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COMBINING ABILITY STUDIES FOR SEED YIELD AND ITS COMPONENTS OVER ENVIRONMENTS IN BLACK GRAM

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ABSTRACT

G x E interaction was observed for most of the seed yield traits in F_1 generation. Heterogeneity present between error variances of two locations indicated that the observed G x E interaction is not linear. Gca x location interaction was observed for seeds/pod, whereas sca x location interaction was observed with respect to harvest index, pod length, and seeds/pod on the basis of combining ability effects both in F_1 and F_2 generations at two locations with positive gca and sca effects recorded for seed yield and its components.

Key words: Combining ability, yield components, blackgram.

Proper choice of parents for hybridization programme requires the knowledge of combining ability in the formulation of systematic and successful breeding programme for the improvement of yield and its components, since it provides an indication of the relative magnitude of additive or nonadditive variances. The selection of high yielding and stable genotypes may be possible through the study of genotype x environment interaction by using parents and their hybrids that would provide information on the interaction of combining ability effects under environmental variability. The present investigation is designed to understand the influence of environmental variation on combining ability involving 11 parents of black gram (*Vigna mungo* (L). Hepper) and their 55 crosses in two environments.

MATERIALS AND METHODS

Eleven black gram cultivars namely, T 9, Co 4, Pant U 30, BP-3, UG 170, JU-78-3, JU-27, HPU-433, PDU-2, Kulu-4 and HPU-617, of diverse origin were crossed in all possible combinations in a diallel excluding reciprocals. In all, 11 parents and their 55 F_1 were planted in completely randomized block design with three replications in single-row plots spaced at 30 cm apart and 10 cm spacing from plant to plant in 1982 at the Palampur and Katrain farms of the Himachal Pradesh Krishi Vishva Vidyalaya. Data were recorded on five random plants of each entry for seed yield, harvest index, pods/plant, clusters/plant, pod length, and seeds/pod. Statistical analysis was done by Method 2, Model 2 of Griffing [1] and combining ability x location interaction analysis in F_1 generation as per Singh [2].

RESULTS AND DISCUSSION

To understand the extent of genotypes x locations interactions and the influence of locations on the gca and sca variances, pooled analysis over both locations was carried out for seed yield and its components in F_1 generation (Table 1). As the variance ratio test indicated heterogeniety of error variances between locations for most of the traits, the results are viewed with caution. Pooled analysis of variance indicated significant differences due to locations and genotypes for all the yield components. Significant mean squares due to genotypes x location interaction with respect to seed yield, harvest index,pods/plant, pod length, and seeds/pod indicated the presence of G x E interaction.

Table 1. Genotype x environment interaction and combining ability analysis over locations for seed yield and its components in F_1 generation of black gram

Source	d.f.	Mean sum of squares					
		seed yield	harvest index	pods per plant	clusters per plant	pod length	seeds per pod
		G x E interaction analysis					
Locations	1	3439.4*	45852.4*	57023.8*	13733.3*	9.41*	20.70*
Genotypes	65	13.4*	217.7*	121.7*	22.0*	0.26*	0.54*
Genotypes x locations	65	72.3*	187.4*	94.2*	15.2	0.19*	0.45*
Error	260	10.1	126.4	94.0	17.8	0.18	0.40
		Combing ability analysis					
Gca	10	1.49	32.4	38.3	4.52	0.15*	0.15
Sca	55	5.01*	79.9*	41.0*	7.83*	0.07*	0.18*
Gca x locations	10	1.97	35.3	36.3	3.17	0.10	0.29*
Sca x locations	55	2.49	67.6*	30.5	5.19	0.06*	0.13*
Error	260	3.38	42.1	31.3	5.94	0.06	0.13

*Significant at 5% level.

Combining ability analysis over locations indicated that mean square due to gca was significant for pod length only, whereas due to sca, it was significant for all the yield traits. The mean square due to gca x location was significant only for seeds/pod whereas mean square due to sca x location was significant for harvest index, pod length, and seeds/pod.

In the absence of error variance homogeneity, the extent of G x E interaction noticed in the present material has been considered to be not of linear nature, therefore, the results obtained at each location are to be viewed independently. However, G x E interaction has been observed for all the traits except clusters/plant. Gca x locations interaction has been noticed with respect to seeds/pod, and sca x locations interaction for harvest index, pod length, and seeds/pod. G x E interaction in black gram has also been reported earlier for various traits [3,4]. The pooled combining ability analysis over locations, thus, indicates the presence of additive variance along with appreciable amount of additive x environmental interaction, as indicated by significant mean squares due to gca and gca x locations for at least two important attributes.

The combining ability analysis for seed yield and its components in F_1 and F_2 generations at Palampur and Katrain is given in Table 2. The combining ability analysis for all the traits in F_1 generation at Palampur indicated significant differences due to sca, indicating the presence of nonadditive gene action in F_1 generation. In F_2 generation, however, analysis of variance was significant only for pod length. At Katrain, combining ability analysis

Table 2. Analysis of variance for combining ability along with expected σ^2_{gca} and σ^2_{sca} with respect to seed yield and its components in F_1 and F_2 generations of black gram at Palampur and Katrain

Location/trait	Mean sum of squares				
	F_1		F_2		
	gca (10)	sca (55)	gca (10)	sca (55)	error (240)
Palampur:					
Seed yield	2.48	6.3* (2.4)	—	—	3.88
Harvest index	65.61	142.5* (81.4)	—	—	61.09
Pods/plant	62.91	58.8* (20.2)	—	—	38.57
Clusters/plant	6.88	12.4* (5.0)	—	—	7.46
Pod length	0.03	0.05* (0.01)	0.05	0.05* (0.01)	0.04
Seeds/pod	0.10	0.11* (0.01)	—	—	0.10
Katrain:					
Seed yield	0.98	1.22* (0.65)	0.63	0.58* (0.01)	0.57
Harvest index	2.13	4.93* (2.58)	4.13	8.01* (5.66)	2.35
Pods/plant	11.68* (–0.08)	12.75* (6.72)	13.55* (0.58)	5.56	6.03
Clusters/plant	0.91	1.19* (0.54)	1.44* (0.05)	0.74* (0.09)	0.65
Pod length	0.22* (0.01)	0.08* (0.04)	0.30* (0.02)	0.06* (0.02)	0.04
Seeds/pod	0.34* (0.01)	0.20* (0.07)	0.36* (0.02)	0.15* (0.02)	0.13

*Significant at 5% level.

Note 1. Degrees of freedom given in parentheses.

2. Values in parentheses under gca, sca and error denote expected σ^2_{gca} and σ^2_{sca} as per Model 2, Method 2 of [1].

indicated significant differences due to gca for pods/plant, pod length, and seeds/pod, where mean square due to sca was significant for seed yield and its component traits in F_1 generation, while in F_2 generation mean square due to gca was significant for pods/plant, clusters/plant, pod length, and seeds/pod, whereas mean square due to sca was significant for seed yield and all its components except pods/plant.

The estimates of expected gca and sca variances as per Model 2 and Method 2 of Griffing [1] revealed that at Palampur dominance variance alone was present with respect to all the yield traits, whereas at Katrain dominance variance alone was present both in F_1 and F_2 generations with respect to seed yield and harvest index. However, for pod length and seeds per pod, predominantly the dominance variance was present in both F_1 and F_2 generations along with an appreciable amount of additive variance in F_1 generation which became more pronounced in F_2 generation. For clusters per plant, dominance variance alone was present in F_1 generation, but in F_2 generation, besides dominance variance, additive variance was also appreciable. With respect to pods per plant, dominance variance was more prominant in F_1 generation along with some portion of additive variance but in F_2 generation, the dominance variance was so reduced that it became negligible and only additive variance was prominent. This upward trend of additive variance in F_2 as compared to F_1 generation could be due to the presence of epistasis.

At Palampur, all the parents had similar gca effects both in F_1 and F_2 generations, as indicated by nonsignificant mean squares due to gca (Table 2). At Katrain, the gca effects were estimated (Table 3) with respect to pods/plant, pod length, and seed/pod in F_1 and

Table 3. Estimates of gca effects for seed yield and its components in black gram in F_1 and F_2 generations at Katrain

Trait	T9	Co4	Pant U 30	BP_3	UG 170	JU-78-3	JU 27	HPU-433	PDU-2	Kulu-4	HPU-617	SE (gi)
F_1 generation:												
Pods/plant	–0.80	2.28*	0.83	–0.23	–0.09	–0.56	0.22	0.31	–0.26	–0.59	–0.11	0.65
Pod length	–0.10*	0.25*	–0.11*	–0.02	–0.09*	–0.08	0.02	0.27*	–0.05	–0.05	–0.04	0.05
Seeds/pod	–0.22*	0.37*	0.01	–0.03	0.02	0.12	0.06	0.05	–0.15	–0.20*	–0.03	0.09
F_2 generation:												
Pods/plant	0.36	0.37	1.36*	1.60*	–0.42	0.32	0.62	–0.62	–1.29*	–1.55*	–0.75	0.65
Clusters/plant	–0.14	0.29	0.27	0.49*	0.18	–0.00	0.18	–0.23	–0.58*	–0.45*	–0.00	0.21
Pod length	–0.34*	0.20*	0.04	0.14*	–0.03	0.04	–0.02	–0.16*	–0.08	–0.09*	–0.01	0.05
Seeds/pod	0.04	0.31*	0.10	0.09	–0.04	0.12	–0.01	–0.03	–0.33*	–0.16	–0.08	0.09

*Significant at 5% level.

F_2 generations, and for clusters per plant only in F_2 generation. The results revealed that for pods per plant, Co4 in F_1 and BP3 in F_2 were the best general combiners. Pant U 30 was another good general combiner in F_2 for pods/plant. The remaining parents were average general combiners for pods per plant in both the generations except PDU-2 and Kulu-4, which were poor general combiners in F_2 generation. For Pod length HPU-433 was the best general combiner in F_1 generation and Co4 in F_2 generation. For seeds/pod, Co4 was the best general combiner both in F_1 and F_2 generations. For clusters/plant, PB 3 was the best general combiner in F_2 generation.

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