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Asian Journal of Plant Science and Research, 2015, 5(10):9-15

ISSN : 2249-7412
CODEN (USA): AJPSKY

Evaluation of relative susceptibility of *Callosobruchus chinensis* Linn. on five different stored pulse seeds

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ABSTRACT

The pulse beetle, Callosobruchus chinensis (L.) (Coleoptera : Bruchidae), is a worldwide insect pest that infests pulses in the fields and seeds in storage. An investigation has been conducted on the life history and ovipositional preference, nature of damage caused by Callosobruchus chinensis reared on five different pulses through two successive generations. Kidney bean preferred most for oviposition followed by cowpea, black gram, small pea and green gram but adult survival rate is low in kidney bean. The adults exhibited a marked preference for smooth, large surfaced and well-filled seeds for oviposition. The pulses selected for the investigation are initially infested by the insects, but degree of infestation varied among the pulses. Thus susceptibility varies in different pulses. The order of susceptibility as per susceptible index was cowpea > green gram > small pea > black gram. Whereas kindey bean found resistant. Damage caused by the beetle also varied and the order is cowpea > green gram > black gram > small pea > kidney bean. This is due to the varied responses of the insect to different host seeds for oviposition and their appropriateness for the successful completion of the life cycle.

Keywords: *Callosobruchus*, Survival, Oviposition, Susceptibility, Percent damage.

INTRODUCTION

The cowpea weevil, *Callosobruchus chinensis* is a cosmopolitan polyphagous pest in the most tropics and subtropics [18].This weevil is reported to be the most damaging pest of legume seeds which are a major source of protein in many countries. Eggs are laid on the seeds surface in stored or pods in the fields and larvae develop within seeds causing weight loss, decreased germination potential and reduction in commercial value [5]. Beetle populations built rapidly in storage. The seeds may be almost completely hollowed out by feeding activities of the larvae, and characteristic emergence hole are evident after the adult leaves the seeds [9]. Thus, severe damage and significant weight loss in stored seeds is caused by larvae, which grow within the pulses and consumed the seeds.

Because of the economic importance and wide spread distribution, the development of suitable control measures for this pest is essential. As it is difficult to find suitable, cheap methods of control, emphasis should be placed on developing new plant varieties that have a natural resistance to bruchids as well as high yield [9]. The knowledge on pest resistance characteristics of seeds and the biology of the pest is therefore very important to achieve this goal.

Most species of the genus *Callosobruchus* are capable of breeding on a wide variety of legumes. The process of host selection and oviposition is mainly influenced by physical and biochemical factors. The degree and resistance and susceptibility of different pulses to bruchid attack vary with their different characteristics [3, 11, 13, 14]. Moreover, stored product insects are a major problem prevalent throughout the world because they reduce the quantity and quality of stored grains [12]. In countries where recent storage technologies have not been introduced, insect damage in stored grains and pulses may account to 40% [15]. The use of synthetic insecticides to control pest infestation in grains cause harmful health hazards to warm-blooded animals and a threat of environmental disruption of the ecosystem [6]. The insects pests affecting stored product pests can be effectively controlled only by analyzing the life cycle and host seed preference of the insect for oviposition.

In the view of the above fact, present investigation was undertaken to study the ovipositional preference of the cowpea beetle to different pulses and their susceptibility, extent of damage for subsequent development.

MATERIALS AND METHODS

Hundred healthy seeds of each type of pulses were evaluated for the study of relative susceptibility to pulse beetle. There were five replications for each experiments. At first, the seeds were weighted and kept in the plastic containers. Five pairs of freshly emerged males and females insects collected from the nucleus culture of green gram and released on each seed legumes. The containers were covered individually with perforated plastic lid and kept under laboratory condition (28.62 ± 2.46°C and 82.61 ± 3.96% r.h). After five days the adult insects were replaced from the containers. Total number of eggs laid in each container was counted without damaging the eggs. The grains were carefully kept in the respective container again and covered with perforated plastic lid. The observation for adult emergence was taken daily and the number of adult emerged were recorded till the emergence of last adult. Thereafter, the grains were poured down from the containers and seed weight of 100 grains was recorded. The healthy and damaged grains were separated and weights were taken separately.

The susceptibility index of different pulses was calculated using the formula by Dobie (1974).

Dobie susceptibility index = $\text{Log}_e Y \times 100/ t$

Where; Y= total number of adult bruchids emerged.
t= median development period (estimated as the time from the middle of oviposition to the emergence of 50% of F1 generation).

Dobie susceptibility index	Categories
1 - 5	Resistant
6 - 10	Intermediate / moderate resistant
11 - 15	Susceptible
16 - 21	Highly susceptible

The amount of damage was converted into percentage with the help of following standard formulae :

$$\% \text{ damage} = \frac{\text{Total no. of grains - No. of undamaged grains}}{\text{Total no. of grains}} \times 100$$

RESULTS AND DISCUSSION

To study the susceptibility of pulses to *C. chinensis* five different pulses viz. green gram, cowpea, black gram, kidney bean and small pea were taken which are commonly available in different store houses. 100 healthy seeds of each pulses were selected on which insects were released. Number of eggs laid were counted. Ovipositioal preference, developmental period, adult survival and percent weight loss of seeds were recorded during two successive generations.

Ovipositional preference
Perusal of Table 1 revealed that significantly higher number of eggs (160.25 eggs per 100 g of seeds) were laid on kidney bean as compared to the other pulses during the first generation. Next to kidney bean, higher number of eggs was also recorded on cowpea (109.25 eggs per 100 g of seeds) followed by black gram (102 eggs per 100 g of seeds), small pea (92.75 eggs per 100 g of seeds) and green gram (79.25 eggs per 100 g of seeds) which were again at per with each other.

During the second generation again higher number of eggs (111 eggs per 100 g of seeds) were laid on kidney bean as compared to the other pulses. Next to kidney bean, higher number of eggs was also recorded on cowpea (110.5 eggs per 100 g of seeds) followed by black gram (102 eggs per 100 g of seeds), small pea (92.75 eggs per 100 g of seeds) and green gram (79.25 eggs per 100 g of seeds) which were again at per with each other (Table 2).

There was no significant difference noted between the number of eggs laid on green gram and small pea during both the generations. No significant difference was noted in case of kidney bean and cowpea during second generation.

Developmental period

The mean developmental period ranged from 26.75 to 32.25 days in different pulses in first generation. Longest developmental period was recorded in kidney bean(32.25 days) followed by black gram (30.25 days), green gram (29.75 days), small pea (27.75 days) and shortest in cowpea (26.75 days). The parameters found from kidney bean and black gram were at per with each other. (Table 1).

Perusal of the Table 2 revealed that the mean developmental period ranged from 26 days to 35.25 days. Longest developmental period was recorded from kidney bean(35.25 days) followed by black gram (29.5 days), small pea (28 days), green gram (27.25 days) and cowpea (26 days).

Adult survival

The mean adult survival on test pulses ranged from 56.69 to 93.23 per cent during first generation. Significantly lowest adult survival was noticed from kidney bean (56.69 per cent) followed by black gram (71.69 per cent), small pea (87.35 per cent), green gram (90.61 per cent) and highest survival rate was noticed from cow pea (Table 1).

Table 1. Host preference of pulse beetle on different pulses (first generation)

Host	*No. eggs laid/ 100g seed	*Developmental period (days)	**Adult survival (%)	**Grain wt. loss (%)
Kidney bean	160.25 (12.38)	32.25 (5.59)	56.69 (48.7)	4.21 (11.72)
Small pea	92.75 (9.1)	27.75 (5.29)	87.35 (68.87)	3.36 (10.9)
Black gram	102 (9.37)	30.25 (5.53)	71.69 (57.7)	2.61 (9.89)
Cow pea	109.25 (10.24)	26.75 (5.19)	93.23 (73.74)	5.21 (13.68)
Green gram	79.25 (9.16)	29.75 (5.5)	90.61 (75.12)	3.86 (11.55)
S.Em ±	0.546	0.176	1.154	0.577
CD (p=0.05)	1.743	NS	3.509	1.755
CV	9.412	5.633	3.559	9.991

** Figures in the parentheses are √x transformed values.*
*** Figures in the parentheses are angular transformed values.*

Table 2. Host preference of pulse beetle on different pulses (second generation)

Host	*No. eggs laid/ 100g seed	*Developmental period (days)	**Adult survival (%)	**Grain wt. loss (%)
Kidney bean	111 (14.36)	35.25 (6.52)	41.82 (48.7)	2.76 (11.72)
Small pea	95.25 (9.1)	28 (5.29)	85.44 (68.87)	2.90 (10.9)
Black gram	106.25 (9.37)	29.5 (5.53)	72.74 (57.7)	3.26 (9.89)
Cow pea	110.5 (10.24)	26 (5.19)	96.21 (74.74)	6.22 (13.68)
Green gram	83.5 (9.16)	27.25 (5.5)	95.32 (75.12)	5.002 (11.55)
S.Em ±	0.577	0.123	1.224	0.508
CD (p=0.05)	N/A	0.374	3.724	1.546
CV	11.493	4.448	3.823	8.921

** Figures in the parentheses are √x transformed values.*
*** Figures in the parentheses are angular transformed values.*

During the second generation the lowest and highest survival rate was recorded from kidney bean (41.82 per cent) followed by black gram (72.74 per cent), small pea (85.44 per cent), green gram (95.32 per cent) and highest in cowpea (96.21 per cent) . No significant difference was noted between cowpea and green gram (Table 2).

Weight loss of grain

Perusal of Table 1 reveal that loss in grain weight among different pulses ranged from 2.61 to 5.21 per cent in first generation. Black gram recorded the significantly lowest weight loss of 2.61 per cent while the highest weight loss was recorded from cowpea (5.21 per cent). The weight loss in cow pea was followed by kidney bean, green gram, small pea of 4.21 per cent, 3.86 per cent and 3.36 per cent respectively.

During the second generation cowpea recorded the significantly highest weight loss of grain of 6.22 per cent followed by green gram (5.002 per cent), black gram (9.89 per cent), small pea (2.90 per cent) and kidney bean (2.76 per cent).

Determination of susceptibility index and percent damage

Susceptibility indices were determined in separate set of experiment and the data pertaining to the experiment on five different was presented in Table 3 revealed that cowpea (12.84) with significantly high susceptibility index followed by green gram (12.32) which was considered to be the next better pulse with less susceptible index. Both of the pulsed can be enlisted under susceptible class. Lowest susceptibility index was noted from kidney bean (0.72) followed by black (4.90), found resistant. While small pea found moderately resistant with susceptible index 6.54.

The highest percent damage by one pair of *C. chinensis* during one month storage period was recorded from cowpea with 56.3 per cent which was significantly higher than the other pulse seeds. No significant difference was noted between green gram and black gram recorded with 38.42 per cent and 32.36 per cent damage respectively. Lowest damage was recorded in small pea (5.32 per cent) and no damage was recorded in kidney bean.

Table 3. Mean susceptibility indices and weight loss following infestation by *C. chinensis* on different pulses

Pulses	Initial wt. (gm)	Final wt. (gm)	% wt. loss	Damage (%)	Susceptibility index	Categories
Green gram	2.6	0.9	6.4 (14.63)	38.42 (38.30)	12.32	Susceptible
Cow pea	10.2	3.2	6.6 (14.91)	56.30 (48.61)	12.84	Susceptible
Black gram	2.8	1.9	3.1 (10.14)	32.36 (34.67)	4.90	Resistant
Kidney bean	27.2	26.2	3.8 (11.24)	0.0002 (0.26)	0.72	Resistant
Small pea	12.6	7.2	4.8 (12.65)	5.32 (13.33)	6.54	Moderate resistant
S.Em (±)			0.08	1.23		
CD (p = 0.05)			0.26	3.09		
CV			10.73	9.36		

Data in parentheses indicate angular transformed value

Perusal of Table 1 revealed that among different pulses, green gram recorded significantly lowest number of eggs(79.2 eggs/female) which was on par with pea (92.7 eggs/female) as against the highest number of eggs observed in kidney bean (160.2 eggs/female) followed by cowpea and black gram 109.2 and 102.0 eggs/female, respectively during the first generation. Similar results were also observed in the next generation (Table 2). Based on fecundity the order of preference was kidney bean> cowpea> black gram> small pea> green gram (Table 1). Kidney bean and cowpea having smooth skinned seed texture and bigger in size that probably encouraged the beetle to prefer more for egg laying. The findings were in conformity with [10] who concluded that oviposition preference of the bruchid might be guided by smoothness of seed coat and size of the grain. The mean developmental period ranged from 26.7-32.2 days in different pulses in first generation and cowpea recorded significantly lowest developmental period followed by small pea, green gram, black gram and kidney bean (Table 1). Similarly. In second generation lowest developmental period was recorded on cowpea (26.0 days) and highest on kidney bean (35.2 days). Green gram (27.2 days) proved better than small pea (28.0 days) and black gram (29.5 days) (Table 2). In a similar experiment, [17] recorded maximum larval mortality and prolonged developmental period in *C. maculatus* and *C. analis* in kidney bean. The mean adult emergence on different pulses ranged from 56.69- 93.23 per cent. Significantly the lowest percentage of adult emergence was recorded in kidney bean while highest survival was observed in cowpea followed by green gram, small pea and black gram (90.61, 87.35 and 71.69% , respectively) in the first generation (Table 1). In the second generation, highest and lowest insect survival was recorded in cowpea (96.21%) and kidney bean (41.82%), respectively. Among other legumes, the order of sequence was green gram > small pea> black gram. The result suggested that cowpea was the most suitable host for *C. chinensis*. The finding was in agreement with [4] who reported that cowpea was the most preferred host for the insect while kidney bean proved non- suitable host as in subsequent generation survival rate of the beetle much reduced. The loss in grain weight among different pulses ranged from 2.61-5.21 percent in first generation and 2.76-6.22 percent in second generation . Black gram recorded significantly lowest weight loss while maximum weight loss was recorded from cowpea followed by kidney bean, green gram and small pea of 4.21 percent, 3.86 percent and 3.36 percent respectively (Table 1). In second generation , kidney bean recorded the minimum weight loss and cowpea again recorded maximum weight loss but highest adult survival (Table 2).

In a separate experiment on percent weight loss and susceptibility index it was found that highest weight loss in percentage was recorded from cowpea followed by green gram, small pea, kidney bean and black gram (Table 3 and Fig 2). This results were in accordance with the studies of [1]. Similar order was recorded in case of susceptibility index. The susceptibility indices revealed that kidney bean (0.72) and black gram (4.90) were resistant and could be regarded as non-suitable hosts for *C. chinensis*. Small pea (6.54) was moderately resistant. The cowpea (12.84) and green gram (12.32) found most suitable host for development of *C. chinensis* among the pulses investigated. The result was in accordance to [19].

Data pertaining from the experiment on percent damage by one pair of *C. chinensis* during one month storage period revealed the fact that the percent damage in green gram, cow pea, black gram, kidney bean and small pea was 38.42, 56.30, 32.36, 0.00 and 5.32 respectively (Fig. 1). Statistical analysis of the data shows that percent damage in cow pea was significantly higher than all the other legumes. There was no significant difference in the damage recorded in green gram and black gram. The percent damage caused into the kidney bean in significantly minimum (Fig 2). Thus, cow pea and kidney bean is the most and least preferred host to *C. chinensis*. The results of the present experiment are comparable with those reported by [8, 16, 7]. Dwivedi and Sharma (1993) reported cowpea and soyabean were the most and least preferred hosts to *C. chinensis*. They also reported a decrease in preference by the bruchid with increasing protein and fat content. Ofuya and Bambigbola (1991) reported the damage potential of *C. chinensis* on 8 legumes. They reported that one or more larvae caused significant weight loss in single seeds of cowpea. Average percentage infestation of seeds of cowpea, green mung, chick pea and black bean was 14.36, 10.08, 9.38 and 3.47 respectively [7]. Aslam (2004) also reported *C. chinensis* as a major pest. It causes about 10% damage to chick pea and renders the grains unfit for human consumption. The result was in agreement with Tun (1979).

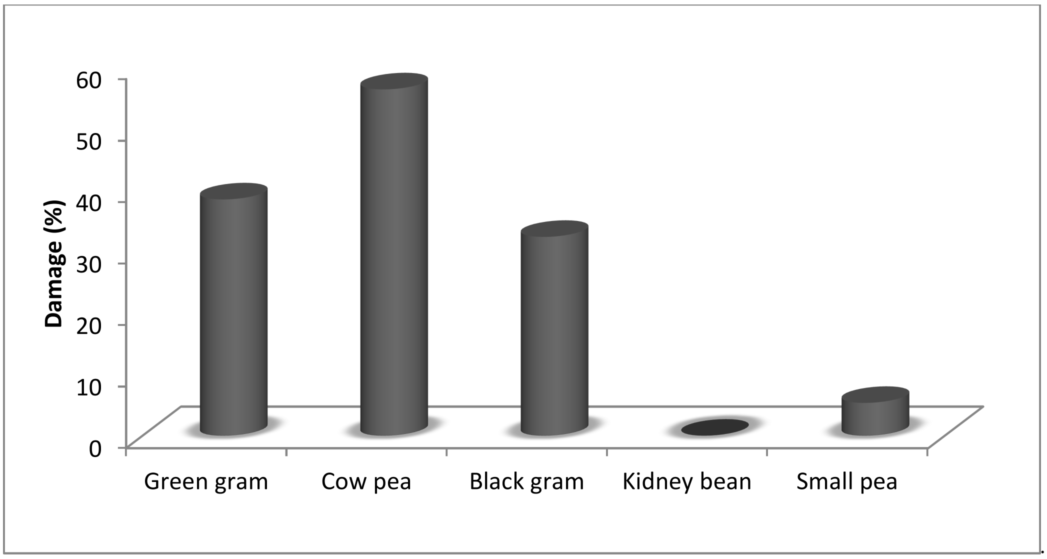

Fig. 1. Percent damage caused by *C. chinensis* in various legumes during one month storage period

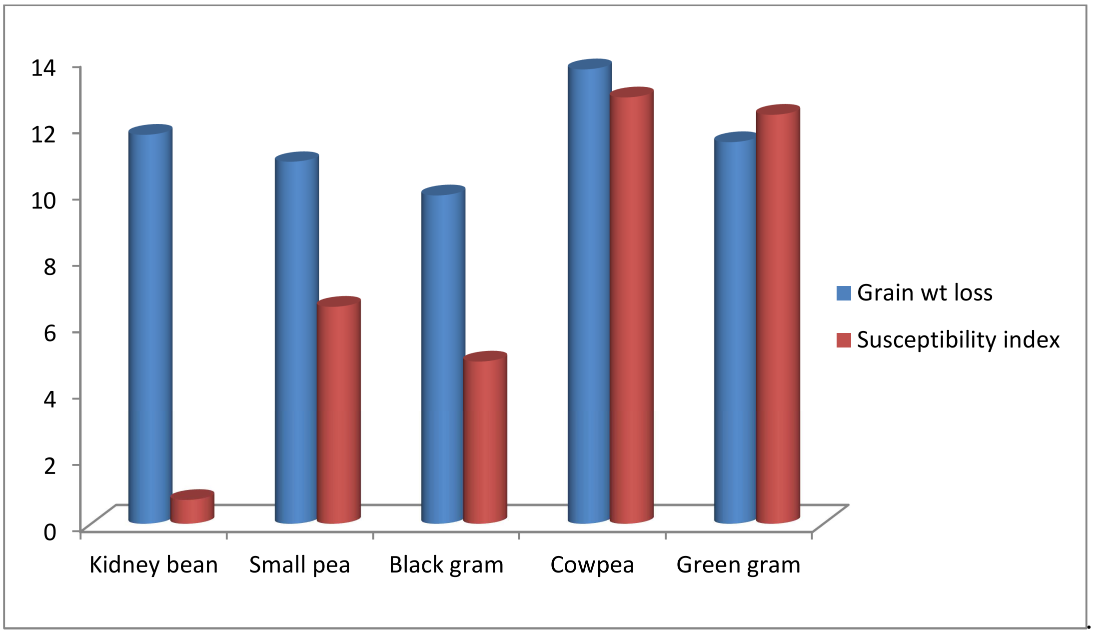

Fig 2. Percent grain wt. loss caused by *C. chinensis* during storage and susceptibility index of the seeds under experiment

CONCLUSION

It may be concluded that cowpea seeds are the most vulnerable legume seeds and the most suitable host for *C. chinensis*. This host seeds had shortest developmental period, maximum adult survival , highest susceptibility index and maximum weight loss. Because of smooth and large surface volume kidney bean provide greater spatial opportunity to lay eggs but the insect failed to complete life cycle successfully and thus kidney bean proved resistance to the insect attack. Green gram also proved as suitable for infestation. The current research paves the way to provide awareness to the farmers not to store cowpea, green gram and other susceptible seeds in the same place and/or at the same time to avoid cross infestation because of their high susceptibility to *C. chinensis*.

Acknowledgement
The authors are thankful to Head and Staff of Department of Plant Protection, Palli Siksha Bhavana, Visva-Bharati, and Department of Agricultural Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal for providing facilities during the experiments.

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