at two different locations with the object of evolving an effective criterion for selecting superior single plants for fibre yield. At Delhi, variation existed only between varieties as a group and mutants as a group, while at Pusa variation also existed among the mutant populations of *C. capsularis*.

A multiple regression approach was used to find the optimum combination of characters for prediction of fibre yield. A process of successive elimination of characters based on the coefficient of determination provided by individual regression equations was employed to arrive at the optimal set of characters for predicting fibre yield. It was found that plant height, basal and mid-diameters and basal and mid-dry fibre weights would provide such an optimal set.

Introduction

In bast fibre crop such as jute, breeders have long felt the need for efficient programmes to select desirable single plants for fibre yield from pure or segregating populations, based on observations taken at optimum stage since it is hard to get both fibre and seed from the same individual selection. With the major objective of evolving such a selection criterion in jute, an experiment was conducted at the Indian Agricultural Research Institute, New Delhi, and its Regional Research Station at Pusa, Bihar, during the year 1972. The results of estimating fibre content on a small number of non-destructive observations using a geometric approach were summarised in an earlier paper (Iyer *et al.*, 1974). An alternative approach would be to use the multiple regression between the observed variables to find the optimum combination of variables which would predict the fibre yield at a desired level of accuracy. The results of such an investigation are reported in this paper.

Materials and Methods

Ten populations, five each of *Corchorus olitorius* L. ('Tossa' jute) and of *C. capsularis* L. ('White' jute), comprising two released varieties and three selections obtained from them after treatment with certain physical (γ-rays and fast-neutrons) and chemical (ethylmethane sulphonate and N-nitrosomethyl urea) mutagens as described in our earlier paper (*loc. cit*), formed the material (for the names of these populations, see Table 1) for this study.

The material was grown in a randomised-block-design with four replications at two locations. Each population was grown in four rows of 4 metres length with a spacing of 5 cm between plants and 30 cm between rows.

Observations were recorded in each replication on a random sample of ten plants for the following characters: (i) Plant height (cm); (ii) Diameter (mm) at 15 cm above ground (B), at the middle of the axis (M) and at the topmost level below the forking point where a bark sample measuring 5 × 1 cm could be removed (T); (iii) Bark thickness (mm) of sample at B, M and T; (iv) Dry bark weight (mg) of sample at B, M and T; (v) Dry fibre weight (mg) of sample at B, M and T; (vi) Days to 50% flowering; and (vii) Total fibre weight (gm) of the ten plants. For further details of the method of taking observations, see Iyer *et al.* (1974).

The analysis of variance on all the characters based on single plant observations and of multiple regression were carried out on an IBM 1620 computer.

Results

An examination of the means of the characters (Table 1) revealed that the *olitorius* variety, JRO-632, was eight days earlier to flower than the *capsularis* variety, JRC-212, as shown by the number of days to 50 per cent flowering at Delhi. However, this difference was not maintained for the values of the other characters. The data on basal, middle and top diameters revealed the well-known fact that *capsularis* has a more tapering stem towards the top than *olitorius*, which was also reflected in the higher fibre yield of the latter species.

On the whole, the table of means demonstrated that the overall variability between the ten populations chosen was very limited for almost all the characters studied at both the locations. In fact, the amount of available variability in the cultivated populations of 'tossa' and 'white' jute, is not high enough to permit choice of higher variability than that made available by these ten populations (see also Basak, 1968).

The analysis of variance at single plant level showed that there was significant variation among populations at both the locations. However, a further study of the subsources of the population variance brought out some interesting facts:

(i) At Delhi, the variation observed in the *olitorius* populations came mainly from the single degree of

Table 1. *Means of quantitative characters in 10 populations of jute*

Character	Location	Populations 1	2	3	4	5	6	7	8	9	10
1. Days to 50% flowering	D	103.0	104.5	103.0	104.5	104.5	110.5	109.5	109.0	108.8	108.5
2. Plant height (cm)	D	299.4	296.9	309.5	297.1	306.9	256.5	263.3	266.3	247.7	251.8
	P	300.4	306.4	309.0	308.1	310.8	229.6	263.5	251.9	234.6	249.4
3. Basal diameter (mm)	D	17.2	16.1	17.1	17.3	18.0	16.7	16.3	17.0	17.6	15.7
	P	14.5	15.1	15.4	14.5	15.2	15.6	15.8	18.7	15.8	16.3
4. Mid-diameter (mm)	D	13.2	12.7	13.2	13.6	14.5	11.8	12.4	12.1	12.6	11.6
	P	11.5	12.4	12.4	12.6	12.4	10.9	10.9	12.9	11.1	11.8
5. Top diameter (mm)	D	8.8	8.8	8.8	9.4	9.5	7.5	7.8	8.0	8.1	7.9
	P	8.9	10.0	9.8	10.0	9.9	9.3	7.9	10.2	8.5	8.6
6. Basal bark thickness (mm)	P	12.4	13.8	12.3	14.1	12.1	12.4	14.0	14.9	11.7	13.7
7. Mid-bark thickness (mm)	P	9.1	10.6	8.9	10.8	9.1	8.8	9.5	10.2	8.5	9.4
8. Top bark thickness (mm)	P	6.9	8.4	6.7	8.8	7.0	6.6	7.4	7.8	6.4	7.4
9. Basal bark weight (mg)	D	162.6	138.0	151.5	150.7	158.2	141.5	139.5	145.4	141.3	121.5
	P	153.7	163.4	148.2	166.8	154.6	135.1	147.1	166.2	126.3	141.0
10. Mid-bark weight (mg)	D	133.7	120.2	124.5	125.3	137.5	111.2	112.8	115.5	114.9	98.2
	P	127.6	140.6	124.9	146.0	133.0	110.0	116.2	131.7	105.3	115.9
11. Top bark weight (mg)	D	98.0	93.2	89.4	94.4	102.3	80.4	78.6	84.2	86.8	74.6
	P	94.8	104.1	96.3	111.0	102.0	89.6	88.0	108.2	86.2	95.2
12. Basal dry fibre wt (mg)	D	109.5	92.3	104.1	102.7	111.7	91.3	93.4	97.0	90.7	76.6
	P	120.1	117.8	107.8	122.2	110.4	92.2	102.3	116.7	83.4	94.2
13. Mid-dry fibre wt (mg)	D	94.7	83.4	86.1	88.6	95.4	74.0	76.3	78.5	76.1	61.8
	P	93.1	101.2	89.2	106.9	97.3	76.0	81.5	95.1	71.6	75.7
14. Top dry fibre wt (mg)	D	61.3	60.4	56.3	61.8	65.5	50.3	50.5	53.5	55.5	46.0
	P	61.2	65.0	61.0	70.2	64.5	56.0	58.3	72.1	53.6	57.1
15. Fibre yield of 10 plants (gm)	D	206.3	161.3	181.3	205.0	206.3	120.0	112.5	123.8	146.3	101.3
	P	160.3	180.8	175.8	198.0	170.5	112.3	118.8	186.3	98.3	103.0

1 — JRO-632; 2 — JRO-878; 3 — JRO-632 NMU 0.01% (M_4); 4 — JRO-878 γ-rays 50 kR (M_1); 5 — JRO-878 NMU 0.01% (M_4); 6 — JRC-212; 7 — JRC-7447; 8 — JRC-212 Fast Neutrons 1 kR (M_4); 9 — JRC-212 NMU 0.01% (M_4); 10 — JRC-7447 γ-rays 50 kR (M_4); JRO — var. of *olitorius* species; JRC — var. of *capsularis* species; D — Delhi; P — Pusa

freedom comparison, 'varieties versus mutants'; in other words, there was no significant variation in varieties or mutants as such, but there was significant variation when varieties as a group were compared with mutants as a group. On the other hand, only the mutants caused the variation observed in the *capsularis* populations. The comparison, *olitorius* versus *capsularis* was also found to be significant.

(ii) At Pusa, no variation was found between the *olitorius* populations; the variation found in the *capsularis* populations was from their mutants only. The apparent difference in the performance of the material at these locations was mainly attributable to the delayed sowing at Pusa and the good environmental conditions under which the crop was grown at Delhi.

These observations held good for all the characters at both the locations; however, there was significant variation among varieties and among mutants of the *olitorius* populations for some bark and fibre weight characters at Delhi. Significant differences were found for all the characters related to bark thickness, bark weight and fibre weight among *olitorius* populations at Pusa.

The results of the multiple regression analysis are summarised in Table 3. In fact, regression equations were first fitted between fibre yield (dependent variable) and each one of the remaining thirteen characters. The characters were allotted serial numbers from 1 to 14, as indicated in Table 3, for easy reference. Based on a ranking of the coefficients of determination for each of these regression equations, the variables — mid-dry fibre weight (mg), basal dry fibre weight (mg), mid-dry bark weight (mg), basal dry bark weight (mg), mid-diameter (mm) and plant height (cm) — which occupied the first six ranks at Delhi — were chosen. Multiple regression equations for all the possible two-way to eight-way combinations, in addition to the best combination of all the characters taken together, were fitted to the data in a bid to search for an optimum combination of characters which could serve as an efficient selection criterion. Since basal diameter was reported to be an important character for determining fibre yield,

Table 2. *ANOVA of some yield characters in jute on single plant basis*

Characters		Source: I	II	III	IV	V	VI	VII	VIII	IX	X	XI
		Mean sums of squares										
1[a]	D	34.1+	2.7	4.5	3.0	0.3	2.5	2.0	0.3	7.5	[1]28.6+	2.2
2	D	[3]24.0+	[2]13.7*	[1]12.5	[2]17.1*	[2]19.4*	[2]23.9+	[1]91.8	[2]38.1+	[2]10.1	[4]20.1+	[1]41.3
	P	[3]45.1+	[1]63.6	[1]72.0	71.5	[2]16.8	[2]75.1+	[3]23.0+	[2]35.1*	80.0	[4]37.4+	[1]10.3
3	D	20.8+	19.2+	25.3*	9.5	32.7+	21.6+	2.4	40.1+	3.5	24.2*	4.2
	P	56.1+	6.7	7.2	8.6	2.3	66.4+	0.8	96.1+	72.6+	[1]21.3+	10.3
4	D	31.3+	17.6+	5.1	16.8+	31.6+	7.6*	8.2	11.1+	0.0	[1]18.1+	2.3
	P	22.4+	7.0	14.5	0.7	12.0	30.2+	0.0	34.8+	51.3+	53.3+	5.6
5	D	20.5+	5.5+	0.1	5.7+	10.4+	2.3	1.5	0.3	7.1*	[1]15.4+	1.1
	P	26.0*	8.5	25.3	0.2	8.2	33.3*	43.5*	38.8*	12.2	67.2*	11.0
6	P	45.4+	34.7+	35.1*	50.4+	3.1	63.5+	51.2+	99.9+	63.0	15.2	7.5
7	P	24.2+	32.9+	46.5+	41.2+	2.5	17.7+	9.8	29.8+	1.5	15.6*	4.0
8	P	25.1+	37.1+	45.0+	51.1+	1.0	13.7+	12.8	19.8+	2.4	23.0+	3.3
9	D	[2]54.1+	[2]35.0+	[3]12.2+	[1]68.4	[1]49.3	[2]35.1+	75.9	[2]65.0+	[1]94.6	[3]20.6+	[1]38.1
	P	[2]72.6+	[2]23.0	[2]18.8	[2]35.7*	[1]19.8	[2]89.9+	[2]28.9	[3]16.3+	[1]54.9	[3]20.2+	[1]97.2
10	D	[2]52.9+	[2]20.3+	[2]36.5+	[2]21.2+	[1]22.7	[2]20.2+	52.3	[2]38.7+	[1]28.3	[3]31.5+	[1]32.7
	P	[2]69.9+	[2]31.1+	[2]33.8*	[2]45.2+	13.0	[2]39.8+	75.3	[2]70.9+	[1]99.3	[3]34.5+	[1]66.3
11	D	[2]31.8+	[1]95.8+	[1]45.1	[2]16.9+	3.6	[1]91.6+	66.3	[2]16.6+	[1]27.8	[3]21.2+	[1]21.4
	P	[2]29.1+	[2]16.9*	[2]17.3	[2]21.9*	[1]64.8	[2]31.8+	50.2	[2]49.1+	[2]28.5*	[2]67.3+	[1]56.4
12	D	[2]43.6+	[2]22.8+	[2]59.3+	[1]93.3*	[2]13.3*	[2]24.3+	85.1	[2]43.8+	[1]86.6	[3]20.5+	[1]23.2
	P	[2]70.6+	[2]15.6*	[1]10.2	[2]23.6*	[2]14.2	[2]63.0+	[2]20.4	[3]11.6+	31.7	[3]32.1+	[1]53.6
13	D	[2]42.4+	[2]11.2+	[2]25.7+	[1]94.0*	44.1	[2]17.8+	[1]10.2	[2]32.9+	[1]43.2	[3]26.6+	[1]21.2
	P	[2]57.6+	[2]19.1+	[2]13.3	[2]31.6+	22.4	[2]33.5+	[1]60.5	[2]63.0+	[1]20.3	[3]30.7+	[1]36.8
14	D	[2]15.1+	[1]43.2+	19.4	[1]85.1+	6.5	[1]51.8+	1.0	[1]99.6+	79.6	[2]98.0+	[1]10.2
	P	[2]14.7+	[1]55.5*	[1]29.1	[1]85.7*	[1]21.5	[2]21.4+	[1]11.0	[2]38.7+	[1]68.5	[2]24.6+	[1]21.3
15[a]	D	68.6+	16.4	40.5*	7.9	9.1	11.1	1.1	20.3	2.7	[1]50.8+	8.6
	P	58.0+	7.8	8.4	8.5	5.7	51.4*	0.9	98.0+	9.0	[1]28.5+	12.7

D — Delhi; P — Pusa.

For description of characters see Table 1.

+ Significant at 1% level; * Significant at 5% level; [a] Based on plot means with error d.f. = 27.

I Populations 9 d.f.; II *Olitorius* sub-populations 4 d.f.; III *Olitorius* varieties 1 d.f.; IV *Olit.* mutants 2 d.f.; V *Olit.* var. vs mut. 1 d.f.; VI *Capsularis* sub-populations 4 d.f.; VII *Caps.* varieties 1 d.f.; VIII *Caps.* mutants 2 d.f.; IX *Caps.* var. vs mut. 1 d.f.; X *Olit.* vs *Caps.* 1 d.f.; XI Error 360 d.f.

1 — For actual figure, multiply by 10^1; 2 — For actual figure, multiply by 10^2; 3 — For actual figure, multiply by 10^3; 4 — For actual figure, multiply by 10^4.

it was also included in the multiple regression analysis, although it did not occupy one of the first few positions at both the locations.

It was observed that the multiple regression equation using all the characters had a coefficient of determination equal to 79 and 89 per cent at Delhi and Pusa respectively. Based on this information, the results of only those combinations of characters which provided at least 70 per cent of determination in either of the locations were considered (Table 3).

The forty observed values corresponding to the replicate population fibre yields were tested for their goodness of fit with the predicted ones by the chi-square test. It was foundthat thevtariaion accounted

Table 3. *Coefficients of determination and their ranks for various multiple regression equations between fibre yield and its components in jute*

Character Combination	Delhi C	Delhi R	Pusa C	Pusa R	Character	Delhi C	Delhi R	Pusa C	Pusa R
13 — Mid-dry fibre weight (mg)	71.1	1	68.8	1	3 — Basal diam (mm)	38.7	8	7.6	13
12 — Basal dry fibre wt (mg)	63.0	2	49.4	5	14 — Top dry fibre wt (mg)	35.3	9	52.7	4
10 — Mid-dry bark wt (mg)	60.8	3	67.4	2	11 — Top dry bark wt (mg)	35.0	10	46.1	8
9 — Basal dry bark wt (mg)	52.2	4	56.1	3	1 — Days to 50% flower	29.5	11	+	+
4 — Mid-diameter (mm)	47.1	5	49.2	6	7 — Mid-bark thickness (mm)	+	+	18.2	10
2 — Plant height (cm)	44.8	6	48.7	7	8 — Top bark thickness (mm)	+	+	11.0	11
5 — Top diameter (mm)	39.5	7	35.4	9	6 — Basal bark thickness (mm)	+	+	9.2	12
2, 13	75.7	1	72.5	4	2, 9, 12	70.4	6	70.2	8
2, 3	71.7	2	71.1	5	2, 4, 10	67.0	7	80.2	3
4, 13	71.5	3	78.5	1	2, 5, 14	61.1	8	77.4	5
10, 13	71.1	4	70.3	7	2, 4, 10, 13	76.8	1	82.5	1
2, 12	70.0	5	64.8	9	2, 12, 13, 14	75.9	2	75.7	4
2, 10	65.0	6	71.0	6	2, 3, 9, 12	73.8	3	80.5	2
4, 10	62.7	7	75.7	2	2, 3, 4,5	71.8	4	76.4	3
2, 9	62.1	8	69.9	8	2, 9, 10, 11	65.9	5	72.0	5
2, 4	61.2	9	73.2	3					
2, 10, 13	76.4	1	73.2	7	2, 3, 4, 12, 13	77.2	1	86.3	1
2, 4, 13	75.9	2	82.5	1	2, 4, 5, 13, 14	76.6	2	83.2	3
2, 3, 12	73.7	3	80.3	2	2, 3, 5, 12, 14	74.3	3	85.4	2
2, 3, 4	71.7	4	74.9	6	1 to 5, 12 to 14	77.9	—	86.7	—
4, 10, 13	71.5	5	78.7	4	All characters	78.8	—	89.4	—

+ Not included; C — Coefficient of determination; R — Rank.

for by the regression was significant in all the equations utilising one or more variables. Similarly, the chi-square test for the goodness of fit over all the forty values did not show any significant departure from the predicted values ($\sqrt{2\chi^2} - \sqrt{2n-1}$ used as a standard normal deviate). The results of the χ^2-test in each of the populations are summarised in Table 4, in order to judge the efficiency of this selection criterion when applied to the chosen segregating populations.

Again, only those combinations of characters where there was complete agreement between observed and predicted fibre yields in at least seven populations out of ten were considered. It can be seen from Table 4 that only the following combinations of characters are worthy of consideration: — 2, 3; 2, 10, 13; 2, 4, 13; 2, 3, 12; 2, 3, 4; 2, 4, 10, 13; 2, 12, 13, 14; and 2, 3, 9, 12, in addition to the combination of all the characters. A comprehensive idea of the relative contribution of each of these characters for prediction of fibre yield can be gained from Table 5.

Discussion

The need for breeders to rely on data collected by non-destructive sampling earlier in the life of an organism and to utilise regression techniques to evolve a sound selection criterion is increasingly being felt (Shelbourne, 1974). The traditional method is to fit regression equations involving all possible combinations of variables, and, after examining the degree of determination of these equations, to decide on the best character-combination for yield prediction. This procedure is feasible only when the number of variables is not unduly large.

In this investigation, a preliminary run of one-variable regression equations was made, and on the basis of the coefficients of determinations provided by each of these variables, only those were retained which had an overall determination of at least 50 per cent in either of the locations. The variable, top dry fibre weight was, however, omitted, although it had a coefficient of determination of 52.7 per cent at Pusa, since it was not found to be in the range of utility at Delhi.

Using some arbitrary, but sound, norms as detailed under "Results", it became apparent that a valid selection criterion should be found from the set of variables consisting of 2 (Plant height), 3 (Basal diameter), 4 (Mid-diameter), 9 (Basal dry bark weight), 10 (Mid-dry bark weight), 12 (Basal dry fibre weight), 13 (Mid-dry fibre weight), and 14 (Top

Table 4. *The population-wise goodness of agreement between observed and predicted fibre yield in jute*

Character combination	Location	p	Populations 1*	2	3	4	5	6	7	8	9	10
13	D	40	++	++	+	+	+	++	—	+	+	++
	P	50	++	+	+	++	++	++	+	++	+	+
2, 3	D	70	++	++	++	+	++	++	++	+	+	++
	P	70	++	++	++	—	++	+	++	++	++	—
2, 13	D	70	++	++	++	+	++	++	++	+	+	++
	P	60	++	+	++	++	++	++	+	++	+	+
2, 10	D	50	++	++	++	+	+	++	++	+	+	+
	P	50	++	+	++	++	++	++	+	—	+	—
3, 12	D	50	++	+	++	—	++	++	—	+	+	++
	P	50	—	—	++	+	++	++	+	++	++	+
4, 10	D	50	++	++	+	—	—	++	++	+	+	++
	P	70	+	+	++	++	++	++	++	++	++	—
2, 4	D	60	+	++	++	—	++	++	++	+	+	++
	P	60	++	++	++	+	++	+	++	+	++	+
3, 9	D	50	++	+	++	—	+	++	++	+	—	++
	P	50	++	—	—	+	++	++	—	++	++	—
2, 10, 13	D	70	++	++	+	++	++	++	++	+	+	++
	P	70	++	+	++	++	++	++	++	++	+	+
2, 4, 13	D	70	++	++	++	+	++	++	++	+	+	++
	P	80	++	+	++	++	++	++	++	++	++	+
2, 3, 12	D	70	++	++	++	+	++	++	++	+	+	++
	P	80	++	++	++	+	++	++	++	++	++	+
2, 3, 4	D	70	++	++	++	+	++	++	++	+	+	++
	P	70	++	++	++	+	++	+	++	++	++	+
2, 9 ,12	D	70	++	++	++	+	++	++	++	+	+	++
	P	50	++	+	++	++	++	++	+	+	+	—
2, 4, 10	D	60	++	++	++	+	+	++	++	+	+	++
	P	70	++	+	++	++	++	+	++	++	++	—
2, 5, 14	D	50	+	++	++	—	+	++	++	+	+	++
	P	70	++	+	++	++	++	+	++	++	++	+
2, 4, 10, 13	D	70	++	++	++	+	++	++	++	+	+	++
	P	80	++	+	++	++	++	++	++	++	++	+
2, 12, 13, 14	D	70	++	++	++	+	++	++	++	+	+	++
	P	70	++	+	++	++	++	++	++	++	+	+
2, 3, 9, 12	D	70	++	++	++	+	++	+	++	+	+	++
	P	80	++	++	++	+	++	++	++	++	++	+
2, 3, 4, 5	D	60	+	++	++	+	++	++	++	+	+	++
	P	70	++	++	++	+	++	+	++	++	++	+
2, 9, 10, 11	D	60	++	++	++	+	+	++	++	+	+	++
	P	60	++	+	++	++	++	++	++	+	+	—

* For details of populations 1—10 see Table 1. D — Delhi; P — Pusa; p — percentage of populations in which perfect agreement was observed; ++ agreement in all the four replicates; + agreement in any three replicates; — agreement in less than three replicates

dry fibre weight); but these characters occurred in eight different regression equations (see "Results"). Consideration of the frequencies of these variables in the equations (Table 5) leads us to the conclusion that the characters which provide an efficient selection criterion for fibre yield are plant height, basal and mid-diameters and basal and mid-dry fibre weights. The geometrical approach to the estimation of fibre yield also stressed the importance of the diameters and the dry fibre weights at base, middle and top, in addition to plant height (Iyer *et al.*, 1974). A critical examination of Table 4 reveals that the selection criterion using four of these variables was able to differentiate even between plants within the highly segregating populations (Nos. 4 and 10 for example), while these observations hold good, with some reservations, in the case of three variables but not so for two. In particular, selection based on height and basal diameter only (which was used by most of the earlier workers) would not be very efficient, as revealed by this study.

It has been observed that the best stage for recording measurements and relating them to actual fibre yield of jute was the small-pod stage (ca. 120 days from sowing) and more than 80 per cent of the bark was distributed between the basal and middle regions taken together both in *olitorius* and *capsularis* populations (Kar, 1961). Little difference was observed in the duration of the active flowering period between these two populations and both were sensitive to photo-induction by short day-light periods of less than 12 hours; periods of longer duration were favourable for prolonging vegetative growth, a desirable economic aspect of jute cultivation (Kar, 1962). Corroborative evidence on these aspects was also observed in the present study.

Table 5. *Relative contribution of the characters in predicting fibre yield in jute*

Characters	f
2. Plant height	8
3. Basal diameter	4
4. Mid-diameter	3
5. Basal fibre weight	3
6. Mid-fibre weight	3
7. Mid-bark weight	2
8. Basal bark weight	1
9. Top bark weight	1

f — Frequency of occurrence in a total of 8 prediction equations (see text for details)

The significant negative correlation observed between plant height and flowering time (Roy, 1966) does not favour the inclusion of flowering time in the selection criterion, and this is also confirmed by the low coefficient of determination (29.5%) obtained in this study. Similarly, the negative correlations observed between fibre-wood ratio on the one hand, and either plant height or fibre yield on the other (Roy, 1965), do not augur well for fibre-wood ratio to be included in the selection criterion as envisaged by Roy (1962). Further (though this character does not figure in the non-destructive selection criteria that we are dealing with), it is pertinent to observe that fibre-wood ratio is not a character which can easily be measured in large samples of segregating populations at the early stages.

As in the case of any selection criterion, its efficiency can only be proved by observing the actual response to selection based on these criteria: further work is in progress and will be reported in due course. It is now possible to use a step-wise regression method to select automatically the best regression equation from among a number of equations (Draper and Smith 1966). Such an investigation has been undertaken with these data and the results comparing the regression with the geometric approach based on the same variables as were found most efficient in this study, will be of considerable applied value.

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Literature

Basak, S. L.: Suggestions for genetic improvement of jute for fibre yield. Indian J. Genet., **28A**, 260—265 (1968).

Draper, N. R., Smith, H.: Applied Regression Analysis. New York: John Wiley & Sons 1966.

Iyer, R. D., Arunachalam, V., Fasih-uz-Zaman, Kundu, B. C., Gupta, K. L.: A non-destructive selection criterion for fibre content in jute. I. Geometric approach. Proc. 2nd SABRAO Congress, New Delhi; Indian J. Genet. Suppl. **34A** (1974).

Kar, B. K.: Investigations on the physiology of jute. Part III. Variations in the production of bark and wood in certain varieties of *Corchorus capsularis* and *C. olitorius*. Proc. Natl. Acad. Sci. India **31B**, 67—75 (1961).

Kar, B. K.: Investigations on the physiology of jute. Part VI. Assessment of flowering behaviour in different varieties of *Corchorus capsularis* and *C. olitorius*. Proc. Natl. Inst. Sci. India **28B**, 49—76 (1962).

Roy, B.: Studies on the factors influencing the yield of fibre in jute. Curr. Sci. India **31**, 293—294 (1962).

Roy, B.: Studies on correlations and means of yield components in relation to jute breeding. Indian Agriculturist **9**, 107—111 (1965).

Roy, B.: Correlation between plant height and flowering time in jute (*Corchorus olitorius* L.) II. Indian Agriculturist **10**, 59—63 (1966).

Shelbourne, C. J. A.: Problems and prospects in the improvement of forest tree species. Proc. 2nd SABRAO Congress, New Delhi; Indian J. Genet. Suppl. **34A**, (1974).

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