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Rank correlation of seed and Fibre Yield Characters in Jute (*Corchorus olitorius)*

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Authors' contributions

This work was carried out in collaboration among all authors. Conceptualization of research authors AR and AD and designing of the experiments, Contribution of experimental materials authors AD, AH and AR and execution of field/lab experiments and data collection, Analysis of data and interpretation authors AD and AR and preparation of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The present study aimed to explore the Rank correlation of seed and fibre yield characters in Jute (*Corchorus olitorius*). Jute cultivation availability of quality seed remains a potential factor as it deals with the fibre. Studying the correlation between both seed and fibre characters at the same time in jute is a complex matter since the sowing season, agricultural practices vary in both the cases. Varieties producing high fibre and seed yield are necessary to meet the deficit in seed supply for the jute producing farmers of West Bengal, India. In this study, the experimental material consisted of thirty six jute (*Corchorus olitorius* L) crosses along with two check varieties. Fibres were harvested at 120 days and the seeds at maturity. The variability in most of the yield (fibre and seed) contributing characters was mainly due to genotype with some extent of environmental influence. To obtain a clear understanding of the inter-relationship between seed and fibre characters a rank correlation was performed instead of simple correlation. A strong positive correlation was found which helped us in finding lines with both high seed and fibre yield. Furthermore, a fibre quality test was also conducted for estimating the fineness and strength of the fibre.

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1. INTRODUCTION

Jute (*Corchorus* sp.), is the golden fibre of Bengal and the most important bast fibre of the world. It comprises more than 60 species out of which two are cultivated, viz. *C. capsularis* L. and *C. olitorius* L. Out of the major problems in jute cultivation in West Bengal, seed deficit is one of the main reasons. Most of the seeds are imported from South India. The costing due to seed deficit makes most of the farmers shift from jute production. We can solve this problem if we are able to develop varieties which will produce quality fibre as well as higher amount of good quality seeds, where the same lines can be planted for fibre in April and for seed production during June. Like other crops, fibre and seed production in jute is also a genetically controlled process but environment plays an important role in the yield and thus, restricts its improvement through selection. Therefore, to formulate selection index for the improvement of both the complex characters through selection, it is necessary to understand the association between seed yield and its component characters as well as fibre yield and its component characters.

In general, in the case of stem fibres, selection criteria for genetic improvement of fibre yield are plant height and basal diameter [1,2,3]. Palit et al. [4], obtained high heritability values ranging from 50% to more than 98% for all yield and quality linked morpho-physiological traits studied in world collection of jute. In case of seed yield, Joseph et al. [5] studied simple correlation concerning yield of seed and its components. In case of olitorius jute, it was found that seed yield per plant was positively correlated with plant height, basal diameter, number of branches, pods per plant and length of branches. Seed weight and pod number made the greatest contribution to yield. A study by Dastidar et al. [6] indicated that pod length, seeds per pod, seed weight per pod, 100 seed weight and days to 50% flowering in olitorius jute, were likely to be operated by non-additive gene action. From the path-coefficient analysis it was shown that a medium flowering genotype with high l00-seed weight, followed by seeds per pod and pod length is most suitable for better seed production in olitorius jute.

2. MATERIALS AND METHODS

The field experiment for the present study was carried out during the Kharif season of 2016 and 2017 at the Teaching Farm of Bidhan Chandra Krishi Viswavidyalaya, Mondouri, Nadia, West Bengal. The experimental soil was Gangetic alluvial sandy loam in texture with good drainage facilities. Temperature in the area ranges from 16°C to 26°C and the average rainfall ranges from 1300-1600 mm.

The experimental material consisted of thirty six jute (*Corchorus olitorius* L.) crosses developed at Bidhan Chandra Krishi Viswavidyalaya under AINPJAF project along with two check varieties. The experiment was conducted in a Randomized Block Design with two replications. Sowing was done in April and June for fibre and seed purpose respectively. The spacing for fibre production was 25 cm row to row distance and it was 35 cm row to row distance in seed production. The difference in spacing is due to the reason that in fibre production branching is not desired whereas in case of seed production increased spacing allows for branching and hence increased seed production. Five randomly selected plants were considered per replication for individual genotype to record data. Fibres were harvested at 120 days followed by retting and the seeds were harvested at maturity (130 days). The fibre and seed were grown in their appropriate sowing seasons to evaluate the performances at their best conditions. Analyses were performed for the present investigation. There are mainly two objectives of the analysis of variance. First, it helps in sorting out the variation due to different sources and second is to provide a basis of test of significance. As the environment (time of sowing, spacing etc.) was different for the accessions for fibre and seed production, a rank correlation was performed to work out the association between the characters.

Rank-Order Correlation: The Spearman correlation coefficient, r_s (ρ), can take values from +1 to -1. A r_s of +1 indicates a perfect association of ranks, a r_s of zero indicates no association between ranks and a r_s of -1 indicates a perfect negative association of ranks. The closer the value of r_s is to zero, the weaker the association between the ranks.

$$\rho = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

Where,

d = difference between ranks and n = no. of observations.

3. RESULTS

3.1 Analysis of Variance for the Characters

Among the fourteen characters under study highest Coefficient of variation (CV) was observed in no. of primary branches followed by no. of pods, seed yield/plant, dry fibre wt/plant (Table 1). The mean squares of all the characters in replication were non-significant, whereas in case of treatments there was significantly high variation in all the characters except seed wt/pod, 1000 seed wt. (Table 2).

It was found that in these lines seed wt/pod and 1000 seed wt were found to be around 0.37g and 1.51g and non significant, these were not taken into consideration for representation. It was also evident that the difference in seed potential or seed yield per plant between these lines were mainly due to the number of pods and number of seeds per pod respectively.

For this reason Seed yield attributing characters like plant height, pods/ plant, branch/plant as well as seed yield for both the species of jute were considered for analysis Srivastava et al. [7].

Analysis of PCV(Phenotypic Coefficient of Variation), GCV(Genotypic Coefficient of Variation), heritability and genetic advance.The GCV, PCV along with heritability, genetic advance were worked out (Table. 3).

3.2 Rank Correlation

The Spearman's rank-order correlation is the nonparametric version of the Pearson product-moment correlation. Spearman's correlation coefficient, (ρ, also signified by r_s) measures the strength and direction of association between two ranked variables. It determines the degree to which a relationship is monotonic, i.e. whether there is a monotonic component of the association between two continuous or ordered variables. Since the fibre and seed yield potentials can be better judged by growing in their optimum date of sowing, rank correlation can be used for ascertaining the selection of the lines.

$$\rho \text{ or } r_s = 1-\{6\sum d^2/n(n^2-1)\} = 0.73$$

This value indicates a strong positive correlation between the fibre and seed traits of the lines. The rank order is shown in Table 4.

3.3 Fibre Quality Test

The strength and fineness parameters were measured using instruments.Fibre fineness was measured by Airflow Fibre Fineness Tester whereas average fibre strength was determined by fibre bundle strength tester as per the standard protocol [8].

The four lines namely, BCCO-17-07, BCCO-17-20, BCCO-17-36 and BCCO-17-01 (selected based on their ranks), which yield high in both dry fibre wt and seed wt along with the checks were tested for fibre fineness and strength in CRIJAF, Barrackpore, West Bengal (Table. 5). In tossa jute, the average fineness is 2.2 tex whereas strength is 18g/tex (shodhganga.inflibnet.ac.in). However it was found that the quality of the fibre was badly affected due to retting conditions and these values should not be treated as index.

4. DISCUSSION

4.1 ANOVA

From the ANOVA table (Table. 2), the values depicted that significant variability is present in almost all of the characters and thereby selection from these characters might be fruitful. In case of seed yield/plant and dry fibre wt/plant, eight and two crosses were found respectively that exceeded the value of the checks.

4.2 Character-wise Discussion on Different Genetic Parameters

There was a slight difference between GCV and PCV in case of plant height [(GCV 10.07), PCV (12.71)], basal diameter [GCV (4.10), PCV (7.31)], plant ht. for seed [(GCV, 9.89), (PCV, 12.51)], no of primary branches [(GCV, 42.78), (PCV, 45.43)], 1000 seed wt. [(GCV, 6.4), (PCV, 8.74)], seed yield/plant [(GCV, 24.26), (26.94)] and dry fibre wt. [(GCV, 15.93), (PCV, 18.92)] indicating that there is a little bit influence of environment.

Whereas in case of bark thickness [(GCV, 8.26), (PCV, 12.56)], no of nodes [(GCV, 6.8), (PCV, 12.52)], green wt [(GCV, 8.54), (PCV, 12.96)], dry stick wt.[(GCV, 6.99), (PCV, 12.85)], no of pods/plant [(GCV, 20.81), (PCV, 24.73)] the difference depicted that these characters were highly influenced by the environment.

Table 1. Mean performance for the characters

Characters	Plant Height (cm)	Basal diameter (mm)	Bark thickness (mm)	No. of nodes	Green wt (g)	Dry stick wt (g)	Dry fibre wt./pl (g)	Plant ht. for seed (cm)	No. of primary branches	No of pods	No. of seeds/ pod	Seed yield/ pl (g)
Grand mean	285.36	1.30	1.07	69.4	168.62	23.91	9.81	149.66	3.23	33.6	229.54	12.04
CV	6.76	6.05	9.46	10.5	9.75	10.78	10.19	7.66	15.3	13.4	8.15	11.70
CD at 5%	3.14	0.57	0.65	5.48	8.22	3.25	2.03	6.86	1.43	4.30	8.77	2.41

Table 2. ANOVA of different characters

Source	df	Plant Height (cm)	Basal diameter (mm)	Bark thickness (mm)	No. of nodes	Green wt (g)	Dry stick wt (g)	Plant ht. for seed (cm)	No. of primary branches	No of pods	Seed yield/ pl (g)	Dry fibre wt.
Replication	1	21.09	0.025	0.032	183.219	820.500	23.637	280.375	0.519	53.891	1.351	3.808
Treatment	37	403.767 **	0.012*	0.026*	97.825**	684.939**	12.228**	569.993**	4.068 **	117.798**	19.059**	5.891**
Error	37	5.793**	0.006	0.010	53.291**	270.142**	6.641**	131.409**	0.244	20.165**	1.985	1.002

**significant at 5% level, **significant at 1% level*

Table 3. Genetic analysis

Characters	Grand mean	Range		Coefficient of Variation %		Heritability (%)	Genetic advance	Genetic advance as percentage of mean
		Min	Max	GCV	PCV			
Plant Height (cm)	147.23	122.46	179.33	10.07	12.71	63	24.2	16.44
Basal diameter (mm)	1.3	1.19	1.44	4.1	7.31	41	0.03	4.62
Bark thickness (mm)	1.07	0.88	1.36	8.26	12.56	43	0.12	11.21
No. of nodes	69.42	56	90	6.8	12.52	30	5.28	7.61
Green wt (g)	168.62	138.33	203.23	8.54	12.96	43	19.55	11.59
Dry stick wt (g)	23.91	19.61	27.8	6.99	12.85	30	1.87	7.82
Pl. ht. for seed (cm)	149.66	119.76	196	9.89	12.51	63	24.12	16.12
No of primary branches	3.23	1.67	6	42.78	45.43	89	2.68	82.97
No of pods	33.58	13	50	20.81	24.73	71	12.11	36.06
Seed yield/ pl (g)	12.04	4.32	19.6	24.26	26.94	81	5.42	45.02
Dry fibre wt. (g)	9.81	7.37	13.43	15.93	18.92	71	2.71	27.62

Table 4. Rank of different lines as per fibre and seed yield

Serial no.	Lines	Parentage	Fibre yield	Rank 1	Seed yield	Rank 2	D	d^2
1	BCCO-17-01	OIJ-015/OIN-028	11.73	7	16.34	3	-4	16
2	BCCO-17-02	OIJ-015/OIN-217	8.83	28	10.32	26	-2	4
3	BCCO-17-03	OIJ-015/OIN-574	9.23	25	9.27	33	8	64
4	BCCO-17-04	OIJ-015/OIN-580	10.44	9	13.75	12	3	9
5	BCCO-17-05	OIJ-015/JRO-620	7.74	34	9.94	28	-6	36
6	BCCO-17-06	OIJ-015/OIJ-267	7.63	35	9.8	30	-5	25
7	BCCO-17-07	OIJ-015/JRO-128	13.43	1	16.09	4	3	9
8	BCCO-17-08	OIJ-015/JRO-878	9.7	19	8.14	37	18	324
9	BCCO-17-09	OIN-028/OIN-217	12.27	6	12.16	15	9	81
10	BCCO-17-10	OIN-028/OIN-574	10.2	13	11.71	18	5	25
11	BCCO-17-11	OIN-028/OIN-580	8.93	26	11.78	17	-9	81
12	BCCO-17-12	OIN-028/JRO-620	8.17	32	13.32	14	-18	324
13	BCCO-17-13	OIN-028/OIJ-267	8.9	27	4.32	38	11	121
14	BCCO-17-14	OIN-028/JRO-128	9.36	21	10.44	25	4	16
15	BCCO-17-15	OIN-028/JRO-878	9.3	22	11.33	21	-1	1
16	BCCO-17-16	OIN-217/OIN-574	10.2	13	14.38	10	-3	9
17	BCCO-17-17	OIN-217/OIN-580	10.65	8	11.14	23	15	225
18	BCCO-17-18	OIN-217/JRO-620	10.32	10	12.11	16	6	36
19	BCCO-17-19	OIN-217/OIJ-267	7.93	33	8.2	36	3	9
20	BCCO-17-20	OIN-217/JRO-128	13.27	2	15.48	7	5	25
21	BCCO-17-21	OIN-217/JRO-878	10.27	12	15.52	6	-6	36
22	BCCO-17-22	OIN-574/OIN-580	9.97	15	15.01	8	-7	49
23	BCCO-17-23	OIN-574/JRO-620	8.33	28	9.29	32	4	16
24	BCCO-17-24	OIN-574/OIJ-267	10.33	11	19.6	1	-10	100
25	BCCO-17-25	OIN-574/JRO-128	9.73	18	15.62	5	-13	169
26	BCCO-17-26	OIN-574/JRO-878	9.27	23	11.16	22	-1	1
27	BCCO-17-27	OIN-580/JRO-620	8.2	30	8.87	34	4	16
28	BCCO-17-28	OIN-580/OIJ-267	8.2	30	11.63	20	-10	100
29	BCCO-17-29	OIN-580/JRO-128	7.37	37	9.63	31	-6	36
30	BCCO-17-30	OIN-580/JRO-878	8.27	29	8.63	35	6	36
31	BCCO-17-31	JRO-620/OIJ-267	7.63	35	10.96	24	-11	121
32	BCCO-17-32	JRO-620/JRO-128	9.94	16	13.99	11	-5	25

Serial no.	Lines	Parentage	Fibre yield	Rank 1	Seed yield	Rank 2	D	d^2
33	BCCO-17-33	JRO-620/JRO-878	9.93	17	9.86	29	12	144
34	BCCO-17-34	OIJ-267/JRO-128	9.27	23	10.2	27	4	16
35	BCCO-17-35	OIJ-267/JRO-878	9.6	20	11.66	19	-1	1
36	BCCO-17-36	JRO-128/JRO-878	12.28	5	17.76	2	-3	9
37	JRO-524	Check	13.03	4	14.73	9	5	25
38	JRO-204	Check	13.07	3	13.48	13	10	100

Table 5. Fibre quality study

Cross	Strength (g/tex)	Fineness (tex)
BCCO-17-07	17.74	3.78
BCCO-17-20	16.86	3.82
BCCO-17-36	19.02	2.99
BCCO-17-01	19.84	2.99
JRO-524	16.98	3.01
JRO-204	17.84	3.02

The GCV and PCV were moderate in case of no of primary branches and seed yield/plant.

4.3 Heritability and Genetic Advance in Each Characters

In a nutshell, heritability was moderate to high in case of plant height, basal diameter, bark thickness, green wt, plant height for seed purpose, no. of primary branches, no. of pods, 1000 seed wt/plant, seed yield/plant and dry fibre wt/plant. Whereas, genetic advance as percentage of mean was moderate to high in plant height, bark thickness, green wt, no. of primary branches, no. of pods, seed yield/plant and dry fibre wt/plant. So for the characters like bark thickness, plant height, green wt, no. of primary branches, no. of pods, seed yield/plant and dry fibre wt/plant direct selection will be helpful. These traits are really important for further improvement.

4.4 Rank Correlation

Correlation between seed and fibre characters at the same time is not posssibe, since fibre production needs harvesting at 120 days and sowing done in March whereas for seed it is grown at july and needs 160 days.

Approaches for combining metric data from multiple series of plant breeding trials have been extensively studied [9], but little information is available regarding ranked data when only a subset of accessions is evaluated in each trial in which it was reported that the ability to combine heterogeneous data from independent trials has important ramifications for data analysis. Results from that study indicate that this kind of metaanalysis is more powerful than individual analyses. Application of the aggregate ranking approach is not limited to plant breeding trials and was even found that it can be applied also in other areas of agricultural and biological research.The value of rank correlation showed a strong positive correlation and from the rank correlation table (Table. 3), four lines, i.e. BCCO-17-07, BCCO-17-20, BCCO-17-36 and BCCO-17-01 were selected based on their ranks on both seed and fibre yield.The fibre and seed yield of all the entries or lines have been depicted in Fig 1.

4.5 Fibre Quality

All the selected lines were higher in strength than the check varieties, whereas in case of fineness, BCCO-17-07(line no 7) and BCCO-17-20(line no 20) surpassed the values of the checks.

However the four lines namely, BCCO-17-07, BCCO-17-20, BCCO-17-36 and BCCO-17-01 yield high in both dry fibre wt and seed wt with

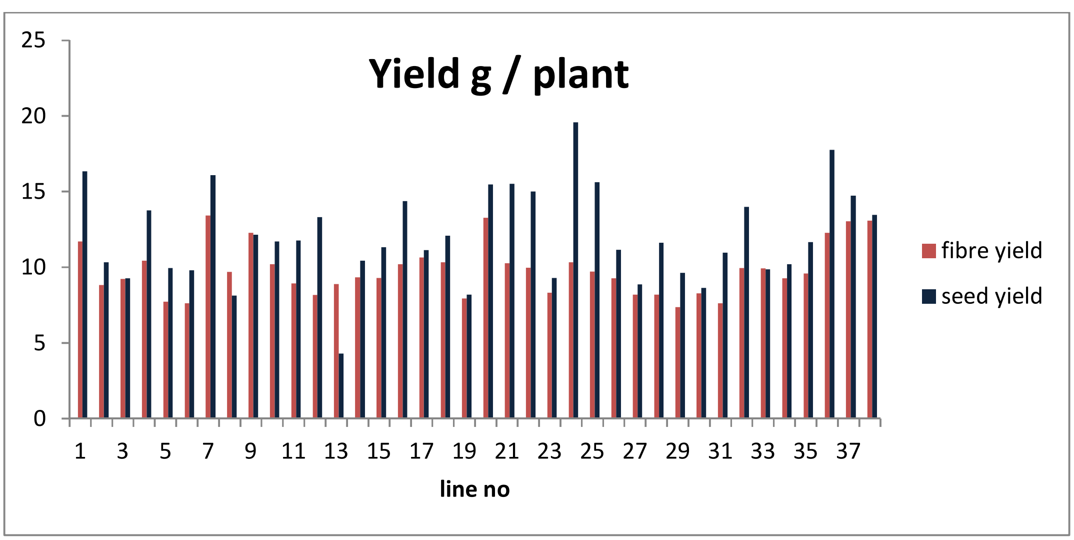

Fig 1. Graphical representation of the fibre and seed yield of the lines

high fibre quality. These lines can be selected for further breeding programmes and also for further breeding trials. Marker study can be done for further validation. JRO-128 was also found as a common parent that can be used in breeding programmes for developing new lines.

5. CONCLUSION

There was a remarkable difference observed between the seed and fibre yield potential in some lines whereas some lines were found to be consistent in both like in BCCO 17-09 and JRO 204, however similar trend was in BCCO 17-03 and BCCO 17-33 but with less yield potential . The consistency in yield can be taken into consideration while release of varieties for optimizing the yield potentials of both fibre and seed under same environment. However the lines BCCO 17-07 and BCCO 17-20 exhibiting high fibre yield and seed yield can be considered for release, as this will benefit in popularization of seed production which still is supposed to be a constraint for jute production.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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