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# Evaluation of chickpea varieties / genotypes for their susceptibility to *C. maculatus* (fabricius)

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**Abstract**
Varietal susceptibility of ten chickpea varieties / genotypes to *Callosobruchus maculatus* was evaluated based on four parameters *viz*., ovipositional preference, Index of suitability, population growth and weight loss during storage in chickpea along with relationship between seed weight and hardness. Adult weight was recorded maximum in the variety GG-5 which recorded not only the highest oviposition preference, percentage survival, index of suitability but also maximum longevity of males and females. Amongst the different chickpea varieties / genotypes evaluated for their varietal susceptibility, JGK-1 and KAK-2 were categorized as resistant (R) based on oviposition preference, index of suitability, adult emergence on *C. maculatus* and weight loss. GJG-3 and GJG-6 were less susceptible (LS) based on all the four parameters. Moderately susceptible (MS) varieties were GAG-1423, GAG-1425 and GG-1 based on oviposition preference, index of suitability and weight loss whereas GG-2 and Dahod Yellow were also moderately susceptible accounted to weight loss. Genotype GG-5 was highly preferred for oviposition by females with more number of adults emerged, higher index of suitability and also higher weight loss. Thus, GG-5 was labelled as highly susceptible (HS) to *C. maculatus* on the basis of all the four criteria.

**Keywords:** *Callosobruchus maculatus*, chickpea varieties, varietal susceptibility, categorization

## 1. Introduction
Pulses (grain legumes) are the second most important group of crops worldwide. Globally, 840 million people are under nourished mainly on account of inadequate intake of proteins, vitamins and minerals in their diets (Chakraborty and Mondal, 2015) [1]. Chickpea is considered to be a healthy vegetarian food being a rich source of dietary fibre, certain minerals *viz.*, Calcium, Phosphorus and Iron and vitamins *viz*., thiamine, riboflavin and niacin. The most important species of storage insect pests of food legumes include the most prominent species *C. chinensis* and *C. maculatus* which are responsible to grain and losses are estimated to the tune of 20 to 60 per cent (Abrol, 1999 and Tarver *et al*., 2007) [2, 3]. *C. maculatus* is primary and most destructive pest of stored pulses found abundant with infestation starting right from the field and continuing to the store with their peak in January showing no incidence from February to July under field condition. In stored condition maximum damage is caused in months of July to September (Borikar and Pawar, 1994[4] and Butani *et al*., 2001) [5]. Evaluation of relative susceptibility to the storage pests provides us information regarding chickpea varieties which guides us to take up appropriate preventive and protective measures with special reference to highly susceptible varieties. In past few years a good number of chickpea were successfully screened for their susceptibility to *Callosobruchus* spp in India. Nevertheless, research on identification and categorization of chickpea varieties into resistant or less susceptible to the stored grain pests ought to be kept parallel with the release of new varieties / genotypes over a period of time.

## 2. Material and Methods
Experiment was conducted on varietal susceptibility of pulse beetle during storage at Department of Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand during 2018 - 19. Ten varieties / genotypes of chickpea *viz*., GAG-1423, GAG-1425, Dahod Yellow, GG-1, GG-2, GG-5, GJG-3, GJG-6, KAK-2, JGK-1 were evaluated for their susceptibility to *C. maculatus*. Experiment was repeated thrice for evaluation based on and seed hardness, oviposition preference, index suitability, population growth and weight loss.

### 2.1 Evaluation based on seed weight and seed hardness

Seed weight and seed hardness of different varieties were determined by standard methods. The weight of 100 seeds of each variety / genotype of chickpea was taken accurately by means of an electronic balance. To record the seed hardness, 3 grains from the stored bulk were selected randomly and analyzed using a standard texture analyzer. Correlation between physical characters of the varieties / genotypes and oviposition made by the pest was also worked out (Pankaj and Singh, 2011) [6].

### 2.2 Evaluation based on oviposition preference

This experiment was conducted in a Completely Randomized Design (CRD) with three repetitions. Under each repetition, 200 bold grains *i.e.*, 20 bold grains of each variety/genotype of chickpea were selected randomly and fixed (using solution of Acacia gum) randomly on white paper sheet (10x20 cm) in such a way so that each grain remains 1 cm apart from each other and crease on the top. For this purpose, 10 x 20 cm area of paper sheet was divided into 200 square blocks and each grain was fixed in the centre of the block. Such three sheets, one sheet as one repetition, were prepared. Each sheet with grains was placed in galvanized cage individually. Ten pairs of *C. maculatus* (3 days old) were released in each cage for egg laying and cage was covered with two fold muslin cloth kept in position by means of rubber band to prevent the adults from escaping. After 5 days of oviposition, the adults were discarded from each cage and the observations on number of eggs laid on 20 grains were recorded. The data on number of eggs laid on 20 grains under each repetition of different varieties / genotypes were subjected to ANOVA after transforming them to appropriate transformation.

### 2.3 Evaluation based on index of suitability

The laboratory screening of different varieties was carried out under no choice condition (Srinivasan and Durairaj, 2007) [7]. Under each repetition, 25 seeds of each variety were taken separately in plastic tube. Three pairs of freshly emerged adults of *C. maculatus* were released in plastic tube to oviposit for 3 days. Following observations were taken.

1. Number of eggs laid after 3 days of oviposition
2. Percentage survival using the formula

$$\text{Percentage survival} = \frac{\text{No. of adults emerged}}{\text{No. of eggs laid}}$$

3. Mean developmental period or the time taken for 50% adults to emerge using the formula

$$\text{Mean developmental period} = \frac{(d_1a_1 + d_2a_2 + d_3a_3 + \ldots\ldots + d_na_n)}{\text{Total no. of adults emerged}}$$

Where

$d_1$=Day at which the adults started emerging (1st day)

$a_1$= No. of adults emerged on $d_1^{th}$ day

4. Index of suitability using formula

$$\text{Index of suitability} = \frac{\text{Log (\% survival)}}{\text{Mean developmental period}}$$

5. Adult weight of 6-24 hrs old adult beetles
6. Adult longevity (by observing daily mortality)
7. $$\text{Per cent weight loss} = \frac{\text{Initial wt. of grain} - \text{Final wt. of grain}}{\text{Initial wt. of grain}} \times 100$$

### 2.4 Evaluation based on population growth

Under each repetition, sterilized 50 g of grains were filled in plastic tube. Twenty unsexed adults of 2-5 days old were released in each tube for oviposition and were kept undisturbed for 5 months. Total number of adults developed were recorded in each repetition after 3 and 5 months of storage. The data on number of adults developed after three and five months of storage were subjected to ANOVA after transforming them to square root transformation.

### 2.5 Evaluation based on weight loss

For this purpose, 100 grains were randomly selected after 3 and 5 months of storage from each sample and segregated into germ eaten grain and beetled grain. Using monopon electronic balance the beetled, germ eaten and healthy seeds were weighed. The percent loss in weight was also calculated sample/repetition-wise using formula (Srivastava *et al.*, 1973) [8].

$$L = (W+G)\text{-}100/S\ (W_1 + G_1)$$

**Where**

L=Percent loss in weight

W= Percentage (by number) of beetled grains

$W_1$=Weight of beetled grains

S=Weight of 100 good grains

$G_1$=Weight of germ eaten grains G=Percentage (by number) of germ eaten grains

### 2.6 Categorizations of Varieties

Based on four parameters the different varieties of chickpea were grouped into 4 categories of susceptibility to *C. maculatus viz.*, resistant, less susceptible, moderately susceptible, highly susceptible. For this purpose mean value of individual variable ($X_1$) were compared with all variables (X) & standard deviation (SD) following scale adopted by Patel *et al.* (2002) [9].

## 3. Results and Discussion

### 3.1 Evaluation Based on Seed weight and Seed hardness

The results in table 1 revealed that there was no significant relationship between the seed weight (r=-0.07) of different varieties with the oviposition preference of *C. maculatus*. Whereas, the correlation between seed hardness and oviposition preference was highly significant (r=-0.80**) and negatively correlated with oviposition preference. This indicates that the varieties / genotypes having higher seed hardness were least preferred by adults for oviposition and *vice-versa.*

**Table 1:** Oviposition preference of C. maculatus on different varieties / genotypes of chickpea and their morphological characters

| Varieties / Genotypes | Weight of 100 seeds (g) | Seed hardness (N) | No of eggs laid/ 20 grains |
|---|---|---|---|
| GAG-1423 | 22.33 | 145.24 | 6.26a (38.18) |
| GAG-1425 | 24.93 | 311.34 | 6.30a (38.66) |
| Dahod Yellow | 19.63 | 236.58 | 5.63ab (30.74) |
| GG-1 | 24.10 | 34.39 | 6.24a (37.89) |
| GG-2 | 25.63 | 236.77 | 5.74a (31.98) |
| GG-5 | 27.13 | 74.04 | 6.33a (39.01) |
| GJG-3 | 23.07 | 289.50 | 5.59abcd (30.21) |
| GJG-6 | 24.17 | 287.38 | 5.63abc (30.73) |
| KAK-2 | 25.57 | 340.84 | 4.8de (21.99) |
| JGK-1 | 24.40 | 483.43 | 4.39e (18.23) |
| S. Em. ± | 0.32 | 1.15 | 0.26 |
| C. D. at 5% | 0.95 | 3.41 | - |
| C. V. % | 2.32 | 0.84 | 7.99 |
| Correlation Coefficient (r) | -0.07 | -0.80** | - |

**Notes:** 1. Figures in parentheses are retransformed values, those outside are $\sqrt{x+1}$ transformed values
2. Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level
3. N: Newton

### 3.2 Evaluation Based on Oviposition Preference

Table 1 depicted that significantly the lowest number of eggs were recorded in variety JGK-1 (18.23) which was at par with KAK-2 (21.99) Next preferred variety was GJG-3 which was at par with GJG-6 with 30.21 and 30.73 eggs laid by females of *C. maculatus*. Beetles showed equal preference to Dahod Yellow (30.74), GG-2 (31.98), GG-1 (37.89), GAG-1423 (38.18), GAG-1425 (38.66) and GG-5 (39.01) which were statistically at par. However, KAK-2 was also at par with GJG-3 at one end. Significantly the highest (39.01) number of eggs were recorded in GG-5 among the ten varieties / genotypes tested and proved to be the most preferred variety for oviposition by female adults of *C. maculatus* among all the varieties screened.

### 3.3 Evaluation Based on Index of Suitability

The data on number of eggs laid after 3 days of oviposition, percentage survival, mean developmental period and index of suitability are presented in Table 2.

#### 3.3.1 Number of eggs laid

The lowest (20.98) number of eggs were recorded in variety JGK-1 which was at par with KAK-2 (27.67). GJG-3 registered 37.88 eggs and was at par with GJG-6 (41.06), Dahod Yellow (42.85), and GG-2 (45.13). The highest preference for egg laying was shown by *C. maculatus* on GG-5 (72.17) which was at par with GAG-1425 (72.00), GAG-1423 (60.51). However, GAG-1423 and GG-1 (47.21) were given equal preference for egg laying which were also found to be at par.

#### 3.3.2 Adult emergence

The lowest (9.31) number of adults were emerged (Table 2) in JGK-1 which was at par with KAK-2 (14.67) followed by GJG-3 (23.52) which was at par with GJG-6, Dahod Yellow, GG-2 with 25.88, 28.71 and 30.83 adults emerged. The highest (57.54) number of adults were emerged in the variety GG-5 which was at par with GAG-1423 (46.88), GAG-1425 (56.67). GG-1 (35.24) was at par with GAG-1423 at one end while it was also at par with Dahod Yellow and GJG-3 at another end.

#### 3.3.3 Percentage Survival

Minimum (44.34%) percentage survival was recorded in JGK-1 followed by KAK-2 (53.00%) which was significantly different from rest of the varieties screened. GJG-3 (62.60%) was at par with GJG-6 (62.85%) which in turn were found to exhibit equal percentage survival like Dahod Yellow (66.81%) and GG-2 (68.28%). Maximum percentage survival was registered in the variety GG-5 (79.71%) which was at par with GG-1 (74.67%), GAG-1425 (78.72%) and GAG-1423 (77.30%). However, GG-1 was also at par with Dahod Yellow and GG-2 significantly.

#### 3.3.4 Mean Developmental Period

Maximum time was taken for 50 per cent adults to emerge in the variety JGK-1 (25.67 days) as shown in Table 1 followed by KAK-2 (22.75 days) which differed significantly. KAK-2 was at par with GJG-3 (21.39 days), GJG-6 (21.09 days), Dahod Yellow (21.07 days), GG-2 (20.61 days), GG-1 (20.57 days), GAG-1423 (20.08 days), GAG-1425 (20.08 days) and GG-5 (19.23 days). However, the least mean developmental period was recorded in GG-5 amongst ten varieties / genotypes.

#### 3.3.5 Index of suitability

Minimum index of suitability was registered in the variety JGK-1 (0.064) followed by KAK-2 (0.076) which were significantly different from each other. KAK-2 was at par with GJG-3(0.084), GJG-6 (0.085). Dahod Yellow (0.087), GG-2 (0.089), GG-1 (0.091), GAG-1423 (0.089), GAG-1425 (0.095) were at par with each other. However, maximum (0.099) index of suitability was recorded in GG-5 amongst ten varieties / genotypes.

**Table 2:** Susceptibility of chickpea varieties / genotypes to *C. maculatus* based on different parameters

| Varieties / Genotypes | No. of eggs laid after 3 days of adult release | Adults emerged | Survival (%) | Mean Developmental Period (days) | Index of suitability |
|---|---|---|---|---|---|
| GAG-1423 | 7.84ab (60.51) | 6.92ab (46.88) | 77.30a | 20.08cd | 0.089abc |
| GAG-1425 | 8.54a (72.00) | 7.59a (56.67) | 78.72a | 20.08cd | 0.095ab |
| Dahod Yellow | 6.62c (42.85) | 5.45cd (28.71) | 66.81bc | 21.07bcd | 0.087bc |
| GG-1 | 6.94bc (47.21) | 6.02bc (35.24) | 74.67ab | 20.57cd | 0.091abc |
| GG-2 | 6.79c (45.13) | 5.64cd (30.83) | 68.28bc | 20.61cd | 0.089abc |
| GG-5 | 8.55a (72.17) | 7.65a (57.54) | 79.71a | 19.23d | 0.099a |
| GJG-3 | 6.24c (37.88) | 4.95d (23.52) | 62.60c | 21.39bc | 0.084cd |
| GJG-6 | 6.49c (41.06) | 5.19cd (25.88) | 62.85c | 21.09bcd | 0.085bcd |
| KAK-2 | 5.35d (27.67) | 3.96e (14.67) | 53.00d | 22.75b | 0.076d |
| JGK-1 | 4.69d (20.98) | 3.21e (9.31) | 44.34e | 25.67a | 0.064e |
| S. Em. ± | 0.28 | 0.27 | 2.59 | 0.60 | 0.003 |
| C. V.% | 7.11 | 8.32 | 6.72 | 4.88 | 5.38 |

**Notes:** 1. Figures in parentheses are retransformed values, those outside are $\sqrt{x+1}$ transformed values
2. Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level

### 3.6 Adult Weight and Longevity of Beetles

The data on weight of adults 24 hrs after emergence from various varieties / genotypes are presented in Table 3. Adults gained minimum weight in the variety JGK-1 (6.36 mg) which was at par with KAK-2 (6.94 mg). All the other varieties were at par with each other in a chronological order of GJG-3 (7.57 mg), GJG-6 (7.74 mg), Dahod Yellow (7.84 mg), GG-2 (7.95 mg), GG-1 (8.57 mg), GAG-1423 (8.60 mg), GAG-1425 (8.63 mg) and GG-5 (8.66 mg). However, adults gained maximum weight 24 hrs after emergence in GG-5.

**Table 3:** Weight of beetles and susceptibility of chickpea varieties / genotypes to *C. maculatus* based on weight loss

| Varieties / Genotypes | Adult weight (mg) | Weight loss (%) |
|---|---|---|
| GAG-1423 | 8.60a | 22.93a (15.18) |
| GAG-1425 | 8.63a | 23.47a (15.86) |
| Dahod Yellow | 7.84ab | 17.68b (9.23) |
| GG-1 | 8.57a | 22.45a (14.58) |
| GG-2 | 7.95ab | 18.27b (9.82) |
| GG-5 | 8.66a | 24.21a (16.81) |
| GJG-3 | 7.57ab | 16.17b (7.76) |
| GJG-6 | 7.74ab | 16.52b (8.08) |
| KAK-2 | 6.94bc | 11.73c (4.13) |
| JGK-1 | 6.36c | 11.33c (3.86) |
| S. Em. ± | 0.33 | 0.76 |
| C. V. % | 7.31 | 7.09 |

**Notes:** 1. Means in parentheses are retransformed values, those outside are arc sin transformed values
2. Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level

The lowest longevity was observed in the variety JGK-1 (6.20) which was at par with KAK-2 (6.53), GJG-3 (7.20), GJG-6 (7.27), Dahod Yellow (7.33), GG-2 (7.40), GG-1 (8.13), GAG-1423 (8.20), and GAG-1425 (8.27) as depicted in Table 4. The highest (8.60) longevity was registered in GG-5 which was at par with GG-1, GAG-1423 and GAG-1425.

The data on longevity (in terms of days) of male beetles on different varieties / genotypes of chickpea are presented in Table 3 shows that the highest (7.67) longevity was registered in GG-5 which was at par with GG-2, GG-1, GAG-1423 and GAG-1425.The lowest longevity was observed in the variety JGK-1 (5.07) which was at par with KAK-2 (5.47), GJG-3 (6.13), GJG-6 (6.20), Dahod Yellow (6.40), GG-2 (6.87), GG-1 (7.20), GAG-1423 (7.20), GAG-1425 (7.27).

**Table 4:** Adult longevity of *C. maculatus* on different varieties / genotypes of chickpea

| Varieties / Genotypes | Adult longevity (days) | |
|---|---|---|
| | Female | Male |
| GAG-1423 | 8.20ab | 7.20ab |
| GAG-1425 | 8.27ab | 7.27ab |
| Dahod Yellow | 7.33bc | 6.40bc |
| GG-1 | 8.13ab | 7.20ab |
| GG-2 | 7.40bc | 6.87abc |
| GG-5 | 8.60a | 7.67a |
| GJG-3 | 7.20bcd | 6.13cd |
| GJG-6 | 7.27bc | 6.20cd |
| KAK-2 | 6.53cd | 5.47de |
| JGK-1 | 6.20d | 5.07e |
| S. Em. ± | 0.33 | 0.28 |
| C. V. % | 7.56 | 7.36 |

**Notes:** Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level

### 3.7 Per cent weight loss

The data on per cent weight loss due to infestation by *C. maculatus* in chickpea varieties thirty days after initial oviposition (Table 3) indicated that significantly the lowest (3.86%) per cent weight loss was obtained in variety JGK-1 which was at par with KAK-2 (4.13%). Varieties GJG-3 and GJG-6 recorded 7.76 and 8.08 per cent weight loss, respectively, remaining at par with Dahod Yellow (9.23%) and GG-2 (9.82%). Varieties GG-1 (14.58%), GAG-1423 (15.18%), GAG-1425 (15.86%) and GG-5 (16.81%) were equal in terms of weight loss as they were at par.

### 4. Evaluation based on population growth

After three months of storage period, minimum (68.32) numbers of adults emerged in variety JGK-1 as given in Table 4 which was at par with KAK-2 (73.29). Adult emergence was at par among the varieties / genotypes GG-2, GJG-3, GJG-6, Dahod Yellow, GG-1, GAG-1423, GAG-1425 and GG-5 with 134.84, 134.98, 135.96, 136.26, 168.65, 171.40, 172.50 and 173.80 adults, respectively. The highest (173.80) numbers of adults were emerged from the variety GG-5 justifying it to be the most susceptible variety among all the varieties investigated for susceptibility whereas, the least in JGK-1, making it resistant.

After five months of storage the lowest adult emergence was observed in JGK-1 (23.32) which was at par with KAK-2 (27.26). Thus, considered as resistant varieties. The next intern was GJG-3 (85.51) which was at par with GJG-6 (85.81), Dahod Yellow (85.97), and GG-2 (84.54) significantly. Adult emergence was significantly at par among varieties GG-1, GAG-1423, GAG-1425 and GG-5 with 111.70, 118.29, 119.54 and 121.99 adults, respectively. However, GG-1 was also at par with GJG-3. Among all the varieties / genotypes, the highest adult emergence was recorded in GG-5 making it highly susceptible variety whereas the least in JGK-1.

**Table 5:** Susceptibility of chickpea varieties / genotypes to *C. maculatus* based on population growth after storage

| Varieties / Genotypes | No. of adults emerged after storage | |
|---|---|---|
| | 3 months | 5 months |
| GAG-1423 | 13.13a (171.40) | 10.92a (118.29) |
| GAG-1425 | 13.17a (172.50) | 10.98a (119.54) |
| Dahod Yellow | 11.72a (136.26) | 9.33b (85.97) |
| GG-1 | 13.03a (168.65) | 10.61ab (111.70) |
| GG-2 | 11.66a (134.84) | 9.25b (84.54) |
| GG-5 | 13.22a (173.80) | 11.09a (121.99) |
| GJG-3 | 11.66a (134.98) | 9.30b (85.51) |
| GJG-6 | 11.70a (135.96) | 9.32b (85.81) |
| KAK-2 | 8.62b (73.29) | 5.32c (27.26) |
| JGK-1 | 8.3b (68.32) | 4.93c (23.32) |
| S. Em. ± | 0.49 | 0.41 |
| C. V. % | 7.23 | 7.85 |

**Notes:** 1. Figures in parentheses are retransformed values, those outside are $\sqrt{x+1}$ transformed values
2. Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level

### 5. Evaluation based on weight loss

It was evident from the data on per cent loss in weight after three months of storage period in chickpea that significantly the lowest (11.58%) per cent weight loss was obtained in variety JGK-1 as represented in Table 6. However, this intern was at par with KAK-2 (12.40%). The next following varieties were GJG-3 (23.30%) and GJG-6 (24.29%). Significantly, Dahod Yellow (27.70%) and GG-2 (28.50%) were found to be at par with GJG-3 and GJG-6.The next four varieties in order were GG-1, GAG-1423, GAG-1425 and GG-5 with 33.45 per cent, 33.70 per cent, 34.78 per cent and 34.92 per cent weight loss. The fore mentioned two interns *viz.*, Dahod Yellow and GG-2 were also observed to be at par with GG-1, GAG-1423, GAG-1425 and GG-5 and proved to be equal in terms of weight loss of infested seeds. Among all the screened entries, significantly the highest (34.92%) per cent weight loss due to the infestation of *C. maculatus* was recorded in GG-5.

After five months of storage, the data on per cent weight loss presented in Table 6 and Fig 4.12 clearly indicated that significantly the lowest (8.52%) per cent weight loss was recorded in JGK-1 which was at par with KAK-2 (9.02%).Variety GJG-3 (16.25%) was at par with GJG-6 (17.21%). The next intern Dahod Yellow recorded 20.68 per cent weight loss and was significantly at par with GG-2 (21.02%). However, GG-1 was also found to be at par significantly with GG-2, whereas GJG-6 was at par with Dahod Yellow. Among the varieties under present investigation, higher weight loss was observed in GG-5 (27.63%) which was at par with GAG-1425 (27.58%), GAG-1423 (26.63%) and GG-1 (24.82%) which registered weight loss of 24.82 per cent. Thus, variety/genotype GG-5, GAG-1423, GAG-1425 and GG-1 were proved as more preferred by *C. maculatus*. JGK-1 and KAK-2 were categorized as resistant, while GG-5 recorded the highest weight loss and were labelled as highly susceptible variety.

### 6. Categorization of chickpea varieties / genotypes for Their Susceptibility to *C. maculatus*

The chickpea varieties / genotypes were categorized into resistant (R), less susceptible (LS), moderately susceptible (MS) and highly susceptible (HS) to *C. maculatus* following the scale adopted by Patel *et al.* (2002). The data were presented in the Table 7.

The results of correlation between seed weight an oviposition preference in the present investigation are in accordance with the findings of Pankaj and Singh (2011) and Suthar (2014) [10] who stated that there was no association between morphological characters of different pulses with host suitability and preference to *C. chinensis.* The earlier workers studied the susceptibility of different chickpea varieties against *C. maculatus* in storage were apart from the varieties / genotypes under present investigation and therefore, the present findings could not be compared except with Patil (2007) [11] and Mahor (2017) [12]. Patil (2007) reported adult emergence of 78.86 per cent in variety GG-1 whereas, in the

present investigation, variety GG-1 reported weight loss of 18.68 per cent and was found to be moderately susceptible on the ground of three parameters *viz.*, oviposition preference, Index of suitability and population growth. Thus, the present findings of GG-1 were not in concurrence with earlier report of Patil (2007). These differences might be attributed to the difference in location (Junagadh) of study and variations in prevailing temperatures and RH during the study period. It was observed that varieties with higher percentage survival recorded lower mean developmental period and higher index of suitability. Mahor (2017) evaluated susceptibility of chickpea varieties to pulse beetle and reported weight loss of greater than 28 per cent in variety JGK-1 which was more or less similar to the present findings.

**Table 6:** Susceptibility of chickpea varieties / genotypes to *C. maculatus* based on weight loss after storage

| Varieties / Genotypes | Weight loss (%) after storage | |
|---|---|---|
| | 3 months | 5 months |
| GAG-1423 | 35.49a (33.70) | 31.07a (26.63) |
| GAG-1425 | 36.14a (34.78) | 31.68a (27.58) |
| Dashed Yellow | 31.76ab (27.70) | 27.05bcd (20.68) |
| GG-1 | 35.27a (33.45) | 29.88ab (24.82) |
| GG-2 | 35.34ab (28.50) | 27.29bc (21.02) |
| GG-5 | 36.25a (34.92) | 31.71a (27.63) |
| GJG-3 | 28.87b (23.30) | 23.77d (16.25) |
| GJG-6 | 29.53b (24.29) | 24.51cd (17.21) |
| KAK-2 | 20.62c (12.40) | 17.48e (9.02) |
| JGK-1 | 19.90c (11.58) | 16.97e (8.52) |
| S. Em. ± | 1.55 | 1.04 |
| C. V. % | 8.76 | 6.86 |

**Notes:** 1. Means in parentheses are retransformed values, those outside are arc sin transformed values
2. Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level

**Table 7:** Categorization of different varieties / genotypes of chickpea for their susceptibility against *C. maculatus*

| Category of resistance | Scale | Varieties / Genotypes |
|---|---|---|
| **Based on oviposition preference** | | |
| $\bar{X}$ = 31.76 SD = 7.165 | | |
| Resistant (R) | 24.60 > $X_i$ | JGK-1, KAK-2 |
| Less susceptible (LS) | 24.60 > $X_i$ > 31.76 | GJG-3, GJG-6, Dahod Yellow |
| Moderately susceptible (MS) | 31.76 > $X_i$ > 38.93 | GG-2, GG-1,GAG-1423, GAG-1425 |
| Highly susceptible (HS) | $X_i$ > 38.93 | GG-5 |
| **Based on index of suitability** | | |
| $\bar{X}$ = 0.086 SD = 0.010 | | |
| Resistant (R) | 0.076 > $X_i$ | JGK-1, KAK-2 |
| Less susceptible (LS) | 0.076 > $X_i$ > 0.086 | GJG-3, GJG-6, Dahod Yellow, GG-2 |
| Moderately susceptible (MS) | 0.086 > $X_i$ > 0.096 | GAG-1423, GG-1, GAG-1425 |
| Highly susceptible (HS) | $X_i$ > 0.096 | GG-5 |
| **Based on population growth** | | |
| $\bar{X}$ = 86.39 SD = 35.75 | | |
| Resistant (R) | 50.64 > $X_i$ | JGK-1, KAK-2 |
| Less susceptible (LS) | 50.64 > $X_i$ > 86.39 | GG-2, GJG-3, GJG-6, Dahod Yellow |
| Moderately susceptible (MS) | 86.39 > $X_i$ > 122.14 | GG-1, GAG-1423, GAG-1425 |
| Highly susceptible (HS) | $X_i$ > 122.14 | GG-5 |
| **Based on weight loss (%)** | | |
| $\bar{X}$ = 19.94 SD = 7.14 | | |
| Resistant (R) | 12.08 > $X_i$ | JGK-1, KAK-2 |
| Less susceptible (LS) | 12.08 > $X_i$ > 19.94 | GJG-3, GJG-6 |
| Moderately susceptible (MS) | 19.94 > $X_i$ > 27.07 | Dahod Yellow, GG-2,GG-1,GAG-1423 |
| Highly susceptible (HS) | $X_i$ > 27.07 | GAG-1425,GG-5 |

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