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Varietal Screening of Black Gram Against Pulse Beetle, *Callosobruchus maculatus* (Fabricius) in Storage

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GP and BK designed and supervised the study. ASN planned, surveyed, analyzed the data and prepared the manuscript. PN and MM provided their expert guidelines and resources for the study. GP reviewed and finalized the manuscript.

Key words
***Callosobruchus maculatus*, Black gram, Screening, Storage loss, Oviposition and adult emergence**

ABSTRACT

Black gram is one of the most important pulses that form an essential component of most of the South Indian breakfasts. But it is severely affected by the attack of pulse beetle that causes about 50 percent loss in seed weight and protein content. In this context, studies were conducted in the laboratory to assess the storage losses caused by pulse beetle, *Callosobruchus maculatus* (Fabricius) and to screen different BG varieties against *C. maculatus*. Nine BG varieties released from Tamil Nadu Agricultural University were collected and 10 pulse beetles each were released into those samples and assessed for seed damage, weight loss, live insects, newborn, oviposition preference, adult emergence, mean development period, and reaction to different varieties based on growth index. The observations were recorded and the results revealed that the varieties CO 5, CO 6, CO 7, and KKM 1 were found to be immune to the attack of pulse beetle and can be stored for two months without treating with any insecticides.

INTRODUCTION

Black gram (*Vigna mungo* L) also known as urd bean is one of the important pulses reported to be originated in India which is the largest producer and consumer of black gram (BG) in the world. BG is a protein rich food containing 26% protein, which is almost three times that of cereals. In addition, it also plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. Being a drought resistant crop, it is suitable for dry land farming and predominantly used as an intercrop with other crops.

In India, Madhya Pradesh stands first in area and production of BG whereas Andhra Pradesh stands first in productivity. Tamil Nadu contributes 9% to the total area and 10% to the total production in the country (https://dpd.gov.in). Seeds of BG contains 26% protein, 58.9 % carbohydrates, 10.8% water, 1.6% fat, 138 mg calcium, 7.57 mg iron (per 100g edible portion). It is the richest source of phosphoric acid and is usually consumed in the form of dal (whole or split). It serves as a nutritive fodder especially for milch cattle and is an excellent green manure.

During storage, pulses are prone to damage due to insects (5%) more so than wheat (2.5%), paddy (2%) and maize (3.5%) (Deshpande and Singh, 2001). In 2005-06, the harvest and post-harvest losses reported at the national level for chick pea, pigeon pea, green gram, and BG ranged from 4.28 to 6.06% (Nanda *et al*., 2012).

Pulse beetles (*Callosobruchus* spp.) belonging to the family Bruchidae are the most devastating pests causing severe damage to BG seeds during storage. It causes about 50% loss in weight and protein content, thus reducing the economic value of the produce. Females lay eggs singly which is glued to the pod surface under field conditions or grains in storage. From the eggs, fleshy, curve shaped, creamy white grub emerges out which feeds on the grain kernel and makes a cavity. Pupation takes place in a pupal cell prepared beneath the seed coat and adult comes out making exit holes.

BG varieties with superior pest tolerance in field are found to be susceptible to pulse bruchid in storage

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(Swamy *et al*., 2016) The most serious of these species are *C. maculatus, C. chinensis* and *C. analis,* whereas *C. maculatus* causes up to 90% yield loss in BG. These infest crops at pod maturity stage and damage is seen after harvest. The adults emerged during storage also cause secondary infestation which leads to total destruction of the seed lot in 3-4 months (Indhu *et al*., 2020). The total developmental period of *C. maculatus* in BG is approximately 26 days (Pranjali *et al*., 2023). The fecundity of south Indian strain of *C. maculatus* is reported to be in a range of 73-94 eggs/female (Thanthianga and Mitchell, 1990).

Different physical, biochemical and molecular mechanisms are involved in BG-bruchid interaction and these can act as important markers for breeding bruchid resistant BG varieties and to develop pest management techniques. This will thus reduce reliance on indiscriminate use of pesticides in controlling bruchids in storage. In order to protect BG seeds from bruchid attack, these seeds can be treated with several plant derived botanicals. Plant derivatives have significant effect on insect infestation. Seeds treated with neem oil showed good tolerance to pulse beetle attack (Parameswari and Vijayan, 2020).

The BG seeds are mixed with insecticides immediately after harvest to protect them from bruchid infestation. The seeds stored for sowing can be treated with insecticides however, it is also meant for consumption and thereby applying chemical treatments poses health hazards. Indiscriminate use of insecticides and other chemical control measures for its management present high risk of persistent toxic residues, resistant strains and environmental pollution (Soumia *et al*., 2017). Identifying natural and sustainable sources of bruchid resistance therefore appears to be a cost-effective and environmentally safe approach for reducing pest damage during storage (Tripathi *et al*., 2020). However, despite the recognition of the damage caused by pulse beetles and the use of various botanicals and breeding approaches, there remains a significant research gap in understanding the specific mechanisms of resistance in BG varieties against different bruchid species, particularly under storage conditions. Most available studies either focus on field resistance or use broad spectrum insecticidal strategies, with limited focus on identifying natural, varietal traits that confer resistance to pulse beetles during storage. Furthermore, comparative studies evaluating the susceptibility of different BG genotypes to these pulse beetles under controlled storage conditions are scarce. This study aims to fill this gap by assessing the resistance of selected BG varieties to pulse beetles, thereby contributing to sustainable pest management and safer storage practices.

MATERIALS AND METHODS

Following methodologies were adopted in the present investigation on the storage loss and the varietal screening of BG against *C. maculatus*.

Storage losses caused by pulse beetles in BG

Nine varieties of BG seeds obtained from different centres of Tamil Nadu Agricultural University *viz.,* VBN 8, 10, 11 (National Pulses Research Centre, Vamban), CO 2, 5, 6, 7 (Department of Pulses, Coimbatore), ADT 6 (Tamil Nadu Rice Research Institute, Aduthurai), KKM 1 (VOC Agricultural College and Research Institute, Killikulam) were assessed for susceptibility to the pulse beetle, *C. maculatus* after one and two months of infestation. The freshly harvested BG seeds of 25 g (approx. of 9 % moisture content) were kept in plastic containers and ten adult weevils were introduced in ambient room conditions (30 ±2 ◦C temperature; 70–80 % relative humidity). The BG seeds along with the insects were incubated in 28±2°C for one month before first evaluation, then again for two months for final evaluation. Susceptibility parameters such as weight loss of grain, number of live and dead insects, number of progenies produced, *etc* were observed. During evaluation, the BG seeds were weighed, number of insects (both dead and alive) were counted and weights of live insects were taken. After removing the beetles from each jar the weight of grains were taken separately on an electric balance from three replicates after 30 and 60 days of insect release. The mean percent loss in weight was calculated by the following formula (Deepika *et al*., 2019):

$$\text{Per cent weight loss} = \frac{\text{Initial weight of seeds (g)} - \text{Final weight of seeds (g)}}{\text{Initial weight of seeds (g)}} \times 100$$

Oviposition and adult emergence of pulse beetles in BG

The newly emerged adults were released for oviposition for 72 h as 10 adults (5 pairs) per 25 g seeds and each variety replicated thrice. The number of eggs laid was recorded on 30 days after infestation. Observations on adult emergence at 24 h interval were continued till no fresh adults appeared. Various insect growth parameters were calculated as follows (Howe, 1971):

$$\text{Per cent adult emergence} = \frac{\text{Number of adults emerged}}{\text{Number of eggs laid}} \times 100$$

$$\text{Mean development period} = \frac{D_1A_1 + D_2A_2 + D_nA_n}{\text{Total no. of adults emerged}}$$

where D_1 is the day on which adult emergence commenced (first day) and A_1 is the number of adults emerging on D_1^{th} day.

Screening of BG varieties against C. maculatus

The seed damage caused by *C. maculatus* in different

BG varieties were assessed by recording the number of damaged and healthy seeds in each replication and percent damage is calculated as follows.

$$\text{Per cent seed damage} = \frac{\text{Number of damaged seeds}}{\text{Total number of seeds}} \times 100$$

Reaction of BG varieties to C. maculatus

The reaction of BG varieties to *C. maculatus* was rated using the scale given by Panigrahi *et al*. (2021) based on the growth index which is calculated using the following formula:

$$\text{Growth Index} = \frac{\text{Per cent adult emergence}}{\text{Mean development period}}$$

The reaction rating scale was: 0.0, Immune; 0.1-2.0, resistant; 2.0-4.0, moderately resistant; 4.0-6.0, moderately susceptible; 6.0-8.0, susceptible; > 8.0, highly susceptible.

Statistical analysis

The data obtained were subjected to statistical analysis adopting completely randomized block design (CRD). The numbers were transformed into corresponding square root values and percentage into arc sine transformed values and analysed using OPSTAT software.

RESULTS

Storage losses caused by C. maculatus *in BG*

Varieties suffered greater weight loss of seeds are VBN 10 (7.11%), ADT 6 (5.37%), VBN 11 (4.15%), CO 2 (3.67%) and VBN 8 (2.67%) after 30 days of release and VBN 10 (16.72%), ADT 6 (8.45%), VBN 8 (7.01%), CO 2 (5.16%) and VBN 11 (4.87%) after 60 days of release of *C. maculatus* (Table I). The other four varieties recorded minimum (1.00-2.23%) weight loss even after 60 days of insect release. Among the nine varieties, no freshly emerged adults were observed in CO 5, CO 6, CO 7 and KKM 1 even after 60 days (Table II). A maximum of 148 freshly emerged adults was observed in ADT 6 followed by CO 2 (122 adults) and then by VBN 10 (109 adults). Weight of individual adult insect was high in ADT 6 which was 0.06 g.

Oviposition and adult emergence of C. maculatus

The number of eggs laid per 25 g of BG seeds was found to be maximum in ADT 6 which recorded 1173 eggs after 30 days of release and 2340 eggs after 60 days of release and which was followed by VBN 10 recording 188.33 and 705 eggs, respectively (Table III). The percent

Table I. Assessment of losses by pulse beetles in different BG varieties after storage for 60 days.

S. No.	Variety	Initial seed wt (g)	Storage for 30 days			Storage for 60 days		
			Seed wt (g)	Wt. loss (g)	Seed wt loss (%)	Seed wt (g)	Wt. loss (g)	Seed wt loss (%)
1.	VBN 8	25	24.33 (4.93)^{ab}	0.67 (1.29)^{b}	2.67 (8.99)^{c}	23.25 (4.82)^{bc}	1.75 (1.66)^{bc}	7.01 (15.35)^{de}
2.	VBN 10	25	23.22 (4.82)^{d}	1.78 (1.67)^{d}	7.11 (15.44)^{e}	20.82 (4.56)^{d}	4.18 (2.28)^{d}	16.72 (24.12)^{e}
3.	VBN 11	25	23.96 (4.90)^{bc}	1.04 (1.43)^{c}	8.16 (10.92)^{cd}	23.78 (4.88)^{b}	1.22 (1.48)^{b}	4.87 (12.46)^{c}
4.	CO 2	25	24.08 (4.91)^{bc}	0.92 (1.38)^{bc}	7.68 (11.03)^{cd}	23.71 (4.87)^{b}	1.29 (1.51)^{b}	5.16 (13.12)^{cd}
5.	CO 5	25	24.51 (4.95)^{ab}	0.49 (1.22)^{b}	1.97 (8.05)^{bc}	24.44 (4.94)^{a}	0.56 (1.25)^{a}	2.23 (8.58)^{b}
6.	CO 6	25	24.86 (4.99)^{a}	0.14 (1.07)^{a}	0.56 (3.96)^{ab}	24.75 (4.98)^{a}	0.25 (1.12)^{a}	1.00 (5.70)^{a}
7.	CO 7	25	24.84 (4.98)^{a}	0.16 (1.08)^{a}	0.64 (4.54)^{ab}	24.54 (4.95)^{a}	0.46 (1.21)^{a}	1.83 (7.76)^{ab}
8.	ADT 6	25	23.66 (4.86)^{cd}	1.34 (1.53)^{c}	5.37 (13.28)^{de}	22.89 (4.78)^{c}	2.11 (1.76)^{c}	8.45 (16.81)^{d}
9.	KKM 1	25	24.90 (4.99)^{a}	0.10 (1.05)^{a}	0.41 (3.42)^{a}	24.53 (4.95)^{a}	0.47 (1.21)^{a}	1.87 (7.82)^{ab}
	SE. D	-	0.029	0.052	2.033	0.027	0.079	1.256
CD (p = 0.05)		-	0.063	0.111	4.273	0.058	0.168	2.641

Figures in the parentheses are square root transformed values. In a column, means followed by a common letter(s) are not significantly different by LSD (p=0.05).

Table II. Development of pulse beetle in different varieties of BG after storage for 60 days.

S. No.	Variety	No. of Insects released	Storage for 30 days			Storage for 60 days			Number of freshly emerged adults		Weight/ adult (g)
			No. of live insects	No. of dead insects	Total no. of insects	No. of live insects	No. of dead insects	Total no. of insects	30 days	60 days	
1.	VBN 8	10	3.00 (1.86)^{b}	17.67 (4.20)^{b}	20.67 (4.55)^{b}	8.67 (3.02)^{b}	59.00 (7.67)^{b}	67.67 (8.22)^{b}	10.67 (3.34)^{b}	57.67 (7.62)^{b}	0.041 (0.735)^{d}
2.	VBN 10	10	54.67 (7.42)^{f}	24.00 (4.90)^{c}	78.67 (8.87)^{f}	37.33 (6.15)^{c}	81.67 (9.04)^{c}	119.00 (10.91)^{d}	68.67 (8.32)^{f}	109.00 (10.46)^{c}	0.035 (0.732)^{b}
3.	VBN 11	10	21.00 (4.63)^{e}	38.00 (6.16)^{d}	59.00 (7.68)^{d}	30.33 (4.98)^{c}	58.67 (7.66)^{b}	69.33 (8.33)^{c}	49.00 (7.03)^{d}	59.33 (7.73)^{b}	0.037 (0.733)^{c}
4.	CO 2	10	5.33 (2.41)^{c}	24.33 (4.93)^{c}	29.67 (5.45)^{c}	29.33 (5.46)^{c}	102.67 (10.13)^{d}	132.00 (11.49)^{e}	19.67 (4.49)^{c}	122.00 (11.07)^{d}	0.041 (0.736)^{d}
5.	CO 5	10	0.0 (1.0)^{a}	10.00 (3.16)^{a}	10.00 (3.16)^{a}	0.0 (1.0)^{a}	10.00 (3.16)^{a}	10.00 (3.16)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}
6.	CO 6	10	0.0 (1.0)^{a}	10.00 (3.16)^{a}	10.00 (3.16)^{a}	0.0 (1.0)^{a}	10.00 (3.16)^{a}	10.00 (3.16)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}
7.	CO 7	10	0.0 (1.0)^{a}	10.00 (3.16)^{a}	10.00 (3.16)^{a}	0.0 (1.0)^{a}	10.00 (3.16)^{a}	10.00 (3.16)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}
8.	ADT 6	10	16.67 (4.20)^{d}	52.33 (7.22)^{e}	69.00 (8.31)^{e}	74.67 (8.67)^{d}	83.33 (9.13)^{c}	158.00 (12.57)^{f}	59.00 (7.71)^{e}	148.00 (12.18)^{e}	0.060 (0.748)^{e}
9.	KKM 1	10	0.0 (1.0)^{a}	10.00 (3.16)^{a}	10.00 (3.16)^{a}	0.0 (1.0)^{a}	10.00 (3.16)^{a}	10.00 (3.16)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}
	SE. D	-	0.155	0.069	0.107	0.821	0.182	0.169	0.119	0.180	0.000
CD (p=0.05)		-	0.334	0.147	0.226	1.741	0.384	0.357	0.253	0.380	0.001

Figures in the parentheses are square root transformed values. In a column, means followed by a common letter(s) are not significantly different by LSD (p=0.05).

adult emergence was found to be maximum in VBN 11 (37.21%) followed by VBN 10 (36.46%) at 30 days after release whereas, after 60 days, CO 2 recorded 31.34% adult emergence followed by VBN 8 (17.23%) (Table III). Though the eggs laid were more in ADT 6, the percent adult emergence was very minimum recording 5.03 and 6.37%, respectively after 30 and 60 days of storage. Few eggs were laid on the BG varieties *viz.,* CO 5, CO 6, CO 7 and KKM but there was nil adult emergence.

Screening of BG varieties against C. maculatus

The percent damage in different BG varieties after 30 days of release of *C. maculatus* showed difference in their damage which varied from 18.27 to 31.33 % after 30 days and 21.76 to 55.42% after 60 days of infestation (Table IV). The maximum percent damage occurred in CO 2 at 30 days and ADT 6 at 60 days after release and the percent damage was found to be nil in CO 6 (0.0%) at 30 and 60 days and 0.07% in CO 5 and 0.24% in KKM 1 and 0.25% in CO 7, respectively.

Reaction of BG varieties to C. maculatus

The BG varieties showed significant differences in their response to *C. maculatus* in terms of oviposition, percent adult emergence, growth index, seed weight loss and mean developmental period. Based on Growth Index, the nine BG varieties were categorized as immune and resistant category (Table V). The BG varieties, CO 5, CO 6, CO 7 and KKM 1 were found to be immune and the varieties *viz.*, VBN 8, VBN 10, VBN 11, CO 2 and ADT 6 showed resistance to *C. maculatus* for two months of storage.

Table III. Oviposition and adult emergence of *Callosobruchus maculatus* stored in different BG varieties for a period of 30 and 60 days.

S. No.	Variety	No. of eggs laid/ 25 g seeds		No. of adults emerged/ 25 g seeds		Percent adult emergence*	
		30 days	60 days	30 days	60 days	30 days	60 days
1.	VBN 8	152.67 (11.95)^{bc}	334.67 (17.78)^{b}	10.67 (3.34)^{b}	57.67 (7.62)^{b}	6.99 (12.01)^{bc}	17.23 (3.78)^{c}
2.	VBN 10	188.33 (13.71)^{c}	705.00 (26.54)^{c}	68.67 (8.32)^{f}	109.00 (10.46)^{c}	36.46 (23.32)^{d}	15.47 (3.08)^{c}
3.	VBN 11	131.67 (11.47)^{bc}	477.67 (21.70)^{b}	49.00 (7.03)^{d}	59.33 (7.73)^{b}	37.21 (24.15)^{d}	12.42 (21.18)^{c}
4.	CO 2	184.00 (13.31)^{bc}	389.33 (19.49)^{b}	19.67 (4.49)^{c}	122.00 (11.07)^{d}	10.69 (7.94)^{c}	31.34 (35.72)^{d}
5.	CO 5	108.33 (10.40)^{b}	108.33 (10.40)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}
6.	CO 6	40.00 (6.32)^{a}	40.00 (6.32)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}
7.	CO 7	34.67 (5.89)^{a}	34.67 (5.89)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}
8.	ADT 6	1173.00 (34.25)^{d}	2340.00 (48.30)^{d}	59.00 (7.71)^{e}	148.00 (12.18)^{e}	5.03 (12.96)^{b}	6.37 (14.61)^{b}
9.	KKM 1	42.33 (6.50)^{a}	42.33 (6.50)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}	0.0 (1.0)^{a}
SE. D		1.391	2.178	0.119	0.180	2.569	2.771
CD (p=0.05)		2.933	4.580	0.253	0.380	5.440	5.867

Figures in the parentheses are square root transformed values. *Figures in the parentheses are arc sine transformed values. In a column, means followed by a common letter(s) are not significantly different by LSD (p=0.05).

Table IV. Percent seed damage by *Callosobruchus maculatus* stored in different BG varieties for a period of 30 and 60 days.

S. No.	Variety	No. of damaged seeds/ 25 g		No. of healthy seeds/ 25 g		Total no. of seeds/ 25 g	Seed damage (%)*	
		30 days	60 days	30 days	60 days		30 days	60 days
1.	VBN 8	100.33 (9.78)^{bc}	122.00 (10.80)^{bc}	333.67 (18.23)^{a}	312.00 (17.64)^{ab}	434.00 (20.73)^{bc}	21.95 (27.71)^{bc}	26.79 (30.97)^{bc}
2.	VBN 10	101.33 (10.09)^{bc}	137.67 (11.75)^{c}	413.67 (20.33)^{c}	378.33 (19.43)^{bcd}	515.00 (22.69)^{de}	19.72 (26.36)^{bc}	26.88 (31.19)^{bc}
3.	VBN 11	69.00 (8.31)^{b}	82.00 (9.04)^{b}	321.33 (17.85)^{a}	308.33 (17.47)^{ab}	390.33 (19.72)^{ab}	18.27 (25.09)^{b}	21.76 (27.55)^{b}
4.	CO 2	131.00 (11.18)^{cd}	155.33 (12.22)^{c}	284.33 (16.80)^{a}	260.00 (16.03)^{a}	415.33 (20.38)^{bc}	31.33 (33.52)^{c}	37.18 (37.19)^{c}
5.	CO 5	0.33 (0.88)^{a}	0.33 (0.88)	484.00 (22.00)^{c}	484.00 (22.00)^{e}	484.33 (22.01)^{cd}	0.07 (1.22)^{a}	0.07 (1.22)^{a}
6.	CO 6	0.0 (1.0)^{a}	0.0 (1.0)^{a}	340.67 (18.45)^{ab}	340.67 (18.45)^{bc}	340.67 (18.45)^{a}	0.0 (1.00)^{a}	0.0 (1.00)^{a}
7.	CO 7	1.00 (1.17)^{a}	1.00 (1.17)^{a}	410.33 (20.25)^{ab}	410.33 (20.25)^{cde}	411.33 (20.28)^{bc}	0.25 (2.47)^{a}	0.25 (2.47)^{a}
8.	ADT 6	167.67 (12.97)^{d}	320.67 (17.92)^{d}	411.33 (20.28)^{ab}	258.33 (16.06)^{a}	579.00 (24.06)^{e}	28.96 (32.56)^{c}	55.42 (48.12)^{d}
9.	KKM 1	1.00 (1.17)^{a}	1.00 (1.17)^{a}	426.27 (20.65)^{c}	426.67 (20.65)^{de}	427.67 (20.68)^{bc}	0.24 (2.42)^{a}	0.24 (2.42)^{a}
SE. D		1.178	1.238	0.872	0.979	0.836	3.508	3.854
CD (p=0.05)		2.492	2.615	1.835	2.061	1.758	7.304	8.037

Figures in the parentheses are square root transformed values. *Figures in the parentheses are arc sine transformed values. In a column, means followed by a common letter(s) are not significantly different by LSD (p=0.05).

DISCUSSION

Studies conducted on nine BG varieties to assess the storage loss as well as screening against infestation of *Callosobruchus maculatus* revealed that seed weight loss varied from 4.87 to 16.72 after two months of storage in five varieties. This was in line with the findings of Subashree *et al*. (2021) who stated that percent weight loss among different progenies ranged from 19.73 to 29.14% in 50 g of mungbean.

The eggs laid per 25 g of BG seeds are maximum in ADT 6 (2340 eggs) after 60 days of infestation but the adult emergence percentage was very low when compared to other varieties. This was similar to the findings of Indhu *et al*. (2020) who stated that the maximum number of eggs (236) was laid by *C. maculatus* on 50 seeds of TU 72 genotype (BG) with an average of 4 eggs per seed. But maximum of one egg was hatched and single adult emerged from the single window. Talekar (1988) also reported chemical factor present in the seeds of resistant genotype prevent the hatching of eggs. Even though seed wouldn't suit for complete adult emergence, *C. maculatus* had oviposition on all the genotypes.

Table V. Reaction of BG varieties to *Callosobruchus maculatus.*

S. No.	Variety	Mean development period	Growth index-30 days	Growth index-60 days	Reaction
1.	VBN 8	28.78 (5.41)[b]	0.31	0.70	Resistant
2.	VBN 10	30.06 (5.53)[bc]	1.22	0.51	Resistant
3.	VBN 11	30.40 (5.56)[cd]	1.24	0.44	Resistant
4.	CO 2	31.53 (5.66)[d]	0.44	1.10	Resistant
5.	CO 5	0.0 (1.0)[a]	0.0	0.0	Immune
6.	CO 6	0.0 (1.0)[a]	0.0	0.0	Immune
7.	CO 7	0.0 (1.0)[a]	0.0	0.0	Immune
8.	ADT 6	31.06 (5.62)[cd]	0.16	0.20	Resistant
9.	KKM 1	0.0 (1.0)[a]	0.0	0.0	Immune
	SE. D	0.061	0.114	0.135	-
CD (p=0.05)		0.129	0.240	0.283	-

Figures in the parentheses are square root transformed values. In a column, means followed by a common letter(s) are not significantly different by LSD (p=0.05).

The maximum seed damage of 55.42% was observed in ADT 6 after 60 days of storage in the present study and which was higher than the findings of Deepika *et al.* (2019) who stated that 14.00 to 36.00 percent damage in different chickpea genotypes after 60 days release of *Callosobruchus chinensis*.

The BG varieties *viz*., CO 5, CO 6, CO 7 and KKM 1 were found to be immune and the varieties *viz.*, VBN 8, VBN 10, VBN 11, CO 2 and ADT 6 showed resistance to *C. maculatus* for two months of storage. The resistance of BG varieties against *C. maculatus* was already reported by Panigrahi *et al*. (2021) that Accession IC259504 (*V. vexillata*) showed complete resistance whereas IC424616 (*V. mungo*) was highly resistant to bruchid infestation based on the three key growth traits *viz*., adult emergence (AE), percent seed weight loss (PSWL) and growth index (GI).

CONCLUSION

The varietal screening of BG against the pulse beetle, *Callosobruchus maculatus* (Fabricius), in storage has yielded valuable insights into the relative susceptibility and resistance of different BG varieties to this pest. The study identified specific varieties that exhibit significant resistance to infestation, offering promising avenues for reducing post-harvest losses. Implementing these findings can contribute to improved food security and economic stability for farmers reliant on BG cultivation.

DECLARATION

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Generative AI and AI-assisted technology statement

The authors declare that no genrative AI was used in the creation of this manuscript.

Statement of conflicts of interest

The authors have declared no conflict of interest.

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