Research Article

Assessment of susceptibility in local chickpea varieties by the cowpea weevil, *callosobruchus maculatus* (Coleoptera: Bruchidae)

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Abstract

Chickpea is an important pulse food that fulfills the requirement of the staple food. *Callosobruchus maculatus* (cowpea weevil) is the most important destructive pest that causes severe economic losses in quantity and nutritional quality. The present work is on the susceptibility of cowpea weevil on four main varieties of chickpea of Pakistan (KP-8mm, KC-12mm, KE-9mm and Desi kala chana). The study was conducted for a period of four months from September to December 2015, under room conditions at moderate temperature of 27 ± 2 °C and $60 \pm 5\%$ relative humidity with 12 hour light and dark cycle to produce many generations of cowpea weevil. Ten pairs of newly emerged adults were released in plastic jars having 100 gram of each of four varieties. All the varieties were checked after the interval of fifteen days to observe the intensity of seed damage by the *C. maculatus*. The highest consumption was observed in KP-8 mm and KC-12 mm 85gm, 79gm respectively, while KE-9 mm showed relatively low consumption that was 71gm, and Desi kala chana was least consumed 62gm by cowpea weevil. The susceptible varieties exhibited soft, moreover, smooth seed coat and white in colour whereas least susceptible had hard and wrinkled seed coat. Based on present observation, it is noted that by growing tolerant varieties infestation of chickpea by cowpea weevil can be limited.

Keywords: Susceptibility; Cowpea weevil; Chickpea

Introduction

Chickpea (*cicer arietinum*) is a valuable pulse crop belongs to family Leguminosae also known as the pea or bean family. Chickpea contributes about 15% of the world's total pulse production [1]. In human diet, it is a big source of protein about 20%,

which fulfills the protein requirement of the people, especially in rural areas of Pakistan [2]. In Pakistan, it is cultivated on an area of about 985 thousand hectares, which produces about 673 thousand tons of chickpea [3]. Two main types of chickpea differ from each other in seed size, shape

and colour. The first type is Desi, small and brown seeds and second is Kabuli, with large white colour seeds. In Thal areas of Punjab and Khyber Pakhtunkhwa provinces, it is grown in rainfed conditions as its production totally depends upon rainfall. In Sindh and Baluchistan, it is grown on residual moisture after rice harvest. Thal is the major chickpea-producing region in Pakistan, which alone contributes about 80% to its production [4, 5]. Every year in developing countries, chickpea seed suffer by notable quantitative and qualitative losses 60% [6] due to pest attack on chickpea seeds. Nearly about 10% of chickpea grain loss occurs in Pakistan, due to *Callosobruchus* species alone in storage [7]. It has been observed that *C. maculatus* is the most destructive pest of chickpea in storage. The larvae feed on the seeds, causing significant damage that affects the chickpea's quality and quantity such as weight loss decreases the grains nutritional value and loses germination capacity [8]. *Callosobruchus maculatus* is very important pest of field as well as of stored pulses like chickpea, cowpea, red gram, black gram and green gram in all over the tropics [9]. The cowpea weevil can damage whole grain of chickpea and within three months it may cause total loss [10]. *Callosobruchus maculatus* larvae feed and develop mainly on seed, while the adults do not need any food or water and lives for 10-14 days just for mating and laying eggs on seeds [11]. In heavy infestation by cowpea weevil, the grains become completely hollow, unmarketable and unfit for human consumption. Therefore, there is a need to search for control to avoid the heavy losses of grains by this pest. Investigating the resistant variety is the best option [12, 13]. The present study is planned to screen susceptibility of four available cultivars of chickpea against cowpea weevil.

Materials and methods

Experimental site

The study was carried out at the insectary of Zoology Department, University of Sindh Jamshoro during September to December 2015.

Infested chickpea seeds were collected from local market of Hyderabad from which adults of *C. maculatus* were collected. The insect adults were brought to the entomology laboratory and identified on the basis of morphological characters. The insects were used to maintain a culture of *C. maculatus* on undamaged chickpea seeds under room conditions at moderate temperature of 27 ± 2 °C and $60 \pm 5\%$ relative humidity in September and October while 22 ± 3 °C and 50 ± 5 relative humidity in November and December with 12 hour light and dark cycle to increase the population of *C. maculatus* adults. The newly emerged adults kept under observation for experimental purpose.

Experimental procedure

The experiment was conducted on three varieties of Kabuli chickpea, KP-8mm, KC-12mm, KE-9mm and one variety of Desi chickpea, Desi Kala chana. The fresh seeds of each variety were sterilized by keeping in freezer for one week at -5°C for monitoring of presence of any infestation. The damage of chickpea varieties by *C. maculatus* were examined in no-choice test in which the pest were confined to oviposit and develop on the same variety to which it released. Ten couples of newly emerged adults were taken from culture and introduced in plastic jars having 100 gram of each of four varieties. The jars were covered with aerated muslin cloth and held tightly with rubber band. The insects were free there to damage the seeds and for oviposition. All the varieties were checked after the interval of fifteen days to observe the intensity of seed damage by the *C. maculatus*. The experiment was conducted for a period of four months from

September to December 2015 after the release of *C. maculatus*. The variation in damage percentage of each variety was observed by infestation, weight loss (g) and seed coat characteristics.

Seed's morphological characters of each variety were observed on a visual basis. All experiments were conducted under room temperature at $27\pm 2^{\circ}\text{C}$ and $60\pm 5\%$ RH supported by [14] and $22\pm 3^{\circ}\text{C}$ and $50\pm 5\%$ RH checked by a thermo hygrometer and a photoperiod of twelve hours.

Results

The present study showed that the damage of *C. maculatus* in all chickpea varieties is variable. I placed four commonly used varieties of chickpea, i.e., KP-8mm, KE-9mm, KC-12mm and Desi Kala Chana against *C. maculatus*. However, all the varieties were more or less susceptible to cowpea weevil due to various factors. The ratio of susceptibility by insect pests to stored products mainly depends upon variety, insect species, seed size, starch quantity and texture of seed [15]. A variety possess many different morphological characters like grain size, wrinkled or smooth surface, variation in color and seed texture [15]. Our observations about morphological characters of four varieties were agreed to the findings of [16], as our all chosen varieties were different in grain size, wrinkled or smooth surface, colour and texture (Table 01). The variation in morphological characters of varieties can effect on the oviposition of insect pests and their developmental period. The legume seeds (cowpea, chickpea etc) with smooth seed coats were more susceptible to *C. maculatus* as compare to those varieties which had rough seed coats [17]. The bruchid of legume seeds lay eggs in little amount on rough seed coated varieties as compare to smooth seed coated varieties [18]. Usually large size legume seeds are more favorable hosts of cowpea weevil than

small size seeds, but in chickpea seeds, thickness of the seed coat is a major physical character that affect to attack of cowpea weevil rather than the size of the seeds [19]. In present study we have noted month wise data of damage on all varieties by cowpea weevil. We found the small size variety i.e. KP-8mm was the most susceptible variety among all other large and medium size varieties. In the same manner the variety which has more oviposition was highly consumed by cowpea weevil. KP-8mm was small size, soft and smooth seed coated variety which voraciously consumed by cowpea weevil. The highest consumption of cowpea weevil in this variety was recorded in September and October 15 and 35 gram while it remain low in November and December 25 and 10 gram. The total consumption of KP-8mm in four months was recorded 85gram out of 100 grams. The mean was recorded 21.25 (Table 02 and Figure 01). KC-12mm variety of chickpea was also highly infested by cowpea weevil. It was large size variety had highest consumption 13 and 32 gram in September and October while in November and December the consumption was recorded 24 and 10 gram. The total consumption of this variety by cowpea weevil was recorded 79gram during whole study period and the mean was recorded 19.75 (Table 3 and Figure 02). KE-9mm was medium size variety had hard texture found moderately susceptible by cowpea weevil. The maximum consumption of KE-9mm was recorded in September and October 11 and 13 gram while lowest in November and December 21 and 8 gram. The total consumption of this variety was recorded 71gram out of 100 grams. Total mean was found 17.75 (Table 4 and Figure 3). The fourth variety was Desi kala chana had small size, brown colored and hard texture. It was found least susceptible variety against cowpea weevil. In this variety also the

highest consumption was found in September and October 9 and 25 gram while in November and December the lowest consumption was recorded 19 and 9 gram. Total consumption was recorded 62 gram and the mean was 15.5 (Table 05 and Figure 04). After susceptibility the morphological characters of seed coat had changed which observed in all varieties. The surface of all varieties became rough and porous. Colour

was also fade (Table 06). Comparison of total consumption of four varieties shown in (Table 07 and Figure 05). KP-8mm variety of chickpea was highly consumed variety by cowpea weevil 85 gram, KC-12mm was second most consumed variety 79 gram, KE-9mm was moderately consumed 71 gram while Desi Kala Chana was least consumed variety by cowpea weevil 62 gram.

Table 1. Physical Characteristics of Fresh seeds of different chickpea varieties

Varieties of chickpea	Seed Morphological characteristics (seed coat)
KP-8mm	Small size, smooth, white color, soft texture
KC-12mm	Large size, smooth, white color, soft texture
KE-9mm	Medium size, smooth, white color, hard texture
Desi kala chana	Small size, wrinkled, brown color, hard texture

Table 2. The consumption of KP-8mm by cowpea weevil (Sep-Oct 2015) at 27±2°C, 60±5% RH (Nov-Dec 2015) at 22±3 °C, 50±5% RH (Beetles Reared on 100 grams)

Months	Total Consumption in grams
September	15
October	35
November	25
December	10
Total Weight Loss	85
Mean	21.25
Standard Deviation	11.08

Figure 1. The consumption of KP-8mm by cowpea weevil (September-December 2015)

Table 3. The consumption of KC-12mm by cowpea weevil (Sep-Oct 2015) at $27\pm 2^{\circ}\text{C}$, $60\pm 5\%$ RH (Nov-Dec 2015) at $22\pm 3^{\circ}\text{C}$, $50\pm 5\%$ RH (Beetles Reared on 100 grams)

Months	Total Consumption in grams
September	13
October	32
November	24
December	10
Total Weight Loss	79
Mean	19.75
Standard Deviation	10.14

Figure 2. The consumption of KC-12mm by cowpea weevil (September-December 2015)

Table 4. The consumption of KE-9mm by cowpea weevil (Sep-Oct 2015) at $27\pm 2^{\circ}\text{C}$, $60\pm 5\%$ RH (Nov-Dec 2015) at $22\pm 3^{\circ}\text{C}$, $50\pm 5\%$ RH (Beetles Reared on 100 grams)

Months	Total Consumption in grams
September	11
October	31
November	21
December	08
Total Weight Loss	71
Mean	17.75
Standard Deviation	10.43

Figure 3. The consumption of KE-9mm by cowpea weevil (September-December 2015)

Table 5. The consumption of Desi Kala Chana by cowpea weevil (Sep-Oct 2015) at $27\pm 2^{\circ}\text{C}$, $60\pm 5\%$ RH (Nov-Dec 2015) at $22\pm 3^{\circ}\text{C}$, $50\pm 5\%$ RH (Beetles Reared on 100 grams)

Months	Total Consumption in grams
September	09
October	25
November	19
December	09
Total Weight Loss	62
Mean	15.5
Standard Deviation	7.89

Figure 4. The consumption of Desi Kala Chana by cowpea weevil (September-December 2015)

Table 6. Physical Characteristics of Infested seeds of different chickpea varieties

Varieties of chickpea	Seed Morphological characteristics (seed coat)
KP-8mm	Small size, rough, yellowish color, porous texture
KC-12mm	Large size, rough, yellowish color, porous texture
KE-9mm	Medium size, rough, yellowish color, porous texture
Desi kala chana	Small size, wrinkled, dull brown color, porous texture

Table 7. Month wise weight loss (g) by *C. maculatus* on different chickpea varieties during September -December 2015

Variety	Initial weight on 01-09-2015	Weight loss (g)				Total weight loss (g)
		Sep	Oct	Nov	Dec	
KP-8mm	100 gm	15gm	35gm	25gm	10gm	85 gm
KC-12mm	100 gm	13gm	32gm	24gm	10gm	79 gm
KE-9mm	100 gm	11gm	31gm	21gm	08gm	71 gm
Desi kala chana	100 gm	09gm	25gm	19gm	09gm	62 gm

Figure 5. The comparison of total weight loss (gm) by *C. maculatus* on four chickpea varieties during September - December 2015

Discussion

In present study the experiments were conducted to observe the intensity of cowpea weevil's damage on four varieties of chickpea. The above result showed that all the varieties of chickpea are susceptible to *C. maculatus* however, varieties with soft, smooth seed coat proved more susceptible as compare with those having hard, wrinkled seed coat. Our results indicated that chickpea susceptibility mostly depends upon thickness of the seed coat than size of grain. KP-8mm variety of chickpea was small in size but we found most susceptibility on it. KC-12mm was the second most susceptible variety, KE-9mm was moderate susceptible while Desi Kala Chana found least susceptible variety of chickpea against

cowpea weevil. Our results revealed that the maximum consumption was recorded in the months of moderate temperature 27-30°C and high humidity 60-65% RH in September and October while lowest consumption was recorded in low temperature 22-25 °C and low humidity 50-55% in November and December. It shows that temperature and relative humidity have positive effects on the consumption of chickpea by cowpea weevil. Previous researchers reported the factors which effect on the infestation rate of cowpea weevil like temperature and humidity [20], host size [21], population density [22] and nutritional value of seed [23]. Our results indicated the 27-30°C and 60-65% RH was suitable temperature and humidity for high consumption of chickpea

by cowpea weevil. As [24] maintained a culture of *C. maculatus* on chickpea for their experiment at moderate temperature that was $30\pm1^{\circ}\text{C}$ and 60 ± 10 RH. The findings of [25] revealed that, at high temperature 40°C or above adult bruchid beetles cannot produce any progeny. Even if we found some extent of survival, the population growth will be very low. At low temperature like -18°C , no any life stage of *C. maculatus* could survive, they were died within 14 days [26]. Our all selected varieties of chickpea affected by Temperature and humidity. The susceptibility by this pest can be controlled by growing tolerant varieties which have hard seed coat.

Conclusions

The results in compilation demonstrate that KP-8mm and KC-12mm varieties of chickpea showed highest susceptibility and are not fit for long time storage while KE-9mm showed moderate susceptibility and Desi kala chana showed least susceptibility, so they can be kept for long time storage. For the former varieties, necessary measures for their protection against *C. maculatus* may be undertaken.

Authors' contributions

Conceived and designed the experiments: N Kouser, N Memon & MA Shah, Performed the experiments: N Kouser, Analyzed the data: N Kouser & N Memon, Contributed reagents/ materials/ analysis tools: Z Saleh, B Mal & DA Solangi, Wrote the paper: N Kouser & N Memon.

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