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A NON-DESTRUCTIVE SELECTION CRITERION FOR FIBRE CONTENT IN JUTE. I. GEOMETRIC APPROACH

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Efficient procedures for selecting desirable single plants from segregating populations are of obvious importance in any breeding programme. The problems are magnified in jute where selection for fibre content should preferably be done at optimum harvest-stage of the crop since (*a*) phenotypic scoring becomes rather difficult when the crop has grown taller than six feet, (*b*) the fibre content needs to be assessed at the optimum stage of harvest, and (*c*) selection on the basis of actual fibre yield becomes unmanageable, particularly when large populations have to be screened.

Selection based on observations taken at optimum stage of harvest will enable jute breeders to handle extensive material in a single season and retain seed of selected individuals for the following season. A method of estimating fibre yield to a reasonable degree of accuracy based on a small number of non-destructive observations on each plant, is thus of great mportance.

MATERIALS AND METHODS

Ten populations, including two released varieties of *Corchorus olitorius,* namely JRO-632 and JRO-878, and two from *C. capsularis,* JRC-212 and JRC-7447 and selections from these four varieties treated with 50 kR Co^{60} gamma-rays (M_1), 0.01 per cent n-Nitrosomethylurea (M_4) and 1 kR fast-neutrons (M_4), formed the material for the study.

The material was grown in a randomized block design with four replications at two locations, Delhi and Pusa (Bihar) during *kharif*, 1972. Each population was grown in four rows of 4 m. length with a spacing of 5 cm. between plants and 30 cm. between rows.

Observations were recorded on a random sample of ten plants for the following characters (Fig. 1) : (*i*) Plant height in 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 could be removed (T), represented as d_B, d_M and d_T respectively; (*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 flowering of 50 per cent of plants in the row; and (*vii*) Total fibre weight (gm.) of the ten plants in each replication.

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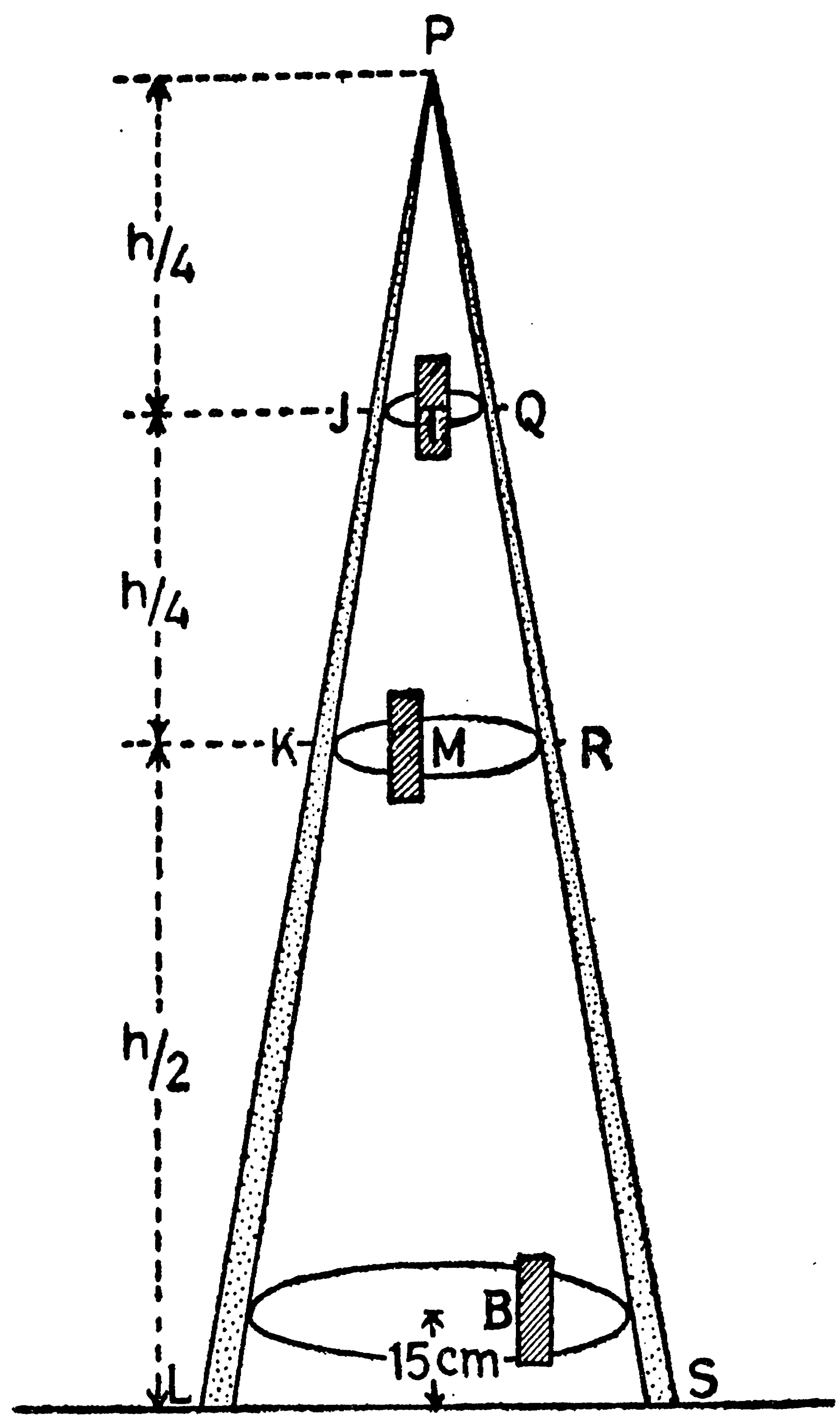

Fig. 1. Diagrammatic representation of the jute stem from which the mathematical formula has been derived for estimating the fibre content. JQ and KR — are the points of division at h/4 and h/2 levels of height from ground level, LS to the forking point P. T, M and B are the positions from which the bark samples of 5 cm $\times$ 1 cm have been removed for analysis.

Plant height was measured as the distance from the ground to the forking point at 115-120 days age when the plants were harvested and strips of bark with an area of 5 cm $\times$ 1 cm were carefully removed at B, M and T regions. These bark samples were taken from different vertical axes so that variations in fibre distribution in the different radii could be accounted for and also to ensure that the food channel is not interrupted at several points along the same line of the axis. The diameter was measured at each of these points using vernier callipers. The bark samples after recording the thickness, were dried in an oven at 80°C to constant weight. The fibre was extracted chemically using a 2 per cent aqueous solution of ammonium oxalate at 80°C, washed thoroughly in running water and dried at the same temperature to constant weight.

Mathematical formulation for fibre yield : The nearest representation of the fibre content from forking point to ground level in the jute bark is found to be answered by a cone of height, say *h* cm (Fig. 1). The points Q and R represent the levels of division at heights 3h/4 and h/2 from S (soil level). The distance PQ has not actually been measured due to practical difficulties, but this is approximated by a length equal to h/4 which appears to serve the purpose in this material.

The fibre yield per unit area was based on f_T for the cone PJQ; on $0.5\,(f_M + f_T)$ for the truncated cone JKRQ, and on $0.5\,(f_M + f_B)$ for the truncated cone KLSR where f_B, f_M and f_T represent the fibre content (mg) of bark samples from the three regions B, M and T respectively.

Bark area PJQ $= \pi d_T/2 \times h/4 = \pi d_T h/8$

Estimated fibre content in PJQ $= \pi d_T h\, b_T/8 \times f_T/5b_T = \pi d_T h f_T/40$

where b_T is the bark thickness of the sample taken at the region T. In a similar way, the estimated fibre content in JKRQ $= \pi h/40 \times (d_T + d_M) \times 0.5\,(f_T + f_M)$ and the estimated fibre content in the region KLSR $= \pi h/40\,(d_M + d_B)\,(f_M + f_B)$. Hence, the estimate of total fibre content of the entire plant is given by

$$\pi h/40\,[d_T f_T + 0.5(d_T + d_M)\,(f_T + f_M) + (d_M + d_B)\,(f_M + f_B)]$$

Results

The data on plant height, diameter at base, middle and top as defined earlier, showed definite variation between the two locations, Delhi and Pusa (Table 1). The crop raised at Delhi performed better than the one at Pusa. It must be mentioned here that the sowing and harvest dates at the two locations differed by a fortnight and superimposed on this, the random samples of ten plants included some partially mature plants as well due to initial disparity in germination, while harvest had to be completed at the same time for uniformity of retting. Further, variation was found between the populations for these characters as well as for fibre yield. The mean values (Table 1) suggest that the populations belonging to *olitorius* had higher values than those of *capsularis*. The degree of variability within populations as measured from the sample of forty plants from all the replications also differed for all the characters.

The estimated and the actual fibre yields of ten plants are presented in Table 2 for each replication and for all the ten populations. The estimated yields at Delhi were closer to the actual yields as compared to those at Pusa. The closeness or otherwise of the estimates cannot be attributed to the species, treatments or the population differences alone. It was gratifying to note that the differences between the estimated and the actual values over all the replications were smaller than those based on individual replications though segregating populations were also included in this study. This implies that the variation between replications was also responsible for the observed differencs. In some of the cases, the degree of closeness of the estimates was quite high (p less than 1 per cent) while in some others it was low (p around 50 per cent). In nearly 80 per cent of the cases, the estimated fibre yield was found to be higher than the observed values but the degree of over estimation was not constant.

Discussion

Ghose & Patel (1945) from a study of the *capsularis* variety D-154 concluded that plant height and basal diameter are positively correlated with

TABLE 1 : *Mean values of some characters related to fibre yield in jute at two locations : Delhi (D) and Pusa (Pu)*

Population	Location	Plant height (cm.)		Diameter (mm.) Base		Diameter (mm.) Middle		Diameter (mm.) Top		Fibre yield of 10 plants (gm)	
		Mean	S.Em	Mean	S.Em	Mean	S.Em	Mean	S.Em	Mean	S.Em
JRO-632	D	299.4	4.31	16.8	0.54	13.2	0.33	8.8	0.34	206.2	25.31
	Pu	300.3	6.48	14.5	0.43	11.4	0.39	8.7	0.41	160.2	9.28
JRO-878	D	269.9	3.71	15.8	0.52	12.7	0.31	8.8	0.22	161.2	10.07
	Pu	306.3	2.28	15.1	0.56	12.4	0.37	10.0	0.38	180.7	30.97
JRO-632	D	309.5	3.03	17.1	0.43	13.2	0.31	8.8	0.22	181.0	11.96
0.01% NMU (M_4)	Pu	307.1	8.11	15.4	0.39	12.2	0.52	9.8	0.32	175.7	5.89
JRO-878	D	297.1	6.38	17.3	0.38	13.8	0.05	9.4	0.29	205.0	27.90
50 kR γ-rays (M_4)	Pu	308.1	5.22	14.5	0.54	12.1	0.43	9.9	0.39	198.0	28.05
JRO-878	D	306.8	3.47	17.1	0.64	14.1	0.41	9.5	0.18	206.2	15.70
0.01% NMU (M_4)	Pu	310.7	4.36	15.1	0.49	12.3	0.44	9.9	0.34	170.5	10.79
JRC-212	D	256.4	3.28	14.1	0.36	14.3	0.29	7.5	0.22	120.0	10.60
	Pu	229.6	2.23	15.5	0.58	10.9	0.38	7.9	0.33	112.2	15.50
JRC-7447	D	263.2	2.07	16.3	0.33	12.4	0.30	7.5	0.21	112.5	6.20
	Pu	263.5	4.25	15.7	0.61	10.9	0.32	7.8	0.23	118.7	15.00
JRC-212, 1 kR	D	247.7	3.49	17.3	0.58	10.1	0.32	8.0	0.29	146.2	25.84
Fast Neutrons (M_4)	Pu	236.3	2.52	15.8	0.51	11.0	0.36	8.4	0.32	98.2	12.62
JRC-212	D	251.9	2.02	15.6	0.29	11.5	0.18	7.9	0.12	101.2	9.21
0.01% NMU (M_4)	Pu	250.1	2.63	14.0	0.31	12.1	0.23	8.6	0.34	103.0	13.50
JRC-7447	D	266.2	2.19	17.0	0.26	12.1	0.19	8.0	0.14	186.2	15.32
50 kR γ-rays (M_1)	Pu	254.1	8.23	18.7	0.61	12.9	0.39	10.2	0.43	123.7	11.60

TABLE 2 : *Observed (O) and estimated (E) fibre yield of 10 plants and % increase/decrease over observed (P) at two locations, Delhi (D) and Pusa (Pu)*

Population*	Location	Replication I			Replication II			Replication III			Replication IV			Total		
		O	E	P	O	E	P	O	E	P	O	E	P	O	E	P
1	D	145.0	116.9	-19.4	185.0	214.8	16.1	240.0	240.8	0.3	255.3	242.2	—5.0	825.0	814.7	—1.2
	Pu	149.0	161.9	8.6	140.0	197.7	41.2	177.0	186.5	5.4	175.0	195.6	15.5	641.0	741.9	15.7
2	D	140.0	144.0	2.9	185.0	207.2	12.0	170.0	160.8	—5.4	150.0	167.7	11.8	645.0	679.7	5.4
	Pu	104.0	159.0	52.9	212.0	230.6	8.8	246.0	253.2	2.9	161.0	199.2	23.7	723.0	842.1	16.5
3	D	150.0	153.9	2.6	175.0	213.0	21.7	200.0	243.7	21.8	200.0	171.7	—14.2	725.0	782.3	7.9
	Pu	180.0	194.6	8.1	170.0	205.1	20.7	190.0	191.0	0.5	163.0	165.2	1.4	703.0	756.0	7.5
4	D	135.0	175.4	29.9	250.0	238.0	—4.8	250.0	180.6	—27.8	185.0	167.0	—9.7	820.0	761.0	—7.2
	Pu	174.0	211.6	21.6	166.0	182.6	10.0	170.0	225.1	32.4	282.0	293.1	3.9	792.0	912.3	15.2
5	D	200.0	238.8	19.4	175.0	201.7	15.3	200.0	221.6	10.8	250.0	230.9	—7.6	825.0	893.0	8.2
	Pu	194.0	247.7	27.7	143.0	157.7	10.2	166.0	204.2	23.0	179.0	220.0	22.9	682.0	829.5	21.6
6	D	90.0	98.2	9.1	135.0	149.4	10.7	120.0	139.7	16.4	135.0	130.2	—3.6	480.0	517.5	7.8
	Pu	113.0	94.6	—16.3	78.0	88.6	13.5	105.0	116.4	10.8	153.0	158.2	3.4	449.0	457.7	1.9
7	D	110.0	118.9	8.1	100.0	126.3	26.3	130.0	169.5	30.4	110.0	132.4	20.4	450.0	547.1	21.6
	Pu	137.0	160.2	16.9	151.0	150.0	—0.7	95.0	138.8	46.1	92.0	116.5	26.7	475.0	565.5	19.1
8	D	85.0	90.1	6.0	210.0	138.5	—34.0	135.0	162.7	20.5	155.0	157.5	1.6	585.0	548.8	—6.2
	Pu	90.0	109.5	21.7	73.0	88.4	21.1	133.0	122.0	—8.3	97.0	112.3	15.7	393.0	432.1	9.9
9	D	100.0	104.6	4.6	88.0	87.5	—0.6	125.0	117.2	—6.2	100.0	90.8	—9.2	413.0	400.1	—3.1
	Pu	141.0	158.4	12.3	103.0	107.4	4.2	88.0	134.5	52.9	80.0	120.0	50.0	412.0	520.2	26.3
10	D	100.0	112.6	12.6	135.0	142.3	5.4	160.0	168.5	5.3	100.0	146.3	46.3	495.0	569.7	15.1
	Pu	183.0	180.0	—1.7	220.0	205.4	—6.6	172.0	200.0	16.3	170.0	165.1	—2.9	745.0	750.5	0.7

*1. JRO-632; 2. JRO-878; 3. JRO-632; 0.01% NMU (M_4); 4. JRO-878, 50 kR γ-rays (M_1); 5. JRO-878, 0.01% NMU (M_4); 6. JRC-212; 7. JRC-7447; 8. JRC-212, 1kR Fast Neutrons (M_4); 9. JRC-212, 0.01% NMU (M_4) & 10. JRC-7447, 50 kR γ-rays (M_4).

yield (+ 0.761 and + 0.914 respectively). Kundu (1959) has indicated the possibility of using anatomical data for estimating the fibre content of jute plant. In a separate study we have examined cross sections of the bark samples taken from base and middle regions of selected varieties and their mutants and found good correlation between fibre distribution and the yield potential (Kundu & Iyer, in preparation). Roy (1962, 1965 and 1967) suggested that fibre : wood ratio of stem should be used as a third criterion for selection in addition to plant height and basal diameter. He further observed negative correlation between plant height and fibre : wood ratio, the coefficients being —0.407 in JRO-632 and —0.470 in Chinsurah Green variety of *C. olitorius*. Based on these criteria, he evolved the variety JRO-7835 of *olitorius* having higher fibre : wood ratio than the standard variety JRO-632.

The aim of our present study was to develop as simple a criterion as possible to estimate the total fibre content in single plants or a sample of plants taken from a population which are to be used directly for selection. The results of this study were encouraging in that very close estimates of the actual fibre yield have been obtained using our mathematical formulation. However, certain drawbacks in the experimental procedure need to be pointed out here :

1. There was some loss in total fibre yields when ten plants were retted together (single plant retting would perhaps have resulted in greater loss of fibre) and consequently the actual fibre yields were below the estimated figure in most cases. Such loss might not, however, have been comparable for all genotypes.

2. The distance from forking point P to Q (Fig. 1) was not measured in each sample which might have vitiated the accuracy of the estimates to some extent. However, from practical considerations, the height h/4 allotted to PQ appears to be close to the actual value.

3. The mathematical formula assumed uniform bark thickness within each of the three regions PJQ, JKRQ and KLSR (Fig. 1). There could be some variation particularly in the region KLSR which ought to be taken into account for obtaining better estimates. This would involve measuring bark thickness alone at five or six places in this region.

The advantages of this approach are, however, apparent—it would be possible to employ effective selection in large segregating populations with a wide range of variability at single plant and population levels; this would provide an effective, rapid screening procedure to scan a large number of genetic stocks in two or three waves, using a smaller number of bark samples in the first and a greater number in the succeeding waves.

SUMMARY

An experiment is described for estimating fibre content in single plants of jute using ten different populations, on the basis of bark samples measuring 5 cm $\times$ 1 cm taken from three different levels of the plant at the time of harvest. A mathematical formula has been derived which has given fairly close estimates of fibre yield as computed from bark sample fibre content, and verified from actual yields of the selections. Some of the possible sources of error in this method have been identified; taking advantage of these, the scope for perfecting it has been pointed out.

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