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# ANTIBIOSIS STUDIES OF *CALLOSOBRUCHUS CHINENSIS* L. (BRUCHIDAE: COLEOPTERA) ON DIFFERENT CULTIVARS OF *CICER ARIETINUM* L. (LEGUMINOSAE: FABALES)

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## ABSTRACT

Chickpea has to face post-harvest losses in storage due to heavy bruchid infestation. Fifteen cultivars of chickpea namely Bittle-98, Parbat, Punjab-91, Paidar-91, C-44, Noor-91, NCS-2003, CM-2000, CH-41/91, Flip 97-192C, Dasht, C-44×E-100YM, NUYT-90395, BH-73111 and CM-72 were studied for antibiosis test of *Callosobruchus chinensis* L. (Bruchidae: Coleoptera). Cultivars having thick, hard, wrinkled and rough seed coat were found more resistant as compared to thin, soft and smooth seed coat. For antibiosis test, the cultivars of C-44, Punjab-91, CM-72, Parbat, Bittle-98, NUYT-90395, Dasht, C-44×E-100YM and NCS-2003 were found resistant showing minimum longevity of *C. chinensis* with a range of 11.53 to 13.56 days. Minimum days (11.53) to 100% mortality were observed for Bittle-98 and the maximum days (16.88) were recorded for Noor-91. The minimum $F_1$ adults (2.67) were observed in grains of Dasht and the maximum (11.46) were recorded in Flip 97-192C. The minimum days (9.16) to 100% mortality of $F_1$ adults were observed in grains of Parbat whereas the maximum days (16.04) were recorded for Flip 97-192C. Chickpea cultivars of Punjab-91, Dasht, Bittle-98 and Parbat were found resistant against *C. chinensis* while Paidar-91 and Flip 97-192C were found susceptible.

**Keywords:** *Callosobruchus chinensis, Cicer arietinum,* antibiosis, mortality, cultivars and resistance.

## INTRODUCTION

Chickpea, *Cicer arietinum* L. (Leguminosae: Fabales) is the third most important pulse crop that contributes 15 percent contribution in total pulse production of the world (FAO, 2012). Chickpea production was 484 thousand tons in Pakistan during 2015 as compared to 399 thousand tons in 2014, which is 21 percent increase (GOP, 2015). The share of Punjab province in chickpea production of the country is nearly 80% (Hussain *et al.,* 2015). Due to high protein contents it has become an important component of human diet in developing countries. Chemical composition of chickpea includes 45% starch, 25% protein, 6% sugar, 6 % crude fiber, 5% fat, 3% ash, 0.19% calcium and other minerals and vitamins are up to 0.01% (Ravi and Harte, 2009).

Chickpea grains face heavy post-harvest losses in storage due to infestations of insect pests particularly of bruchids resulting in loss of germination capacity thereby becoming unfit for human consumption (Farukh *et al*., 2011 and Sarwar *et al*., 2005). Pulse beetle, *Callosobruchus chinensis* (Bruchidae: Coleoptera) is the severe storage pest of chickpea (Fahad, 2011). This pest has caused 55 to 60 percent loss in seed weight and 46 to 66 percent loss in protein contents (Faruk *et al*., 2011). To manage this key pest, synthetic pesticides and fumigants have created serious health hazards in consumers and also caused residual toxicity, environmental pollution and development of resistance in bruchids against pesticides (Khan *et al*., 2015). Use of resistant chickpea cultivars is one of the best options to manage bruchid attack. In lieu of this present study was designed to evaluate varietal resistance in different chickpea cultivars against *C. chinensis.*

## MATERIALS AND METHODS

To execute insect bioassays, culture of *Callosobruchus chinensis* was maintained following Shaheen *et al.* (2006) in Stored Product Entomology laboratory of Pir Mehr Ali Shah Arid Agriculture University Rawalpindi. Chickpea cultivars viz., Bittle-98, Parbat, Punjab-91, Paidar-91, C-44, Noor-91, NCS-2003, CM-2000, CH-41/91, Flip 97-192C, Dasht, C-44×E-100YM, NUYT-90395, BH-

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73111 and CM-72 were obtained from Pulses Research Program (PRP), National Agricultural Research Centre (NARC), Islamabad. Before execution of insect bioassays, chickpea grains were made un-infested, followed by Shaheen *et al*. (2006).

**Antibiosis test:**
In this experiment, plastic jars of 250g capacity were used as experimental units. Fifty grams of each genotype were placed in separate jars and ten pairs (Pairing of beetles was done following Halstead (1963) of one day old beetles were released in each jar. Each genotype was replicated thrice. The jars were then placed in incubator at temperature of 30±2$^{o}$C and 70±5% relative humidity. For antibiosis, following parameters were studied:

**i. Days to 100 % mortality of released *C. chinensis:***
Days to 100 % mortality of released *C. chinensis* were counted to determine the effect of chickpea genotypes/cultivars on the life span of its adults.

**ii. Number of $F_1$ adults emerged:**
Number of $F_1$ adults in each jar was calculated to see inhibition of *C. chinensis* emergence by different chickpea genotypes/cultivars.

**iii. Days to 100 % mortality of $F_1$ adults emerged:**
Days to 100 % mortality of $F_1$ adults were also counted to determine the effect of treatments on fresh emerged generation.
Morphological characteristics of chickpea cultivars including seed texture, seed coat thickness, seed color and seed shape were noted on visual basis in consultation with experts at Pulses Research Program (PRP), National Agricultural Research Centre (NARC), Islamabad (Table 1). Chemical analysis (%age) for protein, carbohydrate, fiber, moisture, mineral (ash) and tannin contents of chickpea cultivars in percentages was done in laboratory of biochemistry in Poultry Research Institute, Government of the Punjab, Rawalpindi (Table 2).
Statistical analysis for recorded data was done through SSPS 21.0 and Duncan's Multiple Range Test (DMRT).

## RESULTS

**Days to 100% mortality of released *C. chinensis***
The cultivars of C-44, Punjab-91, CM-72, Parbat, Bittle-98, NUYT-90395, Dasht, C-44×E-100YM and NCS-2003 were found resistant showing minimum longevity of *C. chinensis* with range of 11.53 to 13.56 days (Figure 1). All these cultivars were statistically similar to each other; however, minimum days (11.53) to 100% mortality were observed in jars provided with grains of Bittle-98. Maximum days (16.88) to 100% mortality were recorded in jars having grains of Noor-91, which was statistically similar to cultivars of Paidar-91, BH-73111, Flip 97-192C and CM-2000; hence these were found susceptible to *C. chinensis*. The range for susceptible cultivars was observed between 14.81 to 16.88 days to 100% mortality of *C. chinensis*. The only one cultivar of CH-41/91 was found partially resistant and/or susceptible against this beetle showing longevity of 14.13 days.

**Number of $F_1$ adults emerged**
Figure 2 indicates that minimum $F_1$ adults emerged (2.67) were observed in jars provided with grains of Dasht, non-significantly followed by Bittle-98 and C-44 with 4.19 and 5.16 $F_1$ adults, respectively; hence declared as resistant to *C. chinensis.* The maximum adults (11.46) were recorded in jars having grains of Flip 97-192C, which was statistically similar with CM-2000, Noor-91, BH-73111, NUYT-90395 and Paidar-91. In these cultivars, range of $F_1$ adults was observed to be 9.42 to 11.46. The cultivars of Punjab-91 CM-72, Parbat, CH-41/91, C-44×E-100YM and NCS-2003 were statistically alike with both the resistant and susceptible cultivars and were classified as partially resistant and/or susceptible cultivars, where $F_1$ adults ranged from 5.74 to 7.59.

**Days to 100% mortality of $F_1$ *C. chinensis***
The cultivars of C-44, Punjab-91, CM-72, Parbat, Bittle-98, NUYT-90395, Dasht and C-44×E-100YM were found resistant showing minimum longevity having range of 9.16 to 11.62 days (Figure 3). All these cultivars were statistically similar to each other; however, minimum days (9.16) to 100% mortality were

observed in jars provided with grains of Parbat. Maximum days (16.04) to 100% mortality were recorded in jars having Flip 97-192C, which was statistically similar to cultivars of Paidar-91, BH-73111, NCS-2003, Noor-91 and CM-2000; hence these were found susceptible. The range for susceptible cultivars was recorded between 13.77 to 16.04 days to 100% mortality of *C. chinensis*. The only one cultivar of CH-41/91 was found partially resistant and/or susceptible against *C. chinensis* with 12.71 days to 100% mortality.

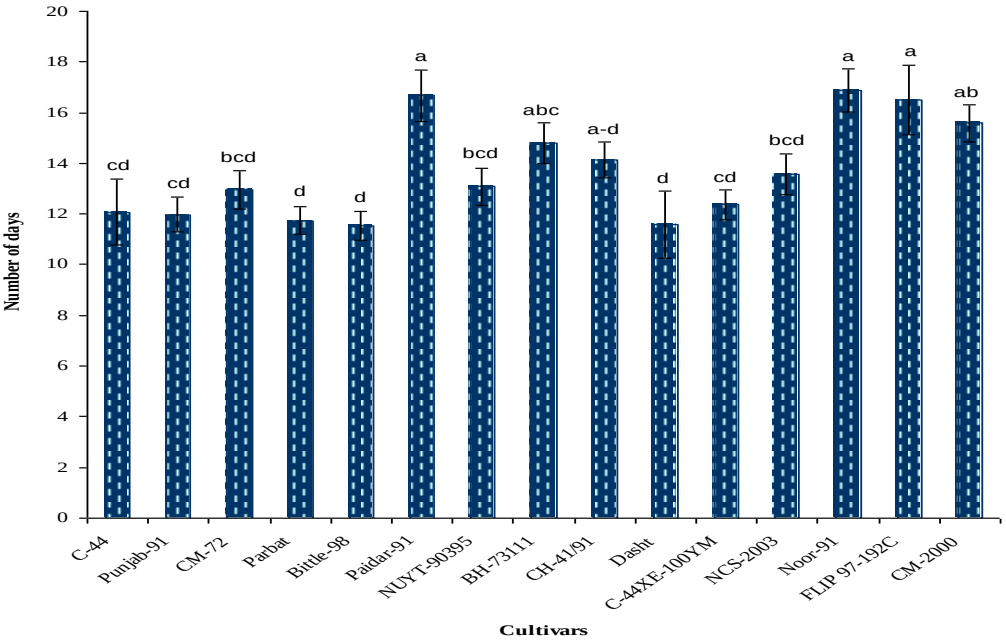


**Figure – 1: Effect of different chickpea cultivars on days to 100% mortality of released *C. chinensis***

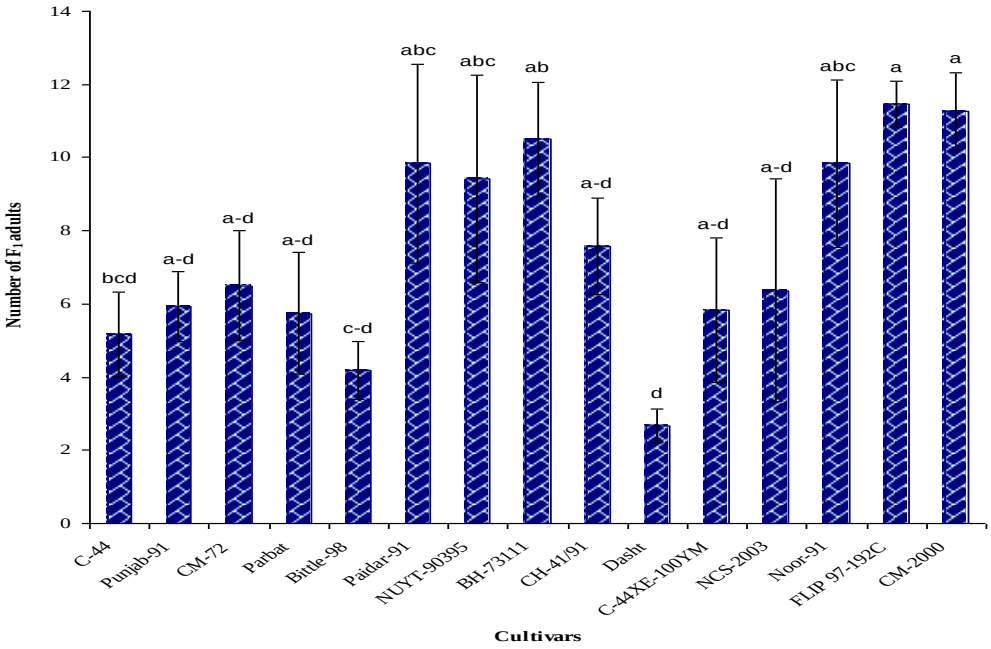


**Figure – 2: Effect of different chickpea cultivars on $F_1$ adults of *C. chinensis* emerged**

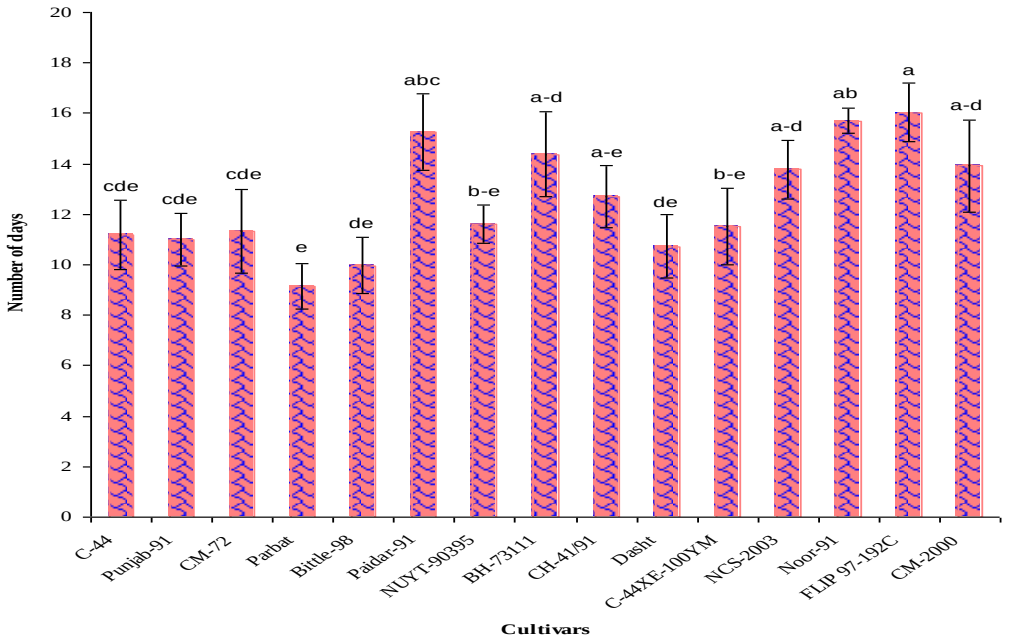


**Figure – 3: Effect of different chickpea cultivars on days to 100% mortality of $F_1$ *C. chinensis* emerged**

**Table – I: Morphological characteristics of grains of different cultivars of *Cicer arietinum* L.**

| **Cultivars of *C. arietinum*** | **Morphological characteristics of seed coat** |
|---|---|
| Noor-91 | Rough, wrinkled, whitish brown, thin (R W $W_b$ T) |
| Bittle-98 | Rough, wrinkled, dark brown, thick ( R W D $T_k$) |
| CM-72 | Rough, brown, wrinkled, thin (R B W T) |
| Parbat | Wrinkled, brown, thick (W B $T_k$) |
| Punjab-91 | Wrinkled, brown, thick (W B $T_k$) |
| NCS-2003 | Wrinkled, brown, thin (W B T) |
| CM-2000 | Rough, whitish brown, thin (R $W_b$ T) |
| CH 41/91 | Rough, dark brown, thin (R D T) |
| Flip 97-192C | Rough, whitish brown, thin (R $W_b$ T) |
| Dasht | Rough, wrinkled, dark brown, thick ( R W D $T_k$) |
| NUYT 90395 | Wrinkled, brown, thin (W B T) |
| BH-73111 | Rough, brown, thin (R B T) |
| C-44× E-100YM | Rough, wrinkled, brown, thick ( R W B $T_k$) |
| Paidar-91 | Wrinkled, Greenish brown, thin (W G T) |
| C-44 | Rough, brown, thick (R B $T_k$) |

**Table – II: Chemical analysis of different cultivars of *Cicer arietinum* L.**

| Cultivars of *C. arietinum* | Dry matter % | Moisture % | Crude protein % | Crude fat % | Crude fiber % | Total mineral (ash) % | Tannin % |
|---|---|---|---|---|---|---|---|
| Noor-91 | 89.70 | 10.30 | 20.68 | 2.60 | 33.50 | 5.00 | 0.93 |
| Bittle-98 | 89.10 | 10.90 | 17.50 | 1.70 | 23.00 | 3.50 | 0.73 |
| CM-72 | 89.80 | 10.20 | 20.12 | 2.60 | 36.50 | 4.00 | 1.02 |
| Parbat | 89.00 | 11.00 | 16.62 | 2.00 | 17.50 | 2.50 | 1.20 |
| Punjab-91 | 88.90 | 11.10 | 21.43 | 4.30 | 10.00 | 3.00 | 1.10 |
| NCS-2003 | 88.76 | 11.24 | 17.50 | 4.98 | 12.00 | 3.01 | 1.03 |
| CM-2000 | 88.67 | 11.33 | 19.25 | 3.58 | 23.00 | 3.76 | 1.27 |
| CH 41/91 | 89.36 | 10.64 | 14.87 | 4.10 | 17.50 | 3.06 | 1.08 |
| Flip 97-192C | 89.30 | 10.70 | 18.40 | 3.36 | 13.00 | 3.37 | 1.03 |
| Dasht | 89.61 | 10.39 | 17.50 | 3.60 | 19.00 | 5.64 | 1.31 |
| NUYT 90395 | 90.96 | 9.04 | 21.87 | 3.00 | 21.00 | 3.97 | 1.15 |
| BH-73111 | 90.11 | 9.89 | 17.50 | 4.15 | 24.00 | 3.14 | 1.05 |
| C-44×E-100YM | 90.26 | 9.74 | 17.50 | 3.92 | 18.00 | 3.11 | 1.21 |
| Paidar-91 | 88.83 | 11.17 | 17.50 | 4.27 | 19.00 | 3.21 | 1.00 |
| C-44 | 89.70 | 10.30 | 17.50 | 3.30 | 39.50 | 5.00 | 0.98 |

## DISCUSSION

It was observed that cultivars having thick, hard, wrinkled and rough seed coat were found more resistant as compared to those having thin, soft and smooth seed coat. Morphological characteristics of different cultivars of *C. arietinum* are presented in Table 1. Data of Table (1) indicates that cultivars with thick seed coat are Parbat, C-44 × E-100YM, Dasht, Bittle-98, Punjab-91 and C-44 and those with thin seed coat include Noor-91, Paidar-91, CM-72, NUYT-90395, NCS-2003, CH-41/91, CM-2000, BH-73111 and Flip 97-192C. The results of this antibiosis study were in accordance to Riaz *et al*. (2000), Khattak *et al.* (2001) and Shafique and Ahmad (2005). In free choice test conducted by Siddiqa *et al*. (2015), the response of two *Callosobruchus* species for oviposition was different on different chickpea varieties. The adult emergence showed no significant difference but percent damage of both species on chickpea varieties was different. Sarwar (2012) also studied relative resistance of twelve chickpea genotypes to the attack of pulse beetle. The most tolerant genotypes to bruchids were CH-52/02 and B-8/03 and the most susceptible ones were CH-86/02 and CC-117/00. The tolerant genotypes have hard and wrinkled seed coat, dark brown color and small size grain. Keneni *et al*. (2011) concluded that the breeding of productive chickpea genotypes with better genetic resistance is a sustainable identifying source of resistance to the pulse beetle.

Based on results of this study, the cultivars namely Bittle-98, Punjab-91, Dasht and Parbat may be suggested for relatively longer storages as those showed resistance against this pest.

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