

# Genetic Variability and Association Studies on Yield and Yield Attributing Traits in Blackgram (*Vigna mungo* L. Hepper)

## ABSTRACT

**Aims:** Low and static productivity (450–800 kg/ha) is one of the main obstacles in blackgram (*Vigna mungo* L. Hepper) crop. The low productivity is due to inadequate seed systems, a lack of access to genetic and genomic resources, and a lack of active breeding initiatives. Hence the present study was carried out to assess the variability and association among yield contributing traits for blackgram improvement programmes.

**Place and Duration of Study:** The field study was carried out during 2019-2020 in V.O. Chidambaranar Agricultural College and Research Institute, Killikulam, Tamil Nadu Agricultural University at Department of Genetics and Plant Breeding.

**Study Design and Methodology:** A total of 60 F<sub>4</sub> progenies developed from the cross IC 436656 x KKB14045 in blackgram for the assessment of *per se* performance, genetic variability and association studies.

**Results:** Based on the production of a single plant, seventeen offspring were determined to be promising. The traits viz., number of clusters per plant, number of pods per plant, and single plant yield showed high PCV and GCV, which indicated that there was a high level of genetic variability in the population. The variables of plant height, number of clusters / plant, number of pods/plant, and single plant yield showed significant heritability and high genetic advancement, indicating additive gene action. Single plant yield was positively and significantly correlated with the traits viz., plant height, number of clusters / plant, number of pods / plant, and number of seeds / pod. Therefore, choosing these characteristics is crucial to creating high yielding blackgram cultivars.

**Key words:** Blackgram, F<sub>4</sub> progenies, Per se performance, Genetic variability, Association studies

## INTRODUCTION

An expensive pulse, blackgram (*Vigna mungo* L. Hepper) is high in iron, copper, calcium, magnesium, zinc, potassium, phosphorus, and vitamin B complex. Presently, India is the world's top producer of black gram, contributing over 70% of the total production. India produces approximately 2.7 million tonnes from an approximately 4.4 m ha area with an average yield of 598 kg/ha (Directorate of Economics and Statistics, 2021). Due of the plants' resilience to severe weather, blackgram cultivation is comparatively simple. Poor management techniques and several physical, biochemical, and crop genetic factors, however, contribute to the low yield of blackgram (agrifarming.in). India's reliance on imports from some other black gram-producing nations has grown because of the poor rate of production expansion (Nair *et al.*, 2024).

Estimating the variability in the plant population is crucial to the breeding program's effectiveness for blackgram. A population's level of genetic variety has a significant impact on how

38 effective selection is. Although the genetic component alone is heritable, the observed variability is a  
39 result of both genotypic and epigenetic variables. Since more diversity expands the potential for  
40 selection, a high degree of phenotypic and genotypic variability is necessary for the selection of good  
41 genotypes. The likelihood that a genotype may be recognized by its phenotypic expression is indicated  
42 by the heritability magnitude. The term "genetic advance" describes how the mean genotypic value of  
43 the chosen families has improved over the population. Because the trait's additive gene action is so  
44 prevalent, high heritability suggests that changes in phenotypic performance could be achieved with  
45 simple selection.

46 Additionally, correlation aids in comprehending how different components affect yield (Kozak  
47 and Kang, 2006). When it comes to creating successful and sustainable breeding programs for seed  
48 yield, when direct selection is not very effective, the relationship between seed yield and plant  
49 characteristics is crucial (Mathivathana *et al.*, 2015). In order to identify ideal progenies and attributes  
50 for yield improvement, the current study concentrated on genetic variability and association studies  
51 in 60 F<sub>4</sub> blackgram progenies.

## 52 MATERIALS AND METHODS

53 The experimental material consisted of 60 F<sub>4</sub> progenies derived from the cross IC 436656 ×  
54 KKB 14045. The field experiment was conducted at Department of Genetics and Plant Breeding at  
55 VOC Agricultural college and Research Institute, Killikulam during 2019-2020. Biometrical traits *viz.*,  
56 plant height (cm), days to fifty percent flowering, number of primary branches / plant, number of  
57 clusters / plant, number of pods / plant, number of seeds / pod and single plant yield (g) were  
58 recorded.

59 All the 60 F<sub>4</sub> progenies were raised in 3 meter row with a spacing of 30 x10 cm and proper  
60 agronomic practices were followed. The statistical methods suggested by Johnson *et al.*, (1955) for  
61 various genetic variability parameters *viz.*, genotypic coefficient of variation (GCV), phenotypic  
62 coefficient of variation (PCV), heritability and genetic advance as percentage of mean (GAM) were  
63 worked out. Genotypic correlation coefficient was worked out using the formulae given by Al-Jibouri  
64 *et al.*, (1958). TNAU STAT software was used for analysis of variability and correlation studies  
65 (Manivannan, 2014).

## 66 RESULTS AND DISCUSSION

67 The *per se* performance of F<sub>4</sub> progenies for the studied traits is given in **Table 1**.

68

69 **Table 1. The *per se* performance of F<sub>4</sub> progenies in blackgram**

SI No	F <sub>4</sub> progenies	Days to 50% flowering	Plant height (cm)	Number of branches / plant	Number of clusters / plant	Number of pods / plant	Number of seeds / pod	Single plant yield (g)
1	1.11	32*	31.25	5.5	18.00	23.00	5.50	3.50

2	1.12	36*	28.40	7.5*	20.50	39.00	5.50	2.73
3	1.13	38	30.65	7.5*	24.00*	33.00	6.00	2.18
4	1.14	39	27.45	7.0	10.50	33.50	6.00	4.61
5	1.47	37*	35.05	7.5*	20.50	31.00	6.50	4.65
6	1.54	37*	31.50	6.0	10.00	24.75	5.50	4.38
7	1.55	34*	19.15	6.0	7.00	11.50	5.00	3.03
8	1.61	38	22.80	6.0	9.00	10.00	5.50	1.68
9	1.65	33*	26.45	4.0	7.00	15.00	5.50	2.50
10	1.67	37*	25.40	6.0	12.50	29.00	5.50	2.93
11	1.73	33*	27.70	6.5	12.50	27.50	6.00	3.49
12	1.75	32*	31.75	7.0	23.50*	30.00	6.00	4.84
13	2.1	45	26.60	6.0	8.00	14.00	5.50	4.02
14	2.12	41	32.50	5.0	20.00	39.50	5.50	12.36*
15	2.19	33*	27.25	6.5	11.50	23.00	6.00	6.90
16	2.2	40	34.25	8.0	26.50*	23.00	5.50	4.45
17	2.23	34*	29.25	7.0	15.50	21.00	5.00	2.43
18	2.25	43	22.10	3.5	10.00	18.50	4.50	4.84
19	2.29	46	22.65	6.0	24.00*	50.50*	5.00	12.54*
20	2.32	39	27.23	7.5*	27.00*	36.50	6.00	11.52*
21	2.33	40	27.90	4.0	14.00	26.00	5.00	4.72
22	4.1	38	30.10	4.5	14.50	33.50	6.00	13.68*
23	4.7	36*	25.90	4.0	11.00	24.00	5.50	4.92
24	4.8	38	27.25	5.5	11.50	29.50	5.50	11.91*
25	4.12	35*	28.50	4.5	10.00	24.50	5.00	3.13
26	4.17	37*	28.00	5.0	9.50	13.00	6.00	3.24
27	4.22	36*	31.15	6.0	13.50	19.50	5.00	6.49
28	4.23	46	22.70	3.0	2.50	7.50	5.00	2.72
29	5.11	35*	29.65	6.5	26.50*	62.00*	6.00	13.32*
30	5.13	39	26.60	6.0	13.50	27.00	5.50	7.30
31	5.14	40	28.75	5.0	23.50*	45.50*	6.00	15.10*
32	5.17	38	25.20	4.5	14.50	27.00	5.50	8.61
33	5.18	36*	31.75	5.0	24.00*	39.50	5.50	9.62
34	5.19	34*	37.25*	5.0	20.00	43.00*	5.50	12.01*
35	5.21	34*	26.43	5.0	16.50	27.00	5.00	8.95

36	5.22	36*	21.90	3.5	7.50	12.00	5.00	1.76
37	5.34	36*	23.00	5.0	15.50	35.50	5.00	10.19
38	5.36	39	27.35	5.0	16.50	28.50	6.00	9.91
39	5.37	39	27.15	4.5	11.50	12.00	5.00	4.65
40	5.41	37*	22.93	4.5	16.00	37.00	5.50	8.61
41	5.42	36*	30.43	6.5	13.50	24.00	6.00	5.47
42	5.45	37*	33.75	4.5	21.00	43.00*	6.00	13.63*
43	5.47	38	41.05*	4.5	30.00*	57.00*	6.00	13.57*
44	5.48	36*	39.70*	4.5	26.00*	42.00*	6.00	17.05*
45	5.51	37*	33.15	5.0	24.50*	36.00	5.50	4.30
46	5.53	34*	22.05	4.5	13.00	28.00	5.50	3.85
47	5.54	35*	22.78	5.0	15.50	25.50	6.00	4.39
48	5.55	34*	25.30	4.5	12.00	25.50	5.00	5.85
49	5.56	32*	30.90	4.5	19.00	44.00*	6.00	13.30*
50	5.57	35*	30.90	5.0	21.00	42.50*	5.50	6.84
51	5.58	34*	47.15*	5.0	37.50*	60.50*	6.00	13.88*
52	5.59	38	35.55	3.5	11.50	28.00	5.50	11.41*
53	5.61	36*	28.20	4.5	16.50	27.00	5.50	13.17*
54	5.66	36*	32.35	5.5	18.00	59.50*	5.50	12.52*
55	5.67	36*	41.55*	6.5	27.50*	59.00*	5.50	14.40*
56	6.7	36*	28.10	5.5	12.00	23.00	5.50	5.62
57	6.14	38	29.35	5.5	16.00	32.00	5.50	6.10
58	6.26	32*	27.80	4.0	14.00	24.00	5.50	6.18
59	6.27	38	22.88	5.0	14.25	22.50	5.50	7.20
60	6.28	39	21.25	5.5	13.00	17.00	5.50	3.93
<b>MEAN</b>		<b>36</b>	<b>28.88</b>	<b>5.4</b>	<b>16.42</b>	<b>30.45</b>	<b>5.55</b>	<b>7.38</b>
<b>CD</b>		<b>1.83</b>	<b>7.37</b>	<b>1.92</b>	<b>6.87</b>	<b>10.82</b>	<b>1.05</b>	<b>3.06</b>

70

71 The progenies viz., 2.12, 2.29, 2.32, 4.1, 4.8, 5.11, 5.14, 5.19, 5.45, 5.47, 5.48, 5.56, 5.58, 5.59,  
72 5.61, 5.66 and 5.67 were identified as potential based on single plant yield. Thirty-seven progenies  
73 exhibited significantly superior performance for early maturity, five progenies for plant height, four  
74 progenies for number of **branches / plant**, thirteen progenies for number of **clusters / plant**, twelve  
75 progenies for number of pods/plant. The identified progenies may be forwarded to further generations  
76 in blackgram improvement programs.

77 Variability parameters in F<sub>4</sub> progenies of the cross IC 436656 × KKB 14-45 is given in **Table 2**.  
 78 High PCV and GCV were observed for the traits viz., number of clusters / plant (43.51% and 38.16%  
 79 respectively), number of pods / plant (44.61% and 40.93% respectively) and single plant yield (59.35%  
 80 and 55.63% respectively) suggesting the presence of high genetic variability present in the population  
 81 and selection is effective for these traits. Priya *et al.*, (2018) reported the similar results for the traits  
 82 viz., single plant yield, number of clusters / plant, number of pods / plant; Pratap *et al.*, (2019) for the  
 83 traits viz., number of pods / plant and grain yield / plant; Narayanan *et al.*, (2021) for the traits viz.,  
 84 number of pods / plant and single plant yield.

85 High heritability coupled with high genetic advance were observed in the traits viz., plant height  
 86 (61.92% and 26.35% respectively), number of clusters / plant (76.93% and 68.94% respectively),  
 87 number of pods / plant (84.16% and 77.34% respectively) and single plant yield (87.86% and 107.42%  
 88 respectively). The trait number of branches per plant showed both strong genetic advancement and  
 89 medium heritability (47.82% and 24.49%, respectively), indicating additive gene action for the genetic  
 90 regulation of these traits. Sushmitharaj *et al.*, (2018) and Sathees *et al.*, (2019) reported similar findings  
 91 for number of clusters / plant and single plant yield; Priya *et al.*, (2018) for the traits viz., plant height,  
 92 number of primary branches / plant, number of clusters / plant, number of pods / plant and single plant  
 93 yield. Vadivel *et al.*, (2019) for the traits viz., number of branches / plant, number of pods / plant and  
 94 seed yield / plant; Gomathy *et al.*, (2020) for plant height, number of primary branches / plant, number  
 95 of clusters / plant, number of pods / plant and yield; Pratap *et al.*, (2019) for plant height; Narayanan *et*  
 96 *al.*, (2021) for number of pods / plant and single plant yield.

97 **Table 2 Variability parameters in F<sub>4</sub> progenies of the cross IC 436656 × KKB 14-45**

Traits	GCV	PCV	Heritability (%)	GAM (%)
Days to 50% flowering	8.29	8.66	91.66	16.35
Plant height (cm)	16.26	20.66	61.92	26.35
Number of branches / plant	17.19	24.86	47.82	24.49
Number of clusters / plant	38.16	43.51	76.93	68.94
Number of pods / plant	40.93	44.61	84.16	77.34
Number of seeds / pods	2.64	9.79	7.27	1.47
Single plant yield (g)	55.63	59.35	87.86	107.42

98

99 The association between the yield and component traits is presented in **Table 3**. The trait single  
 100 plant yield had significant and positive association with the traits viz., plant height (0.507), number of  
 101 clusters/plant (0.588), number of pods/plant (0.749) and number of seeds/pod (0.295). Similar  
 102 significant and positive association was reported in blackgram by Soheli *et al.*, (2016) for pods/plant;  
 103 Sushmitharaj *et al.*, (2018) for plant height, number of clusters / plant and number of pods / plant in  
 104 thirty two advanced black gram genotypes; Keerthiga *et al.*, (2018) for number of seeds / pod in 30 F<sub>4</sub>

105 progenies of greengram; Priya *et al.*, (2018) for number of pods/plant and number of clusters/plant in  
 106 one hundred and twenty black-gram genotypes; Blessy and Naik (2018) for number of pods/plant and  
 107 number of clusters / plant in fourteen blackgram genotypes. Sathees *et al.*, (2019) for plant height,  
 108 number of clusters / plant, number of pods/plant and number of seeds / pod in one hundred and sixty-  
 109 two F<sub>2</sub> plants of the cross IC 436656 x KKB 14045; Pratap *et al.*, (2019) for number of pods/plant,  
 110 number of seeds/pod and plant height; Gomathy *et al.*, (2020) for number of clusters / plant and number  
 111 of pods / plant in 140 F<sub>3</sub> progenies developed from the cross IC 436656 x KKB14045. Narayanan *et al.*,  
 112 (2021) for number of clusters / plant, number of pods/plant and number of seeds / pod in F<sub>4</sub> black gram  
 113 population.

114 From inter correlation studies, days to 50 % flowering was significant and negative association  
 115 with number of seeds / pod (-0.223); plant height had significant and positive association with number  
 116 of clusters / plant (0.700), number of pods / plant (0.617) and number of seeds / pod (0.433); number  
 117 of branches / plant had significant and positive association with number of clusters / plant (0.322) and  
 118 number of seeds / pod (0.361); number of clusters / plant had significant and positive association with  
 119 number of pods / plant (0.809) and number of seeds / pod (0.428); number of pods / plant was in  
 120 significant with number of seeds / pod (0.379). Blackgram breeding programs would benefit greatly from  
 121 the selection of these traits, which might be used to increase blackgram yield.

122 **Table 3. Correlation coefficients among yield components in F<sub>4</sub> progenies of the cross IC 436656**  
 123 **x KKB 14045**

Traits	Days to 50% flowering	Plant height (cm)	Number of branches / Plant	Number of clusters / plant	Number of pods / plant	Number of seeds / pod	Single plant yield (g)
Days to 50% flowering	1	-0.208	-0.067	-0.11	-0.104	-0.223*	0.048
Plant height (cm)		1	0.143	0.700*	0.617*	0.433*	0.507*
Number of branches / Plant			1	0.322*	0.144	0.361*	-0.161
Number of clusters / Plant				1	0.809*	0.428*	0.588*
Number of pods / plant					1	0.379*	0.749*
Number of seeds / pod						1	0.295*
Single plant yield (g)							1

124 \* Significant at 5% level

## 125 CONCLUSION

126 It is crucial to measure the variability in the plant population to ensure the effectiveness of the  
 127 blackgram breeding program. Based on a single plant's yield, seventeen offspring were determined to

128 be promising. A high degree of genetic variability in the population was suggested by the high PCV and  
129 GCV of the variables yield per single plant, number of clusters / plant, and number of pods / plant.  
130 Among the variables with high genetic progress and high heritability that demonstrated additive gene  
131 activity were plant height, number of clusters / plant, number of pods / plant, and single plant yield. The  
132 yield of a single plant was found to be positively and significantly correlated with plant height, number  
133 of clusters / plant, number of pods / plant, and number of seeds / pod. Thus, selecting these traits is  
134 essential to producing high yielding blackgram cultivars.

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### 138 **COMPETING INTERESTS**

139 Authors have declared that no competing interests exist

### 140 **Disclaimer (Artificial intelligence)**

141 Authors hereby declare that NO generative AI technologies such as Large Language Models  
142 (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing  
143 of this manuscript.

### 144 **AUTHORS' CONTRIBUTIONS**

145 'Author D.S' designed the study, wrote the protocol and performed the statistical analysis, 'Authors  
146 J.J & J.J.J' wrote the first draft of the manuscript and managed the literature searches. 'Author J.L.J'  
147 'Author A.M', and 'Author S.J' managed the analyses of the study. All authors read and approved the  
148 final manuscript.

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