Indian J. Genet., 50 (3): 283–288 (1990)

COMBINING ABILITY ANALYSIS FOR ROOT WEIGHT AND SHOOT WEIGHT IN *OLITORIUS* JUTE

D. K. DE AND K. K. GHOSH DASTIDAR

Department of Genetics and Plant Breeding, Bidhan Chandra Krishi Viswavidyalaya Mohanpur, West Bengal 741252

(Received: August 18, 1989; accepted: September 12, 1989)

ABSTRACT

In a seven-parent diallel cross of *Corchorus olitorius*, the nature of inheritance of dry weight of roots and shoots was studied after 15, 30 and 45 days of crop growth. Varieties Russian Red and Peking are recommended as parents for future hybridization due to their high general combining ability effects. Among the crosses with good specific combining ability effects, Sudan Green x Russian Red, JRO-7835 x Russian Red and Russian Red x Peking are expected to yield rare transgressive segregants, which may be useful in breeding for drought tolerance. Population improvement through diallel selective mating or mass selection with concurrent random mating should be followed to exploit both additive and nonadditive gene actions for these two characters.

Key words: Diallel, *Corchorus olitorius*, root weight, shoot weight, transgressive segregates, gca, sca, drought tolerance.

The two cultivated species of jute (*Corchorus olitorius* and *C. capsularis*) can be defined from the point of view of their physiological adaptation in root characters to environmental stresses like drought and water logging [1]. Inheritance study of different root characters in *capsularis* jute has revealed the predominant role of dominance [2]. Inheritance of root weight and shoot weight under dry conditions at different stages of growth in *C. olitorius* jute is reported in the present paper.

MATERIALS AND METHODS

The material consisted of seven *olitorius* varieties four of which were exotic selections (Russian Red, Sudan Green, Tanganika and Peking) and three were local cultivated varieties (JRO-632, JRO-7835 and JRO-878). All seven *olitorius* strains were crossed in all possible combinations without reciprocals. The 7 parents and 21 F_1 were grown in randomized block design with three replications. Each treatment was sown in five rows, 3 m long and 30 cm apart, with the plant-to-plant distance of 5–7 cm in a sandy loam soil. Fertilizers were

applied in the NPK ratio of 40 : 20 : 20 kg/ha at the time of field preparation and all other normal cultural practices were followed. Observations were recorded in 15 seedlings from each plot, excluding the border plants, 15, 30 and 45 days after germination. Care was taken to minimize the damage to the root system of each individual plant. Roots of each plant were thoroughly washed in tap water to remove all the traces of soil. Dry weight of root and shoot was recorded in each treatment at each growth stage. Combining ability analysis was done by following Model 1, Method 2 of Griffing [3].

RESULTS AND DISCUSSION

Both general and specific combining abilities (gca, sca) were highly significant for root and shoot dry weight at all stages of growth (Table 1). This indicates the importance of both additive and nonadditive gene actions in controlling the inheritance of root and shoot weight under dry conditions.

Table 1. Analysis of variance of combining ability for root characters in jute

Character	Source	d.f.	15 days	30 days	45 days
Dry weight of roots	Gca	6	2.41**	1274.9**	0.0856**
	Sca	21	1.21**	1184.5**	0.0666**
	Error	54	0.03	4.2	0.0002
Dry weight of shoots	Gca	6	86.58**	95171.7**	6.3604**
	Sca	21	89.39**	58160.01**	10.7467**
	Error	54	1.60	164.9	0.0187

** Significant at 1% level.
Note. Data recorded on 15th and 30th days in mg, and on 45th day in g.

The gca estimates of parents along with their mean values (Table 2) indicate that varieties Russian Red and Peking are good general combiners for both characters studied at all stages of growth. Varieties JRO-7835 and Sudan Green were also found to be good combiners in some cases. Since the data at 45 days were recorded in higher unit (g), in general, the gca effects of root and shoot dry weight decreased in the 45-day samples. Since high gca effect is due to additive and additive x additive interaction and represents the fixable components of genetic variance, the varieties Russian Red and Peking could be effectively used in breeding.

The best five crosses selected on the basis of per se performance and sca effects are presented in Table 3. When these five crosses were considered, it was found that the cross Sudan Green x Russian Red exhibited significant heterotic effect on the 15th and 30th days

of growth for dry root weight. Cross JRO-7835 x Russian Red also gave significant heterotic effects on 30th day only. On the other hand, at 45-day stage, only the cross Russian Red x Peking showed significant heterotic effect. All these three crosses also had significant sca

Table 2. Estimates of general combining ability effects and character means (in parentheses) for root and shoot weight in jute

Character	Parent	15 days	30 days	45 days
Dry weight of root	JRO-632	0.11	-5.60**	0.02**
		(5.25)	(123.50)	(1.01)
	JRO-7835	-0.38**	5.15**	-0.08**
		(3.50)	(53.83)	(0.46)
	JRO-878	-0.04	-5.89**	-0.03**
		(3.25)	(92.83)	(0.93)
	Russian Red	0.31	15.47**	0.05**
		(4.17)	(91.50)	(0.93)
	Sudan Green	-0.78**	8.53**	0.09**
		(2.25)	(99.75)	(0.64)
	Tanganika	-0.41**	-20.86**	-0.06**
		(3.50)	(38.50)	(0.57)
	Peking	0.93**	3.20**	0.18**
		(5.58)	(108.58)	(1.09)
SE (gi)		0.06	0.64	0.004
Dry weight of shoot	JRO-632	-1.27**	-64.98**	-0.11**
		(40.00)	(665.4)	(4.87)
	JRO-7835	4.21**	-6.58	0.17**
		(39.97)	(374.0)	(3.26)
	JRO-878	-1.99**	-29.02**	-0.54
		(27.33)	(617.8)	(2.89)
	Russian Red	3.98**	138.02**	-0.65
		(35.00)	(553.8)	(3.39)
	Sudan Green	-0.97*	17.71**	-0.33**
		(31.00)	(673.8)	(3.07)
	Tanganika	-4.18**	-164.42**	-0.34**
		(24.00)	(289.4)	(2.55)
	Peking	0.28	109.28**	1.80**
		(46.23)	(1061.9)	(10.58)
SE (gi)		0.39	3.96	0.04

*, ** Significant at 5% and 1% levels, respectively.

Note. Root and shoot weight (in parentheses) recorded in mg on 15th and 30th days and in g on 45th day.

effects and were considered as good x good general combiners, except at 15-day stage. Only variety Sudan Green was a poor combiner. A similar trend was also observed for dry shoot weight in early stages of growth (on 15th and 30th days). At 45-day stage, on the other hand, none of the crosses showed significant heterotic effect for shoot weight.

Table 3. The best five crosses of jute selected on the basis of per se performance and sca effects for root and shoot development in jute

Character	Growth stage	Crosses identified on the basis of	
		per se performance	sca effects
Dry weight of root	15 days	Sudan Green x Russian Red	Sudan Green x Russian Red
		JRO-632 x Peking	JRO-878 x JRO 7835
		JRO-878 x JRO-7835	JRO-632 x Peking
		Russian Red x Peking	Tanganika x JRO-632
		JRO-878 x Peking	JRO-878 x JRO-632
	30 days	Sudan Green x Russian Red	Sudan Green x Russian Red
		JRO-7835 x Russian Red	JRO-878 x JRO-7835
		JRO-878 x JRO 7835	JRO-7835 x Russian Red
		Russian Red x Peking	Tanganika x Peking
		JRO-7835 x Peking	Tanganika x JRO-7835
	45 days	Russian Red x Peking	Russian Red x Peking
		JRO-7835 x JRO-632	JRO-7835 x JRO-632
		Tanganika x Peking	Tanganika x Peking
		JRO-7835 x Peking	Sudan Green x JRO-632
		Tanganika x Russian Red	Sudan Green x JRO-7835
Dry weight of shoot	15 days	Sudan Green x Russian Red	Tanganika x Russian Red
		Tanganika x Russian Red	Sudan Green xJRO-878
		JRO-7835 x Peking	Sudan Green x Russian Red
		JRO-878 x Russian Red	Tanganika x JRO-7835
		Sudan Green x JRO-878	JRO-878 x Russian Red
	30 days	Sudan Green x Russian Red	Sudan Green x Russian Red
		JRO-7835 x Russian Red	JRO-7835 x Russian Red
		Russian Red x JRO-632	JRO-878 x JRO-7835
		JRO-878 x Peking	Russian Red x JRO-632
		Russian Red x Peking	JRO-878 x Peking
	45 days	Tanganika x Peking	JRO-7835 x JRO-632
		JRO-7835 x JRO-632	Sudan Green x Russian Red
		JRO-7835 x Peking	Tanganika x Peking
		JRO-878 x Peking	Tanganika x Sudan Green
		Sudan Green x Peking	JRO-878 x JRO-7835

The study of root system at early stages of crop growth in *olitorius* jute is of great significance from the standpoint of breeding for drought tolerance. Basak and Chowdhury [1] showed that *C. olitorius* with a deeper root system can easily adapt to drought conditions. Under this situation, development of a stable heterotic hybrid for both root and shoot characters in *olitorius* jute is of great importance for getting higher fibre yield combined with drought tolerance. A prerequisite for high, uniform and stable heterotic effect is the correct gene content in the homozygous state, or if the appropriate alleles are completely dominant without affecting performance of the heterozygote [4]. Among the crosses with good sca effects, although variety Sudan Green was a poor combiner at 15-day stage, it was a good combiner at 30 day stage. Such opposite trends in gca effects at different growth stages were reported earlier in *capsularis* jute [5]. But if the crosses showing high sca effects involved one or both high general combiners, they can be successfully exploited for varietal improvement, as they are expected to throw stable transgressive segregates carrying fixable gene effects [6]. Therefore, crosses Sudan Green x Russian Red, JRO- 7835 x Russian Red, and Russian Red x Peking may be of substantial value in breeding for drought tolerance.

Since both additive and nonadditive variances were important in the genetic control of both root and shoot weight, population improvement through diallel selective mating [7] or mass selection with concurrent random mating [8] can yield new cultures with high drought tolerance.

ACKNOWLEDGEMENT

The authors wish to express their deep sense of gratitude to Dr. S. Dana, Professor of Genetics and Plant Breeding, Bidhan Chandra Krishi Viswavidyalaya, for kindly examining the manuscript and giving valuable suggestions.

REFERENCES

1. S. L. Basak and B. B. Chowdhury. 1967. Genetic variation and phenotypic plasticity of roots in two cultivated species of jute (*Corchorus olitorius* L. and *C. capsularis* L.). Biol. Plant., 9(4): 292–300.

2. P. K. Ghosh, C. Bhattacharya and S. C. Rakshit. 1989. Heterosis and genetics of root characters of the male sterile line of capsularis jute. Proc. National Seminar on Heterosis Breeding in Self-Pollinated Plants. Bidhan Chandra Krishi Viswavidyalaya, Kalyani: 169–171.

3. B. Griffing. 1956. Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci., 9: 463–493.

4. J. L. Jinks. 1983. Biometrical genetics of heterosis. *In*: Heterosis Reappraisal of Theory and Practice (Ed. R. Frankel). Springer – Verlag Publication, Berlin: 1–46.

5. K. K. Ghosh Dastidar and P. N. Bhaduri. 1985. Combining ability for plant height and base diameter at different stages in *capsularis* jute. Exptl. Genet., **1**(2): 52–58.

6. R. Singh, G. S. Bhullar and K. S. Gill. 1983. Combining ability over environments in durum wheat. Indian J. Genet., **43**(2): 152–156.

7. N. F. Jensen. 1970. A diallel selective mating system for cereal breeding. Crop Sci., **10**: 629–635.

8. R. J. Redden and N. F. Jensen. 1974. Mass selection and mating systems in cereals. Crop Sci., **14**: 345–350.