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LINKAGE STUDIES IN JUTE (*CORCHORUS CAPSULARIS* L.)

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ABSTRACT

In jute (*Corchorus capsularis*), leafy stipule was linked to cordate leaf (p= 9.2), persistent petiole (p=43.3), green testa colour (p=33.6); and cordate leaf was linked with dwarf stem (p=26.9). Independent segregation was noted between narrow leaf, yellow leaf and cordate leaf and between leafy stipule and dwarf stem. New gene symbols for dwarf stem (Dw-dw), persistent petiole (Ppt-ppt), cordate leaf (Cd-cd), yellow leaf (Yl-yl) and green testa (Gr-gr) are proposed. Gene symbols for narrow leaf (Sr-sr) and leafy stipule (Sfl-sfl) proposed by earlier workers have been retained.

Key words: Jute, *Corchorus capsularis*, joint segregation, linkage, gene symbol.

Linkage between genes for bitter taste and branching habit and between corolla colour and anther colour in *Corchorus capsularis* were reported [1]. Linkage between genes for branching habit and fasciation of stem and between blue testa and snow white fibre have also been reported [2, 3]. In view of such a scanty information on linkage in this species, attempts were made to determine linkage between other marker characters.

MATERIALS AND METHODS

In capsularis jute the normal leaf shape is ovate-oblong with acuminate leaf apex, margin coarsely toothed or serrated and the petiole is deciduous, i.e. falls off with the senescence of lamina. In this study, a leaf variant (Fig. 1a, b) with cordate shape has been investigated, in which the acuminate leaf apex was absent and the length/breadth ratio was different (2.1:1) from that of the standard ovate-oblong leaf (2.8:1). Another leaf variant had deep serration and narrow lamina (narrow leaf). The wild type stipule is linear, filiform (length 11.7 mm, width 0.9 mm) while the variant stipule was broad and leafy (length 33.3 mm, width 5 mm; Fig. 1c, d). The petiole in the new variant was persistent. These variants along with a dwarf stem type were crossed in thirteen different combinations (Tables 1–7), and F_2 segregations were recorded in each cross. Joint segregation for two characters in each

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cross was tested by χ^2 method for independent assortment. Wherever linkage between two characters was detected, the recombination frequency and its standard error were calculated by the maximum likelihood method.

RESULTS AND DISCUSSION

From the phenotypes in F_1 generation it was noted that leafy stipule, narrow leaf, cordate leaf, green testa, yellow leaf, persistent petiole and dwarf stem were recessive. Similar information was reported earlier [2–4], except for dwarf stem, persistent petiole, cordate leaf and yellow leaf. Segregation in F_2 generations (Tables 1–7) confirmed that leafy stipule, narrow leaf, cordate leaf, green testa, yellow leaf, persistent petiole, dwarf stem were monogenic recessive. Since the inheritance of dwarf stem, persistant petiole, cordate leaf, yellow leaf and green testa is being reported for the first time, gene symbols for them are proposed here as Dw-dw, Ppt-ppt, Cd-cd, Yl-yl, and Gr-gr, respectively. The leafy stipule here could be similar to foliaceous stipule, described in this species, for which gene symbol Sfl-sfl was proposed [4] and is retained as such. However, this assumption needs to be confirmed by complementation test. Similarly, the gene symbol Sr-sr proposed earlier [2] for narrow leaf is also retained, subject to confirmation by complementation test. It is not certain whether the blue testa of *C. capsularis* reported earlier [3] is controlled by the same gene as the green testa character reported here.

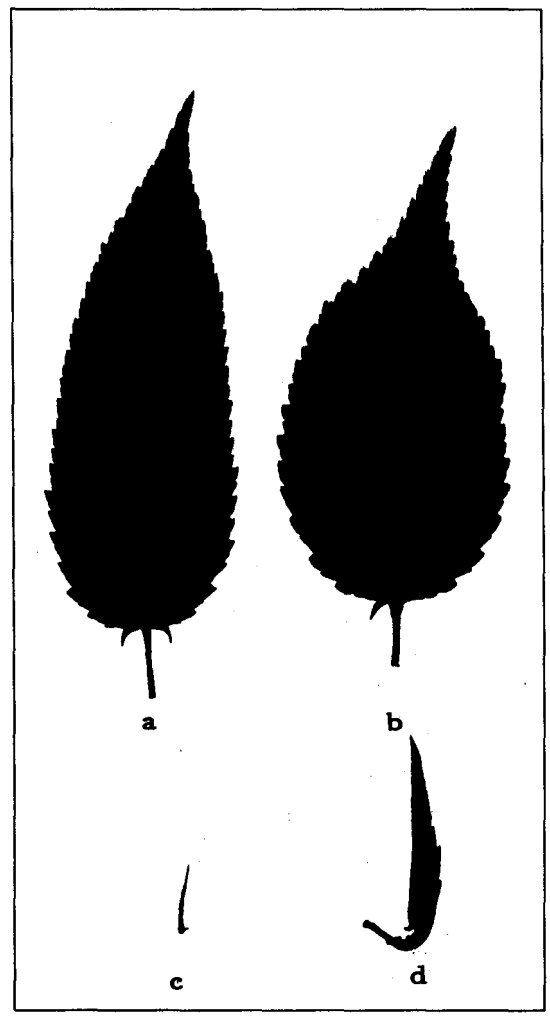

Fig. 1. **Showing (a) Normal leaf, (b) Cordate leaf, (c) Normal stipule and (d) Leafy stipule.**

The presence or absence of linkage was detected from the data on joint segregation of character pairs of each of the thirteen crosses. Only the crosses where linkage was detected are presented in Tables 8–11. Character pairs involved in the rest of the

Table 1. Inheritance of leafy stipule character in *C. capsularis*

Cross	Stipule type		F_2 plants			χ^2	P
	parents	F_1	normal stipule	leafy stipule	total	(3:1)	
Leafy stipule x dwarf stem	Leafy x normal	Normal	189	48	237	2.945	0.10–0.05
Cordate leaf x leafy stipule	Normal x leafy	Normal	471	141	612	1.255	0.50–0.25
Green testa x leafy stipule	Normal x leafy	Normal	346	103	449	1.016	0.50–0.25
Leafy stipule x persistent petiole	Leafy x normal	Normal	242	66	308	2.095	0.25–0.10
Leafy stipule x narrow leaf	Leafy x normal	Normal	359	116	475	0.085	0.90–0.75
Leafy stipule x yellow leaf	Leafy x normal	Normal	685	207	892	1.531	0.25–0.10
Heterogeneity						1.976	0.95–0.90

Table 2. Inheritance of cordate leaf character in *C. capsularis*

Cross	Leaf shape		F_2 plants			χ^2	P
	parents	F_1	normal leaf	cordate leaf	total	(3:1)	
Cordate leaf x leafy stipule	Cordate x normal	Normal	471	141	612	1.255	0.50–0.25
Cordate leaf x dwarf stem	Cordate x normal	Normal	448	159	607	0.467	0.50–0.25
Narrow leaf x cordate leaf	Normal x cordate	Normal	354	96	450	3.227	0.10–0.05
Cordate leaf x yellow leaf	Cordate x normal	Normal	171	71	242	2.430	0.10–0.05
Cordate leaf x persistent petiole	Cordate x normal	Normal	305	92	397	1.411	0.25–0.10
Heterogeneity						11.735	0.025–0.010

Table 3. Inheritance of narrow leaf character in *C. capsularis*

Cross	Leaf type		F_2 plants			χ^2	P
	parents	F_1	normal leaf	narrow leaf	total	(3:1)	
Leafy stipule x narrow leaf	Normal x narrow	Normal	364	111	475	0.085	0.90–0.75
Narrow leaf x cordate leaf	Narrow x normal	Normal	354	96	450	3.227	0.10–0.05
Narrow leaf x dwarf stem	Narrow x normal	Normal	266	76	342	1.407	0.25–0.10
Heterogeneity						0.075	> 0.95

Table 4. Inheritance of yellow leaf character in *C. capsularis*

Cross	Leaf colour		F_2 plants			χ^2	P
	parents	F_1	green	yellow	total	(3:1)	
Leafy stipule x yellow leaf	Green x yellow	Green	677	215	892	0.383	0.75–0.50
Cordate leaf x yellow leaf	Green x yellow	Green	188	54	242	0.931	0.50–0.25
Yellow leaf x dwarf stem	Yellow x green	Green	362	108	470	1.024	0.50–0.25
Heterogeneity						0.423	0.90–0.70

Table 5. Inheritance of persistent petiole character in *C. capsularis*

Cross	Petiole types		F_2 plants			χ^2	P
	parents	F_1	normal petiole	persis-tant petiole	total	(3:1)	
Leafy stipule x persistent petiole	Normal x persistent	Normal	241	66	307	2.095	0.25–0.10
Cordate leaf x persistent petiole	Normal x persistent	Normal	308	89	397	0.706	0.50–0.25
Persistent petiole x dwarf stem	Persistent x normal	Normal	530	168	698	0.232	0.75–0.50
Heterogeneity						0.156	0.95–0.90

Table 6. Inheritance of dwarf stem character in *C. capsularis*

Cross	Stem types		F_2 plants			χ^2	P
	parents	F_1	normal tall	dwarf	total	(3:1)	
Cordate leaf x dwarf stem	Tall x dwarf	Tall	451	156	607	0.159	0.75–0.50
Narrow leaf x dwarf stem	Tall x dwarf	Tall	264	78	342	0.887	0.50–0 25
Yellow leaf x dwarf stem	Tall x dwarf	Tall	366	104	470	2.086	0.25–0.10
Persistent petiole x dwarf	Tall x dwarf	Tall	532	166	698	0.552	0.50–0.25
Leafy stipule x dwarf stem	Tall x dwarf	Tall	172	65	237	0.744	0.50–0.25
Heterogeneity						3.566	0.50–0.25

Table 7. Inheritance of green testa character in *C. capsularis*

Cross	Testa types		F_2 plants			χ^2	P
	parents	F_1	chocolate testa	green testa	total	(3:1)	
Green testa x leafy stipule	Green x chocolate	Chocolate	338	111	449	0.019	0.95–0.90

Table 8. Joint segregation of leafy stipule and cordate leaf and their recombination frequency in *C. capsularis*

Cross	Phenotype		F_2 plants					$\hat{p}$	SE $\hat{p}$
	parents	F_1	normal leaf		cordate leaf		total		
			normal stipule	leafy stipule	normal stipule	leafy stipule			
Cordate leaf x Leafy stipule	Cordate leaf Normal stipule Normal leaf Leafy stipule	Normal leaf and stipule	346	125	125	16	612	0.39	0.02
	χ^2	P							
Leafy stipule	1.225	0.50–0.25							
Cordate leaf	1.255	0.50–0.25							
Linkage	12.273	< 0.005							

Table 9. Joint segregation of leafy stipule and green testa and their recombination frequency in *C. capsularis*

Cross	Phenotype		F_2 plants					$\hat{p}$	SE $\hat{p}$
	parents	F_1	normal stipule		leafy stipule		total		
			chocolate testa	green testa	chocolate testa	green testa			
Green testa x Leafy stipule	Normal stipule Green testa Leafy stipule Chocolate testa	Normal stipule Chocolate testa	244	102	94	9	449	0.34	0.03
	χ^2	P							
Leafy stipule	1.016	0.50–0.25							
Green testa	0.019	0.95–0.90							
Linkage	17.117	< 0.005							

Table 10. Joint segregation of leafy stipule and persistent petiole and their recombination frequency in *C. capsularis*

Cross	Phenotype		F_2 plants					$\hat{p}$	$SE\hat{p}$
	parents	F_1	normal stipule		leafy stipule		total		
			normal petiole	persistent petiole	normal petiole	persistent petiole			
Leafy stipule x Persistent petiole	Leafy stipule Normal petiole Normal stipule Persistent petiole	Normal leaf Normal petiole	181	61	61	5	308	0.4382	0.0394
	χ^2	p							
Leafy stipule	2.095	0.25–0.10							
Persistent petiole	2.095	0.25–0.10							
Linkage	7.071	0.01–0.005							

Table 11. Joint segregation of cordate leaf and dwarf stem and their recombination fraction in *C. capsularis*

Cross	Phenotype		F_2 plants					$\hat{p}$	$SE\hat{p}$
	parents	F_1	normal leaf		Cordate leaf		total		
			normal stem	dwarf stem	normal stem	dwarf stem			
Cordate leaf x Dwarf stem	Cordate leaf Normal stem Normal leaf Dwarf stem	Normal leaf Normal stem	347	101	104	55	607	0.2693	0.0217
	χ^2	p							
Cordate leaf	0.467	0.50–0.25							
Dwarf stem	0.159	0.75–0.50							
Linkage	9.433	< 0.005							

crosses showed independent segregation. Leafy stipule character was found to be linked with cordate leaf, green testa and persistent petiole. Linkage was also detected between cordate leaf and dwarf stem. Thus, the genes for leafy stipule, green testa, cordate leaf, persistent petiole and dwarf stem are located on the same chromosome. The genes for persistent petiole, cordate leaf, green testa mapped at the distances of 43.3, 39.2 and 33.6 map units, respectively, from leafy stipule gene, sfl. Since dwarf stem character is linked

with cordate leaf with a map distance of 26.9 it should also be linked with leafy stipule character. However, linkage between leafy stipule and dwarf stem could not be detected, possibly due to the location of the dwarf gene at a distance beyond 50 map unit from the leafy stipule gene. Similar explanation may be true for independent segregation of cordate leaf and persistent petiole which are supposed to be linked. To detect these linkages three-point tests will be necessary. Separate crosses needs to be planned for detection of linkage relations amongst the genes for persistent petiole, green testa, cordate leaf and dwarf stem. The genes for narrow leaf, yellow leaf and cordate leaf are not linked as they segregated independently.

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