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Host preference and effect of pulse beetle, *Callosobruchus maculatus* (F.) on quality of different pulses

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ABSTRACT

A laboratory experiment was conducted on the host preference and qualitative losses of pulse beetle, *Callosobruchus maculatus* F. (Coleoptera: Bruchidae) on six different pulses *viz.*, Black gram, Green gram, Pigeonpea, Chickpea (*Desi*), Cowpea and Pea. The comparison of egg laying under no choice and multiple-choice condition revealed that egg laying was less on the seeds of all the pulses under multiple-choice condition. However, under no choice condition maximum eggs were laid on cowpea (89.3), whereas in multiple-choice condition the egg laying was maximum on pigeonpea (66.3). Similarly low seed damage was recorded in all the pulses under multiple-choice condition except in case of pigeonpea (28.3%). Maximum standard germination, seed viability and seedling vigour index was found in black gram (55.1%, 56.0% and 1410.1) and minimum in cowpea (33.6%, 22.0% and 679.0), respectively. Shoot, root and seedling lengths of all the pulses were affected adversely due to the incidence of pulse beetle. The shoot length was 10.2 cm (black gram) to 18.1 cm (pigeonpea). The root length was 7.2 cm (chickpea) to 10.8 cm (cowpea) and seedling length varied from 21.1 cm (chickpea) to 27.1 cm (black gram).

Key words: *Callosobruchus maculatus*, host preference, pulses

INTRODUCTION

Pulses constitute the main source of protein in developing countries like India, where per capita consumption of animal protein is very low. Pulses can be stored for considerable periods of times after harvest but during storage they may be attacked by various insect species. In India, over 200 species of insects have been recorded infesting various pulses (CABI, 2007). Among these, pulse beetle, *Callosobruchus maculatus* (Fabricius) [Coleoptera: Bruchidae] is major pest that causes serious damage and is cosmopolitan (Bhalla *et al.*, 2008). It is a holometabolic insect with the egg and adult stage found on the grain and the larval and pupal stages living inside the grain. The larvae bore into the pulse grains and eat up the endosperms which become unsuitable for human with reduced viability for replanting or for the production of sprouts (Devi and Devi, 2014). Host preference in different pulses were reported by Chander and Ghosh (2006) and Amna *et. al* (2003). The present investigations on host preference of pulse beetle, *Callosobruchus maculatus* and its qualitative losses in different pulses were conducted in laboratory at 29-30^{0}C and 65-70 per cent RH.

MATERIALS AND METHODS

Preference of various pulses by *C. maculatus* under multiple-choice condition:

To study the host preference and effect of *C. maculatus* on quality of different pulses, a laboratory experiment was conducted during 2014-15 in the laboratory at Department of Agriculture, OPJS University Churu, in completely randomized block design with six treatments *i.e.*, 6 pulses [Green gram (*Vigna radiata*), Black gram (*Vigna mungo*), Pigeonpea (*Cajanus cajan*), Chickpea (Desi) (*Cicer arietinum*), Cowpea (*Vigna sinensis*), Pea (*Pisum sativum*)] and 3 repetitions.

For the purpose, the stock culture of *C. maculatus* (F.) was maintained in the laboratory at room temperature (29±1^{0}C). Under each treatment, 3 plastic open containers (each 5 x 7 cm) were taken and each was filled with 50g conditioned grains after this one vial of each treatment were kept in plastic tub in a circle with a pad of muslin cloth in the centre. There after thirty virgin pairs of newly emerged adults (0-24 h old) adult beetles (5 pair/treatment) of *C. maculatus* were isolated from stock culture using key of sex differentiation (Raina, 1970) and introduced on muslin pad in the plastic tub and covered with muslin cloth to allow aeration and to prevent escape of the beetles. One plastic tub served as one replication. Three replications were maintained. These were left undisturbed for one month period and following observations were recorded at the end.

i) Number of eggs laid/fecundity
ii) Per cent grain damage/per cent grain infestation

$$\text{Grain infestation (\%)} = \frac{\text{No. of grains observed}}{\text{No. of grains observed}} \times 100$$

Effect of *C. maculatus* on quality parameters was studied by germination test: After one month of storage, 50 seeds of each treatment were kept 'Between the paper' (BP) at 25±1^{o}C temperature (ISTA, 1985). All the treatments were replicated thrice. On the 7th day after start of the test, the paper towels were opened to record the standard germination (%), abnormal seedling (%), seed viability and vigour index. Five normal seedlings were selected randomly from each replication at the end of germination test. Shoot length and root length of each of the five seedlings was measured and recorded in cm and average seedling length was calculated. The parameter-wise data were subjected to ANOVA. The statistical analysis was done as per procedure suggested by Sharma and Rathore (2006).

RESULTS AND DISCUSSION

Fecundity: Under multiple-choice condition the average fecundity (eggs/female) by *C. maculatus* was 66.3 on pigeonpea, which significantly differed from other pulses i.e. cowpea (63.6), black gram (63.1), green gram (56.2), chickpea (41.4) and 29.1 on pea (Table 1). In case of multiple-choice, scores of eggs were laid on the plastic tub and the muslin cloth used in this experiment and that is why the total number of eggs laid on various pulses in multiple-choice condition is less as compare to no choice condition.

Perusal of the data (Table 1) on number of eggs laid by *C. maculatus* on various pulses under no choice and multiple-choice condition, showed that under no choice condition number of eggs laid was comparatively higher than multiple-choice condition, irrespective of the pulses. Maximum eggs were laid on cowpea (89.3) under no choice condition but in multiple-choice condition maximum eggs were laid on pigeonpea (66.3). In case of no choice condition 89.3 eggs were laid on cowpea whereas in multiple-choice condition 63.6 eggs were laid.

Seed Damage: The data recorded on seed damage by *C. maculatus* to various pulses under multiple-choice condition is presented in Table 1. Maximum seed damage was found in pigeonpea (28.3%), which was significantly higher than other pulses, i.e. cowpea (22.6%), Pea (20.9%), green gram (17.1%), black gram (14.2%) and 3.7 per cent in

chickpea. In case of multiple-choice condition, seed damage was less as compare to no choice condition because of less number of the eggs actually laid on the seeds in multiple-choice condition as compared to no choice condition.

The data on comparison of seed damage caused by *C. maculatus* under no choice condition and multiple-choice condition are presented in Table 1. It shows that under no choice condition seed damage was comparatively higher than multiple-choice condition, irrespective of the pulse. Maximum seed damage was observed in pigeonpea in both the conditions and it was 27.1 per cent under no choice condition and 28.3 per cent under multiple-choice condition.

The variation in seed damage was significant among various pulses in no choice condition. Maximum seed damage occurred in pigeonpea (27.1.5%), followed by cowpea (23.7%), pea (22.3%) and minimum in chickpea (8.6%). Ghosal and Senapati (2006) observed that per cent seed damage by *C. chinensis* was highest in lentil (42.6) followed by green gram (29.9), grasspea (22.4), red gram (18.6), Bengal gram (11.3), cowpea (13.8) and pea (10.5). The seed damage by *C. analis* was highest on cowpea (19.6) followed by black gram (11.0), green gram (13.8) and lowest on pea (9.8). Under multiple-choice condition maximum seed damage occurred in pigeonpea (28.3%), followed by cowpea (22.6%) and minimum in chickpea (3.7%). Chandra and Ghosh (2006) found that the seeds of Kabuli gram, red gram and pea have soft seed coat and more intra-seed space, thus these were more suitable for the egg laying and larval entry, therefore, causes more seed damage. The seed coat of Bengal gram and lentil are thick and hard which restricted the entry of the larvae.

Standard Germination: Among the various pulses, the standard germination ranged from 33.6 to 55.1 per cent (Table 2) and maximum standard germination in infested seeds was observed in black gram (55.1%), followed by chickpea (51.0%), pigeonpea (47.0%), pea (45.6%), green gram (39.6%) and the lowest standard germination was observed in cowpea (33.6%).

Seed Viability: The seed viability of infested pulses was ranged from 22 to 56 per cent. The seed viability was maximum in black gram (56%), followed by pea (54%), pigeonpea (51%), chickpea (49%), green gram (36%) and minimum in cowpea (22%).

Seed Vigour Index: The Seedling Vigour Index of infested pulses was compared with the Seedling Vigour Index of uninfested pulses. Maximum vigour index was found in black gram (1410.1), followed by pigeonpea (1289.2), chickpea (1036.0), pea (960.0), green gram (839.3) and cowpea (679.0).

Root and shoot length: Root length is a parameter to determine the seedling vigour on seedling length basis. Seedling root length also has an important application under field conditions. It is expected that higher root length would provide more opportunities for the uptake of nutrients from the soil and help in better seedling establishment.

Seedling shoot length is a parameter to determine the Seedling Vigour Index on seedling length basis. Shoot length is directly proportional to surface area of the seedlings which results into increased photosynthesis and hence more vigorous seedling growth.

The data on the effect of *C. maculatus* infestation on root length of various infested pulses are presented in Table 3 revealed that among the various pulses, the seedling root length ranged from 7.2 to 10.8 cm. The maximum seedling root length (10.8 cm) was recorded in cowpea followed by pigeonpea (9.6 cm), black gram (9.2 cm), pea (7.9 cm), green gram (7.7 cm) and minimum 7.2 cm in chickpea.

The data on the effect of *C. maculatus* infestation on shoot length of various pulses are presented in Table 3 revealed that the maximum shoot length of infested pulses 18.1 cm was recorded in pigeonpea followed by cowpea (15.8 cm), green gram (12.9 cm), chickpea (11.6 cm), pea (11.2 cm) and minimum 10.2 cm in black gram.

The data on effect of *C. maculatus* infestation on seedling length of various pulses are presented in Table 3, showed that the maximum seedling length in infested pulses was observed in black gram (27.1 cm) followed by pigeonpea (26.6 cm), cowpea (25.3 cm), green gram (22.3 cm), pea (21.6 cm) and minimum in chickpea (21.1cm).

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Table 1. Fecundity and seed damage caused by *Callosobruchus maculatus* on various pulses under no choice and multiple-choice condition

Pulse	Variety	Fecundity/female		Seed damage (%)	
		No choice condition	multiple choice condition	No choice condition	multiple choice condition
Green gram	SML – 668	73.1	56.2	19.2	17.1
Black gram	T – 9	68.3	63.1	15.4	14.2
Pigeonpea	Manak	74.8	66.3	27.1	28.3
Chickpea	C -235	56.6	41.4	8.6	3.7
Cowpea	V-578	89.3	63.6	23.7	22.6
Pea	Azad -1	50.7	29.1	22.3	20.9
C.D. at 5%		7.6	18.7	2.8	11.7

Table 2. Effect of *Callosobruchus maculatus* infestation on standard germination, seed viability and vigour index of various pulses

n=5 pairs/50 g/one month

Pulse	Variety	Standard germination (%)		Seed viability (%)		Seedling vigour index	
		Uninfested	Infested	Uninfested	Infested	Uninfested	Infested
Green gram	SML – 668	89.0	39.6	86	36	3210.7	839.3
Black gram	T – 9	83.0	55.1	89	56	3601.9	1410.1
Pigeonpea	Manak	88.0	47.0	87	51	3721.6	1289.2
Chickpea	C -235	85.0	51.0	86	49	2664.3	1036.0
Cowpea	V-578	86.0	33.6	87	22	3436.2	679.0
Pea	Azad -1	79.0	45.6	81	54	2458.6	960.0
C.D. at 5%		0.74	0.49	0.59	0.31	3.13	1.69

Table 3. Effect of *Callosobruchus maculatus* infestation on average root, shoot and seedling length of various pulses

n=5 pairs/50 g/one month

Pulse	Variety	Root length (cm)		Shoot length (cm)		Average seedling length (cm)	
		Uninfested	Infested	Uninfested	Infested	Uninfested	Infested
Green gram	SML – 668	13.2	7.7±0.3	19.9	12.9±0.4	36.7	22.3
Black gram	T – 9	16.3	9.2±0.4	22.8	10.2±4.4	41.8	27.1
Pigeonpea	Manak	14.6	9.6±0.1	23.6	18.1±0.4	41.3	26.6
Chickpea	C -235	11.1	7.2±0.2	16.7	11.6±0.3	31.8	21.1
Cowpea	V-578	15.8	10.8±0.3	21.8	15.8±0.2	39.3	25.3
Pea	Azad -1	11.6	7.9±0.1	16.9	11.2±0.3	31.2	21.6
C.D. at 5%		0.58	0.36	0.42	0.27	1.3	0.9