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Comparative Developmental Compatibility of *Callosobruchus maculatus* on Cowpea, Chickpea and Soybean Genotypes

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ABSTRACT

Seeds of all legumes are vulnerable to be attacked by seed beetles, both in field and storage. The resistant/tolerant genotypes certainly be helpful to reduce storage losses by bruchids and other insect pests and can be exploited by the breeders for the evolution of new varieties. This vital information of varietal resistance among different genotypes of cowpea, chickpea and soybean will assist in devising the control procedures against these legendary pest species. The expansion of insect resistance and high yielding varieties having moderate to high levels of resistance is a promising approach for exploration of integrated pest management strategy. By keeping in view a comparative growth performance of *C. maculatus* on genotypes of different legumes has been studied. And the results revealed that all the legume genotypes of soybean (except harasoya) and cowpea with smooth seed coat texture were highly preferred by *C. maculatus* for egg laying than chickpea genotypes (kabuli>desi). Among all the genotypes of three legumes highest percentage of adult emergence, growth index, percentage reduction in weight and low developmental period was recorded in cowpea followed by chickpea (kabuli>desi) and least in soybean which may be due to physical and chemical factors which resist the growth and development of *C. maculatus* on soybean genotypes.

Key words: *Callosobruchus maculatus*, cowpea, chickpea and soybean genotypes

INTRODUCTION

Grain legumes popularly known as pulses play an important role in Indian Agriculture, not only to increase the soil fertility for obtaining reasonable high yields from succeeding crops but also in providing proteinaceous grains and nutritive fodder. Pulses contain at least two to three times more proteins and the amount of lysine is also two to three times higher in their proteins as compared to the proteins of cereal grains. For, vegetarian diet, pulses form the major source of proteins. Infect lysine is the most limiting essential amino acid in the cereals which is very well supplemented by pulses. It has been estimated that about 60-80% of all grain produced in the tropics is stored at farm level and out of which 25-40% of stored agricultural products is lost both quantitatively and qualitatively annually because of the activity of storage pests (De Lima, 1987). Several options including environmental manipulations to discourage growth, development and reproduction have proved effective in controlling storage insect pests. Such environmental manipulation can be attained by employing a number of chemical, mechanical, cultural and physical methods. Although, chemical pesticides are effectively used against storage insect pests but are inseparably associated with a number of drawbacks including health hazards, high costs and also concern about environmental pollution and food safety. Certain morphological and physiological characteristics inherited by plants from a core of defence mechanism against insects and other pest and pathogens that would otherwise attack them. These defences are the result of long term natural selection. These morphological features either produce physical stimuli or inhibit insect activity. From the gene pool of a crop species, certain crosses produce phenotypes that vary from complete susceptibility to high levels of resistance against insects.

An effective and environment-friendly management option against insect pest in different legumes, cereals and other stored crops could be achieved by improving genetically resistant varieties of plants. Nevertheless, most of the breeding programs pursued higher to focus more on improving seed yield and quality than improving resistance against insect pests. Varietal or genotypic tolerance to storage pests seems to be the most potential means of reducing post-harvest losses. Studies have indicated that none of bengal gram and cowpea varieties were completely immune to attack of pests. The use of resistance breeding is a possibility, provided factors responsible for resistance are intensified.

MATERIALS AND METHODS

For the study of comparative evaluation of different genotypes against *C. maculatus,* samples of thirteen genotypes of soybean genotypes viz., JS-335, JS-9305, JS-9560, Bragg, Palamsoya, P2-2, Pb-1, Himsoya, P9-2-2, Shivalik, Harasoya, PK-472, P13-4, were obtained from CSK Himachal Pradesh Krishi Vishvavidalaya, Palampur, samples of eight chickpea cultivars viz., HK-1, HK-2, HC-1, HC-5, C-235, GNG-663, GNG-1481 and GNG-1581 from CCS, Agriculture University, Hisar, and samples of ten genotypes of cowpea (*V. sinensis*) viz., IC-106816, IC-106817, IC-106819, IC-106826, IC-106831, IC-106835, IC-106839, IC-326634, IC-326996 and IC-311584, from National Bereau of Plant Genetic Resources (NBPGR) Phagli, Shimla for the experimental studies. Experiments were undertaken under controlled conditions of temperature (28±2°C) and relative humidity (65±5%) in biological oxygen demand incubator (DB-2025, Decibel) with ten replications.

For the study of genotype preference, fifty weighed seeds of each soybean, chickpea and cowpea genotype were kept separately in petridishes and two pairs of one to two days old adults (2 males and 2 females) of *C. maculatus* were released in them separately. The released insects were removed after 72 h with the expectation of maximum ovulation and oviposition during this period. The numbers of eggs laid on seeds of each genotype were recorded. The experiment was continued for next 60 days, to observe the adult emergence and their percentage was recorded as:

$$\text{Adult emergence (\%)} = \frac{\text{No. of adults emerged}}{\text{Total No. of eggs laid}} \times 100$$

The period taken from oviposition to adult emergence was recorded as developmental period. The percent adult emergence divided by the developmental period in days was taken as growth index:

$$\text{Growth index} = \frac{N}{AV}$$

where, N is the number of adults emerged and AV is the developmental period.

The reduction in weight loss in seed weight (g) was taken after the infestation and it was deducted from the initial weight recorded earlier, before infestation and percent loss in seed weight was calculated for each genotype:

$$\text{Weight loss (\%)} = \frac{\text{Initial weight-Weight of infected seeds}}{\text{Initial weight}} \times 100$$

Statistical analysis: All experiments were performed in ten replications. Analysis at every time point from each experiment was carried out in triplicate. Means, standard errors and standard deviations were calculated from replicates within the experiments and analyzed using Microsoft Excel XP.

RESULTS AND DISCUSSION

Among all the genotypes of cowpea, chickpea and soybean, the cowpea and soybean genotypes with maximum oviposition rate ranged from (70.25±2.22 to 89.75±2.63) (Table 1) and (58.25±2.50 to 86.25±2.75) (Table 2), respectively were highly preferred for egg laying by *C. maculatus* as compared to chickpea (45.5±2.65 to 68.75±2.99) genotypes (Table 3). According to

Table 1: Comparative developmental compatibility of *Callosobruchus maculatus* on cowpea

Genotype	No. of eggs laid	Adult emerged (%)	Developmental period (days)	Growth index	Weight loss (%)
IC106816	84.25±2.63	56.97	19.00±1.15	3.00	46.05
IC106817	81.50±2.08	58.28	19.75±1.26	2.95	43.80
IC106819	79.75±2.22	60.82	19.50±1.29	3.12	55.85
IC106826	80.00±2.58	58.44	20.25±1.50	2.89	42.45
IC106831	89.75±2.63	51.81	24.00±1.82	2.16	34.64
IC106835	87.75±2.63	49.29	21.00±2.16	2.35	35.93
IC106839	88.25±3.77	46.74	22.50±1.29	2.08	23.99
IC326634	70.75±3.40	62.19	20.50±1.73	3.03	28.11
IC326996	70.25±2.22	60.80	20.00±1.41	3.04	35.49
IC311584	77.25±2.22	60.84	21.50±1.29	2.83	37.72

Table 2: Developmental compatibility of *Callosobruchus maculatus* in soybean genotypes

Genotype	No. of eggs laid	Adult emerged (%)	Developmental period (days)	Growth index	Weight loss (%)
JS-335	86.25±2.75	9.28	35.75±1.50	0.26	6.18
JS-9305	81.75±2.22	1.53	58.25±0.96	0.03	1.47
JS-9560	81.00±2.16	1.85	42.25±2.22	0.04	2.10
Bragg	71.00±2.83	0.00	0.00	0.00	0.00
Palam soya	81.50±1.91	9.51	47.50±1.29	0.20	5.42
P-2-2	80.50±2.38	4.04	54.75±1.71	0.07	3.42
Pb-1	80.75±2.50	3.41	55.00±1.63	0.06	3.41
Himsoya	78.75±1.71	13.02	49.50±1.00	0.26	10.38
P9-2-2	78.00±3.92	4.17	48.00±1.15	0.09	5.87
Shivalik	81.50±1.73	1.84	57.50±0.71	0.03	1.37
Harasoya	58.25±2.50	2.29	56.33±0.58	0.04	2.98
PK-472	62.00±1.83	12.10	47.75±0.96	0.25	10.34
P13-4	74.00±3.16	16.55	46.00±0.82	0.36	11.22

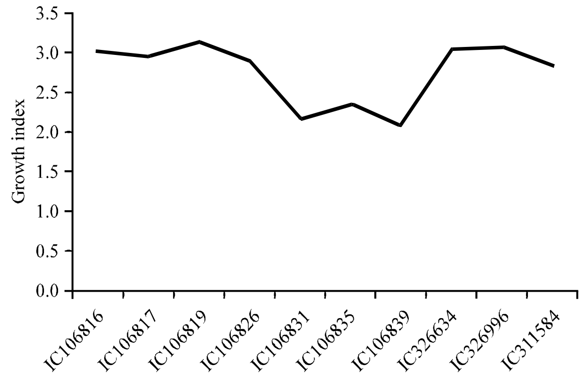

Fig. 1: Growth index of *Callosobruchus maculatus* on cowpea genotypes

Table 3: Developmental compatibility of *Callosobruchus maculatus* on chickpea genotypes

Genotype	No. of eggs laid	Adult emerged (%)	Developmental period (days)	Growth index	Weight loss (%)
HK-1	66.75±2.71	56.38	27.75±1.25	2.03	32.29
HK-2	68.75±2.99	61.27	28.75±2.12	2.13	31.52
HC-1	53.75±2.22	46.51	31.00±1.82	1.50	23.52
HC-5	55.50±2.65	43.26	31.25±1.70	1.38	18.30
C-235	48.50±2.89	41.23	31.75±1.89	1.29	8.05
GNG-663	45.50±2.65	48.50	29.50±1.11	1.64	22.34
GNG1488	53.51±2.45	55.78	29.75±1.50	1.87	27.40
GNG-1581	50.75±2.06	49.15	30.50±1.29	1.61	14.05

observations, the texture of seed coat appears to play a major role in the selection of oviposition sites by *C. maculatus*. The females preferred seeds with smooth coat to rough coat as both the legume genotypes (cowpea and soybean) possessed the smooth coat surface except in Hara soya which is intermediate in seed coat surface as compared to chick pea in which three genotypes possess smooth surface and other have wrinkled and rough surface. Similar results were recorded by Wijenayake and Karunaratne (1999) and Kellouche *et al.* (2004) who revealed that *V. unguiculata* genotypes with smooth surfaces preferred for egg laying over rough seed surface of *C. arietinum* genotypes by *C. maculatus*.

The results of present study revealed that among all the genotypes of three legumes highest percentage adult emergence of *C. maculatus*, growth index, percentage reduction in weight and low developmental period as 46.74-62.19%, 2.08-3.12, 23.99-55.85% and 19.0±1.15 to 24.0±1.82 days was recorded in cowpea genotypes, respectively (Table 1 and Fig. 1) followed by chickpea 41.23-61.27%, 1.29-2.13, 8.05-32.29% and 27.25±1.25 to 31.75±1.89 days, respectively (Table 2 and Fig. 2). These results are supported by the findings of Kazemi *et al.* (2009) and least percent adult emergence (0-16.55%), growth index (0.00-0.36), percentage weight loss (0.00-11.22%) and highest developmental period (35.75±1.50-58.25±2.96 days) was recorded in soybean genotypes (Table 2 and Fig. 3) used in the present study, which might be because of physical and chemical factors, which resist the growth and development of *C. maculatus* in soybean genotypes. The inability of *C. maculatus* to develop on soybean can be attributed mainly to high protein-carbohydrate ratio of the seed in addition to its saponin content and this composition may be inculcated in other legumes to get rid of pest problems (Applebaum *et al.*, 1969).

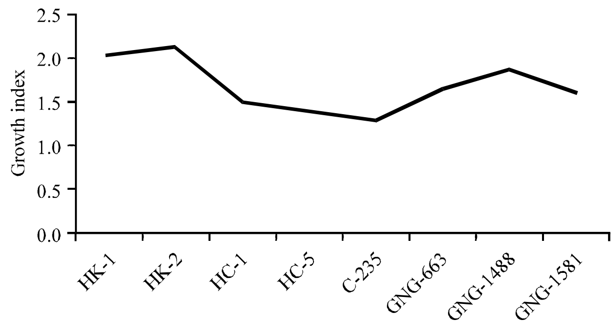

Fig. 2: Growth index of *C. maculatus* on chickpea genotypes

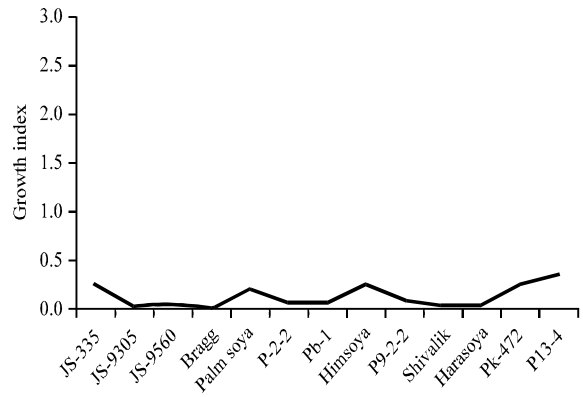

Fig. 3: Growth index of *C. maculatus* on soybean genotypes

A number of physical and chemical factors of seeds appear to be responsible for the reduction of the development of *C. maculatus* in some legume genotypes. The ability of larvae to penetrate in seed coat appears to be influenced by physical properties of the seed coat such as thickness, hardness and roughness supported by Manohar and Yadava (1990) and Pessu and Umeozor (2004). In addition, in soybean, factors such as high proteins, high amount of fats and presence of antinutritional factors may have been responsible for the death of larvae after the penetration into cotyledons of soybean. Similar results were given by Mphuru (1981) who reported that the ability of soybean to resist the attack of bruchid was attributed to the presence of high fat contents in the seeds. Wijenayake and Karunaratne (1999) reported that compactness of the soybean seed cotyledon may cause difficulties for the larvae to feed resulting in their death due to starvation.

The present study clearly indicates that the preference for oviposition by females is not an indicator of suitability for the development of *C. maculatus* as least adult emergence was recorded from the most preferred genotypes of soybean as compared to chickpea genotypes which possessed high adult emergence although were less preferred by the female for oviposition than soybean genotypes. The recorded results revealed that among all the genotypes of three legumes the egg laying was preferred as soybean>cowpea>chickpea (kabuli>desi). The adult emergence, growth index values and weight loss was maximum recorded in cowpea>chickpea (kabuli>desi)>soybean genotypes. The findings of present studies are in accordance with those of other workers (Reed *et al.*, 1987; Ahmed *et al.*, 1989; Lambrides and Imrie, 2000; Pessu and Umeozor, 2004;

Kellouche *et al*., 2004; Swella and Mushobozy, 2009; Erle *et al*., 2009) who have previously reported that the tolerant varieties showed the least loss in weight of seeds due to bruchid infestation, which could be attributed to the small size, the presence of well-formed texture layer and presence of antinutritional components in the seeds.

The resistant behaviour of soybean genotypes than cowpea and chickpea genotypes to *C. maculatus* might be because of the presence of antinutritional factor like phenols, tannins, lignins and TIU in high amount as compared to cowpea and chickpea which resist the development of eggs to adults.

From the foregoing discussion, it can be concluded that the food consumed by the larvae varied with grain host, perhaps owing to the difference in the physical factors or chemical constituents of the genotypes. Kashiwaba *et al*. (2003) revealed that chemical compounds contained in the cotyledons of beans had an inhibitory effect on the growth of bruchid species and the variation in different parameters may be due to genetic factors, possibly because of biochemical contents such as tannin contents, trypsin inhibitors, phenols etc. (Deshpande *et al*., 2011).

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