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RESEARCH ARTICLE

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Assessment of Variability and Association on Bruchine Resistance Traits (*Callosobruchus maculatus* F.) among Segregating Populations of Blackgram [*Vigna mungo* (L.) Hepper]

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ABSTRACT

Background: Bruchine is one of the notorious pests that renders both the quantity and quality of pulses stored produce especially blackgram. Hence the present study was carried out to ascertain the essential selection indices among the bruchine resistance traits involved.

Methods: A laboratory experiment was conducted to estimate the variability parameters for traits related to bruchine infestation in various crosses of blackgram *viz.,* MDU1 × TU68, VBN6 × TU68 and VBN8 × TU68 at National Pulses Research Centre, Vamban. Observations were recorded for eight bruchine resistance traits on each single plants from three crosses.

Result: The results indicated that all traits *viz.,* total number of adult emergence, developmental time, mean developmental period, index of susceptibility, seed damage (%) and seed weight loss (%) recorded high PCV and GCV in all crosses except developmental time which had moderate to low variation. All traits also recorded high heritability and genetic advance as per cent of mean in all crosses except developmental time. Developmental time had moderate to high heritability and genetic advance over the crosses. Considering skewness and kurtosis, the cross MDU 1 × TU 68 had a wide variation for total number of adult emergence and seed damage. Hence the cross MDU 1 × TU 68 could be selected for the selection of bruchid resistant individuals. The association studies revealed that traits *viz.,* developmental time, total number of adult emergence, index of susceptibility and seed damage were reliable selection indices for the seed weight loss.

Key words: Blackgram, Bruchine resistance, Correlation, Seed weight loss, Variability.

INTRODUCTION

Blackgram [*Vigna mungo* (L.) Hepper] is one of the important pulse crops of India. India is the largest producer and also consumer of blackgram. It is referred to as the "king of the pulses" due to its delicious taste and numerous other nutritional qualities. It is also popular for its fermented foods in Southern India. In India, the area that comes under blackgram is about 4.50 million hectares with a production of 2.83 million tonnes (Project Coordinator's Report, 2019). Among various biotic and abiotic yield limiting factors, storage pests that feed on seeds have always been one of the most important biotic constraints for the crop and cause severe economic loss during post-harvest storage. The net quantum of productivity and its economic value is constantly being affected by the storage pests, especially the storage pest bruchine (*Callosobruchus* sp.) (Swella and Mushobozy, 2009). Bruchine infestation primarily starts in the field condition and carry over into the storage condition where the seeds are completely damaged within 2-3 months. Damaged seeds lose their seed weight as well as their nutritional quality. So, the post-harvest losses are the major obstacles to fulfilling food security in developing nations (Somta *et al.,* 2007; Ponnusamy *et al.,* 2014). The post-harvest damage caused by the bruchine beetles varies from crop to crop depending on the prevalent species and their respective biotype. In India, *C. maculatus* is responsible for 90% yield loss in black gram (Soundararajan *et al.,* 2013). The success of any breeding program depends on the magnitude of genetic variability and the extent of association between traits. Assessment of variation and identifying the key characteristics are essential for framing the selection indices for bruchine resistance. Hence, a study was

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undertaken to determine the magnitude of variability and association present among the segregating populations of different crosses in blackgram and identify the key traits for bruchine resistance.

MATERIALS AND METHODS

The experiment was performed at National Pulses Research Centre (NPRC), Tamil Nadu Agricultural University, Vamban, Tamil Nadu, India, at the latitude of 10.363505 °N and longitude of 78.902283 °W. The bioassay against the F_2 generation of three crosses for the bruchine resistance was carried out at the Entomological Laboratory at NPRC, Vamban.

Plant materials and breeding population

The experimental materials consisted of three susceptible blackgram genotypes for bruchine resistance *viz.,* MDU 1, VBN 6 and VBN 8 as female parents and the bruchine resistant blackgram genotype TU 68 (Ragul *et al.,* 2021) as a male parent. MDU 1 was released from Agriculture College and Research Institute, Tamil Nadu Agricultural University, Madurai for commercial cultivation. VBN 6 and VBN 8 was released from National Pulses Research Centre, Tamil Nadu Agricultural University, Vamban. The genotype TU 68 was developed from the cross TU 94-2 × *Vigna mungo* var. *silvestris* by the Bhabha Atomic Research Centre, Trombay. These blackgram genotypes were involved in three cross combinations *i.e.,* MDU1 × TU68, VBN6 × TU68 and VBN8 × TU68.

Bioassay on genetic materials for bruchine resistance

The seeds of every single plant of all crosses *viz.,* MDU1 × TU68, VBN6 × TU68 and VBN8 × TU68 in the F_2 generation were taken as the test material against bruchine resistance. The bruchine beetles (*Callosobruchus maculatus*) were collected from the storehouses of NPRC, Vamban. The assay procedure of was followed with some modification as followed by Ragul *et al.* (2021). The released insects and the seeds were placed in 15 cm diameter plastic petri plates for sufficient aeration. Five pairs of insects were allowed to remain in petri plates for five days for oviposition. Adults were removed from petri plates after five days. The infested seeds were maintained at 30±2°C and 70% relative humidity for 50 days after infestation (DAI).

Data collection and statistical analysis

Observations recorded on 50 seeds of every single plant from three crosses are as follows:

a) Number of eggs per 50 seeds.
b) Mean number of eggs per seed (Sewsaran *et al.,* 2019).
c) Developmental time (egg+larval+pupal stages) (days) *i.e.,* the time taken for the first adult emergence on the genotypes from the date of adult release.
d) Total number of adult emergence at 50 days after infestation (DAI).
e) Mean developmental period (days).
f) Howe's Index of susceptibility.
g) Seed damage (%).
h) Seed weight loss (%).

Seed damage and seed weight loss were estimated on 50 days after adult infestation (DAI). The adults who emerged were counted daily and removed from the petri plates to avoid secondary infestation. Various genetic parameters like PCV, GCV, heritability and genetic advance as per cent of mean were worked out by adopting the methods given by Johnson *et al.* (1955). A simple correlation between seed yield as well as its component traits and among themselves was worked out as per the method suggested by Johnson *et al.* (1955). The data were analyzed using the statistical software TNAUSTAT statistical package (Manivannan, 2014).

RESULTS AND DISCUSSION

The mean and the variability parameters for bruchine resistance among the F_2 populations of three crosses *viz.*, MDU 1 × TU 68 (C1), VBN 6 × TU 68 (C2) and VBN 8 × TU 68 (C3) are presented in Table 1. Simple correlations coefficients among bruchine resistance traits and their interrelationships are summarized in Table 2.

Variability studies

PCV and GCV are essential in understanding the nature and magnitude of variability present in the population due to the genetic and non-genetic causes. As GCV provides the total amount of heritable portion in the total variability, PCV also includes the environmental variability. The results indicated that the phenotypic coefficient of variation estimates was higher than the genotypic coefficient of variation for all the characters studied indicating the environmental influence over the traits. Among the crosses, high PCV and GCV were recorded for the traits *viz.*, number of eggs per 50 seeds, mean number of eggs per seed, total number of adult emergence, mean developmental period, index of susceptibility, seed damage (%) and seed weight loss (%). The developmental time recorded moderate to low levels of PCV and GCV among the crosses. Similar results were recorded by Swamy *et al.* (2016) for the seed weight loss (%) and total number of adult emergence. Indhu *et al.* (2018) also reported similar results for bruchine resistance traits.

High heritability and high GAM were recorded for traits *viz.*, total number of adult emergence, mean developmental period, index of susceptibility, seed damage (%) and seed weight loss (%) for all the crosses involved in the study. However, the traits number of eggs per 50 seeds and mean number of eggs per seed recorded moderate heritability and high GAM in the cross MDU 1 × TU 68 and high heritability and high GAM in crosses *viz.*, VBN 6 × TU 68 and VBN 8 × TU 68. The trait developmental time had high/moderate heritability and moderate GAM in all crosses. High heritability along with high genetic advance indicates the presence of additive gene action. This results suggests that selection will be very effective for these traits due to additive gene action. Indhu *et al.* (2018) also reported similar findings.

Table 1: Variability parameters for various bruchine resistance traits in F2 generation of various crosses in blackgram.

Character	Cross	PCV(%)	GCV (%)	h2 (%)	GAM (%)	Skewness	Kurtosis
No. of eggs/50 seeds	C1	31.55	24.21	58.87	40.31	0.34	-0.08
	C2	45.49	40.68	79.99	78.96	0.91**	0.80
	C3	49.91	45.04	81.45	88.21	0.51	-0.31
Mean no. of eggs/seed	C1	31.55	24.21	58.87	40.31	0.34	-0.08
	C2	45.49	40.68	79.99	78.96	0.91**	0.80
	C3	49.91	45.04	81.45	88.21	0.51	-0.31
Developmental time (egg+larval+pupal stages)	C1	16.30	14.39	77.92	27.56	1.37**	0.95*
	C2	9.53	7.23	57.53	11.89	0.84**	0.74
	C3	14.75	12.17	68.13	21.80	0.71**	2.37**
Total no. of adult emergence	C1	71.19	70.03	96.78	149.50	0.35	-1.13*
	C2	94.99	85.85	81.69	168.37	1.29**	1.22**
	C3	134.01	107.54	64.40	187.26	2.37**	7.63**
Mean developmental period (days)	C1	25.14	25.10	99.75	54.41	-2.46**	7.52**
	C2	38.92	38.89	99.85	84.32	-1.82**	2.08**
	C3	54.45	54.42	99.89	118.02	-1.18**	-0.40
Index of susceptibility (IS)	C1	49.85	48.95	96.40	104.28	0.22	0.64
	C2	81.50	79.68	95.57	169.04	0.81**	0.88
	C3	114.66	111.46	94.50	235.11	1.43**	2.58**
Seed damage (%)	C1	71.19	70.03	96.78	149.50	0.35	-1.13*
	C2	94.99	85.85	81.69	168.37	1.29**	1.22*
	C3	134.01	107.54	64.40	187.26	2.37**	7.63**
Seed weight loss (%)	C1	34.28	32.50	89.88	66.86	-0.61**	0.92
	C2	77.87	63.05	65.56	110.78	1.15**	1.40*
	C3	134.07	126.43	88.92	258.70	2.48**	6.71**

*,** -Significant at 5% and 1% respectively. C1 = MDU 1 × TU 68; C2 = VBN 6 × TU 68; C3 = VBN 8 × TU 68.

Note: PCV= Phenotypic coefficient of variation; GCV = Genotypic coefficient of variation; h2 = Heritability (%); GAM = Genetic advance as per cent of mean.

Among the F_2 population involved for the bruchine resistance, no skewness/normal distribution was observed for traits *viz*., number of eggs per 50 seeds, mean number of eggs per seed, total number of adult emergence, index of susceptibility and seed damage (%) in the MDU1 × TU 68 cross. However, traits *viz*., mean developmental period and seed weight loss (%) had negative skewness indicating more segregants with higher values. In VBN 6 × TU68 cross, all traits recorded positive skewness shows a lesser proportion of the segregants were in the susceptible region among the characteristics. However, all traits except number of eggs per 50 seeds, mean number of eggs per seed and mean developmental period recorded positive skewness in VBN 8 × TU68 cross. In this cross, number of eggs per 50 seeds and mean number of eggs per seed had no skewness while mean developmental period had negative skewness. Among the traits number of eggs per 50 seeds and mean number of eggs recorded the mesokurtic nature of distribution for all the crosses. The trait total number of adult emergence and seed damage (%) recorded the platykurtic distribution in the cross MDU 1 × TU 68. Traits *viz*., index of susceptibility and seed weight loss had mesokurtic nature while developmental time and mean developmental period had leptokurtic nature in the cross MDU 1 × TU 68. The cross VBN 6 × TU 68, has recorded mesokurtic nature of distribution for developmental time and index of susceptibility while other traits *viz*., total number of adult emergence, mean developmental period, seed damage (%) and seed weight loss (%) showed leptokurtic nature of distribution. All the traits in VBN 8 × TU 68 cross had leptokurtic nature of distribution except mean developmental period. Mean developmental period had mesokurtic nature in this cross. Those traits with platykurtic distributions indicate broader variability in the population which can be utilized for selection and further improvement of the traits.

Association studies

Simple correlations coefficients between seed weight loss (%) among the bruchine resistance traits and its inter-correlation are recorded and summarized in Table 2. It indicates that the seed weight loss had a significant and positive association with total number of adult emergence, index of susceptibility and seed damage in all three crosses. These results indicate that the decrease in the total number of adult emergence or index of susceptibility or seed damage will result in decrease in seed weight loss. Seed weight loss had a significant and negative association with developmental time and mean developmental period in all three crosses. This negative association indicates, increase in the developmental time or mean developmental period

Table 2: Simple correlations between bruchine resistance traits among F_2 generations of various crosses in blackgram.

Characters	Cross	Mean no. of eggs/ seed	Developmental time (egg+larval +pupal stages)	Total no. of adult emergence	Mean developmental period (days)	Index of susceptibility (IS)	Seed damage (%)	Seed weight loss (%)
No. of eggs/ 50 seeds	C1	1.00**	-0.14	0.14	-0.21*	0.20*	0.14	0.27**
	C2	1.00**	-0.19	0.20	0.06	0.30**	0.19	0.19
	C3	1.00**	-0.38**	0.37**	0.37**	0.35**	0.37**	0.34**
Mean no. of eggs/seed	C1		-0.14	0.14	-0.22*	0.20*	0.14	0.28**
	C2		-0.19	0.19	0.06	0.29*	0.18	0.18
	C3		-0.38**	0.38**	0.37**	0.35**	0.38**	0.34**
Developmental time (egg+larval+pupal stages)	C1			-0.72**	0.45**	-0.77**	-0.72**	-0.56**
	C2			-0.64**	-0.55**	-0.68**	-0.64**	-0.62**
	C3			-0.55**	-0.66**	-0.61**	-0.55**	-0.48**
Total no. of adult emergence	C1				-0.47**	0.87**	1.00**	0.63**
	C2				0.22	0.83**	1.00**	0.92**
	C3				0.30**	0.85**	1.00**	0.90**
Mean developmental period (days)	C1					-0.73**	-0.47**	-0.42**
	C2					0.10	0.22	-0.23*
	C3					-0.27*	- 0.30**	-0.28*
Index of susceptibility (IS)	C1						0.87**	0.65**
	C2						0.82**	0.81**
	C3						0.85**	0.77**
Seed damage (%)	C1							0.63**
	C2							0.92**
	C3							0.90**

** -Significant at 5% and 1% respectively. C1 = MDU 1 × TU 68; C2 = VBN 6 × TU 68; C3 = VBN 8 × TU 68.

will decrease the seed weight loss. Traits *viz.*, number of eggs per 50 seeds and mean number of eggs/seed had a significant and positive association with seed weight loss in two crosses *viz.*, MDU 1 × TU 68 and VBN 8 × TU 68 only while cross VBN 8 × TU 68 had no association.

The trait seed damage showed a significant and positive association with total number of adult emergence and index of susceptibility in all three crosses. However, the trait seed damage recorded a significant and negative association with developmental time while it had a significant and negative association with mean developmental period in two crosses *viz.*, MDU 1 × TU 68 and VBN 8 × TU 68. This trait had a significant and positive association with no. of eggs/50 seeds and mean no. of eggs/seed in the cross VBN 8 × TU 68 alone while other crosses had no association.

Index of susceptibility had a significant and positive association with number of eggs per 50 seeds, mean number of eggs per seed and total number of adult emergence. It also recorded a significant and negative association with developmental time. A similar negative association between index of susceptibility and mean developmental period was observed in two crosses *viz.*, MDU 1 × TU 68 and VBN 8 × TU 68 while VBN 6 × TU 68 had no association.

Total number of adult emergence had a significant negative association with developmental time in all crosses. This trait had a significant and positive association with no. of eggs/50 seeds and mean no. of eggs/seed in the cross VBN 8 × TU 68 alone while other crosses had no association. Hence these correlated traits can be directly involved in the genetic improvement program. The developmental time had a significant and negative association with no. of eggs /50 seeds and mean no, of eggs/seed in the cross VBN 8 × TU 68 while other crosses had no association. No. of eggs/50 seeds had a significant and positive association with mean no. of eggs/seed in all crosses.

CONCLUSION

Based on the preceding discussion, it can be concluded that all traits recorded high PCV and GCV in all crosses except developmental time which had moderate to low variation among crosses. All traits also recorded high heritability and genetic advance as per cent of mean in all crosses except developmental time. Developmental time had moderate to high heritability and genetic advance over the crosses. The cross MDU 1 × TU 68 had no skewness for number of eggs/50 sees, mean no. of eggs/seed, total no. of adult emergence, index of susceptibility and seeds damage. In the case of kurtosis also, the cross MDU 1 × TU 68 had mesokurtic nature for no. of eggs/50 seeds, mean no. of eggs/seed, index of susceptibility and seed weight loss. Considering skewness and kurtosis, the cross MDU 1 × TU 69 had a wide variation for total no. of adult emergence and seed damage. Hence this cross can be subjected to a selection of bruchid resistant individuals. Based on the association studies, it can be concluded that all traits had a significant association with seed weight loss (%). However, traits *viz.*, no. of eggs/50 seeds, mean no. of eggs/seed and mean developmental time had variation in the association with seed weight loss and among themselves in various crosses. Hence, traits *viz.*, developmental time, total no. of adult emergence, index of susceptibility and seed damage were reliable selection indices for the seed weight loss.

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