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COMBINING ABILITY FOR YIELD AN ITS COMPONENTS IN RICE BEAN

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ABSTRACT

Combining ability analysis in rice bean [*Vigna umbellata* (Thunb.) Ohwi & Ohashi] was studied in a 6 x 6 diallel cross without reciprocals in F_1 and F_2 generations. The variances due to gca and sca were highly significant, indicating the importance of additive and nonadditive gene action for all the 9 traits. The estimates of gca components were higher in magnitude than that of sca component for all the traits except seeds/pod, indicating the importance of additive gene action for the traits. Parent RCRT-64 was a good general combiner for all the traits except seeds/pod. Eight hybrids were good specific combinations for grain yield. For improvement of the crop yield, biparental mating followed by recurrent selection or by selective diallel mating system to exploit additive and nonadditive gene action is suggested.

Key words: Rice bean, *Vigna umbellata*, combining ability.

Rice bean [*Vigna umbellata* (Thunb.) Ohwi & Ohashi] is an important underutilized grain legume with great potential in the north eastern hill region, but its improvement by breeding has been mostly limited to the examination of varietal differences and selection from local variability, with very few genetic investigations. The most appropriate breeding methodology to be adopted for improvement of a crop depends primarily on the combining ability of the parents in the hybridization programme and also the nature of gene action involved in the expression of quantitative traits of economic importance. Information on these aspects is very limited in rice bean [1]. Hence the present investigation has been undertaken to get information on the combining ability of the parents and gene action for yield and its components in rice bean.

MATERIALS AND METHODS

Six rice bean genotype, viz RBL-2, RBL-50, RBL-52, RBL-13, RBL-35 and RCRT-64, were crossed to get 15 cross combinations. The entire material comprising of 15 F_1, 15 F_2 and 6 parents was grown in randomized block design with 3 replications at the research farm of

ICAR Research Complex for NEH Region, Sikkim Centre, Tadong, Gangtok, Sikkim. Two rows of 2 m length constituted a plot for each parent and F_1 and five rows for each F_2 population. The distances between rows and plants were 40 cm and 10 cm, respectively. Observations were recorded on five random plants from each plot of parents and F_1, and 10 random plants from each F_2 for 9 quantitative traits (Table 1). The replication means were analysed for combining ability following Method 2, Model 1 of Griffing [2]. Analysis of variance was performed separately for F_1 and F_2 generations.

Table 1. Analysis of variance (mean squares) for combining ability for 9 characters in a six-parent diallel cross in rice bean

Source		d.f.	Days to flowering	Days to maturity	Plant height	Branches per plant	Pods per plant	Pod length	Seeds per pod	100-seed weight	Grain yield
Gca	F_1	5	314.9**	347.9**	3222.6**	1.2**	145.0**	0.5**	1.0**	13.0**	38138.3**
	F_2	100	416.0**	449.2**	3466.1**	1.2**	139.8**	1.4**	0.9**	12.7**	20331.4**
Sca	F_1	15	4.4**	7.2**	463.4**	0.7**	58.7**	0.3**	1.8**	0.5**	3003.0**
	F_2	100	19.9**	23.4**	400.8**	0.5**	34.5**	0.5**	1.6**	0.6**	3496.6**
Error	F_1	100	0.5	0.9	10.6	0.1	2.2	0.1	0.1	0.1	194.4
	F_2	100	0.5	0.9	11.9	0.1	1.6	0.1	0.1	0.1	217.6

*P = 0.05, **P = 0.01.

RESULTS AND DISCUSSION

Analysis of variance for combining ability revealed highly significant gca and sca variances in both the F_1 and F_2 generations for all the characters, indicating the presence of additive as well as nonadditive gene effects in the parents and hybrids for these characters. Shanmugasundaram and Sree Rangasamy [3] also reported highly significant gca and sca variances for five yield component traits in black gram. However Das and Dana [1] reported predominance of nonadditive variance in rice bean for green and dry fodder yield. The variances due to gca were of higher magnitude than the corresponding sca variances for all the characters except for seeds/pod, suggesting predominance of additive gene action in respect of these traits and nonadditive gene action for seeds/pod.

The gca estimates indicated that the parent RCRT-64 was a good general combiner for all the traits except seeds/pod. The parent RBL-50 was a good general combiner for grain yield only. The other parents with good general combining ability estimates were RBL-35 for plant height, RBL-50 for branches/plant, RBL-13 for pods/plant and pod length, and RBL-2 for seeds/pod.

Table 2. Estimates of general combining ability effects of six parents for nine characters in a six-parent diallel mating design of rice bean (F_1 and F_2)

Parent	Days to flowering		Days to maturity		Plant height		Branches per plant		Pods per plant		Pod length		Seeds per pod		100-seed weight		Grain yield	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
RBL-2	-3.44^{**}	-3.36^{**}	-2.14^{**}	-2.82^{**}	-18.88^{**}	-22.09^{**}	-0.60^{*}	-0.63^{**}	-4.18^{**}	-3.27^{**}	0.00	-0.18	0.57^{*}	0.54^{*}	-0.54^{*}	-0.47	-2.13	-11.56^{*}
RBL-35	-2.44^{**}	-3.07^{**}	-0.39^{**}	-0.61^{**}	2.61	6.46^{**}	0.02	0.13^{*}	0.26	-0.73^{*}	-0.06	-0.46^{*}	0.15	0.09	0.06	0.07	-60.21^{**}	-11.93^{*}
RBL-52	-1.36^{**}	-0.61^{**}	-3.35^{**}	-2.57^{**}	-18.03^{**}	-17.84^{**}	-0.08	0.00	-3.05^{**}	-4.07^{**}	-0.15^{*}	-0.15	-0.36^{*}	-0.42^{*}	-0.50^{*}	-0.51	-80.04^{**}	-80.14^{**}
RBL-13	-1.82^{**}	-3.32^{**}	-1.81^{**}	-3.24^{**}	1.63	0.53^{**}	-0.09	-0.21^{*}	0.75^{*}	2.04^{*}	0.40^{*}	0.69^{*}	-0.27	-0.26	-0.96^{*}	-0.92^{*}	-6.25	-1.26
RBL-50	-3.61^{**}	-4.15^{**}	-5.35^{**}	-5.69^{**}	-3.54^{**}	-3.21^{**}	0.19^{*}	0.24^{**}	-1.58^{*}	-1.30^{*}	-0.35^{*}	-0.17	0.18	0.21	-0.62^{*}	-0.65^{*}	37.46^{**}	36.53^{**}
RCRT-64	12.68^{**}	14.51^{**}	13.03^{**}	14.93^{**}	36.20^{**}	36.16^{**}	0.57^{**}	0.48^{**}	7.80^{**}	7.33^{**}	0.16^{*}	0.28^{*}	-0.27	-0.16	2.52^{**}	2.49^{**}	111.17^{**}	68.36^{**}
SE (gi)	0.24	0.22	0.30	0.32	1.05	1.12	0.06	0.06	0.47	0.40	0.07	0.07	0.07	0.07	0.07	0.19	0.49	4.76
SE (gi-gj)	0.37	0.34	0.47	0.49	1.63	1.73	0.09	0.09	0.73	0.62	0.10	0.11	0.11	0.11	0.11	0.97	6.97	7.37

The sca estimates indicated that the crosses RBL-50 x RCRT-64, RBL-13 x RBL-50, RBL-52 x RCRT- 64, RBL-35 x RCRT-64, RBL-2 x RCRT-64 and RBL-52 x RBL-13 produced superior hybrids. The sca of 30 heterotic crosses for yield and its component traits indicated that most of the good specific cross combinations for different characters involved either one or both good gca parents. The crosses involving high x high gca parents indicates the possibility of complementary epistasis acting in the direction of additive effects of the good combiners. The crosses of high x low gca parents with positive sca effects may be due to dominant x recessive interaction, expected to produce desirable segregates in F_2. However, crosses between low x low gca parents indicated the importance of nonadditive genetic variation and can be exploited by heterosis breeding or multiple crosses, followed by intermating among the desirable segregates. Similar results were reported by Shanmugasundaram and Sree Rangasamy [3] in black gram.

The present study has identified parents RCRT-64 and RBL-50 as superior general combiner for yield and its component traits. The importance of additive as well as nonadditive genetic components is highlighted. Improvement in yield and its attributes should be possible by resorting to biparental mating, followed by recurrent selection or by selective diallel mating system.

Table 3. Estimates of specific combining ability effects for nine characters

Cross	Days to flowering		Days to maturity		Plant height		Branches/plant	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
RBL-2 x RBL-35	– 1.10*	– 2.08*	– 3.30*	– 5.89*	– 222.67*	– 5.37*	0.84*	1.06*
RBL-2 x RBL-52	1.82*	1.13*	4.33*	0.07	11.14*	– 1.81	– 0.79*	– 1.01*
RBL-2 x RBL-13	1.28*	3.17*	– 1.55*	– 0.93	4.87	– 8.17*	– 0.31*	– 0.63*
RBL-2 x RBL-50	0.40	– 0.99	– 0.67	– 2.80*	6.31	2.66	– 0.49*	0.19
RBL-2 x RCR-64	3.78**	7.01*	2.29*	4.90*	– 40.16*	– 32.07*	– 1.50*	– 1.45*
RBL-35 x RBL-52	0.82	– 1.16	– 1.42*	– 2.14*	– 15.55*	1.77	– 1.80*	– 0.77*
RBL-35 x RBL-13	– 0.05	0.21	– 3.63*	– 3.80*	– 0.29*	– 0.66	– 0.23	– 0.23
RBL-35 x RBL-50	1.07*	0.38	– 0.42	– 2.01*	– 7.11*	– 5.92*	0.02	– 0.01
RBL-35 x RCR-64	2.11*	4.71*	– 0.46	0.70	42.15**	30.71*	0.45*	0.22
RBL-52 x RBL-13	– 1.80*	– 0.58	– 1.67*	– 0.51	– 6.97*	– 1.36	0.08	0.21
RBL-52 x RBL-50	– 1.01*	– 2.08*	1.54*	– 0.39	7.87*	10.04*	0.36*	0.29
RBL-52 x RCR-64	– 1.30*	5.92*	– 0.51	5.32*	– 3.21*	– 5.94*	0.75*	0.75*
RBL-13 x RBL-50	– 0.55	– 1.04	2.33*	0.28	– 10.80*	– 6.99*	– 0.10	– 0.07
RBL-13 x RCR-64	0.49	– 6.70*	– 1.05	– 9.35*	27.79*	35.97*	0.59*	0.83*
RBL-50 x RCR-64	2.28*	5.46*	2.16*	5.45*	20.97*	27.38*	– 0.29*	– 0.16
SE (sii)	0.54	0.49	0.69	0.72	2.38	2.53	0.13	0.13
SE (sij)	0.37	0.60	0.83	0.88	2.88	3.10	0.15	0.15
SE (sij-sik)	0.98	0.89	1.24	1.32	4.31	4.37	0.23	0.22
SE (sij-skl)	0.91	0.83	1.14	1.22	3.98	4.23	0.22	0.21

*,**P = 0.05 and P = 0.01 levels, respectively.

REFERENCES

1. N. D. Das and S. Dana. 1978. Diallel analysis of forage yield in rice bean. Indian Agric., **2**(3): 151–157.

in 15 crosses of rice bean (F_1 and F_2)

Pods/plant		Pod length		Seeds/pod		100-seed weight		Grain yield	
F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
- 1.29	- 1.69	0.58*	- 1.50*	- 0.09	- 0.25	- 0.01	0.14	20.38*	8.23
- 3.98*	- 1.82	0.12	0.37*	0.88*	1.34*	0.17*	0.34*	- 33.12*	- 0.56
- 4.31*	- 5.59*	- 1.17*	0.11	1.83*	1.19*	- 0.16	- 0.04	- 15.24*	9.90
- 2.24	0.78	- 0.06	0.35*	1.31*	1.45*	- 0.30*	- 0.05	7.71*	26.77*
- 16.09*	- 9.32*	- 0.02	- 0.21	1.16*	1.51*	1.59*	1.11	69.01*	- 60.06*
- 11.08*	- 7.80*	- 0.09	- 0.52*	2.74*	2.06*	0.06	0.25*	- 5.37	14.82
0.82	4.54*	- 0.52*	- 0.10	0.02	0.51*	0.48*	0.77*	22.84*	16.27
4.16*	- 2.50	0.36*	0.63*	- 0.16	0.07	- 0.43*	- 0.61*	- 43.87*	35.15*
6.18*	8.94*	- 0.18	0.44*	- 0.85*	- 0.70*	0.25*	0.27*	65.76*	151.65*
- 1.07	2.30*	- 0.09	- 0.14	- 0.71*	- 0.43	- 0.23*	- 0.25*	639.34*	- 36.52*
- 2.07	2.34*	- 0.14	0.15	- 0.33*	- 0.50*	- 0.35*	- 0.46*	- 59.04*	6.02
12.42*	1.75	- 0.15	0.16*	- 0.95*	- 0.79*	1.19*	1.32*	55.26*	- 14.81
- 2.10	1.43	0.73*	0.69*	0.29*	0.44*	0.02	0.11	43.51*	13.82
4.22*	6.67*	1.04*	1.00*	- 0.70*	- 0.67*	- 0.99*	- 0.93*	- 58.20*	20.98*
0.59	4.07*	- 0.09	0.08	- 0.38*	- 0.36	- 0.26*	0.00	75.42*	- 88.48*
1.10	0.91	0.16	0.16	0.16	0.16	0.16	0.14	10.20	10.79
1.30	1.10	0.19	0.19	0.19	0.20	0.19	0.17	12.31	13.08
1.94	1.64	0.28	0.28	0.29	0.29	0.29	0.26	18.44	*19.51
1.79	1.53	0.26	0.26	0.27	0.28	0.26	0.24	17.10	18.06

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

3. P. Shanmugasundaram and S. R. Sree Rangasamy. 1994. Combining ability for yield and its components in black gram. Indian J. Genet., **54**(1): 6–9.