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Evaluation of okra [*Abelmoschus esculentus* (Moench) L.] as bast fibre crop

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ABSTARCT

Selection of better genotypes and hybrids, spinnability, yarn test and path analysis of okra fibre were carried out. On the basis of per se performance, KS-3/2 and Selection 71-14 were best among five parents and PBN-57 X Selection 71-14 and KS-3/2 X PBN-57 among the hybrids for both fibre yield and fibre quality. The genotypic and phenotypic co-efficient of variation were highest for fibre yield followed by dry weight of wood among the parents. For hybrids, high gcv was shown by plant height and pcv by dry weight of wood. The okra fibre is coarser than jute and hence unspinnable alone. The tenacity of blended yarn was poorer than the normal jute yarn. The dry weight of wood showed direct effect on fibre yield. Analysis of fibre fineness and tenacity, fibre cell length (36 - 138μ) showed very high direct effect and its direct selection may improve both fineness and tenacity. The poor quality of okra fibre might be due to late harvesting of plants leading to lignified coarse cell wall.

Key words: Bast fibre, combining ability, diallel

The reckless use of synthetic fibres such as polyethylene, polypropylene, polyester and acrylic in recent years for different purposes has caused great concern for the environmentalists. Now many advanced countries are looking for replacement of these synthetic packages by eco-friendly jute-fibre-like materials having bio-degradability and annual renewability. As an additional source of jute like fibre crop, the okra plants might be considered since okra plants are potential fruit and bast fibre producer and this is a valuable raw material for textile industry for the manufacture of coarse fabrics as well as for cordage (rope and cords). Since bast fibre is very strong, hygroscopic and resistant to rot, it can be widely used for making sacks for sugar and other food products. So far, all breeding programmes directed towards genetic amelioration of okra have concentrated only on fruit yield and its component characters along with resistance against particular diseases and pests. In the present investigation, an attempt has been made to evaluate okra as bast fibre crop.

MATERIALS AND METHODS

Five okra varieties *viz*., BO-1, KS-3/2, PBN-57, Pusa Selection-7 and Selection 71-14 and their ten F_1 plants were grown in a Randomized Block Design with three replications at Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal during summer and rainy seasons.. Seeds were sown in lines at 30 cm x 60 cm spacing from plant to plant and row to row respectively. NPK fertilizers were applied at the rate of 80:40:40 kg ha^{-1}, where 50% of nitrogenous fertilizer was top-dressed after a month of sowing. Weeding and spraying of monocotophus for control of jassid were done timely. Irrigation for summer crop was done whenever needed. The spinnability and yarn test were performed in jute spinning system following the method used for jute fibre at Jute Technological Research Laboratory, Kolkata.

Ten plants were randomly selected from each variety and their crosses in both the experiments for yield estimation of pods *i.e.*, vegetable yield and the rest of the plants were utilized for making crosses and selfing. The plants of both the parents and their hybrids were used for bast fibre extraction and fibre quality analysis. The cross pollinated and selfed pods were harvested from time to time and data were recorded whenever needed. The path analysis for fibre yeild, pod yield, fibre fineness and tenacity were estimated following procedures given by Dewey and Lu (1959). Retting and fibre extraction were made following the same process used in jute.

RESULTS AND DISCUSSION

The *per se* performance of parents and hybrids for seven characters *viz.* fibre yield, plant height, basal circumference, dry wood yield, vegetable yield, days to first flower and total number of branches is presented in table 1. The five parents showed significant variation for the first four characters. Their hybrids also revealed similar results for these characters except for the fibre yield where hybrids are insignificantly different. The genotypic and phenotypic coefficient of variation for parents was highest for fibre yield (59.41 gcv and 72.54 pcv) closely followed by dry wood yield (58.95 gcv and 70.75 pcv).

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Table 1: Mean performance of parents (A) and hybrids (B) for fibre yield and vegetable yield

	Parents and hybrids	Plant height (cm)	Basal circumference (cm)	Total No. of branches	Fibre yield (g)	Dry wood yield (g)	Vegetable yield (g)	Days to 1st flower
	BO – 1	64.62	8.06	3.74	8.67	25.36	16.17	40.82
	KS- 3/2	73.72	10.99	2.87	14.07	61.56	19.90	42.45
A	PBN –57	45.86	7.14	3.15	4.23	14.64	13.85	44.80
	Pusa Selection 7	51.22	8.68	2.84	7.77	16.37	15.67	46.50
	Selection 71-14	93.89	9.04	1.99	15.00	51.85	17.12	43.42
	LSD (0.05)	**36.50**	**1.64**	**3.43**	**7.78**	**24.96**	**5.67**	**1.48**
	G.C.V.	**23.54**	**15.30**	**23.23**	**59.41**	**58.95**	**8.36**	**4.90**
	P.C.V.	**37.77**	**18.25**	**66.59**	**72.54**	**70.75**	**20.05**	**5.22**
	BO – 1 X KS – 3/2	112.03	8.32	2.67	8.87	22.19	15.75	42.49
	BO – 1 X PBN – 57	60.39	10.50	3.34	8.20	28.34	14.67	41.34
	BO –1 X Pusa Selection 7	84.66	8.26	3.10	6.32	23.40	17.10	37.25
	BO – 1 X Selection 71-14	84.00	8.02	3.06	6.65	16.54	19.20	41.44
B	KS – 3/2 X PBN – 57	115.30	9.50	3.08	9.12	29.97	17.50	40.77
	KS – 3/2 X Pusa Selection 7	67.84	6.31	4.84	12.47	30.30	14.23	42.06
	KS – 3/2 X Selection 71-14	117.94	10.34	2.34	7.89	29.30	13.20	39.53
	PBN – 57 X Pusa Selection 7	81.54	6.47	3.43	6.44	15.40	17.74	41.57
	PBN – 57 X Selection 71-14	89.34	9.70	3.59	10.87	29.34	16.74	42.74
	Pusa Selection 7 X Selection 71-14	58.13	10.45	4.17	11.39	30.37	14.00	42.81
	LSD (0.05)	**31.56**	**3.12**	**2.12**	**6.17**	**26.22**	**6.59**	**4.03**
	G.C.V.	**19.29**	**14.79**	**12.75**	**14.26**	**14.53**	**2.07**	**3.06**
	P.C.V.	**25.99**	**22.96**	**33.95**	**31.60**	**43.98**	**20.47**	**5.73**

Note: A : Parents and B : Hybrids G.C.V.: Genotypic coefficient of variation, P.C.V.: Phenotypic coefficient of variation

The days to first flower and basal circumference revealed the close gcv and pcv range indicating the preponderance of genetical influence in the expression of these characters. Thus selection of these characters for further improvement will be rewarding. However, the higher value of pcv than the gcv for rest of the characters including for fibre yield indicated that the apparent variation in these characters is not only due to genotypic but also due to environment. Therefore, the selection for improvement of these characters should not be carried out. In case of hybrids, high gcv was observed for plant height (19.29) and high pcv in dry weight of wood (43.98). Both fibre yield and vegetable yield showed high range of gcv and pcv. This shows much environmental effect on expression of these characters which is in agreement with the earlier findings of Mishra *et al* (1990). Two varieties – Selection 71-14 and KS-3/2 and the hybrids BO-1 X KS-3/2, KS-3/2 X PBN-57, KS-3/2 X Pusa Selection - 7 and PBN-57 X Selection 71-14 are the best on the basis of their performances with respect to fibre yield, plant height, basal circumference and dry wood yield.

Table 2: Mean values of quality parameters of okra fibre from five parents (A) and ten hybrids (B)

	Parents and hybrids	Fibre length (cm)	* Fibre fineness (denier)	Tenacity (g Tax^{-1})	Ultimate fibre cell length (μ)	* Ultimate fibre cell breadth (μ)	Cell length breadth ratio
	BO – 1	38.50	122.00	30.40	43.15	1.45	29.70 : 1
	KS – 3/2	43.00	74.00	35.90	83.41	1.88	44.22 : 1
A	PBN – 57	37.00	75.00	37.85	46.78	1.01	46.06 : 1
	Pusa Selection 7	33.50	81.00	27.30	36.26	1.59	22.72 : 1
	Selection 71-14	51.50	132.00	38.60	137.08	1.95	69.99 : 1
	BO – 1 X KS – 3/2	52.50	121.00	29.60	22.84	1.01	22.49 : 1
	BO – 1 X PBN – 57	55.00	63.00	26.40	24.66	0.72	33.99 : 1
	BO –1 X Pusa Selection 7	55.00	81.00	26.90	20.30	1.08	18.66 : 1
B	BO – 1 X Selection 71-14	54.00	72.00	27.90	37.35	0.72	51.50 : 1
	KS – 3/2 X PBN – 57	62.00	62.00	42.40	21.75	0.65	33.33 : 1
	KS – 3/2 X Pusa Selection 7	57.50	95.00	39.70	27.56	0.65	42.22: 1
	KS – 3/2 X Selection 71-14	77.50	92.00	49.60	50.77	0.94	53.84 : 1
	PBN – 57 X Pusa Selection 7	48.50	60.00	28.00	65.27	1.01	64.28 : 1
	PBN – 57 X Selection 71-14	78.50	54.00	32.50	58.75	2.03	28.92 : 1
	Pusa Selection 7 X Selection 71-14	88.50	84.00	43.00	24.66	0.94	26.15 : 1
	Grand Mean	**55.50**	**84.54**	**34.41**	**46.71**	**1.17**	**39.21 : 1**
	Parental Mean	**40.70**	**96.80**	**34.01**	**69.34**	**1.58**	**42.55 : 1**
	Hybrid **Minimum**	**48.50**	**121.00**	**26.40**	**20.30**	**2.03**	**18.66 : 1**
	Range **Maximum**	**88.50**	**54.00**	**49.60**	**65.27**	**0.65**	**64.28 : 1**

*Note: A : Parents and B : Hybrids, * lower scores are considered better*

The fibre quality with respect to six traits *viz.* fibre length, fibre fineness, tenacity, cell length and breadth and cell length-breadth ratio was estimated. Data presented in table 2 for comparative study on the basis of fibre quality *via-a-vis* of jute, it was found that KS-3/2 and Selection 71-14 were best among the parents. The hybrids PBN –57 X Selection 71-14, KS-3/2 X PBN - 57 and BO-1 X PBN – 57 are best in quality among F_1s. The spinning test of okra fibre indicated that it is three times coarser than jute fibre. Hence it is difficult to spin okra fibre in small scale jute spinning system. Therefore, two yarn samples were spun with admixture of TD2 jute fibre of 25% and 50% blend composition but result was unsatisfactory (Table 3). The strength of the blended yarns was poorer than the normal jute yarn of the source count. The physical test for bundle tenacity and fibre fineness are 16.40 g Tex^{-1} and 7.1 Tex respectively.

The path analysis revealed highest (0.6010) direct effect of dry wood yield and its indirect effect via basal circumference (0.3076 cm) on fibre yield (Table 4). Analysis for fibre fineness indicated very high direct effect of ultimate fibre cell length (2.1966 μm) followed by fibre tenacity (0.2334) (Table 5). The indirect effect of cell length via cell breadth (1.5374) and cell length-breadth ratio (1.5331) also showed very high effect. The path analysis for fibre tenacity indicated that fibre length had the highest direct effect (0.5807) followed by fibre fineness and cell length. The high residual effects for fibre yield (0.6529), fineness (0.6154) and tenacity (0.5560) indicate that there are other influential sources beside the characters studied.

Table 3: Yarn test result of okra fibre samples

Sl. No.	Parameters tested	Sample No. 1 Jute 50% and okra 50%	Sample No. 2 Jute 25% and okra 75%
1	Grist (Tax)	365.0	386.0
2	Breaking Load (kg)	2.4	2.3
3	Quality index (g Tex^{-1})	6.7	6.0
4	Breaking ext %	1.6	1.9
5	Breaking Ext CV%	28.0	25.0
6	Strength CV%	31.0	32.0

Table 4: Direct and indirect effects of four different characters on fibre yield in five parents and ten hybrids of okra

Characters	Plant height	Basal circumference	Vegetable yield	Dry wood yield	Genotypic correlation with fibre yield
Plant height	**0.0539**	-0.0042	0.0305	0.0052	0.0854
Basal circumference	0.0053	**-0.0431**	0.0056	0.3076	0.2754
Total number of branches	0.0248	-0.0036	**0.0663**	0.0024	0.0899
Dry weight of wood	0.0005	-0.0221	0.0003	**0.6010**	0.5797

Note: Residual effect = 0.6529 (Bold letters denotes direct effect)

Table 5: Direct and indirect effect of five different characters on fibre fineness and tenacity (in brackets) in five parents and ten hybrids

Characters	Fibre length	Fibre tenacity/ fibre fineness	Ultimate fibre cell length	Ultimate fibre cell breadth	Cell length-breadth ratio	Genotypic correlation with fibre fineness
Fibre Length	**-0.3044**	0.1229	-0.3565	0.2141	0.1300	-0.1939
	(0.5807)	(-0.0409)	(-0.0360)	(0.0375)	(-0.0147)	(0.5266)
Fibre tenacity/	-0.1603	**0.2334**	0.3531	0.1416	-0.4311	0.1367
fibre fineness	(-0.1126)	**(0.2109)**	(0.0683)	(-0.0444)	(0.0145)	(0.1368)
Ultimate fibre cell	0.0494	0.0375	**2.1966**	-0.8869	-1.0888	0.3078
length	(-0.0943)	(0.0649)	**(0.2219)**	(-0.1553)	(0.1235)	(0.1607)
Ultimate fibre cell	0.0514	0.0261	1.5374	**-0.2672**	-0.0953	0.2002
breadth	(-0.0981)	(0.0422)	(0.1553)	**(-0.2219)**	(0.0108)	(-0.1117)
Cell length-	0.0262	0.0666	1.5831	-0.0800	**-1.5107**	0.0852
breadth ratio	(-0.0500)	(0.0180)	(0.1599)	(-0.0140)	**(0.1714)**	(0.2853)

Note: Residual effect = 0.6154. (Bold letters denotes direct effect)

In comparison, okra fibre is inferior to jute due to late harvesting of okra plants probably the fibre cells were lignified causing coarseness on it which is unsuitable to spun alone *i.e,* without mixing it with jute fibre. Early harvest preferably at the last flowering stage and the fibres from different varieties must be evaluated separately. The present investigation points out that okra plants might be a source of bast-fibre, which may be used for various purposes though it's quality might not be as good as jute fibre.

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