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## Screening the seeds of different chickpea genotypes against pulse beetle *C. chinensis* L. in laboratory condition.

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**Abstract**

This study was conducted to evaluate the resistance/ tolerance of 15 chickpea cultivars viz., BDNG 797, VIKRAM, BDNG 804, BDNG 801, PG 805-17-5, AKG 1303 JAKI 9218, BDNG 2010-1, PG 13107, AKG 1109, SAKI 9516, PG 0819-43, AKG 1401, ICCV 3137 and ICCV 86111 against pulse beetle. Chickpea genotypes/ varieties viz. ICCV 86111, AKG 1303, PG 805-17-5, BDNG 801 and Vikram were found least preferred against *C. chinensis* in which lowest numbers of eggs laid by pulse beetle, least adult emergence, developmental periods and seed infestation and weight loss. Based on ovipositional preference, significantly lowest number of eggs (16.67 eggs / 100 seeds) were laid on variety ICCV - 86111 which was found at par with the genotypes AKG - 1303 (17.00 eggs / 100 seeds) followed by PG-805-17-5 (17.33eggs/100seeds) and Vikram (18.33 eggs/ 100 seeds). The significantly highest per cent adult emergence was recorded in ICCV-3137 (82.33 per cent) followed by Jaki -9218 (81.00 per cent), Saki -9516 (80.00%), PG 13107 (78.33 per cent), AKG 1401 (76.67 per cent), BDNG 804 (76.67 per cent) and BDNG 2010-1 (76.67 per cent) which was found at par with each other. On an average the shortest beetle completed its developmental period was found significantly 27.50 days in ICCV 86111 which was at par with PG-805-17-5 (27.51 days) followed by AKG-1303 (27.65days), Vikram (28.09 days) and BDNG 797 (28.76 days), respectively. The variety ICCV 3137, SAKI 9516 and BDNG 804 was most susceptible on the basis of above parameter.

**Keywords:** Chickpea, *C. chinensis*, screening

**Introduction**

Chickpea (*Cicer arietinum* L.) is considered as “King of Pulses” and is commonly known as “Bengal Gram or Chana”, belongs to family Fabaceae. It is an important winter season soil fertility restorative legume crop and is grown globally as food source. The origin of chickpea is still controversial as postulated by several botanists in different geographical origins. De Candolle (1883) [4] vaguely identified that the region between the South of the Caucasus and in the North of Persia are the place of possible origin of chickpea as this was also supported by (van der Maesen, 1972) [23], (Vavilov 1926) [22] supported the ideas that the South west Asia and the Mediterranean region as the primary centers of origin with Ethiopia as the secondary centers.

In India 117 species of bruchids belonging to 11 genera have been recorded infesting different pulses (Arora, 1977) [2]. The genus *Callosobruchus* attacks grain legumes during both pre and post-harvest stages all over the world. But in India *C. maculatus*, *C. analis* and *C. chinensis* are the predominate pest species of the genera (Dias, 1986) [5]. Among the grain insects spends its entire immature life in individual legume seeds, where they cause weight loss, decrease germination potential and diminish the market as well as nutritional value of the commodity. In India, Gujar and Yadav (1978) [7] recorded 32.2 to 55.7 per cent loss in seed weight and 17.0 to 53.5 per cent loss in protein content. In case of severe infestation cent per cent damage is caused by the pest (Pruthi and Singh, 1950) [14].

Keeping this in view, an attempt is was made to screen chickpea cultivars against pulse beetle (*C. chinensis*). Although many reports have been published by using the different plant products against pulse beetle hosted on lentil, chickpea, green gram, arhar etc.

Therefore, the present studies were carried out to screened the seed of different chickpea genotypes against pulse beetle and evaluate the effect of different eco-friendly protectants

against pulse beetle, *C. chinensis* reared on chickpea seeds in laboratory condition.

## Material and methods

### 3.5.4.1 No. of eggs laid on genotypes / varieties

The number of eggs laid on each variety was count after 72 hrs of the release of *C. chinensis* with the help of hand lens.

### 3.5.4.2 Adult emergence

Per cent adult emergence was calculated using following formulae (Howe, 1971) [8]

$$\text{Per cent adult emergence} = \frac{\text{Number of adult emerged}}{\text{Number of eggs laid}} \times 100$$

### 3.5.4.3 Total developmental period of pulse beetle on each genotype

The mean developmental periods of the pulse beetle in the test varieties was calculated by using the data obtained from the number of adults emerged on each day and the number of days required for adult emergence. This can be determined by subtracting the first day of egg laying from day of adult emergence as suggested by Howe, (1971) [8].

$$\text{Mean Development Period} = \frac{d_1a_1 + d_2a_2 + d_3a_3 + \dots + d_na_n}{\text{Total Number of adult emerged}}$$

Where,  $d_1$  - day at which the adults started emerging (1<sup>st</sup> day),  
 $a_1$  - Number of adults emerged on  $d_1$  th day.

### 3.5.4.4 Growth index of pulse beetle on different genotypes

The growth index was calculated by the formula given by Singh and Pant (1955) as- Growth Index =  $S / T$

Where,  $S$  = Per cent of adult emergence,  
 $T$  = Average developmental period (days).

The genotypes susceptibility to *C. chinensis* was determines on the basis of per cent grain damage and loss in seed weight.

### 3.5.4.5 Per cent seed infestation by pulse beetle on chickpea genotypes

A 55 days after starting the experiment 100 grains of each tray were used to calculate the per cent seed infestation. The damaged and healthy grains were sorted out and counted in each replication. One or more holes per seed were considered as damaged grains.

The following formula was used to work out the per cent seed infestation.

$$\text{Per cent seed infestation} = \frac{\text{Number of damaged grains}}{\text{Total number of grains}} \times 100$$

### 3.5.4.6 Weight loss due to pulse beetle on different genotype

For working out the weight loss, the beetles, frass, excreta etc. were removed from each compartment and then weighted by using single pan electronic balance. The 55 days after starting experiment 100 grain on tray of each were used to calculate the weight loss.

The per cent loss in weight was calculated by using following formula.

$$\text{Weight loss (\%)} = \frac{I-F}{I} \times 100$$

Where,  $I$  = initial weight of grains,

$F$  = final weight of grains after removal of beetles, frass and excreta etc.

## Result and discussion

### 4. 1 To screen the seeds of different chickpea genotypes against *Callosobruchus chinensis* in laboratory condition

Fifteen varieties/ genotypes of chickpea were taken to morphological characteristics of different genotypes to test the pest ovipositional preference, total developmental period (egg to adult), adult emergence, growth index, per cent seed infestation and per cent weight loss caused by pulse beetle, *C. chinensis* of each variety.

#### 4.1.1 Categorization of chickpea genotypes on the basis of morphological characters

The details of assesses of test weight, width of seed, length of seed, seed characters, seed colour and seed size like morpho/physical characters of fifteen different chickpea genotypes against adult of *C. chinensis* are as under: -

##### 4.1.1.1 Test weight of seed (100 seeds)

The test weight of 100 seeds/grains of different chickpea genotypes was taken by numerical counting and weighing of sound grains. The grains in 50 g sample of each variety were counted replication wise and their average was taken them with biological aspects of test insect. The maximum test weight of 100 seeds of genotypes PG 805-17-5 (32.33g) followed by PG 0819-43 (28.33g) and Jaki 9218 (26.00g). The entry BDNG 801 and ICCV 86111 had less test weight of seed (21.33 and 21.33g) as compared to check entry BDNG 797 (25.33g).

##### 4.1.1.2 Seed width

The seed width of grains observed in different chickpea genotypes was found varied during course of study and the genotypes BDNG 804 (7.34 mm) was followed by PG 805-17-5 (7.24 mm) and PG 0819-43 (7.09mm) recorded the maximum width of seeds and lower seed width was recorded in genotypes Vikram (3.14 mm) and was followed by AKG 1109 (6.16mm) and AKG 1401 (6.23 mm) and seed width of check genotypes BDNG-797 was (6.77 mm)

##### 4.1.1.2 Seed length

The differences in the seed length of grains observed in different had highest seed length chickpea genotypes was found varied during course of study and the genotypes PG. 805-17-5 (10.10 mm) and was whereas, followed by PG 0819-43 (9.84 mm) and Jaki 9218 (9.74 mm) seed length was observed in genotypes AKG 1401 (8.24 mm) followed by BDNG 801 (8.52 mm) and BDNG 2010-1 (8.75 mm) and seed width of check genotypes BDNG 797 was (8.84 mm), respectively.

##### 4.1.1.3 Seed characters, colour and size

The differences in the seed characters, colour and size of grains were observed in fifteen chickpea genotypes some genotypes were slightly smooth, wrinkled and in seed colours were almost yellowish to brown and small to medium size of seed were present.

These results are in close association with Painter (1951) [10] who defined the preference and non – preference as a group of characters and insect response that lead to or away from the

use of plant varieties for oviposition, food and shelter or combined of three. Similarly, Kamble *et. al.* (2016)<sup>[9]</sup> reported in respect of morphological seed characters and egg laying preference indicated that the variety Digvijay and Vijay exhibited wrinkled seed coat, rough, yellowish brown colour and medium size seed characteristics were found to be least

preferred for oviposition as compared to bold seeded varieties viz. PG-12, Virat and PG-5 which having white to brown colour characteristics influenced high rate of oviposition found that tolerant genotypes exhibited hard and wrinkled seed coat, have dark brown colour and had small size grain, thus more or less support the present findings.

**Table 1:** Categorization of chickpea genotypes on the basis of morphological characters.

S. No.	Genotypes	Weight of 100 seed (g)	width of seed (mm)	Length of seed (mm)	character of seed	Seed colour	Seed size
1	BDNG-797	25.33	6.77	8.84	Slightly smooth	yellowish brown	Medium
2	VIKRAM	25.67	3.14	9.35	smoother	yellowish brown	Medium
3	BDNG-804	25.67	7.34	9.36	attractive surface	Brown	Medium to bold
4	BDNG-801	21.33	6.31	8.52	slightly wrinkled	Brownish	Small
5	PG-805-17-5	32.33	7.24	10.1	slightly Rough	dark brown	Bold
6	AKG-1303	23.67	6.61	9.56	Wrinkled surface	Yellowish	Small
7	JAKI-9218	26.00	6.78	9.74	Slightly smooth	Yellow	Medium
8	BDNG-2010-1	23.67	6.61	8.75	slightly Rough	brownish yellow	Medium
9	PG-13107	25.00	6.38	9.36	Smoother	yellowish brown	Small
10	AKG-1109	23.00	6.16	8.85	slightly smooth	brown yellow	Small
11	SAKI-9516	22.33	6.55	9.22	slightly Rough	Brown	Bold
12	PG-0819-43	28.33	7.09	9.84	Rough surface	dark brown	Medium
13	AKG-1401	23.33	6.23	8.24	slightly Rough	creamy white	Medium
14	ICCV-3137	21.67	6.49	9.04	Smoother	Brown	Medium
15	ICCV-86111	21.33	6.27	9.16	wrinkled surface	Yellow	Small

#### 4.1.2. Ovipositional preference

With the view to test the ovipositional preference of *C. chinensis* free-choice test was used in which twenty-five pairs of one to two days old adults of *Callosobruchus chinensis* were released in petri dish placed in the center of the tray after putting the seeds of fifteen different chickpea genotypes/varieties. Eggs were counted 72 hours after release of pulse beetle and number of grains with eggs worked out and summarized.

##### 4.1.2.1 Number of eggs laid by pulse beetle on different chickpea genotypes:

The data shows significant variation with a range of 16.67 to 68.00 eggs/ 100 seeds in number of eggs laid by female of pulse beetle *C. chinensis* free-choice test was used in which twenty-five pairs of one to two days old adults of *Callosobruchus chinensis* were released in petri dish placed in the center of the tray after putting the seeds of fifteen different chickpea genotypes/varieties. Eggs were counted 72 hours after release of pulse beetle and number of grains with eggs worked out and summarized.

##### 4.1.2.1 Number of eggs laid by pulse beetle on different chickpea genotypes

The data shows significant variation with a range of 16.67 to 68.00 eggs/ 100 seeds in number of eggs laid by female of

pulse beetle *C. chinensis* 1303 (17.00 eggs / 100 seeds) followed by PG-805-17-5 (17.33eggs/100seeds) and Vikram (18.33 eggs/ 100 seeds), respectively.

The next sets of genotypes by *C. chinensis* with lower oviposition BDNG 801 (24.33 eggs/100 seeds) followed by genotypes PG 0819-43 (28.00 eggs/ 100 seeds). In remaining genotypes average oviposition was AKG 1109 (34.33 eggs/ 100 seeds) followed by BDNG 797 (38.33 eggs/ 100 seeds), BDNG 2010-1 (48.33 eggs/ 100 seeds) and AKG 1401 (51.67 eggs/ 100 seeds), respectively. The significantly maximum number of eggs were recorded on ICCV – 3137 (68.00 eggs/100 seeds) and which was at par with Jaki 9218 (66.33eggs/m100 seeds).

Bruchid prefers oviposition on smooth surfaced, healthy and larger seeds as compared to small and rough surface. In present findings comparatively, lowest numbers of eggs were laid on seed of ICCV – 86111 and AKG-1303 which are small sized and wrinkled. However, the maximum number of eggs were laid on seed of ICCV-3137 were the smooth surfaced, yellowish brown in colour. Jaki -9218 is slightly smooth, yellow in colour. Saki – 9516 is slightly rough in surface and dark brown grain colour, which had medium grain size thus, indicating that is medium sizes seed with smooth surface by the pulse beetle for oviposition as compared to small wrinkled seeds with rough surface.

**Table 2:** Ovipositional preference (Free choice test) and Adult emergence of *Callosobruchus chinensis* on different chickpea varieties.

Sr. No	Genotypes	Total Number of Egg laid by female per 100 seed	No. of Adult emergence (%)
1	BDNG-797	38.33 (6.23)*	73.33 (58.91)**
2	VIKRAM	18.33 (4.34)	70.00 (56.79)
3	BDNG-804	53.33 (7.34)	76.67 (61.12)
4	BDNG-801	24.33 (4.98)	70.00 (56.79)
5	PG-805-17-5	17.33 (4.21)	68.33 (55.76)
6	AKG-1303	17.00 (4.18)	68.33 (55.76)
7	JAKI-9218	66.33 (8.18)	81.00 (64.16)
8	BDNG-2010-1	48.33 (6.99)	76.67 (61.12)
9	PG-13107	59.33(7.74)	78.33 (62.26)
10	AKG-1109	34.33 (5.90)	71.67 (57.84)
11	SAKI-9516	54.67 (7.43)	80.00 (63.43)



12	PG-0819-43	28.00 (5.34)	70.00 (56.79)
13	AKG-1401	51.67 (7.22)	76.67 (61.12)
14	ICCV-3137	68.00 (8.28)	82.33 (65.15)
15	ICCV-86111	16.67 (4.14)	67.67 (55.35)
	"F" test	Sig	Sig
	SE (m)±	0.09	1.63
	CD at 5%	0.27	4.65
	CV (%)	2.63	4.47

\*Figures in parentheses are square root transformation values.

\*\* Figures in parentheses are sine transformation values.

Losses in quantity and nutritional quality. The tolerant genotypes exhibited hard and wrinkled seed coat, dark brown colour and small size grain. These characteristics demonstrated a significant harmful effect to pest appearance and grain damage.

The vulnerable genotypes had soft and smooth seed coat, white seed colour and bigger grain size that caused vulnerability to *C. maculatus*. Based on the investigation, chickpea genotypes CH-52/02 and B-8/03 deserve special consideration and may be recommended for relatively longer storage to achieve the goal of long term and sustainable pest management strategies. Similarly, Kamble *et al.* (2016) [9] reported the ovipositional preference of *C. chinensis* L. on different chickpea genotypes he reported that the minimum number of eggs were laid on the variety Vijay (17.75 eggs/30 seeds) while the maximum number of eggs (31.33 eggs/30 seeds) on oviposition recorded 28.33 to 31.33 eggs respectively. Results in respect of morphological seed characters and egg laying preference indicated that the variety Digvijay and Vijay exhibited wrinkled seed coat, rough, yellowish brown colour and medium size seed characteristics were found to be least preferred for oviposition as compared to bold seeded varieties viz. PG-12, Virat and PG-5 which had white to brown colour characteristics influenced high rate of oviposition.

The present findings are in accordance with Chakraborty and mondal (2016) [3] who reported Ovipositional preference was dependent on the seed colour, seed texture, seed weight, thickness of seed coat, seed moisture and various parameters. Whereas, Raghuwanshi *et al.* (2016) [16] Screened of certain gram genotypes against *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) during storage they observed maximum number of eggs laid on genotypes ICCV-07301 (34.35) whole maximum number of eggs (17.3) where laid on genotypes ICCV-990126. Significantly higher weight loss (24.98%) was noticed SG-98310 which was followed by SG-950226 (16.64%) the highest per cent infestation was observed in ICCV-990126 (73.33%). After 60 days of infestation the protein content increased by 30.30% in kabuli genotypes and by 48.37% in *deshi* genotypes.

Almost similar finding in respect of relationship between seed size, seed surface as well as shape of seed and ovipositional preference was reported by Patil *et al.* (2009) [12], Shafique and Ahmad (2002) [15], Shaheen *et al.* (2006) [17], Tripathi *et al.* (2015) [20], Raghuwanshi *et al.* (2016) [16]. Thus, present finding are in corroboration with earlier workers.

#### 4.1.2.2 No. of adult emergence of *C. chinensis* on different genotypes of chickpea:

The perusal of data indicated that significantly lowest per cent adult emergence was recorded in ICCV-86111 (67.67 per cent) which was at par with PG-805-17-5 (68.33 per cent) followed by AKG – 1303 (68.33 per cent), PG 0819-43 (70.00 per cent), BDNG 801 (70.00 per cent), Vikram (70.00

per cent), AKG 1109 (71.67 per cent) and BDNG 797 (73.33 per cent).

Which was Highest per cent adult emergence was recorded in ICCV-3137 (82.33 per cent) followed by Jaki -9218 (81.00 per cent), Saki -9516 (80.00%), PG 13107 (78.33 per cent), AKG 1401 (76.67 per cent), BDNG 804 (76.67 per cent) and BDNG 2010-1 (76.67 per cent) and were found at par with each other.

Thus, the results indicate that seed size and seed colour had not much influence on per cent adult emergence. However, medium to bold seeded varieties with smooth surface had some influence on the adult emergence.

Almost more or less similar results were reported by Patil *et al.* (2009) [12] who recorded highest per cent adult emergence (98.9%) in Maxican doller which is bold seeded with smooth surface. Similarly, Ahmed *et al.* (2017) [1] reported eleven varieties of chickpea for evaluation of physical parameters of seed viz., seed texture, seed coat thickness, 100 seed weight, colour, shape and size to understand the basis of resistance against pulse beetle, *C. chinensis* revealed that PKG 1, PKG 2, BG 1003 and BG 1053 were most preferred for oviposition while PBG 1, BGM 547 and PG 114 were least preferred. The lowest per cent adult emergence was observed on PBG 1 (17.28 %) while the maximum per cent adult emergence was observed on PKG 1 (19.90 %) differ significantly however, significant variation in the total development period from ovipositing to adult emergence (28.67-32.33 days) was recorded in different varieties and Singal (1987) [18] who recorded percentage adult emergence and growth index of *Callosobruchus chinensis* for stored seeds of 22 genotypes of *Cicer arietinum*. While no genotype was completely resistant, H 83-114, H 84-71, H 83-31, H 84-71, H 84-8 and H 84-8 and H 84-1 were the least susceptible.

#### 4.1.2.3 Total developmental period of *C. chinensis* on different genotypes of chickpea.

The perusal of total developmental period of pulse beetle (number of days taken by the adult to emergence since the oviposition period) on different genotypes had range of 27.50 (ICCV 86111) to 31.85 (ICCV 3137) days.

Lowest developmental period was recorded of 27.50 days in ICCV 86111 which was statistically at par with PG-805-17-5 (27.51 days) followed by AKG-1303 (27.65days), Vikram (28.09 days) and BDNG 797 (28.76 days), respectively.

The longest developmental period was found in ICCV-3137 (31.85 days) which in term of followed by Jaki -9218 (31.33 days), AKG-1401(31.14 days), PG-13107 (30.93days) and Saki-9516 (30.01days) found at par with which others.

Thus, the result indicated that seed colour did not play important role in influencing total developmental period. However, seed surface and seed size have somewhat influence on total developmental period of *C. chinensis*.

The present findings are in accordance with Ahmed *et al.* (2016) who reported the fecundity of the pulse beetle female varied significantly on different chickpea varieties, the

development period for eggs (5.33-7.0 days), larva (17.0 18.67 days) and pupa (5.67-7.33 days) on different varieties did not differ significantly however, significant variation in

the total development period from eggs to adult (28.67- 32.33 days) was recorded in different varieties.

**Table 3:** Total developmental period of *Callosobruchus chinensis* on different varieties of chickpea.

Sr. No	Genotypes	Total developmental periods (Days) *	Growth Index
1	BDNG-797	28.76 (5.41)	2.68
2	VIKRAM	28.09 (5.35)	2.65
3	BDNG-804	29.80 (5.50)	2.74
4	BDNG-801	27.69 (5.31)	2.78
5	PG-805-17-5	27.51 (5.29)	2.53
6	AKG-1303	27.65 (5.31)	2.79
7	JAKI-9218	31.33 (5.64)	2.64
8	BDNG-2010-1	29.45 (5.47)	2.76
9	PG-13107	30.93 (5.61)	2.57
10	AKG-1109	29.07 (5.44)	2.78
11	SAKI-9516	30.01 (5.52)	2.72
12	PG-0819-43	28.74 (5.41)	2.73
13	AKG-1401	31.14 (5.62)	2.67
14	ICCV-3137	31.85 (5.69)	2.75
15	ICCV-86111	27.50 (5.29)	2.64
	'F' test	Sig	Sig
	SE(m)±	0.04	0.28
	CD at 5%	0.12	0.52
	CV (%)	1.33	1.19

\*Figures in parentheses are square root transformation values.

Similar results were also reported by patil *et al.* (2009) <sup>[12]</sup> who recorded the longest developmental periods on resistant variety than susceptible variety. Raghuwanshi *et al* (2016) <sup>[16]</sup> reported that total developmental periods was longer on *deshi* genotypes which had rough surface and bigger size.

The present findings are true with report of Gatoria and Gill (2008) who studied growth and development of pulse beetle, *C. chinensis* on 10 kabuli and 13 desi chickpea genotypes during July-August 2005. They reported that larval penetration, development of larvae up to the last larval instar/pupal stage, adult emergence and growth index did not vary significantly among the different chickpea genotypes. Genotypes GLK 21159, GL 21107, GL 22038, PBG 1 and GLK 23023 recorded significantly longer development period (27.00, 26.67, 26.67, 26.67, 26.33 days, respectively) and less seed damage (49.99, 52.22, 54.44, 52.22, 55.55%, respectively), whereas PBG 204 recorded shorter development period (25.67 days) and higher grain damage (71.11%). Differences in the adult longevity among different chickpea genotypes were significant only in females.

#### 4.1.2.4. Growth index of *Callosobruchus chinensis* on different chickpea varieties.

The data pertaining to growth index of *C. chinensis* on different varieties revealed that growth index ranged from (2.64 to 2.79).

Lowest growth index was recorded in PG-805-17-5 (2.53) which was followed by PG-13107 (2.57), ICCV-86111(2.64), Jaki- 9218 (2.64), Vikam (2.65) and AKG-1401 (2.67) and BDNG-797 (2.68) which were statistically at par with each others. The next promising group of varieties which higher growth index were Saki-9516 (2.72) followed by PG-0819-43(2.73), BDNG-804 (2.74) and ICCV-3137 (2.75), which were statistically at par with each other. The higher growth index were recorded in AKG – 1303 (2.79) followed by BDNG -801(2.78), AKG-1109 (2.78) and BDNG -2010-1(2.76) are found at par with each others. Higher growth index was recorded in more preferred varieties which has

maximum food value as protein for the development of *Callosobruchus chinensis* as compared to resistant varieties.

Thus, the result indicated that resistant varieties which had rough surface and small size had lowest growth index as compared to susceptible varieties. Umrao and Verma (2003) <sup>[21]</sup> reported that the genotypes with low protein content were least susceptible to the *C. chinensis*, whereas pea genotypes with highest protein content were susceptible to pulse beetle. The present findings are accordance with Raghuwanshi *et al.* (2016) <sup>[16]</sup> who reported more or less similar results about the growth index ranging from 2.37 to 2.89 on different chickpea varieties and revealed that growth index susceptibility was higher (2.48) which had rough surface. However, Johnson *et al.* (1990) calculated the percentage of insect survival, the mean development period and index of suitability of *C. chinensis* on chickpea and classified five genotypes as resistant out of 23 studied. *C. maculatus* larvae showed different behavior. Physical factors of the seeds were not associated with resistance.

#### 4.1.2.5 Per cent seed infestation due to *C. chinensis* on different chickpea genotypes

The result on per cent infestation caused by *C. chinensis* to seed of different chickpea genotypes varied significantly. Perusal of per cent seed infestation on different chickpea varieties was varied from ICCV 86111(19.32 per cent) to ICCV 3137(70.67 percent).

The significantly minimum per cent of seed infestation was recorded on ICCV-86111 (19.32 per cent) which was at par with AKG-1303 (20.53 per cent) followed by PG-805-17-5 (20.94 per cent) and Vikram (21.06 per cent), respectively. The highest per cent seed infestation were recorded in ICCV-3137 (70.67%) and found more preferred for seed infestation. The next group of varieties comprised of PG-0819-43 (30.30%) followed by AKG-1109 (40.66%) and BDNG-797 (42.20 %) recorded, moderate per cent seed infestation.

Thus, the result indicated that seed surface plays important role in causing per cent seed infestation. However, the variety ICCV-3137 had smoother surface and was found more

suitable for seed damage while ICCV-86111 and AKG-1303 were least preferred for seed damage.

The present findings are accordance with Erler *et al.* (2009) [6] who reported that the per cent seed damage was recorded in *kabuli* varieties which had smooth surface and creamy white, lowest per cent seed damage was recorded in *deshi* type varieties which had rough surface and brown to black colour.

The present findings are in accordance with Parameshwarappa *et al.* (2007) [11] who studied twelve

varieties of chickpea for extent of damage, seed quality, varietal resistance and susceptibility to pulse beetle (*C.chinenesis*) and found that none of the twelve varieties of chickpea were found immune to the infestation by *C. chinensis* L. However, there was significant difference in relative susceptibility of different varieties to bruchid attack. It was found that ICCV-10 was the most susceptible whereas ICCV-03311 was the least susceptible variety as compared to other varieties.

**Table 4:** Per cent seed infestation and weight loss of different chickpea genotypes

Sr. No	Genotypes	Per cent seed infestation **	Per cent weight loss (55 DAR of PB) **
1	BDNG-797	42.20 (40.51)	9.19 (17.65)
2	VIKRAM	21.06 (27.32)	5.64 (13.73)
3	BDNG-804	58.72 (50.02)	10.02 (18.45)
4	BDNG-801	23.16 (28.77)	5.28 (13.28)
5	PG-805-17-5	20.94 (27.23)	4.72 (12.54)
6	AKG-1303	20.53 (26.95)	4.63 (12.42)
7	JAKI-9218	50.14 (45.08)	9.02 (17.47)
8	BDNG-2010-1	46.66 (43.09)	8.89 (17.35)
9	PG-13107	55.02 (47.88)	9.13 (17.58)
10	AKG-1109	40.66 (39.62)	8.67 (17.12)
11	SAKI-9516	64.04 (53.15)	11.17 (19.52)
12	PG-0819-43	30.30 (33.40)	6.64 (14.93)
13	AKG-1401	49.54 (44.75)	9.29 (17.75)
14	ICCV-3137	70.67 (57.21)	12.30 (20.53)
15	ICCV-86111	19.32 (26.08)	4.41 (12.12)
	"F" test	Sig	Sig
	SE(m)±	0.64	0.28
	CD at 5 %	1.84	0.81
	CV (%)	2.83	3.04

\*\*Figures in parentheses are angular transformation values.

DAR of PB – days after release of pulse beetle.

#### 4.1.2.6. Per cent weight loss of different chickpea genotypes

The per cent weight losses were recorded in different genotypes with the lowest weight loss in ICCV-86111 (4.41 per cent) which was statistically at par with AKG-1303 (4.63 per cent) and PG-805-17-5 (4.72 per cent) indicating resistance to pulse beetle. In contrast to that, significantly highest weight losses were recorded in ICCV-3137 (12.30 per cent) followed by Saki-9516 (11.17 per cent) which was found at par with each other indicating susceptibility to pulse beetle.

The next group of varieties which recorded moderate per cent weight loss viz., BDNG – 801(5.28 per cent) and Vikram (5.64percent) as compared to check BDNG 797 (9.19 per cent).

Thus, the results indicated that susceptibility had much influence on per cent weight loss. The varieties ICCV-3136 and Saki-9516 had smooth surface which found more susceptible for seed damage ultimately more per cent weight loss recorded as compared to least susceptible varieties. Similarly, result indicated that susceptibility had much influence on per cent weight loss. The varieties PhuleG-D-8108 and BDNG-798 had smooth surface which were found more susceptible for seed damage in turn more per cent weight loss recorded as compared to least susceptible varieties.

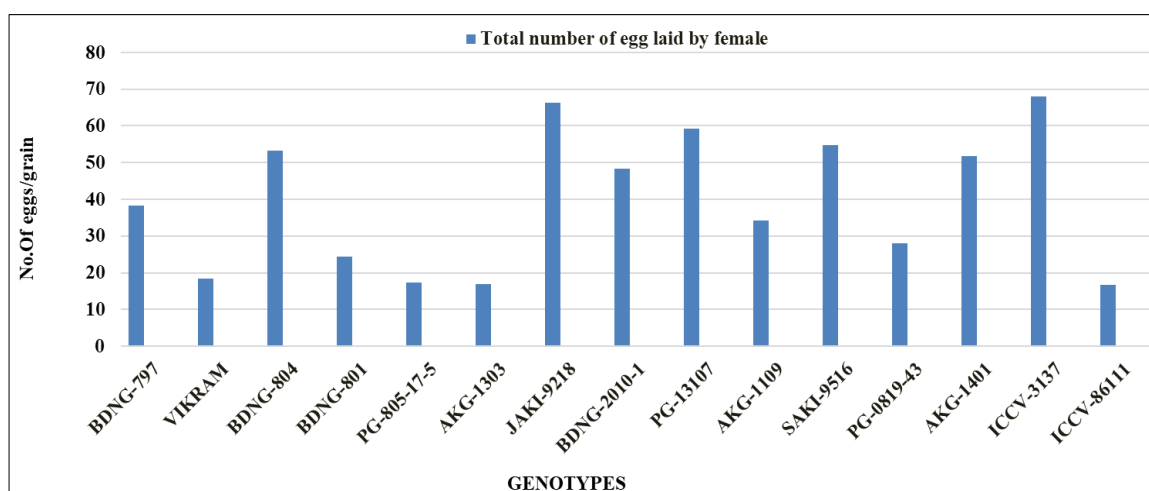
The present findings are accordance with Patil *et al* (2009) [12] who reported that significantly highest per cent weight loss (77.9%) due to *Callosobruchus chinensis* was recorded in Mexican doller which had smooth bold seeded susceptible variety as compared to rest of varieties. More or less similar results were reported by Raghuvanshi *et al* (2016) [16] who recorded the per cent weight loss was lowest (5.78%) in *deshi* genotypes SG-97311 which had rough surface and highest (24.98%) in *Kabuli* genotypes SG-98310 which had smooth seed surface.

Pokharkar and Chauhan (2010) who reported the differences in their susceptibility were recorded on the basis of percentage grain damage, per cent weight loss. Maximum chickpea seed damage (81.60%) and weight loss (75.67%) were found in variety 'Kabuli' was found in variety 'Vishal', while minimum seed damage (62.79%) and weight loss (35.63%) were found in variety 'Vishal'. Siddiqua *et al* (2013) who tool weight loss as a standard parameter, cultivar Lawaghar (4 % weight loss) was significantly least susceptible, KK-2 (28 per cent) and Sheenghar (31per cent) moderately susceptible while KC-98 (60 per cent) and KK-1 (70 per cent) were highly susceptible. The results of free-choice test also revealed that none of the cultivar was completely immune to the attack of *C. chinensis*.





Screening of different genotypes against pulse beetle

**Fig 1:** Number of eggs laid by pulse beetle on different chickpea genotypes (Free choice test)

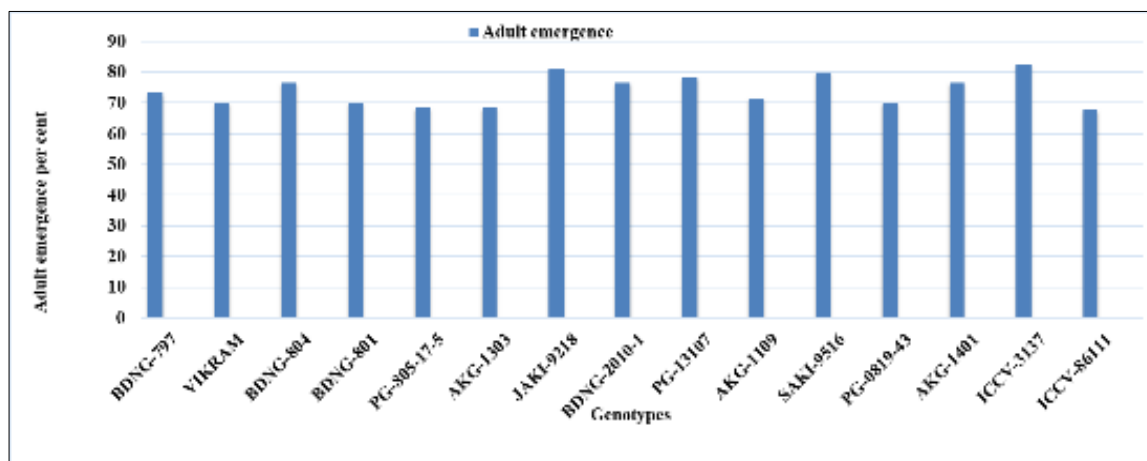


Fig 2: Number of adult emergence of *Callosobruchus chinensis* on different genotypes of chickpea

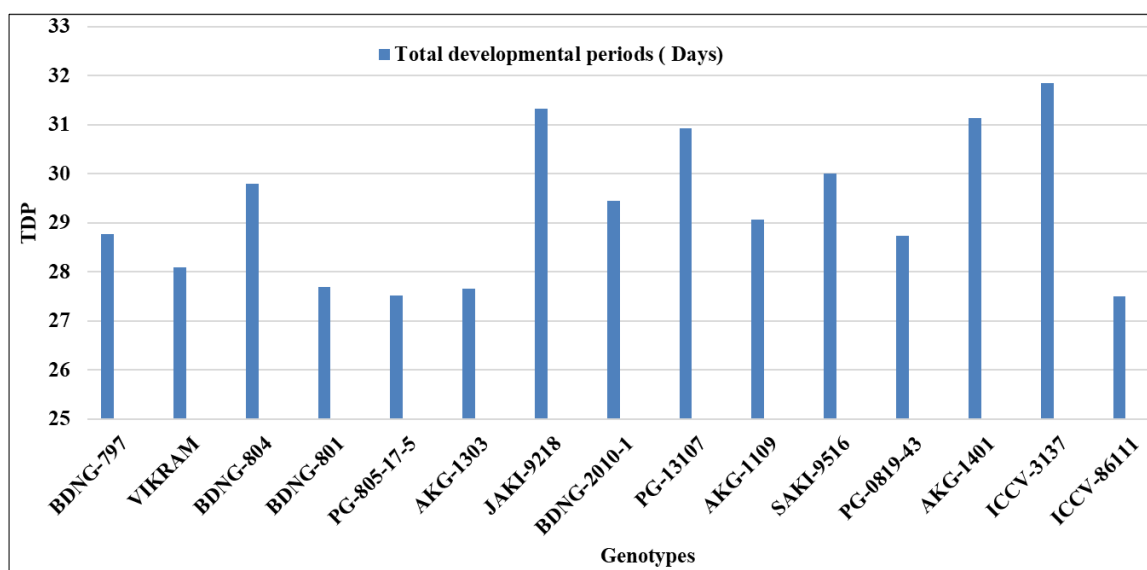


Fig 3: Total developmental period of *Callosobruchus chinensis* on different chickpea varieties

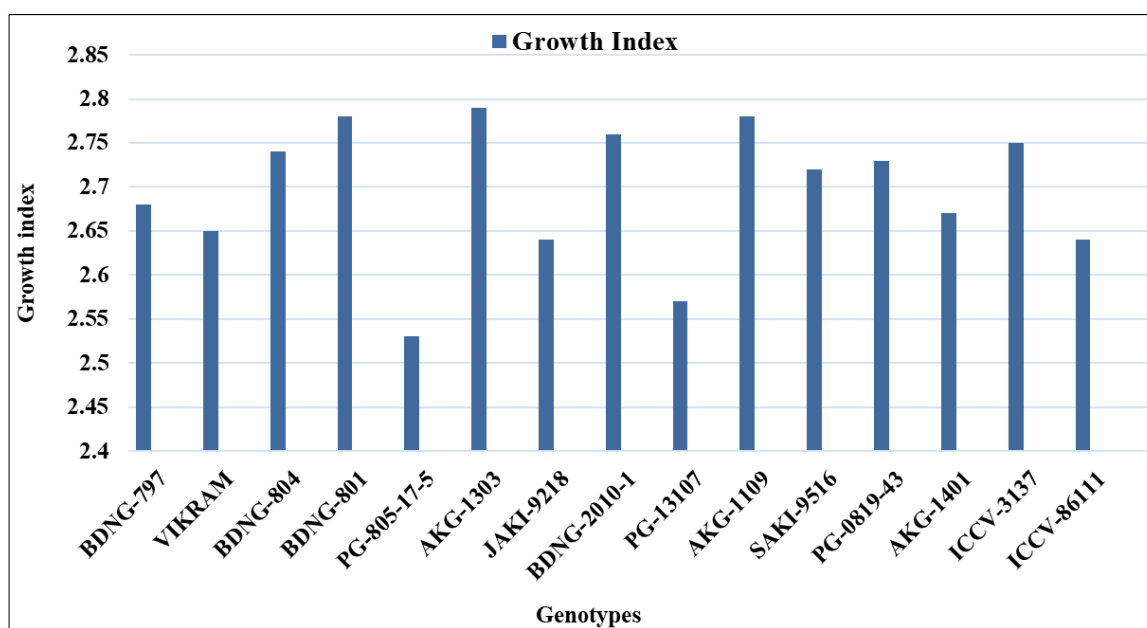
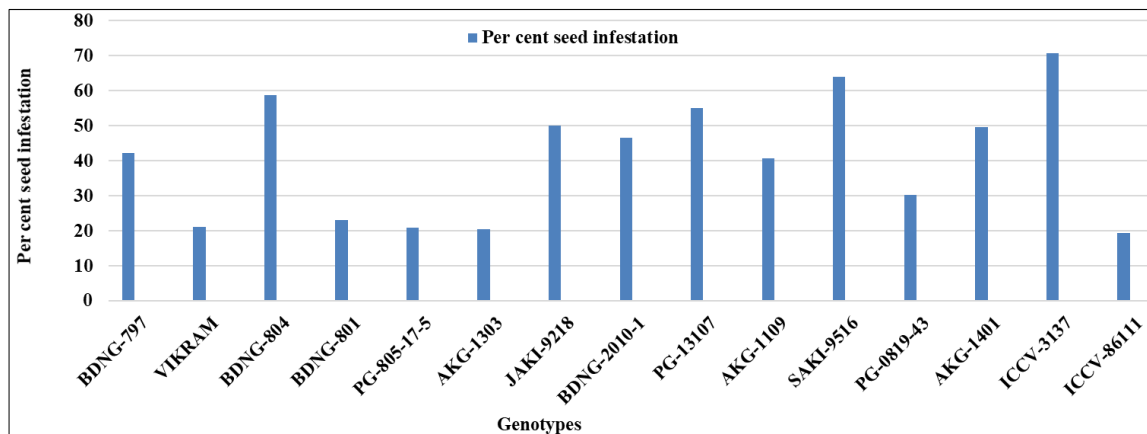


Fig 4: Growth index of *Callosobruchus chinensis* on different chickpea genotypes.





**Fig 5:** Per cent infestation due to *Callosobruchus chinensis* on different chickpea genotypes.

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