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A Comparative Study on the Susceptibility of Chickpea Cultivars to the Insect Callosoprocus *Chinensis L.* and *Callosobruchus analis F.*

Rajesh [a*], Ashok Kumar Sau [a], Shakuntala [b], Vijendra Kumar [a], Satpal Singh [c] and A. N. Jha [a]

[a] Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India.
[b] RCP College, Roorkee, Sri Dev Suman University, Uttrakhand-247667, India.
[c] ICAR-CICR Regional Station Sirsa, Haryana-125055, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Chickpea is important pulse crop of India and in terms of production it rank first in legumes. During storage, chickpea (*Cicer arietinum* L.) is severely attacked by some bruchid species, especially *Callosobruchus chinensis* L. and *C. analis* F. (Coleoptera: Bruchidae), resulting in losses in quantity and quality. In the present study eight cultivars (BG-256, Pusa-372, BGD-72, Pusa-1088, Pusa-5023, Pusa-5028, Pusa-1103, BG-1108) of chickpea were selected and evaluated against *C. chinensis* and *C. analis*. The choice and no choice methods were adopted to evaluate oviposition, emergence, mean development period (MDP) and growth index (GI) of selected chickpea cultivars on two years produce. The results revealed that there are significant differences in biological parameters which recorded by choice and no choice methods among selected varieties. The difference in varietal suitability or unsuitability affects the bruchid growth and development. Also it was found that stored seeds are more suitable to one species than other species according to storage duration. One year old seeds were found more suitable than freshly harvested seeds in case of Callosobruchus analis, but in case of *Callosobruchus chinensis* except few varieties maximum freshly harvested seeds were found more susceptible. These

**Corresponding author: E-mail: rjshroshan579@gmail.com;*

varietal characteristics responsible for such a behavior may be used and incorporated in breeding programme to develop high yielding varieties which are also resistant to insect infestation during storage.

Keywords: Chickpea; cultivars; growth index; mean development period.

1. INTRODUCTION

Pulses constitute a major source of dietary protein for majority of the vegetarian population of India. Chickpea (*Cicer arietinum* L.) is an ancient crop that has been grown in Asia, the Middle East and parts of Africa for many years [1]. It is one of the most important pulse crops of India and extensively grown in dry and rain-fed areas. India is the largest producer of chickpea world with a share of about 70 % in area and 67 % in the production [2]. In India chick pea production is 9.9 million tons with 10.041 t/ha productivity from 9.5 million ha area. According to Lale [3], grain storage has often resulted in quantitative and qualitative losses due to physical, chemical, and most important biological factors such as pests which may be birds, rodents, fungi and insects of which storage insect pests are the most important. Bruchid (*Callosobruchus chinensis* L) is one of the most important insect pests of pulses in storage. The larvae of this species feed and develop exclusively on the seed of chickpeas, while the adults do not require food or water and spend their limited lifespan (1–2 weeks) in mating and laying eggs on seeds. It cause damage during storage resulting in losses in quantity and nutritional quality. Apart from their direct losses by consumption of kernels, they accumulate frass, exuviae, and insect cadavers which may result in grain that is unfit for human consumption and/or induced changes in the storage environment warm, moist 'hot-spots' that are suitable for the development of storage fungi that cause further losses [4].

The storage insect pest management is mostly relied on the use of synthetic insecticides and fumigants for the past several years; however, their continued usage has led to a number of problems including insect resistance, toxic residues in food grains, and environmental pollution. Breeding legume crops to improve their resistance against storage insect pests, is an environment-friendly technology [5]. It will reduce both over dependence on chemicals and seed loss due to the bruchid attack [6]. The development and use of tolerant/resistant chickpea cultivars offer a simple, cheap and attractive way for the reduction of bruchid damage since it requires little knowledge by farmers, free of extra cost to farmers and also enhances the effectiveness of other pest control tactics such as cultural and biological means [7]. Hence, many studies were conducted periodically to evaluate seeds of many leguminous accessions for resistance against different bruchid species [8]. The present study was conducted to evaluate eight cultivars of chickpea for resistance against *Callosobruchus chinensis* and *Callosobruchus analis***.**

2. MATERIALS AND METHODS

Eight varieties of chickpea (BG-256, Pusa-372, BGD-72, Pusa-1088, Pusa-5023, Pusa-5028, Pusa-1103, BG-1108) were selected for present study and 200 g cultivars produce of each were procured for two consecutive years from the pulse laboratory, Division of Genetics, Indian Agricultural Research Institute, New Delhi and the experiment was conducted in Division of Entomology, Indian Agricultural Research Institute, New Delhi. Each cultivar was kept separately in a muslin cloth tightened with rubber band and kept in desiccators maintaining 60% relative humidity by potassium hydroxide. Insect cultures of *Callosobruchus chinensis* and *Callosobruchus analis* were maintained separately as a stock culture in a glass jar (15.5 cm × 10.5 cm) on chickpea. Glass jar covered with markin cloth tightened with rubber band and kept at 27±1.5°C and 60% relative humidity according to Solomon [9].

Free choice test was carried out in olfactory chamber and four grains were kept in a single hole and each cultivar randomly replicated thrice in the chamber. Five pairs of 3-4 days old adult insect were transferred in a central hole and fixed with lid. Like these three chambers were used which comprised nine replications. Forced choice test was carried in small petri-dish (7.5 cm dia.). Around 36 grains of each cultivar were kept in which 5 pairs of adult insects (3-4 days old) were transferred. Insects were separated after 24 hrs. in both (free and forced) tests. Four grains of

each cultivar in both conditions were kept in a homeopathic vial plugged with cotton. These vials were kept in BOD chamber at 27±1.5°C and 60% RH. The number of eggs laid on the surface were counted and after a week number of hatched eggs were also recorded. Similar procedures were followed in case of *Callosobruchus analis*. The adult emergence was recorded up to complete emergence. From the recorded data, growth index value Howe [10] was calculated from per cent emergence of adult beetle and mean development period.

3. RESULTS AND DISCUSSION

3.1 Susceptibility of Chickpea Produces to *Callosobruchus chinensis* during First Year

Free choice

Out of eight cultivars most suitable cultivar recorded Pusa-372 with growth index value 0.1461. Least susceptibility recorded in Pusa 5023 with GI value 0.1096. However maximum egg laying 5.88 was found in Pusa1088 on four grains followed by 5.55 eggs on Pusa372. The maximum emergence 90.09% recorded in Pusa-372. Mean development period varied from 30.0 days to 32.0 days.

Force choice

In this method maximum eggs 9.00 recorded on BG1103 while the maximum per cent emergence 59.02 was found in BG-1108 and this variety was found most suitable with GI value 0.1743. Pusa1088 was found least susceptible cultivar with GI value 0.1099. However, mean development period (MDP) ranged between 23.4 (BG-1108) to 29.6 (BGD-72) (Table 1a).

3.2 Susceptibility of Chickpea Produces to *Callosobruchus chinensis* during Second Year

Free choice

In this fresher's cultivar, the minimum egg (0.33) was observed in Pusa 5023 and that too were 100 per cent emerged. Therefore, this variety observed the most susceptible with GI value (0.1550). Least susceptible variety recorded as Pusa1103 with GI value 0.0947. Mean development period ranged from 29.6 (Pusa-1103) to 31.2 (BG-1108).

Force choice

Maximum (10.4) egg laying was found in BG1108 and maximum per cent emergence (82.21) recorded in this cultivar that is why this cultivar showed most susceptible with GI value 0.1959. Minimum (0.55) egg laying was observed on 4 grain and recorded minimum 20.00 per cent emergence in BGD-72. However, Pusa-372 showed least susceptibility of growth index value 0.0922 followed by BG-256 (0.1022) and BGD-72 (0.1185) (Table 1b).

3.3 Susceptibility of Chickpea Produces to *Callosobruchus analis* during First Year

Free choice

Egg laying was not minimum but emergence was minimum 35.11% recorded in Pusa1088, mean development period was maximum 34.00 days, but this cultivar was found to be least susceptible with growth index 0.1047. This cultivar was followed by Pusa5028 (0.1213) and BG256 (0.1233). Most susceptible cultivar noted as BG1108 as the highest per cent emergence 88.5 and maximum growth index (GI) 0.1443.

Force choice

More than 80 per cent emergence observed with the minimum development period of 28.2 days in BG1108. Therefore, in this condition also maximum growth index 0.1570 observed and cultivar found to be most susceptible for *Callosobruchus analis*. Least susceptible cultivar was differed with the free choice condition and recorded minimum (28.57) per cent emergence and minimum growth index value (0.1117) in case of BGD-72 followed by Pusa1088 (0.1326) and BG-256 (0.1366) (Table 2a).

3.4 Susceptibility of Chickpea Produces to *Callosobruchus analis* during Second Year

Free choice

Maximum (5.00) eggs laid on Pusa5023 and the maximum per cent emergence (81.35) was observed in BGD-72 that is why this cultivar showed maximum susceptibility to *Callosobruchus analis* with the maximum value (0.1293) of growth index. The minimum (0.0988) value of growth index and the minimum per cent

emergence 22.68 was observed in Pusa5028 showed least susceptibility. This variety followed by Pusa1103 (0.1062), Pusa1088 (0.1221) and BG1108 (0.1224) (Table 2b).

Force choice

The result of force choice was similar as like as number of eggs laid on grain surface. The maximum 14.22 eggs per 4 grain was observed in pusa5023, but the maximum (80.14) per cent emergence was recorded in Pusa 1088. Mean development period (MDP) varied from 30.3 (Pusa-1103) to 34.00 (Pusa-1088). In this condition the least susceptibility was observed in BGD-72 (0.1093) and the most susceptible cultivar was recorded Pusa5023 with growth index value (0.1549).

Table 1a. Mean value of oviposition, emergence, per cent emergence, mean development period (MDP) and growth index (GI) of *Callosobruchus chinensis* in different cultivars of chickpea during first year under free and force choice condition

S. No.	Cultivars	Oviposition	Emergence	Per cent emergence	MDP	GI
1.	BG-256	2.10	1.33	63.33	31.00	0.1338
		(3.77)	(2.00)	(53.05)	(28.9)	0.1374
2.	Pusa-372	5.55	5.00	90.09	30.8	0.1461
		(6.66)	(2.11)	(31.68)	(28.4)	0.1217
3.	BGD-72	0.44	0.22	50.00	30.00	0.1305
		(1.11)	(0.44)	(39.64)	(29.6)	0.1243
4.	Pusa-1088	5.88	4.66	79.25	30.84	0.1418
		(5.22)	(1.11)	(21.26)	(27.8)	0.1099
5.	Pusa-5023	0.66	0.22	33.33	32.00	0.1096
		(0.66)	(0.11)	(16.66)	(25.00)	0.1125
6.	Pusa-5028	0.22	1.11	50.00	30.00	0.1304
		(4.77)	(2.11)	(44.23)	(24.4)	0.1553
7.	Pusa-1103	2.22	1.66	74.77	30.5	0.1414
		(9.00)	(4.11)	(45.66)	(24.3)	0.1572
8.	BG-1108	2.11	1.44	68.24	30.13	0.1402
		(4.88)	(2.88)	(59.02)	(23.4)	0.1743

Figures in parentheses are force choice condition

Table 1b. Mean value of oviposition, emergence, per cent emergence, mean development period (MDP) and growth index (GI) of *Callosobruchus chinensis* in different cultivars of chickpea during second year under free and force choice condition

S. No.	Cultivars	Oviposition (No.)	Emergence	Per cent emergence	MDP	GI
1.	BG-256	1.11	0.77	69.36	30.6	0.1385
		(1.00)	(0.33)	(33.00)	(34.2)	0.1022
2.	Pusa-372	1.66	1.11	66.86	30.6	0.1373
		(1.00)	(0.23)	(22.00)	(33.5)	0.0922
3.	BGD-72	1.11	0.88	79.27	30.6	0.1429
		(0.55)	(0.11)	(20.00)	(33.0)	0.1185
4.	Pusa-1088	6.11	5.33	87.23	30.6	0.1446
		(6.00)	(2.33)	(38.83)	(28.8)	0.1270
5.	Pusa-5023	0.33	0.33	100.00	29.7	0.1550
		(3.22)	(2.44)	(75.77)	(22.2)	0.1949
6.	Pusa-5028	2.00	1.66	83.00	30.6	0.1444
		(6.33)	(2.11)	(33.33)	(23.5)	0.1492
7.	Pusa-1103	2.00	0.33	16.50	29.6	0.0947
		(8.44)	(4.88)	(57.82)	(22.8)	0.1779
8.	BG-1108	5.00	3.66	72.20	31.2	0.1372
		(10.4)	(8.55)	(82.21)	(22.5)	0.1959

Figures in parentheses are force choice condition.

Table 2a. Mean value of oviposition, emergence, per cent emergence, mean development period (MDP) and growth index (GI) of *Callosobruchus analis* to chickpea cultivars during first year under free and force choice condition

S. No.	Cultivars	Oviposition (No.)	Emergence	Per cent emergence	MDP	GI
1.	BG-256	1.33	0.88	66.16	34.00	0.1233
		(3.77)	(1.88)	(49.86)	(28.6)	0.1366
2.	Pusa-372	1.00	0.77	77.00	34.00	0.1277
		(0.77)	(0.22)	(85.71)	(28.4)	0.1567
3.	BGD-72	0.11	0.11	100.00	34.00 (30.00)	0.1354
		(0.77)	(0.22)	(28.57)		0.1117
4.	Pusa-1088	1.88	0.66	35.11	34.00	0.1047
		(0.44)	(0.22)	(50.00)	(29.5)	0.1326
5.	Pusa-5023	1.55	1.00	64.52	32.1	0.1384
		(11.77)	(8.88)	(75.45)	(29.4)	0.1470
6.	Pusa-5028	1.88	0.88	46.81	31.7	0.1213
		(6.11)	(3.77)	(61.70)	(28.4)	0.1451
7.	Pusa-1103	3.66	1.77	48.36	30.9	0.1255
		(5.77)	(2.88)	(49.91)	(28.5)	0.1372
8.	BG-1108	2.00	1.77	88.5	31.0	0.1443
		(12.33)	(10.33)	(83.78)	(28.2)	0.1570

Figures in parentheses are force choice condition

Table 2b. Mean value of oviposition, emergence, per cent emergence, mean development period (MDP) and growth index (GI) of *Callosobruchus analis* in different cultivars of chickpea during second year under free and force choice condition

S. No.	Cultivars	Oviposition (No.)	Emergence	Per cent emergence	MDP	GI
1.	BG-256	0.77	0.55	71.43	34.00	0.1255
		(3.66)	(2.55)	(69.67)	(32.1)	0.1322
2.	Pusa-372	1.55	1.11	71.61	34.00	0.1256
		(1.00)	(0.44)	(44.00)	(32.00)	0.1182
3.	BGD-72	1.77	1.44	81.35	34.00	0.1293
		(1.00)	(0.33)	(33.00)	(32.00)	0.1093
4.	Pusa-1088	2.44	1.55	63.52	34.00	0.1221
		(2.77)	(2.22)	(80.14)	(32.1)	0.1365
5.	Pusa-5023	5.00	2.55	51.00	30.7	0.1281
		(14.22)	(10.22)	(71.87)	(27.6)	0.1549
6.	Pusa-5028	3.88	0.88	22.68	31.6	0.0988
		(4.88)	(2.44)	(50.00)	(27.1)	0.1443
7.	Pusa-1103	4.44	1.11	25.00	30.3	0.1062
		(11.66)	(5.11)	(43.82)	(28.2)	0.1340
8.	BG-1108	3.88	1.77	45.62	31.2	0.1224
		(5.33)	(3.22)	(60.41)	(28.0)	0.1465

Figures in parentheses are force choice condition

The results from the present study revealed that all the selected chickpea varieties were not affected equally from the attack of *C. chinensis* and *C. analis.* Khanna et al. [11] reported BGD-72 and BG-1103 the most susceptible for *C. chinensis* and *C. analis* in the testing of 7 cultivars in free choice condition. They also recorded BG-1101 cultivar was least susceptible with growth index (GI) value 0.91 and 1.13, respectively, for *C. chinensis* and *C. analis*. Jha et al. [12] reported that Pusa-72 was better with GI value 0.153 and 0.377 for free and force choice condition, respectively. However, *C. analis* showed that cultivar Pusa-1088 was least

susceptible and GI values found 0.0259 and 0.107 for force and free choice condition, respectively. Similarly, Jha et al. [13] in different combinations of eight cultivars of chickpea found BGD-72, BG -1103 and Pusa-372 showed GI value 0.082, 0.073 and 0.101, respectively, for *C. analis* in free choice conditions. However, in case of force choice conditions no development recorded in two varieties under force choice conditions only BGD-72 showed 0.107 GI value. In case of *C. chinensis* BGD-72, BG-1103 and Pusa-372 responded 0.159, 0.156 and 0.153 GI value, respectively, for free choice while 0.186, 0.187 and 0.018 recorded for force choice test [14]. Evaluated a total of 11 chickpea varieties for resistance to the pulse beetle *C. maculatus*, and reported that, in general, the desi chickpeas were more resistant to the beetle than the kabuli chickpeas. We think the differences in the seed coat of chickpea affected oviposition and larval development of the bruchid.

desi chickpea grains (14.53%) had a lesser ovipositional preference. smooth seed coat and well-filled seeds were most preferred by *C. maculatus* for egg-laying, short developmental time, maximum adult emergence [15]

4. CONCLUSION

The bruchid suitability or unsuitability was influenced by varietal differences, old and fresh varieties, and varied situations (choice and no option). In the case of *C. analis*, one year old variations were found to be more suited than fresh variants, however in the case of *C. chinensis*, fresh varieties were shown to be more susceptible than one year old varieties, with the exception of a few types.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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