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Studies on Combining Ability and Genetic Advance in Blackgram (*Vigna mungo* L. Hepper) Under Rainfed Condition.

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Research Article

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ABSTRACT

Combining ability analysis was worked out for seed yield and its contributing characters from Line ×Tester mating design using fourteen lines and three testers of blackgram. Observations were recorded on thirteen traits including seed yield. Significant variability of lines, parents vs crosses and line × tester effect was observed for number of clusters and pods per plant, seed yield and test weight. Significant variability for combining ability of crosses and line × tester effect was recorded with number of clusters and pods/plant, seeds/pods, number of seeds/plant, total biomass, seed yield and test weight. Number of seeds/plant and number of pods/plant recorded high genetic advance while days to 50% flowering, total number of branches and plant height recorded high heritability (narrow sense). Highly significant GCA for seed yield was observed in two lines IC587753 and IC436720 and these lines also recorded significant GCA for number of pods and seeds/plant. Among the three testers selected significant GCA for seed yield was observed with LBG-20 and this genotype also recorded significant GCA for total number of branches total biomass and test weight. The crosses IC436519 × T-9, IC587752 × T-9, IC436720 × PU-19 and IC398971 × PU-19 recorded significant SCA for seed yield and these crosses can be used for recurrent selection breeding method for improvement of seed yield.
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INTRODUCTION

Blackgram commonly known as urd bean is an important pulse crop of the tropic and sub-tropic areas and has been identified as a potential crop in Indian subcontinent including Bangladesh, Pakistan, Myanmar and Thailand [1,2]. It is a major pulse crop, widely cultivated and consumed in India as a source of dietary protein because of its high protein content (24%) [3]. However the yield of this crop is very low because of the non-availability of high yielding cultivars and the lack of stability in performance of released cultivars across years [4]. As a consequence, it is essential to develop varieties with high and stable yield to meet the growing demand and to expand the area under its cultivation. Evaluation and exploitation of germplasm for various yield contributing characters is necessary for the development of improved varieties. High yielding genotypes selected from germplasm need to prove their superiority under various agro-ecological conditions [5]. Combining ability analysis is an important and powerful tool for selecting superior parents in hybridization programme. This will help in selection of superior single plants in segregating generation for developing high yielding varieties. The estimation of genetic advance and heritability will further help in selecting desirable segregants in the breeding programme for developing improved cultivars.

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The present study was under taken to understand general and specific combining ability of parents and crosses respectively of blackgram for various yield attributes and select suitable parents for further breeding programme.

MATERIALS AND METHODS

Fourteen blackgram genotypes obtained from Regional Centre NBPGR, Hyderabad which were originally collected from different agro-climatic zones of Andhra Pradesh were used as lines. These are IC587753, IC436720, IC436519, IC343947, IC519805, IC343952, IC587752, IC587751, IC282009, IC436753, IC436610, IC436665, IC398971 and IC281987. Three nationally released varieties were used as testers *viz.*, PU-19, LBG-20 and T-9. With fourteen lines and three testers, 42 crosses were made during kharif 2012.

The seeds of F1 hybrids and parental lines were sown in randomized complete block design with three replications on 25th June 2013 at Hayathnagar research farm, CRIDA, Hyderabad. Each row of 1m length consists of 10 plants with a spacing of 10cm between the plants and 30cm between two rows was maintained. The plants were grown purely under rainfed condition and 555.4mm rainfall was received in 32 rainy days during the crop growth. The minimum temperature was 19.0^{o}C and the maximum was 38.6^{o}C and relative humidity and sun shine hours during crop growth period varied from 44.0% to 97.0% and 0.0 to 10.3 hrs respectively. The observations recorded on five selected plants of parents as well as each cross were days to 50% flowering, plant height (cm), total number of branches, number of clusters and number of pods/plant, pod length (cm), seeds/pod, number of seeds/plant, seed yield (g/pl), 100 seed weight as test weight (g), total biomass (g/pl), fodder biomass (g/pl) and harvest index (%). The mean data was analyzed for GCA, SCA using method described by Kempthorne [6]. Combining ability analysis is frequently employed to identify the desirable parents for inclusion in hybridization programme. The estimation of genetic advance was done as proposed by Johnson et al. [7] and heritability as developed by Singh and Chowdary [8].

RESULTS AND DISCUSSION

The *per se* values for the seed yield and its components of line & testers and hybrids of blackgram were presented in Table 1 and 2 respectively. The analysis of variance (ANOVA) revealed significant treatment effect for all the characters under study. This gives the evidence of genetic variability among lines, testers and hybrids which provides basis for further analysis of general and specific combining ability of parents and crosses (Table 3). The ANOVA revealed highly significant mean sum of square for plant height, days to 50% flowering, total biomass and fodder biomass, seed yield, test weight, per plant number of clusters, pods and seeds for treatment, parents and crosses. However four characters namely total number of branches, pod length, seeds/pod and harvest index did not show significance for one or more than one of above three parameter. Significant variability was observed for number of clusters and pods/pl, seed yield and test weight for lines, parents vs crosses and line × tester effect. High magnitude of variance due to lines and testers for above mentioned characters indicates that the presence of considerable variability among the lines and testers. Similar results were reported in pigeon pea by Hazarika et al. [9], Jahagirdar [10] and Sameerkumar et al. [11] for pods/plant, seeds/pod, pod length, test weight, seed yield. The analysis for combining ability showed significant variance for seven characters viz., number of clusters, pods and seeds /plant, seeds/pods, total biomass, seed yield and test weight for crosses and line x tester effect (Table-4).

General combining ability (GCA) analysis

Highly significant GCA for seed yield was observed in IC587753 and IC436720 including number of pods and number of seeds /plant (Table-5). Significant GCA for number of clusters were observed in IC587753, IC436519 and IC436665; for plant height in IC436665 and for100 seed weight in IC436753 and IC281987. Krarup and Davies [12] suggested that plant height, number of pods, number of seeds/pod, seed yield and test weight are primary yield contributing components in peas. Plant breeders routinely select for these parameters to increase seed yield in legumes [13, 14, 15,16, 17]. Out of three testers selected, significant GCA for seed yield was observed in LBG-20, as well as total biomass, number of branches and test weight. Tester T-9 showed significant GCA for days to 50% flowering and seeds/pods. Significant GCA values indicate the importance of additive or additive x additive gene effect [18]. High GCA of the parent along with high *per se* performance can be considered as good parent for hybridization and selection in the breeding programmes for traits governed by additive and additive x additive gene effect [19]. In the present study though the lines

IC436665, IC436720, IC343952, IC587751 and IC436519 showed high *per se* performance for seed yield, significant GCA was recorded by only one line IC436720, revealing that it can be a good parent for breeding programme.

Specific combining ability (SCA) analysis

The specific combining ability effects were considered to be the best criteria for selection of superior hybrids. In the present study highly significant SCA for seed yield was observed in four crosses i.e., IC436720 × PU-19, IC436519 × T-9, IC587752 × T-9 and IC398971 × PU-19 (Table-6). The cross IC436720 × PU-19 showed highly significant SCA for seed yield and also showing best *per se* performance due to significant GCA of the parent IC436720. Das and Das Gupta [20] reported that the additive gene action in sesame was predominant in the genetic control of seed yield/plant. While the crosses IC436519 × T-9, IC587752 × T-9 and IC398971 × PU-19 showed significant SCA for seed yield but the parents of these crosses had non-significant GCA effect. It indicates that in these crosses, non-additive gene action was predominant for seed yield. The significant SCA was observed for pods/plant in IC436720 × PU-19 and IC436519 × T-9; for number of clusters in IC436720 × PU-19, IC519805 × LBG-20, IC282009 × PU-19, IC436665 × T-9 and IC281987 × LBG-20; for number of seeds/plant in IC436720 × PU-19, IC436519 × T-9 and IC587752 × T-9; for seeds/pod in IC343947 × T-9 and IC587752 × LBG-20; for test weight in IC398971 × PU-19, for total biomass in IC436519 × T-9 and for fodder biomass in IC436665 × LBG-20 and IC281987 × PU-19.

The estimates of genetic variance of GCA and SCA (Table-7) revealed significant variance due to GCA and SCA for seed yield 1.20, 4.43; 0.93, 5.98 for number of clusters, 9.51, 28.05 for number of pods/plant; 354.64, 964.88 for number of seeds/plant; 1.05, 1.45 for fodder biomass and 0.02, 0.04 for test weight respectively. These results also revealed that the variance due to SCA was higher than GCA, indicating that the seed yield and yield components characters were predominately controlled with the influence of non-additive gene action. Similar results were reported with pigeon pea by Sunil Kumar et al. [21] and Sameer Kumar et al. [11].

Variance due to additive and dominant effect for seed yield was 2.41 and 4.43 respectively with additive/dominance ratio as 0.54 and indicating degree of dominance of 1.36. The data was also used to calculate the heritability for traits in narrow sense. The heritability (narrow sense) for seed yield was 27.54%. The gene action of additive/dominance was 0.31 for number of clusters, 0.68 for number of pods/plant, 0.73 for number of seeds/plant. The low ratio of additive variance to dominance for above mentioned characters indicating the predominant role of non-additive gene action. The ratio of additive variance to dominance was less than unity for above traits suggesting a major role of non-additive gene action. Similar findings were reported by Rajarathinam and Rathnaswamy [22] in black gram, Sreekumar [23, 24] in green gram and cowpea.

The degree of dominance for number of clusters (1.79), number of pods/plant (1.21) and number of seeds/plant (1.17) was more than one hence these traits are dominant in nature. The high estimate of heritability (narrow sense) was recorded for plant height (53.31), number of branches (69.55), days to 50% flowering (90.04). In the present study the traits showed low heritability were number of clusters (19.58), number of pods (31.15), number of seeds /plant (30.88), fodder biomass (40.19), test weight (33.02), seed yield (27.54), seed/pod (15.45) and harvest index (14.23). The genetic advance for the above traits was 1.24, 5.04, 30.49, 1.89, 0.23, 1.68, 0.13 and 1.49 respectively. This indicates that effect should be made to exploit both additive and dominance genetic variance in selection of superior segregants in subsequent generations.

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Table 1: Mean performance of seed yield and its components of lines and testers of blackgram

Parents	Plant height (cm)	Total No. of branches	Days to 50% flowering	No. of clusters	No. of pods	Pod length (cm)	Seeds/ pod	No. of seeds/pl	Total biomass (g/pl)	Fodder biomass (g/pl)	Seed yield (g/pl)	100 seed wt(g)	HI (%)
Lines													
IC587753	29.92	4.00	36.00	14.67	36.50	5.00	6.10	198.07	27.42	15.56	11.47	5.84	42.77
IC 436720	33.45	3.67	35.00	16.00	44.83	5.17	6.00	287.40	37.35	14.83	14.80	5.81	41.06
IC 436519	34.75	2.83	35.33	16.00	39.17	5.04	6.20	203.62	27.24	14.04	14.30	6.24	52.60
IC 343947	27.97	2.83	37.00	16.17	42.50	4.84	6.27	231.15	23.91	12.72	10.84	4.60	45.42
IC 519805	34.08	2.83	36.67	12.67	39.67	5.18	6.00	209.73	23.14	13.05	11.45	5.22	48.64
IC 343952	28.90	3.00	38.33	14.67	47.17	5.11	6.10	308.17	29.33	12.99	14.36	4.67	48.92
IC587752	33.70	3.50	36.00	16.00	48.50	4.84	5.90	289.00	30.04	14.40	14.09	4.83	46.21
IC587751	35.83	4.67	39.67	18.17	52.50	5.05	6.23	303.58	33.78	15.51	14.33	4.62	43.38
IC 282009	35.17	3.33	37.67	13.00	42.17	4.94	6.37	237.87	26.47	14.31	12.99	5.87	50.96
IC 436753	34.33	3.00	38.33	14.00	37.33	4.68	6.10	222.82	24.54	12.94	12.14	5.29	49.39
IC 436610	30.42	2.83	36.33	13.67	43.17	4.86	6.23	260.81	26.80	12.88	12.87	5.01	51.70
IC 436665	41.08	4.00	41.33	15.17	54.00	4.63	6.10	340.29	46.68	20.65	17.20	5.11	38.52
IC 398971	32.42	3.00	35.67	13.33	41.33	4.86	6.10	242.68	25.54	12.95	13.72	5.70	54.50
IC 281987	31.00	3.00	35.67	10.00	31.33	4.84	6.37	177.89	22.13	11.77	9.68	5.82	46.37
CD 95% GCA (Line)	2.25	0.55	0.56	1.48	4.29	0.19	0.26	28.65	3.49	1.49	1.59	0.22	4.54
SE (Lines)	1.13	0.27	0.28	0.75	2.16	0.10	0.13	14.40	1.76	0.75	0.80	0.11	2.28
Testers													
PU-19	33.08	3.17	36.33	12.67	42.83	4.72	6.03	267.17	27.41	12.79	14.18	5.12	52.55
LBG-20	26.50	4.17	38.00	17.17	47.50	4.64	5.87	276.33	26.66	12.79	14.32	4.99	54.97
T-9	16.50	4.17	32.33	14.67	39.17	4.48	5.37	225.33	23.60	11.66	11.15	4.55	47.11
CD 95% GCA (Tester)	1.04	0.25	0.26	0.69	1.99	0.09	0.12	13.26	1.62	0.69	0.73	0.10	2.10
SE (Tester)	0.52	0.13	0.13	0.34	1.00	0.04	0.06	6.67	0.81	0.35	0.37	0.05	1.06

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Table 2: Mean performance of seed yield and its components of hybrids of blackgram

Hybrids	Plant height (cm)	No. of branches	Days to 50% flowering	No. of clusters	No. of pods	Pod length (cm)	Seeds/ pod	No. of seeds/pl	Total biomass (g/pl)	Fodder biomass (g/pl)	Seed yield (g/pl)	100 seed wt. (g)	HI (%)
Line x tester													
IC587753 × PU-19	33.33	5.50	34.00	23.00	64.33	5.71	6.80	383.33	40.39	17.71	21.00	5.48	52.04
IC 436720 × PU-19	31.50	5.00	34.33	20.83	62.33	5.22	6.03	367.33	33.65	12.49	19.60	5.35	58.37
IC 436519 × T-9	34.67	4.50	35.33	19.67	45.83	5.60	6.27	249.50	28.55	13.66	13.49	5.44	47.55
IC 343947 × T-9	30.73	3.83	36.67	17.67	43.33	4.95	7.17	263.83	27.09	15.25	14.55	5.47	54.95
IC 519805 × LBG-20	31.37	4.50	37.00	19.17	47.50	5.11	6.53	261.73	29.66	12.31	15.69	5.97	53.56
IC587752 × LBG-20	27.10	4.33	36.33	16.50	47.17	4.98	6.97	236.38	26.51	13.72	12.23	5.18	46.80
IC587752 × T-9	33.83	3.00	36.00	16.50	45.50	4.87	6.40	253.14	28.91	15.06	13.37	5.21	47.31
IC 282009 × PU-19	33.35	3.67	37.00	20.83	52.00	4.95	6.23	280.33	30.19	13.64	15.38	5.56	50.57
IC 436665 × T-9	43.08	3.33	41.67	24.50	49.00	4.88	6.80	267.65	34.81	19.29	15.08	5.67	43.26
IC 398971 × PU-19	36.25	4.33	35.67	18.67	55.50	4.56	6.13	311.00	32.97	13.96	17.86	5.75	53.97
IC 281987 × PU-19	35.85	4.33	35.67	14.83	45.00	4.71	6.20	251.67	33.12	17.32	14.20	5.64	48.51
IC 281987 × LBG-20	31.60	4.50	36.00	20.83	53.67	5.01	6.47	309.16	32.47	13.75	17.54	5.70	54.01
CD 95% SCA	3.89	0.95	0.98	2.57	7.43	0.34	0.44	49.63	6.05	2.58	2.75	0.39	7.86
SE (Crosses)	1.95	0.48	0.49	1.291	3.74	0.17	0.22	24.95	3.04	1.300	1.38	0.19	3.95

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Table 3: Analysis of variance of parents and hybrids for seed yield and its contributing characters of blackgram.

Source of Variations	df	Plant height (cm)	Total No. of branches	Days to 50% flowering	No. of clusters	No. of pods	Pod length (cm)	Seeds / pod	No. of seeds /pl	Total biomass (g/pl)	Fodder biomass (g/pl)	Seed yield (g/pl)	Test wt. (g)	HI (%)
Replicates	2	9.72	1.95	1.70	2.84	20.53	0.04	0.36	1357	36.03	13.15	1.84	0.33	41.44
Treatments	58	56.28**	1.59**	10.80**	25.13**	159.43**	0.18**	0.34**	6533**	83.27**	20.00**	20.61**	0.47**	88.79**
Parents	16	81.45**	1.04	12.25**	11.63**	100.71**	0.12	0.16	5990**	111.11**	13.13**	10.34*	0.85**	67.21
Parents (Line)	13	34.07**	0.98	9.85**	11.91**	115.85**	0.09	0.06	7015**	129.76**	14.17**	11.24*	0.89**	64.35
Parents (Testers)	2	209.17**	1.00	25.44**	15.25	52.33	0.04	0.36	2219	12.18	1.28	9.77	0.27	48.70
Parents (L vs T)	1	441.98**	1.94	17.03**	0.66	0.66	0.75**	1.14**	211.9	66.50	23.30*	0.02	1.46**	141.34
Parents vs Crosses	1	15.19	14.31**	0.10	195.49**	431.49**	0.02	1.77**	849.6	77.44	16.71	32.98*	1.93**	5.56
Crosses	41	47.46**	1.50**	10.49**	26.24**	175.70**	0.21**	0.38**	6883**	72.54**	22.77**	24.32**	0.28**	99.24**
Line Effect	13	114.99**	2.01**	31.44**	33.17	253.57	0.35*	0.27	10432*	128.15**	51.02**	32.43	0.32	178.98*
Tester Effect	2	43.65	10.34**	4.78**	24.30	315.08	0.18	0.68	11390	127.84	12.81	40.44	0.85*	8.34
Line * Tester Eff.	26	13.98	0.56	0.45	22.93**	126.05**	0.14*	0.42**	4762**	40.49	9.41*	19.02**	0.22**	66.36
Error	116	11.47	0.68	0.72	5.00	41.90	0.09	0.15	1867	27.77	5.05	5.72	0.11	46.88

* Significant at 5% level, ** Significant at 1% level

Table 4: Analysis of variance of combining ability of parents and hybrids for seed yield and its contributing characters of blackgram

	df	Plant height (cm)	Total No. of branches	Days to 50% flowering	No. of clusters	No. of pods	Pod length (cm)	Seeds/ pod	No. of seeds/pl	Total biomass (g/pl)	Fodder biomass (g/pl)	Seed yield (g/pl)	Test wt. (g)	HI (%)
Replicates	2	15.00	4.82**	1.52	0.66	3.93	0.09	0.09	196.96	40.84	17.57	0.38	0.24	67.35
Crosses	41	47.46**	1.50**	10.49**	26.24**	175.70**	0.21**	0.38**	6883.07**	72.54**	22.77**	24.32**	0.28**	99.24**
Line Effect	13	114.99**	2.01**	31.44**	33.17	253.57	0.35*	0.27	10431.95*	128.15**	51.02**	32.43	0.32	178.98*
Tester Effect	2	43.65	10.34**	4.78**	24.30	315.08	0.18	0.68	11389.39	127.85	12.81	40.44	0.85*	8.34
Line × Tester Eff.	26	13.98	0.56	0.45	22.93**	126.05**	0.14	0.42**	4761.99**	40.49*	9.41	19.02**	0.22**	66.36
Error	82	14.45	0.71	0.73	5.82	41.64	0.09	0.17	1893.49	22.99	6.22	5.44	0.09	40.92

* Significant at 5% level, ** Significant at 1% level

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Table 5: General Combining Ability of lines and testers for seed yield and its contributing characters in blackgram

Parents	Plant height (cm)	Total No. of branches	Days to 50% flowering	No. of clusters	No. of pods	Pod length (cm)	Seeds/ pod	No. of seeds/pl	Total biomass (g/pl)	Fodder biomass (g/pl)	Seed yield (g/pl)	100 seed wt(g)	HI (%)
Lines													
IC587753	-1.23	1.02 **	-2.30 **	4.04 **	13.30 **	0.38 **	0.34 **	83.44 **	6.04**	1.15	4.24 **	-0.14	2.44
IC 436720	-0.41	0.40	-2.08 **	0.42	4.63 *	0.18	-0.11	36.70 *	0.72	-0.76	1.68 *	-0.08	3.77
IC 436519	1.94	0.40	-1.41 **	1.87 *	2.19	0.37 **	0.06	17.59	4.14 *	1.56 *	1.40	0.10	-1.83
IC 343947	-3.41 **	0.40	-0.30	1.04	2.08	0.02	0.08	9.40	-2.14	-0.97	0.17	-0.12	4.27
IC 519805	-0.745	0.24	0.25	-1.13	1.41	0.08	-0.01	1.39	-0.56	-1.33	0.29	0.11	1.78
IC 343952	-5.09 **	-0.32	0.14	-0.57	-4.48 *	0.01	-0.04	-33.47 *	-4.05*	-2.16 **	-2.00 *	-0.05	0.09
IC587752	-2.73 *	-0.37	-0.75*	-0.85	-5.15 *	0.003	0.22	-38.81 **	-4.96**	-1.68 *	-2.83 **	-0.33 **	-1.87
IC587751	-1.62	-0.54	2.81**	0.42	-1.65	-0.14	-0.09	-8.63	-3.71*	-2.21 **	-1.06	-0.18	3.14
IC 282009	1.05	-0.26	0.14	-0.52	0.02	-0.15	-0.23	-6.12	1.29	0.14	0.13	0.18	-2.43
IC 436753	-1.00	-0.37	0.59 *	-3.02 **	-4.48 *	-0.17	-0.22	-22.43	-1.81	-0.91	-0.37	0.40 **	1.46
IC 436610	-0.16	-0.71 *	-0.08	-3.41 **	-9.26 **	-0.14	-0.10	-53.28 **	-2.71	0.005	-2.97 **	-0.08	-6.61 **
IC 436665	10.26 **	0.02	4.81**	1.59 *	-0.26	-0.13	0.001	-6.84	7.68 **	7.2 **	-0.50	-0.02	-10.90 **
IC 398971	1.333	-0.15	-0.86**	0.70	1.30	-0.29 **	-0.13	12.58	-0.03	-0.41	0.76	-0.02	1.44
IC 281987	1.816	0.24	-0.97 **	-0.57	0.35	-0.02	0.23	8.60	0.12	0.30	1.04	0.24 *	5.26 *
CD 95% GCA(Line)	2.25	0.55	0.56	1.48	4.29	0.19	0.26	28.65	3.49	1.49	1.59	0.22	4.54
SE (Lines)	1.13	0.27	0.28	0.75	2.16	0.10	0.13	14.40	1.76	0.75	0.80	0.11	2.28
Testers													
PU-19	0.12	0.10	-0.38 **	0.35	1.95	0.08	-0.12	8.01	-0.08	-0.50	0.04	-0.14 **	0.1
LBG-20	-1.07 *	0.44 **	0.12	0.52	1.18	-0.04	-0.02	10.93	1.78 *	0.59	0.96 *	0.14 **	0.39
T-9	0.95	-0.54 **	0.26 *	-0.87 *	-3.13 **	-0.05	0.14 *	-18.94 **	-1.70 *	-0.09	-1.00 **	-0.003	-0.49
CD 95% GCA(Tester)	1.04	0.25	0.26	0.69	1.99	0.09	0.12	13.26	1.62	0.69	0.73	0.10	2.10
SE (Tester)	0.52	0.13	0.13	0.34	1.00	0.04	0.06	6.67	0.81	0.35	0.37	0.05	1.06

* Significant at 5% level, ** Significant at 1% level

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Table 6: Specific Combining Ability estimates for seed yield and its contributing characters in blackgram

Hybrids	Plant height (cm)	No. of branches	Days to 50% flowering	No. of clusters	No. of pods	Pod length (cm)	Seeds/ pod	No. of seeds/pl	Total biomass (g/pl)	Fodder biomass (g/pl)	Seed yield (g/pl)	100 seed wt (g)	HI (%)
Line x tester													
IC587753 × PU-19	2.08	0.34	-0.17	1.70	2.71	0.35 *	0.27	35.16	4.61	2.50	2.59	0.27	1.95
IC 436720 × PU-19	-0.57	0.45	-0.06	3.15 *	9.38*	0.06	-0.04	65.91**	3.19	-0.80	3.75 **	0.09	6.95
IC 436519 × T-9	1.91	0.43	0.29	0.26	10.24 **	0.07	0.34	62.31 *	7.2 *	0.44	3.88**	0.006	1.34
IC 343947 × T-9	0.82	-0.07	-0.15	0.59	-1.98	0.07	0.65**	16.66	1.11	1.76	1.26	0.11	3.62
IC 519805 × LBG-20	0.82	-0.21	-0.23	2.87 *	-1.46	0.18	0.26	-7.19	-1.37	-1.50	0.31	0.24	3.84
IC587752 × LBG-20	-1.46	0.23	0.10	-0.07	4.77	0.12	0.46*	7.54	-0.13	0.25	-0.03	-0.12	0.73
IC587752 ×T-9	3.24	-0.13	-0.37	1.32	7.41	0.01	-0.26	54.21 *	5.76	2.28	3.07*	0.06	2.11
IC 282009 × PU-19	-0.18	-0.21	0.38	4.09 **	3.66	0.12	0.28	21.73	-0.84	-0.55	1.08	0.04	5.35
IC436665 × LBG-20	2.00	0.17	-0.12	-4.02**	-8.12 *	-0.20	-0.51 *	-44.99	0.76	2.93*	-2.87 *	-0.17	-7.82
IC 436665 × T-9	-0.5	-0.18	-0.26	6.87**	6.02	0.15	0.36	36.71	-0.98	-2.45	2.46	0.21	7.10
IC 398971 × PU-19	2.43	0.34	0.05	0.70	5.88	-0.13	0.08	33.70	3.26	0.32	2.94 *	0.42 *	4.87
IC 281987 × PU-19	1.55	-0.048	0.16	-1.85	-3.67	-0.24	-0.22	-21.66	3.26	2.96*	-1.01	0.06	-4.41
IC 281987 × LBG-20	-1.51	-0.214	-0.01	3.98 **	5.77	0.18	-0.05	32.90	0.75	-1.69	1.42	-0.17	0.81
CD 95% SCA	3.89	0.95	0.98	2.57	7.43	0.34	0.44	49.63	6.05	2.58	2.75	0.39	7.86
SE (Crosses)	1.95	0.48	0.49	1.291	3.74	0.17	0.22	24.95	3.04	1.300	1.38	0.19	3.95

* Significant at 5% level, ** Significant at 1% level

Table 7: Estimates of GCA, SCA and genetic parameters for seed yield and its contributing characters in black gram crosses

	Plant height (cm)	No. of branches	Days to 50% flowering	No. of clusters	No. of pods	Pod length (cm)	Seeds/ pod	No. of seeds/pl	Total biomass (g/pl)	Fodder biomass (g/pl)	Seed yield (g/pl)	100 seed wt (g)	HI (%)
sl^2 Line HS(σ^2GCA Line)	11.50**	0.15**	3.41**	3.13	23.52	0.03*	0.013	951.6*	11.15**	5.11**	2.97	0.02	14.68*
sl^2 Tester HS(σ^2GCA Tester)	0.77	0.23**	0.10**	0.46	6.50	0.002	0.013	226.7	2.38	0.18	0.83	0.02*	-0.92
sl^2 GCA (Average) HS.	2.66**	0.21**	0.68**	0.93*	9.51**	0.01**	0.01	354.6 **	3.93**	1.05**	1.20**	0.02**	1.83*
sl^2 L * T (SCA) (σ^2 SCA)	0.84	-0.04	-0.09	5.98**	28.05**	0.02	0.09*	964.9**	4.24	1.45*	4.43**	0.04*	6.49
sl^2 a(F = 1) (σ^2 Additive)	5.32	0.43	1.36	1.86	19.01	0.01	0.02	709.3	7.86	2.11	2.41	0.04	3.67
sl^2 D(F = 1) (σ^2 Dominant)	0.84	-0.04	-0.09	5.98	28.05	0.02	0.09	964.9	4.24	1.45	4.43	0.04	6.49
sl^2 a / Var. D (σ^2 a/D)	6.36	-11.11	-15.09	0.31	0.68	0.79	0.28	0.73	1.85	1.45	0.54	0.99	0.56
Degree of Dominance	0.40	0.30	0.26	1.79	1.21	1.12	1.87	1.17	0.73	0.83	1.36	1.004	1.33
Heritability (Narrow Sense) %	53.31	69.55	90.04	19.58	31.15	23.40	15.45	30.88	36.81	40.19	27.54	33.02	14.23
Genetic Advance 5 %	3.47	1.128	2.28	1.24	5.01	0.12	0.13	30.49	3.50	1.89	1.68	0.23	1.49

* Significant at 5% level, ** Significant at 1% level.

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CONCLUSION

Present study revealed that significant GCA was observed for seed yield in two blackgram lines *viz.*, IC587753 and IC436720 and significant SCA was recorded in four crosses viz., IC436720 × PU-19, IC398971 × PU-19, IC436519 × T-9 and IC587752 × T-9. There was wide variation among selected blackgram parents, GCA and SCA effects for most of the traits including seed yield. This indicates that blackgram lines and crosses with significant GCA and SCA effects respectively may be utilized for selection of superior segregants in segregation breeding generation and generation advancement for developing improved cultivars.

The study also revealed the predominance of non-additive genetic control for most of the traits including seed yield. In such situation, exploitation of heterosis would be ideal. However in legumes specially in blackgram, exploitation of heterosis may not be feasible in the present scenario. In such cases recurrent selection, biparental mating followed by selection may be an effective alternative in improving seed yield level of this important pulse crop.

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