Bangladesh J. Bot. **43**(1): 9-17, 2014 (June)

BREEDING FOR PREMATURE FLOWERING RESISTANT LINES WITH IMPROVED FIBRE YIELD AND QUALITY IN TOSSA JUTE (*CORCHORUS OLITORIUS* L.)

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Key words: Breeding, Elite lines, Fibre quality, Fibre yield, Premature flowering resistance

Abstract

Ten diverse tossa jute genotypes of different eco-geographic origin were crossed with four well adapted varieties as testers to produce 40 F_1s in line × tester mating design. Based on general and specific combining ability, 10 desirable cross combinations were selected and carried forward up to F_4 generation by modified bulk method for further selection. Out of 890 selected promising single plant progenies from different cross combinations at F_5 generation, 223 were further selected for premature flowering resistance and better growth performance over the ruling checks by sowing them at middle of March. Among 223 promising lines, 13 were short listed based on fibre yield and fibre quality parameters. Yield performance of these elite lines evinced that six lines *viz.* JRO 2405, JRO 2402, JRO 2404, JRO 2602, JRO 2406 and JRO 2407 were critically different from both the check varieties, JRO 524 and JRO 8432. These six high yielding lines having comparable or better fibre quality and showing resistance to premature flowering enabled them to be most suitable to fit in multiple cropping systems. Out of these 6 elite lines, JRO 2407 was identified as a new variety of tossa jute.

Introduction

Jute is a versatile, environment friendly, fibre crop and is one of the leading cash crops of India. It is the cheapest bast fibre and most important vegetable fibre crop in the world next to cotton in terms of usage, global consumption, production and availability (Ahmed and Nizam 2008). It is a biodegradable and renewable ligno-cellulosic fibre (Mir *et al*. 2008). Jute fibre is obtained from the bark of *Corchorus olitorius* L. (tossa jute) and *C. capsularis* L. (white jute) (Palve and Sinha 2005). Earlier tossa jute, a short day crop, was possible to sow only after middle of April and the acreage in favour of tossa jute was only 40% of the total jute acreage in the country (Ghosh 1983). But tossa jute generally flowers prematurely when sown before the middle of April. Long duration and premature flowering traits made this crop unsuitable for multiple cropping systems. To fit paddy after jute in multiple cropping systems three *C. olitorius* varieties i.e. JRO (Jute Research Olitorius) 878, JRO 7835 and JRO 524 (Chakraborty and Ghosh 1969) were bred in the 70's and two more tossa jute varieties i.e. JRO 8432 (Chowdhury and Das 2003) and JRO 128 were released in 1999 and 2002, respectively (Kar *et al*. 2010) incorporating premature flowering resistance from ‘Sudan Green’, an exotic germplasm from Sudan, Africa and ‘Tanganyika 1’, an exotic strain from Tanzania, Africa, permitting sowing in middle of March. These varieties were widely accepted by the farmers due to high yield and suitability to fit jute in crop rotation with transplanted Aman (wet-season) paddy. Thus the trait premature flowering resistance offered early sowing of tossa jute avoiding the risk of premature flowering i.e. without

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hampering vegetative growth (fibre formation) as well enabled jute to be fitted in multiple cropping sequences which ultimately boosted the productivity (Karmakar *et al*. 2008, Kar *et al*. 2009). Development and acceptance of these premature flowering resistant and early sowing varieties dramatically converted the area under jute cultivation from the domain of white to tossa jute. As a result, the present acreage in favour of tossa jute is 85% of the total jute area (Ghosh 1983). National productivity went on increasing, the balance between *capsularis* and *olitorius* are titled towards the latter, which is now 10 : 90 per cent (Karmakar *et al*. 2008). With the advent of globalization and the growing concern for ecological and environmental security there is increasingly renewed interest worldwide for the production of jute and its diversified uses including industrial applications. Jute varieties with improved fibre quality are of great demand for production of diversified value added products. Therefore, development of premature flowering resistant lines with higher fibre yield and better fibre quality in tossa jute is an important breeding objective of the jute breeders. In other words, restructuring of plant type having broad genetic base from diverse sources with a definite prospect of obtaining higher yield and better fibre quality is the prime objective of jute breeding. In an attempt to select transgressive segregates, diverse genotypes of different eco-geographic origin with known potentiality for different desirable attributes were crossed in line × tester mating design and on the basis of combining ability, desirable cross combinations were selected (Kumar *et al*. 2002) to be carried forward for further selection.

The present investigation aims at developing premature flowering resistant lines of tossa jute along with improved fibre yield and quality from the selected cross combinations and thereby to refurbish high yielding better fibre quality varieties capable of being sown earlier than the existing varieties without risk of premature flowering rendering them to be better fitted in multiple cropping systems as well industrial applicability.

Materials and Methods

Ten diverse tossa jute genotypes *viz.* Juta nonsoong, JRO 620, JRO 66, Palmate leaf, KEN/SM/024, TAN/X/087, Selection-2, BC-3, JRO 3352 and JRO 52 of different eco-geographic origin with known potentiality for high fibre yield, finer fibre quality, resistance to biotic/abiotic stresses and resistance to premature flowering were crossed with four well adapted varieties *viz.* JRO 524, JRO 878, JRO 632 and JRO 7835 as testers to produce 40 F_1s in line × tester mating design in the year 1999 (Kumar *et al*. 2002). The experimental materials were derived from the germplasm pool of Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore, Kolkata, West Bengal, India. All 40 hybrids and their 14 parents were grown together in randomized block design (RBD) with three replications in rainy season of 2000 at CRIJAF Farm, Barrackpore, Kolkata, West Bengal, India (22°45′N and 88°26′E). On the basis of general and specific combing ability, 10 desirable cross combinations (KEN/SM/024 × JRO 524, KEN/SM/024 × JRO 878, Selection-2 × JRO 878, Selection-2 × JRO 632, BC-3 × JRO 524, JRO 2352 × JRO 632, JRO 3352 × JRO 7835, JRO 52 × JRO 524, JRO 52 × JRO 878 and JRO 52 × JRO 632) were chosen from these 40 crosses and were carried forward up to F_4 generation by modified bulk method in which some selections were made instead of allowing the population entirely on nature. At F_4 generation in 2003-04, 89 individuals from each cross were selected on the basis of visual agro-morphological characters mainly plant height, basal diameter and growth performance.

Eight hundred ninety selected promising single plant progenies at F_5 were evaluated at the same location by growing them under appropriate thermo-photoperiodic regime by sowing in middle of March, 2004 with ruling check varieties, JRO 524 and JRO 8432 to assess the degree of premature flowering resistance of these lines. Vegetative growth for at least 100 days before switching over to reproductive phase was considered to be optimum resistance to premature flowering. On this basis, out of 890 promising lines, 223 premature flowering resistant lines were identified as they flowered after 100 days. The selected lines were grown in RBD with 3 replications in 2005-06. Fifty eight elite lines were further selected on the basis of visual observation on plant height and growth performance. Ten random plants were harvested from each of these 58 lines and two check varieties i.e. JRO 524 and JRO 8432. Data were recorded for plant height (cm), base diameter (cm), green weight (g), fibre yield (g) and fibre percentage. Fibre yield data i.e. dry fibre weight and dry stick weight were recorded after extraction and drying of fibre and stick. The proportion of dry fibre weight of ten plants to dry fibre plus dry stick weight of these ten plants or the fibre percentage was considered as an appropriate measure of harvest index. Fibre quality parameters *viz.* fibre strength (g/tex) and fibre fineness (tex) of these 58 lines were assessed at National Institute of Research for Jute and Allied Fibres Technology, Kolkata, India. Fibre fineness is the diameter of the filament measured from the replicated samples by airflow method, while fibre strength is calculated as the breaking load of the fibre sample divided by the linear density of the unstrained fibre which is referred to as its tenacity. This trait was determined by fibre bundle strength tester which gives an average value of fibre strength of different fibre samples.

Out of 58, thirteen lines (sl. nos. 2, 8, 9, 12, 14, 35, 43, 45, 46, 47, 48, 50 and 57) having higher fibre yield and higher values for other traits of study were selected further.

These 13 promising lines in F_7 having premature flowering resistance with better fibre quality were subjected to microplot yield trial along with ruling check varieties, JRO 524 and JRO 8432 in 2006-07 in RBD with 3 replications at Central Seed Research Station for Jute and Allied Fibres, Budbud, Burdwan, West Bengal, India (22°30′N and 88°26′E). The sowing was done in middle of March. The plot size was 3.0 m × 4.5 m. Row to row and plant to plant distances were 30 cm and 5 - 7 cm, respectively. Net plots were harvested and plot yield data were recorded.

In each generation the significance test (F test), standard error (SE), critical difference (CD) and coefficient of variation (CV%) of all the parameters under study were carried out following Gomez and Gomez (2010).

Results and Discussion

Average performance of fibre yield and yield contributing characters of 58 selected premature flowering resistant lines of *C. olitorius* jute in F_6 (Table 1) revealed that selections 2, 8, 9 and 12 from the cross combination, KEN/SM/024 × JRO 524, and selections 14 and 35 from the cross combination KEN/SM/024 × JRO 878 evinced higher values for fibre yield and some yield contributing characters, medium value for fibre strength and lower value for fibre fineness.

A few selections *viz.* 43, 45, 46, 47, 48, 50 and 57 from the cross combinations BC 3 × JRO 524, JRO 3352 × JRO 632, JRO 3352 × JRO 7835, JRO 52 × JRO 524, JRO 52 × JRO 878 and JRO 52 × JRO 632 exhibited higher and desirable values for maximum number of yield contributing characters and fibre quality parameters. These 13 lines were short listed on the basis of high yield, yield components and quality traits (Table 2). It may be mentioned here that the germplasms, Sudan Green and Tanganyika 1, were utilized so far, as resistant source in breeding premature flowering resistant variety. The newly bred lines combined high yield with premature flowering resistance from KEN/SM/024 (Kumar 2004) and finer fibre quality from JRO 878. Fibre yield of all 13 short listed promising lines evinced higher values over the check varieties (Table 2). Fibre strength of 4 promising lines *viz.* JRO 2407 and JRO 2502 from the cross

Table 1. Average performance of fibre yield, yield contributing characters and fibre quality parameters of 58 selected premature flowering resistant lines of *C. olitorius* in F_6 generation.

Sl. No.	Pedegree	Fibre yield (g)	Fibre (%)	Plant height (cm)	Base diam. (cm)	Green weight (g)	Fibre strength (g/tex)	Fibre fineness (tex)
1	KEN/SM/024 × JRO 524 (F_6)	12.10	34.09	310.07	1.24	141.00	30.00	2.80
2	,,	12.07	31.61	323.60	1.23	169.83	26.40	3.10
3	,,	11.57	29.40	306.93	1.23	161.17	25.00	2.70
4	,,	11.50	32.74	310.23	1.18	155.00	28.20	-
5	,,	9.97	33.29	302.33	1.17	139.00	27.32	2.80
6	,,	11.27	33.14	328.10	1.23	162.50	27.20	2.75
7	,,	9.63	30.22	300.43	1.24	149.50	27.50	2.70
8	,,	12.00	30.57	308.17	1.27	147.50	26.30	2.90
9	,,	12.03	30.53	318.53	1.29	156.67	25.80	3.10
10	,,	9.93	30.63	322.87	1.35	141.17	24.00	2.50
11	,,	11.57	32.91	318.93	1.20	158.67	26.40	2.80
12	,,	12.43	31.83	323.77	1.34	147.83	23.70	2.80
13	KEN/SM/024 × JRO 878 (F_6)	11.90	33.19	311.77	1.32	150.50	27.80	2.60
14	,,	12.47	34.23	312.07	1.26	160.83	26.50	2.80
15	,,	10.23	31.91	303.33	1.28	136.67	26.60	2.60
16	,,	8.37	30.39	287.97	1.21	114.33	25.60	-
17	,,	11.47	31.05	308.50	1.20	150.00	26.63	3.10
18	,,	9.70	29.35	338.83	1.27	139.40	27.40	2.70
19	,,	10.03	30.52	316.73	1.21	126.33	25.50	2.70
20	,,	9.70	30.62	314.40	1.32	137.17	25.75	2.70
21	,,	10.67	30.29	322.00	1.29	145.17	26.00	2.60
22	,,	9.33	29.55	303.27	1.39	140.67	26.60	2.60
23	,,	9.40	31.69	304.03	1.30	117.00	29.16	2.70
24	,,	10.03	32.14	301.33	1.30	137.33	23.20	2.70
25	,,	11.40	32.88	323.40	1.22	134.67	25.35	2.90
26	,,	8.97	29.48	297.67	1.17	118.50	27.40	-
27	,,	9.60	27.95	314.17	1.37	134.67	27.85	2.50
28	,,	9.53	33.02	311.87	1.32	124.67	25.20	3.20
29	,,	9.30	32.59	317.33	1.29	119.67	-	-
30	,,	9.57	31.75	316.17	1.37	133.67	27.60	2.70
31	,,	9.30	32.23	301.83	1.28	153.83	24.30	2.30
32	,,	10.90	33.43	319.83	1.26	139.97	24.60	-
33	,,	8.97	32.56	316.50	1.22	119.67	25.40	2.60
34	,,	13.10	31.38	345.50	1.44	155.33	26.40	3.60
35	,,	12.90	29.86	338.00	1.39	180.17	27.60	2.20

(Contd.)

(Contd.)

36	Selection-2 × JRO 632 (F_6)	9.43	29.52	330.83	1.16	127.67	25.90	2.20
37	,,	8.50	30.02	308.17	1.25	128.33	25.50	-
38	,,	11.60	32.79	341.67	1.35	153.00	25.80	2.90
39	,,	9.63	26.65	300.00	1.29	145.67	28.00	2.70
40	,,	9.47	30.72	329.50	1.34	139.67	24.00	2.50
41	,,	8.80	31.41	300.50	1.15	126.67	26.20	2.20
42	,,	11.03	29.28	339.67	1.19	161.17	29.49	2.90
43	BC-3 × JRO 524 (F_6)	12.53	30.43	339.67	1.24	155.67	25.60	3.30
44	,,	11.97	32.95	334.83	1.16	146.67	27.20	3.10
45	JRO 3352 × JRO 632 (F_6)	13.20	33.77	347.17	1.36	184.50	27.00	3.10
46	,,	12.77	28.87	341.33	1.31	194.00	24.25	2.60
47	JRO 3352 × JRO 7835 (F_6)	12.70	28.08	344.67	1.35	193.07	23.70	2.40
48	,,	12.80	29.37	327.00	1.28	172.67	25.20	2.70
49	JRO-52 × JRO 524 (F_6)	11.93	32.85	325.87	1.27	164.33	24.30	2.60
50	JRO 52 × JRO 878 (F_6)	12.63	32.14	339.00	1.28	201.67	26.00	2.80
51	,,	9.77	28.90	324.00	1.27	154.10	26.90	2.60
52	,,	9.37	25.96	326.00	1.13	133.67	26.20	2.50
53	,,	10.00	30.33	327.50	1.19	144.00	27.60	3.00
54	JRO 52 × JRO 632 (F_6)	12.10	31.21	330.50	1.24	174.67	29.30	2.90
55	,,	10.97	31.14	320.83	1.25	190.00	25.70	2.90
56	,,	8.93	30.10	324.03	1.19	120.33	29.40	2.70
57	,,	13.20	32.75	306.50	1.16	138.50	25.00	2.90
58	,,	14.27	30.73	327.50	1.24	145.00	25.30	2.75
59	JRO 524 (Check var. 1)	9.77	29.57	287.55	1.15	115.33	26.40	3.40
60	JRO 8432 (Check var. 2)	11.10	31.17	310.33	1.13	121.67	27.10	2.80
F. test		HS	HS	NS	NS	HS		
Std. error		0.77	1.14	14.67	0.11	9.24		
S.E. difference		1.09	1.61	20.75	0.15	13.07		
CD (p = 0.05)		2.17	3.19	41.08	0.30	25.87		
CV %		12.37	6.37	7.97	14.91	10.87		

HS denotes highly significant and NS not significant.

combination KEN/SM/024 × JRO 878 as well JRO 2504 from the cross JRO 3352 × JRO 632 were superior to the check variety, JRO 524. But only one line, JRO 2502 showed higher tenacity over both the check varieties. On the other hand, 4 lines namely JRO 2502, JRO 2505, JRO 2601 and JRO 2602 recorded higher fineness over both the check varieties.

Performance of these short-listed lines in microplot yield trial evinced highly significant differences among themselves for fibre yield indicating the presence of genotypic difference (Table 3). Some of the promising lines *viz.* JRO 2405, JRO 2402, JRO 2404, JRO 2602, JRO 2406

Table 2. **Short listed 15 promising tossa jute lines with average fibre yield and quality characters.**

Line. No.	Line	Pedegree	Fibre yield (g/plant)	Fibre (%)	Plant height (cm)	Base diameter (cm)	Green weight (g/plant)	Fibre tenacity (g/tex)	Fibre fineness (tex)
2	JRO 2402	KEN/SM/024 × JRO 524	12.07	31.61	323.60	1.23	169.83	26.40	3.10
8	JRO 2404	,,	12.00	30.57	308.17	1.27	147.50	26.30	2.90
9	JRO 2405	,,	12.03	30.53	318.53	1.29	156.67	25.80	3.10
12	JRO 2406	,,	12.43	31.83	323.77	1.34	147.83	23.70	2.80
14	JRO 2407	KEN/SM/024 × JRO 878 (F_6)	12.47	34.23	312.07	1.26	160.83	26.50	2.80
35	JRO 2502	,,	12.90	29.86	338.00	1.39	180.17	27.60	2.20
43	JRO 2503	BC 3 × JRO 524 (F_6)	12.53	30.43	339.67	1.24	155.67	25.60	3.30
45	JRO 2504	JRO 3352 × JRO 632 (F_6)	13.20	33.77	347.17	1.36	184.50	27.00	3.10
46	JRO 2505	,,	12.77	28.87	341.33	1.31	194.00	24.25	2.60
47	JRO 2601	JRO 3352 × JRO 7835 (F_6)	12.70	28.08	344.67	1.35	193.07	23.70	2.40
48	JRO 2602	,,	12.80	29.37	327.00	1.28	172.67	25.20	2.70
50	JRO 2603	JRO 52 × JRO 878 (F_6)	12.63	32.14	339.00	1.28	201.67	26.00	2.80
57	JRO 2604	JRO 52 × JRO 632 (F_6)	13.20	32.75	306.50	1.16	138.50	25.00	2.90
59	JRO 524	Check var. 1	9.77	29.57	287.55	1.15	115.33	26.40	3.40
60	JRO 8432	Check var. 2	11.10	31.17	310.33	1.13	121.67	27.10	2.80

and JRO 2407 yielded significantly and critically higher than the ruling check varieties and out-yielded JRO 524 by 25.20 - 37.47% and JRO 8432 by 19.03 - 30.67%. Their fibre quality was also comparable with the check varieties. Out of these 6 high yielding lines, 5 were selected from crosses between exotic germplasm and well adapted variety. All these 6 lines showing premature

Table 3. Performance of the selected elite tossa jute lines with regard to average fibre yield and fibre quality.

Line/ variety	Fibre yield (q/ha)	Increased % over ruling check varieties		Fibre tenacity (g/tex)	Fibre fineness (tex)
		JRO 524	JRO 8432		
JRO 2402	28.16	35.19	28.53	26.40	3.10
JRO 2404	27.62	32.60	26.06	26.30	2.90
JRO 2405	28.63	37.47	30.67	25.80	3.10
JRO 2406	26.08	25.20	19.03	23.70	2.80
JRO 2407	26.08	25.20	19.03	26.50	2.80
JRO 2502	21.06	1.10	-3.88	27.60	2.20
JRO 2503	22.69	8.93	3.56	25.60	3.30
JRO 2504	25.00	20.02	14.10	27.00	3.10
JRO 2505	18.13	-12.96	-17.25	24.25	2.60
JRO 2601	21.99	5.57	0.37	23.70	2.40
JRO 2602	26.93	29.28	22.91	25.20	2.70
JRO 2603	22.38	7.44	2.15	26.00	2.80
JRO 2604	24.69	18.53	12.69	25.00	2.90
JRO 524 (Check var. 1)	20.83	-	-5.18	26.40	3.40
JRO 8432 (Check var. 2)	21.91	- 4.93	-	27.10	2.80
F test = Highly significant					
SE (m) ± = 1.26					
CD (P = 0.05) = 3.65					
CV% = 14.84					

flowering resistance in mid-March sowing were found suitable for sowing even earlier than the existing varieties without any risk of premature flowering and thereby allowing transplantation of paddy after jute in multiple cropping sequences. Out of these 6 promising lines, JRO 2405 and JRO 2407 had been qualified as most outstanding lines in IET (Initial Evaluation Trial), AVT-I (Advanced Varietal Trial-I), AVT-II and Adaptive trials. In February, 2011 identification proposal of these two varieties were submitted in the AINP workshop for release. Out of these two varieties JRO 2407 has been identified for release as a new variety for entire tossa jute growing belt of the country.

With the advent of intensive agriculture and introduction of multiple cropping system jute crop faced competition from other major crops and pushed back more and more to the poor and marginal land. The inevitable result was the fall in productivity. It was then felt necessary to fit jute crop in multiple cropping sequences. A jute crop should be harvested by middle of July if one desires to transplant the ‘aman’ (‘wet-season’) paddy as successive crop. In jute, maximum fibre production takes place during the period starting from flowering to early pod stage (Maiti and Mitra 1972, Mitra and Maiti 1974) and usual harvest time is at 50% pod stage which used to fall during mid-August to end-August allowing a crop minimum of 135 days growth (Kumar *et al.* 1994). Therefore, to fit paddy after jute it was felt necessitate to develop new jute varieties, which could be sown earlier than mid-April. But being a short day crop sowing of tossa jute earlier than mid-April induces premature flowering, which is highly undesirable for jute crop grown for fibre and is hence not suitable for areas where jute must be sown early to release the land for the next crop. Therefore, it was essential to develop new tossa jute varieties suitable for early sowing i.e. in mid-March without any risk of premature flowering which will be suitable in multiple cropping sequences and able to release of land for rice cultivation. Such varieties will be harvested by mid-July allowing hardly 120 days crop growth which will also fit in multiple cropping sequences. In the present study the newly identified tossa jute variety, JRO 2407 derived from the cross between KEN/SM/024 × JRO 878, is an early maturing, premature flowering resistant variety having better fibre quality suitable for multiple cropping system. This new variety combined high yield with premature flowering resistance from KEN/SM/024 (Kumar 2004) and finer fibre quality from JRO 878. Interestingly the fibre fineness of this new variety is 2.80 tex which is superior to the available premature flowering resistant early sowing tossa jute varieties like JRO 524 (fineness is 3.40 tex), JRO 7835 (fineness is 3.50 tex) (Begum and Kumar 2011). This finer and stronger fibre may be utilized for the production of finer count blended yarn. Seed sample of JRO 2407 was sent to NBPGR and the National Identity number- IC 587431 was received.

Therefore, it may be inferred that the newly identified tossa jute variety, JRO 2407, developed from the heterogenous base population from different eco-geographic origin having wider genetic base and premature flowering resistance is suitable for early March sowing. The variety can replace the cultivated varieties like JRO 524 and JRO 8432 for higher yield and better quality of fibre. If this variety is sown in early March, it will be more profitable than the existing varieties used in multiple cropping and will be widely accepted by the farmers due to its higher fibre yield coupled with finer fibre quality and suitability to fit in the crop rotation with transplanted Aman (wet-season) paddy. Besides, it will meet the great demand of jute industry for production of diversified and value added products.

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(Manuscript received on 4 October, 2012; revised on 19 January, 2014)