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GENETICS AND PLANT BREEDING

Genetic analysis of yield attributes in ricebean (*Vigna Umbellata* Thunb.) under hot and humid climatic conditions

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ABSTRACT

Combining ability studies were carried out in ricebean through line x tester analysis involving two lines and six testers for nine quantitative traits. The relative estimates of variance due to specific combining ability (*sca*) were higher than variance due to general combing ability (*gca*) for days to 50% flowering, days to maturity, plant height, number of pods per plant, number of seeds per pod, pod length, grain yield per plant and 100-seed weight indicating the pre-dominance of non-additive gene action for these traits. The parents LRB 482 and KBR1 were good general combiners for plant height, number of pods per plant and grain yield per plant. The hybrid combination RBL 35 x KBR 1 recorded highly significant *sca* effects for days to maturity, number of primary branches per plant, number of pods per plant, number of seeds per pod, pod length and grain yield per plant along with high *per se* performance.

Highlights

- Line x tester analysis was carried out in ricebean involving two lines and six testers for nine quantitative traits at Regional Research Station (RRS) Gurdaspur, Punjab
- The cross combinations; RBL 6 x LRB 482 and RBL 35 x KBR1 were identified to be best and could be exploited further, for transgressive segregation for grain yield and component traits in ricebean

Keywords: Combining ability, *Vigna umbellata*, ricebean, line x tester analysis

Vigna umbellata (Thunb.) Ohwi & Ohashi; commonly known as ricebean or climbing mountain bean is an underexploited tropical grain legume; grown mainly in tribal regions of north eastern hills and hilly tracts of Western and Eastern Ghats in India. It is a potential legume crop due to its wider adaptability, high nodulating capacity, resistance to foliar diseases and stored grain insect-pests. Protein in ricebean is rich in limiting amino acids, methionine and tryptophan. Its seeds contain vitamins such as thiamine, riboflavin, niacin and ascorbic acid (Buergelt *et al.* 2009). It is grown on limited scale due to non-availability of suitable genotypes with erect and compact growth habit, early and synchronous maturity. Genetic information on major yield attributing traits is a pre-requisite of crop improvement. However, the success in the crop improvement programme depends primarily upon identification of best parental lines which may produce valuable gene combinations. The knowledge of combining ability is useful to assess mating ability of parents in self pollinated crops and at the same time elucidate the nature and magnitude of gene action involved (Baker, 1978). The present investigation was therefore, carried out to know the type of gene action governing yield and yield contributing traits and to identify the parents and crosses which could be exploited for future breeding programme under hot and humid climatic conditions.

Material and methods

The experimental material for the present study comprised of 12 F_1's of ricebean generated by crossing two lines viz, RBL 6, RBL 35 and six diverse testers viz, namely ;, LRB 482 , RRB 18 , EC 018171 , KBR 1 , V 2492 and V 2494 . The genotypes RBL 6, RBL 35 and LBR 482 are high yielding ricebean genotypes from Punjab Agricultural University Ludhiana. RRB 18 is high yielding advance breading line from Birsa Agricultural University, Ranchi (Jharkhand), KBR 1 from Uttar Banga Krishi Vishwavidyalaya, Cooch Bihar (West Bengal), EC 018171 is a high yielding germplasm line from NBPGR, New Delhi; V2492 and V2494 are early maturing lines from Govind Ballabh Pant University of Agriculture and Technology, Ranichauri (Uttrakhand).

These 20 genotypes (12 F_1's and 8 parents) were sown in two replications at RRS, Gurdaspur in Punjab during kharif 2015. The climate at Gurdaspur is hot and humid during kharif season which is conducive for growth of ricebean crop. Each treatment was sown in 4 m long single row plot spaced 30 cm apart. Within rows seeds were sown at 10 to 12 cm distance. Observations were recorded on five random plants from each F_1 and parents on seven quantitative traits namely, plant height (cm), number of primary branches per plant, number of pods per plant, number of seeds per pod, pod length (cm), grain yield per plant (g) and 100-seed weight (g). Days to 50% flowering and days to maturity were recorded on plot basis. The statistical analysis was done as per the procedure given by Kempthorne (1957) for combining ability analysis.

Results and discussion

The analysis of variance for combining ability revealed that sufficient variability existed in the material for all the traits studied. The variance due to the parents was highly significant for days to maturity, plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod, pod length, grain yield per plant and 100- seed weight. The variance due to hybrids was highly significant for days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod and grain yield per plant. The variance due to parent versus hybrid was highly significant for days to maturity, plant height, and number of seeds per pod indicating the presence of substantial heterosis for these traits in the crosses. The variance due to lines was highly significant for days to maturity, plant height and number of primary branches per plant. The variance due to testers was highly significant for plant height and 100- seed weight. The analysis of variance due to lines x testers was highly significant for days to 50% flowering, days to maturity, number of primary branches per plant, number of pods per plant, number of seeds per pod and grain yield per plant indicating that lines interacted sufficiently with testers. The significant differences among different genotypes of ricebean and their F_1 hybrids for grain yield and other components traits in different sets of material were also reported by Gill *et al.* (2014), Mishra *et al.* (2008) and Lakshmana *et al.* (2007).

The relative estimates of variance due to *sca* were higher than variance due to *gca* for days to 50% flowering, days to maturity, plant height, number of pods per plant, number of seeds per pod, pod length, grain yield per plant and 100-seed weight, suggesting that selection and inter-mating in early segregating generations will be desirable for exploiting non-additive gene effects. Das and Dana (1978) reported the pre-dominance of non-additive variance in ricebean for green and dry fodder yield. However, Singh and Singh (1996) reported the presence of both additive and non-additive gene effects in the parents and hybrids for grain yield and different components traits in ricebean. Laksmana *et al.* (2007) also reported that both additive and non-additive gene effects were important for plant height, number of branches per plant, number of cluster per plant, number of pods per plant, pod length, seeds per pod, 100-seed weight and grain yield per plant.

The estimates of gca and per se performance of parents are given in Table 2. The parents with high per se performance and significant gca effects are considered as good general combines for deriving desirable transgenic segregates in self pollinated crops. The line RBL 6 and testers EC018171, V2492 and V2494 recorded significant negative gca effects for days to maturity suggesting that these parents are good general combiners for breeding for early maturity as they showed high negative gca effects. For plant height, line RBL6 and testers LRB 482 and KBR1 showed highly significant negative gca effects indicating them to be a good general combiner for breeding for dwarf varieties in ricebean. The testers RRB 18, and EC 018171 recorded significant

Table 1. Analysis of variance for various traits in ricebean

Source	df	Days to50% flowering	Days to maturity	Plant height (cm)	Number of primary branches / plant	Number of pods plant	Number of seeds/ pod	Pod length	Grain yield/ Plant (g)	100-seed wt. (g)
Parents	7	4.82	92.35**	357.35**	1.40**	404.25**	2.98**	1.38**	146.13**	8.42**
Hybrids	11	14.56**	115.74**	620.21**	1.46**	684.22**	1.97**	0.95**	599.72**	0.44
F_1 vs Parents	1	0.59	367.53**	743.45**	0.86	129.07	4.96**	1.32	6.34	1.05
Lines	1	100.04**	35.04	2882.04**	1.76**	2.04	1.46	0.88	1.50	2.34
Testers	5	6.08	191.07	743.45**	1.57	484.94	1.47	0.29	791.80	5.06**
Lines x Testers (LxT)	5	5.94*	56.54**	44.62	1.28**	1019.94**	2.87**	1.62	527.30**	0.44
Error (Me)	19	1.92	4.76	33.26	0.14	40.01	0.38	0.21	20.33	1.48
δ^2 gca		5.89	7.06	221.02	-4.74	97.06	0.26	0.13	16.33	1.94
δ^2 sca		2.01	25.89	5.68	0.57	489.96	1.24	0.70	253.48	2.13
δ^2 gca/ δ^2 sca		2.93	0.27	38.91	-8.31	0.19	0.21	0.18	0.06	0.91

**, ** Significant at P= 0.05 and 0.01 respectively*

Table 2. Estimates of gca effects of parents for various traits in ricebean

Sr. No.	Parent	Days to50% flowering	Days to maturity	Plant height (cm)	Number of primary branches/ plant	Number of pods/ plant	Number of seeds/ pod	Pod length	Grain yield/ Plant (g)	100-seed wt. (g)
					Lines					
1	RBL 6	-2.04** (62.0)	-1.21** (113.50)	-10.96** (115.75)	-0.27 (4.50)	0.23 (70.00)	-0.03 (9.45)	-0.19 (8.15)	-0.25 (62.50)	0.31 (7.00)
2	RBL 35	2.04** (63.0)	1.24* (110)	10.96** (127.50)	0.24 (4.75)	-0.29 (55.0)	-0.02 (8.15)	-0.19 (8.05)	0.34 (50.00)	-0.47 (6.85)
	S.E.(±)	0.28	0.45	1.18	-7.78	1.29	0.13	-9.46	0.92	2.48
					Testers					
1	LRB 482	-1.38 (59.50)	9.88** (114.0)	-9.13** (101.0)	0.19 (3.40)	8.79* (51.50)	-0.13 (8.45)	-0.24 (8.45)	15.00** (50.00)	-0.01 (6.55)
2	RRB 18	-1.13 (63.0)	6.38** (111.0)	2.25 (122.65)	0.44* (3.75)	2.54 (40.50)	0.27 (7.20)	0.08 (7.55)	6.25* (45.00)	0.19 (6.55)
3	EC 018171	1.13 (64.50)	-5.38** (113.0)	5.63 (134.0)	0.56* (4.25)	2.29 (43.0)	0.52 (8.50)	-0.24 (8.15)	8.25** (43.50)	-0.04 (6.90)
4	KBR 1	-0.63 (62.0)	0.88 (102.50)	-22.75** (117.0)	0.31 (3.00)	12.04** (45.50)	0.70* (7.65)	0.48* (7.85)	5.25* (41.50)	-0.01 (6.20)
5	V 2492	1.63* (62.50)	-6.88** (98.5)	13.38** (102.0)	-0.44* (2.75)	-8.21* (31.50)	-0.83* (5.45)	-0.02 (6.10)	-13.75** (34.00)	-0.16 (6.45)
6	V 2494	0.38 (60.50)	-4.88** (98.0)	10.63** (97.50)	-1.06** (2.50)	-17.46** (24.00)	-0.55 (6.90)	-0.07 (6.60)	-21.00** (40.00)	-0.01 (6.65)
	S.E.(±)	0.63	0.99	2.63	0.18	2.89	0.28	0.21	2.06	5.54

**, ** Significant at P= 0.05 and 0.01 respectively*

Table 3. Specific combining ability effects, mean performance and general combining ability effects of parents and promising crosses in ricebean

Sr. No.	Character	Cross Combination	**sca effects**	***Per se* performance**	**gca effects of parents**
1	Days to 50% flowering	RBL 35 x EC 018171	-2.04**	63.50	H x L
2	Days to maturity	RBL 6 x EC 018171	-5.29**	89.50	H x H
		RBL 35 x KBR 1	-5.95**	92.50	M x L
3	Number of Primary branches per plant	RBL 6 x EC 018171	0.39*	4.00	L x M
		RBL 35 x KBR 1	1.10**	5.00	L x L
3	Number of pods per plant	RBL 6 x LRB 482	20.95**	71.50	L x M
		RBL 6 x EC 018171	13.45**	57.50	L x L
		RBL 35 x KBR 1	24.29**	77.50	L x H
		RBL 35 x V 2492	7.04*	40.00	L x M
4	Number of seeds per pod	RBL 6 x LRB 482	0.65**	7.50	L x L
		RBL 6 x RRB 18	0.90**	8.15	L x L
		RBL 35 x KBR 1	1.42**	9.15	L x M
6	Pod length (cm)	RBL 6 x RRB 18	0.77**	7.90	L x L
		RBL 6 x V 2492	0.62*	7.60	L x L
		RBL 35 x LRB 482	0.56*	7.75	L x L
		RBL 35 x KBR 1	0.68**	8.60	L x M
7	Grain yield per plant (g)	RBL 6 x LRB 482	7.75**	67.50	L x H
		RBL 6 x RRB 18	9.00**	60.00	L x M
		RBL 6 x V 2492	5.50*	36.50	L x H
		RBL 35 x KBR 1	22.00**	72.50	L x M

*, ** Significant at P= 0.05 and 0.01 respectively H – High, L – Low, M – Medium

positive gca effects for number of primary branches per plants and their mean values were also high. Whereas, the testers LRB 482 and KBR 1 were good general combiners for number of pods per plant as they showed significant gca effects and high per se performance for this important yield component. The tester KBR 1 showed significant gca effects for number of seeds per pod and pod length also. For grain yield, the testers LRB 482, RRB 18, EC 018171 and KBR 1 were good general combiners. In the present study, the gca effects of parents indicated that the parent LRB 482 was a good general combiner for days to maturity, plant height, number of pods per plant and grain yield per plant. KBR1 was another good general combiner for plant height, number of pods per plant, number of seeds per pod, pod length and grain yield per plant .The high *gca* effects are generally ascribed to additive gene effects or additive x additive interaction effects (Griffing 1956), hence these good general combiners can be used in breeding programme of ricebean.

The *sca* effect is an important criterion for the evaluation of hybrids. Among the various gene interactions contributing towards *sca*, the additive x additive type of gene interaction is fixable in later generations in self pollinated crops like ricebean. Thus, the ultimate aim of a breeder is to generate desirable transgressive segregants to develop potential homozygous lines through hybridization. The cross-combinations with significant desirable *sca* effects for various traits along with mean performance and *gca* effects of the parents are listed in Table 3.

The cross RBL 35 x KBR 1 recorded highly significant desirable sca effects and high mean values for days to maturity, number of primary branches per plants, number of pods per plants, number of seeds per pod, pod length and grain yield per plant suggesting that it can be exploited for transgressive segregation for these traits. The cross RBL6 x EC018171 gave significant sca effects for number primary branches per plant and number of pod per plant and lowest mean value for day to maturity. For days to 50% flowering, the hybrid ; RBL 35 x EC 018171 recorded significant negative sca effect. The cross RBL 6 x LRB 482 recorded highly significant sca effect for number pod per plants, number of seeds per pod and grain yield per plant, The cross RBL 35 x V 2492 also gave significant sca effects for number pod per plants . The won RBL6 x RRB18 recorded highly significant sca effect and high mean value for number of seeds per pod , pod length and grain yield per plant. For pod length , two more crosses RBL 6 x V 2492 , RBL 35 x LRB 482 gave significant sca effects . The cross RBL 6 x V 2492 also recorded significant sca effect for grain yield per plant

It was observed that the desirable cross combinations included low x high, low x medium, high x high and low x low *gca* effects of parents. In crosses with low x high or low x medium *gca* effects, the high positive *sca* effects may be due to dominant x recessive gene interaction expected to produce desirable segregants in subsequent generations (Lingham, 1961). However, crosses between low x low combiners indicated the importance of non-additive genetic variation and they can be exploited by heterosis breeding or multiple crosses followed by intermating among the desirable segregants. Similar results were reported by Misra *et al.* (2008), Singh and Singh (1996) in ricebean . In the present study, the cross combination viz. RBL 6 x LRB 482 and RBL 35 x KBR1 were identified to be best and could be exploited further, for transgressive segregation for grain yield per plant and other component traits for cultivation of ricebean under hot and humid climatic conditions.The study described the importance of both additive and non-additive genetic components for inheritance of yield and its component traits.

References

Baker RJ 1978 Issues in diallel analysis. Crop Science 18:533-536 doi:10.2135/*cropsci1978*.0011183X001800040001x

Buergelt D, Oppen M and Yadavendra JP 2009 Quality parameters in relation to consumer’s preference in ricebean. Presentation at international conference on grain legumes, Feb.14-16,2009, Kanpur, India

Das ND and Dana S (1978) Diallel analysis of forage yield in ricebean. Indian Agriculture 2: 151-157

Gill RK and Tyagi vikrant 2014 Combining ability analysis for grain yield and component traits in ricebean. Crop improvement 41: 105-108.

Griffing B 1956 Concepts of general and specific combining ability in relation to diallel crossing systems. Australian Journal of Biological Sciences 9 : 463-493

Kempthorne O 1957 An introduction to genetic statistics. 2nd ed. John Wiley and Sons, New York, USA and Champman and Hall Ltd, London, U.K.

Lakshmana D, Reddy BGS and Ramesh S 2007 Studies on combining ability in ricebean. Legume Research 30: 311-312.

Lingham DC 1961 The high – low method of crop improvement. Crop Science 1 : 376-378

Mishra TK, Panda RR, Bastia D and Box LK 2008 Combining ability analysis of quantitative traits in ricebean. Emirates Journal of Food Agriculture 20: 51-56

Singh G and Singh M (1996) Combining ability for yield and its components in ricebean. Indian Journal of Genetics and plant breeding 56: 520-525