# Comparative response of Groundnut genotypes to bruchid beetle, *Caryedon serratus* Oliver in storage

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## ABSTRACT

Thirty groundnut genotypes (18 of Virginia bunch, 5 Spanish bunch and 7 Virginia runner group) were screened for their relative response to *Caryedon serratu*s using no choice test under laboratory condition (32 to $35^0$ C). The results showed that the number of eggs laid by *C. serratus* ranged from 19.3 to 115.0 and adult emergence varied from 11.0 to 63.7 beetles. Per cent damage to the kernels was highest in 'GG-20 (80.7%) and lowest in T-28 (7.6 %)'. First three principle components (PC) accounted for approximately 84% observed variation in the data. Breakdown of cumulative variance revealed the contribution of PC 1 and PC 2 and PC 3 were 46, 21 and 17%, respectively towards cumulative variance. The vertex genotypes were GG- 20, AK-303, AK-265, T-28, ALR-1 and ALR-3 of these genotypes, only one genotype, T-28 exhibited less egg counts, adults emergence and % damage while the rest recorded higher values for these traits. Association studies also revealed that genotypes with large seed size may be more susceptible to bruchid infestation.

**Key words:** *Arachis hypogaea, Caryedon serratu*s, Principal component analysis.



Groundnut, *Arachis hypogaea* L. is the important oilseed crop grown in semi-arid regions of Asia and Africa, often stored as nuts in shell or as kernels. The Groundnut bruchid beetle, *Caryedon serratus* is a major storage pest affecting the groundnut produce and is widely distributed across Asia. Groundnut bruchid beetle has wide host range (Mohan & Akhil, 2004). Primary infestation starts from the field which is critical in the establishment of bruchids during storage. Female beetle lays eggs on pods and kernels; larva bore into pods and kernels causing damage up to 60 % and the resultant weight loss of about 50 % in groundnut and further prone to aflatoxin contamination which make it unfit for human consumption. Therefore, the present investigation was undertaken to find out relative response of groundnut genotypes to the bruchid beetle in storage.

## Materials and Methods

The experiment was conducted at the Directorate of Groundnut Research, Junagadh, Gujarat, during 2010-2011. Thirty genotypes (18 Virginia bunch, 5 Spanish bunch and 7 Virginia runner group) were screened for their relative response to bruchid beetle (*C. serratu*s) using no choice test under laboratory condition in a CRD with three replications. The newly emerged adults were collected and paired. Three pairs of adults were released into plastic containers of 500 g capacity containing 30 g of groundnut kernels. The mouth of containers were then covered with a muslin cloth and secured with the help of a rubber band to prevent infestation from outside. Experimental set up was kept undisturbed for 7 days, after that adults were removed and number of eggs laid on the kernels was counted. The plastic container was again covered tightly secured and kept undisturbed till adult emergence. Number of adults emerged were recorded till no adults emerged for three consecutive days. Number and weight of damaged and undamaged kernels were also recorded. Kernel damage was determined using the formula, Kernel damage (%) = (Number of damaged kernels / total number of kernels) ×100 while % weight loss was calculated using count and weight method.

Weight loss of kernels (%) = (Wu ×Nd) – (Wd × Nu) × 100) / (Wu × (Nd +Nu)

Where, Wu= Weight of undamaged kernels,

Nu= Number of undamaged kernels,

Wd= weight of damaged kernels

Nd= Number of damaged kernels

The standardized data were then, subjected to principal component analysis (PCA) (Pearson, 1901) and the scatter plot was developed for component 1 and 2. The PCs with eigen value >1.0 were considered as inherently more informative than any single variable alone (Keiser, 1960). To display the genotype by trait two-way data on a bi-plot the following formula was used (Yan & Rajcan, 2002).

$$T_{ij} - Tj = (\lambda_1 \zeta_{il} \tau_{j1} + \lambda_2 \zeta_{i2} \tau_{j2} + \varepsilon_{ij})\ sj$$

Where, '*Tij*' is the average value of genotype '*I*' for trait '*j*'; '*Tj*' is the average value of trait 'j' over all cultivars, 'sj' is the standard deviation of trait '*j*' among the genotype averages;'$\zeta_{i1}$'and '$\zeta_{i2}$' are the PC1 and PC2 scores, respectively, for genotype '*I*'; '$\tau_{j1}$' and '$\tau_{j2}$' are the PC1 and PC2 scores, respectively for trait '*j*' and 'εij' is the residual of the model associated with the genotype 'i' and trait 'j'. A genotype by trait (GT) bi-plot was also constructed by plotting the PC1 scores against the PC2 scores for each genotype and trait. Phenotypic coefficients of correlation between characters were determined by using variance and covariance components (Al-Jibourie *et al.,* 1958).

## Results and Discussion

The experimental results showed that the number of eggs laid by *C. serratus* ranged as low as 19.3 to as high as 115.0. Lowest number of eggs were recorded in variety 'T-28' (19.3) followed by Chandra (40.0) which were significantly superior over other genotypes for this trait. Adult emergence from infested kernels varied from 11.0 to 63.7 beetles. Lowest adult emergence was observed in T-28 (11.0) followed by Kadiri-3 (17.3). Highest counts of egg laid (115.0) and adult emergence (63.7) were recorded by GG-20 followed by ALR-3 (97.7 eggs; 54.0 adults). The genotype, GG-20 recorded highest % damage to the kernels (80.7) followed by RS-138 (70.0). Whereas it was lowest

**Table 1.** Oil content, 100-kernel weight, seed colour and size of groundnut genotypes.

| Variety | Group | Seed colour | Seed shape | Oil content (%) | 100 kernel weight (g) |
|---|---|---|---|---|---|
| CSMG 884 | VB | Rose | Fusiform | 50.0 | 44.4 |
| RSB 87 | VB | Red | Fusiform | 48.6 | 39.1 |
| RS 138 | VB | Red | Spheroidal | 50.2 | 30.1 |
| HNG 10 | VB | Salmon | Spheroidal | 51.0 | 39.9 |
| Kadiri 3 | VB | Rose | Spheroidal | 49.6 | 34.1 |
| ICGS 5 | VB | Salmon | Fusiform | 50.0 | 27.9 |
| M 552 | VB | Salmon | Spheroidal | 50.9 | 40.2 |
| LGN 2 | VB | Rose | Fusiform | 49.0 | 30.5 |
| ALR 1 | VB | Red | Fusiform | 52.0 | 30.5 |
| BG 1 | VB | Rose | Fusiform | 49.3 | 39.1 |
| BG 3 | VB | Rose | Fusiform | 49.0 | 36.9 |
| T 64 | VB | Rose | Spheroidal | 50.9 | 44.8 |
| ICGV 86325 | VB | Salmon | Spheroidal | 49.8 | 31.5 |
| AK 265 | VB | Salmon | Spheroidal | 47.0 | 40.0 |
| AK 303 | VB | Salmon | Fusiform | 49.0 | 48.7 |
| BG 2 | VB | Rose | Fusiform | 51.4 | 39.2 |
| TMV 10 | VB | Variegated | Spheroidal | 53.8 | 43.6 |
| GG 20 | VB | Rose | Spheroidal | 54.9 | 43.6 |
| R 8808 | SB | Salmon | Spheroidal | 48.5 | 30.6 |
| R 9251 | SB | Salmon | Spheroidal | 50.0 | 25.3 |
| ALR 3 | SB | Salmon | Elongated | 50.0 | 31.1 |
| TAG 24 | SB | Salmon | Spheroidal | 53.3 | 36.8 |
| AK 159 | SB | Salmon | Fusiform | 51.0 | 29.9 |
| Karad 4-11 | VR | Rose | Spheroidal | 48.0 | 34.9 |
| S 230 | VR | Rose | Fusiform | 50.0 | 37.1 |
| T 28 | VR | Rose | Fusiform | 50.3 | 27.8 |
| M 13 | VR | Salmon | Spheroidal | 50.2 | 43.6 |
| GAUG 10 | VR | Rose | Spheroidal | 51.0 | 40.4 |
| RS 1 | VR | Rose | Fusiform | 45.0 | 36.1 |
| Chandra | VR | Salmon | Fusiform | 50.5 | 45.5 |

**Table 2.** Number of eggs, and adults emerged, percent damage and percent weight loss caused by bruchid beetles on groundnut genotypes.

| Variety | Group | No. of eggs laid | No. of adults emerged | Damage (%) | Weight loss (%) |
|---|---|---|---|---|---|
| CSMG 884 | VB | 77.3 (8.7)* | 45.0 (6.8) | 60.3 (7.7) | 3.8 (2.0) |
| RSB 87 | VB | 44.7 (6.3) | 29.0 (4.8) | 34.8 (5.3) | 1.2 (1.5) |
| RS 138 | VB | 74.3 (8.6) | 40.7 (6.4) | 70.0 (8.3) | 8.8 (3.1) |
| HNG 10 | VB | 70.0 (8.3) | 37.0 (6.0) | 55.0 (7.4) | 4.2 (2.3) |
| Kadiri 3 | VB | 46.0 (6.7) | 17.3 (4.1) | 29.7 (5.5) | 4.9 (2.3) |
| ICGS 5 | VB | 92.3 (9.6) | 52.0 (7.2) | 47.6 (6.9) | 4.2 (2.2) |
| M 552 | VB | 50.0 (6.5) | 38.0 (5.8) | 39.7 (5.8) | 2.2 (1.7) |
| LGN 2 | VB | 56.7 (7.2) | 23.7 (4.9) | 27.6 (5.1) | 3.6 (2.0) |
| ALR 1 | VB | 47.7 (6.9) | 26.3 (5.2) | 24.3 (5.0) | 20.2 (4.5) |
| BG 1 | VB | 62.0 (7.7) | 44.7 (6.4) | 38.4 (5.9) | 2.0 (1.7) |
| BG 3 | VB | 43.3 (6.4) | 32.3 (5.7) | 27.4 (5.2) | 0.8 (1.3) |
| T 64 | VB | 82.7 (9.1) | 49.7 (7.1) | 64.9 (8.1) | 5.5 (2.5) |
| ICGV 86325 | VB | 85.3 (9.2) | 49.7 (7.1) | 47.5 (7.0) | 2.0 (1.7) |
| AK 265 | VB | 49.7 (6.7) | 19.3 (4.3) | 27.6 (4.9) | 1.5 (1.6) |
| AK 303 | VB | 61.0 (7.8) | 40.7 (6.4) | 53.1 (7.30) | 1.7 (1.6) |
| BG 2 | VB | 62.3 (7.9) | 46.3 (6.9) | 53.3 (7.30) | 1.7 (1.6) |
| TMV 10 | VB | 65.0 (8.0) | 33.3 (5.9) | 36.9 (6.1) | 9.5 (3.2) |
| GG 20 | VB | 115.0 (10.7) | 63.7 (8.0) | 80.7 (9.0) | 5.0 (2.4) |
| R 8808 | SB | 58.3 (7.5) | 28.0 (5.0) | 40.6 (6.4) | 7.4 (2.4) |
| R 9251 | SB | 84.3 (9.0) | 41.7 (6.4) | 26.7 (5.1) | 1.3 (1.5) |
| ALR 3 | SB | 97.7 (9.9) | 54.0 (7.4) | 46.5 (6.8) | 13.9 (3.3) |
| TAG 24 | SB | 67.0 (7.9) | 26.7 (5.3) | 33.1 (5.8) | 5.3 (2.4) |
| AK 159 | SB | 41.3 (6.4) | 19.7 (4.3) | 25.2 (4.8) | 1.5 (1.5) |
| Karad 4-11 | VR | 62.3 (7.9) | 50.7 (7.1) | 61.7 (7.8) | 10.9 (3.2) |
| S 230 | VR | 56.7 (7.5) | 33.3 (5.8) | 37.3 (6.1) | 1.2 (1.5) |
| T 28 | VR | 19.3 (4.4) | 11.0 (3.4) | 7.6 (2.9) | 1.7 (1.6) |
| M 13 | VR | 62.0 (7.9) | 45.3 (6.8) | 54.2 (7.4) | 4.9 (2.4) |
| GAUG 10 | VR | 52.0 (7.0) | 38.3 (6.1) | 43.9 (6.4) | 2.8 (1.9) |
| RS 1 | VR | 73.0 (8.6) | 46.3 (6.8) | 48.3 (7.0) | 3.3 (2.0) |
| Chandra | VR | 40.0 (6.3) | 39.7 (6.3) | 39.8 (6.2) | 2.2 (1.8) |
| S.Em.± | | 1.13 | 0.90 | 0.97 | 0.56 |
| C.D.at 5 % | | 3.22 | 2.53 | 2.73 | 1.58 |

*Figures in parenthesis are square root transformed values

in T-28 (7.6) followed by ALR-1 (24.3) and were significantly superior over other genotypes. Per cent weight loss was more in ALR-1 (20.2 %) followed by Karad 4-11 (10.9 %), however weight loss was the least in BG-3 (0.8%) closely followed by RSB-87 (1.2%) and S-230 (1.2%) which were significantly superior over other genotypes. Mishra *et al.* (1997) evaluated 18 varieties of groundnut and cv. IC GS -52 and OG 85-1 suffered least from the attack of red flower beetle. Chakraborty *et al.* (2004) correlated seed parameters and susceptibility of seeds during storage.

First three principle components (PC) accounted for about 85% variance towards weight loss due to bruchid infestation. Breakdown of this cumulative variance revealed the contribution of 46% and 21% of variance by PC 1 and PC 2, respectively and PC 3 contributed 17% towards cumulative variance (Table 3). Different sets of characters were found to be distributed among different components. First principal component (PC 1) that explained 46% of variation was significantly correlated (>0.70) with number of eggs laid, number of adults emerged and damage (Table 3). Second component (PC 2) significantly correlated with weight loss whereas third component (PC 3) corresponds to oil content. Two-dimensional scatter diagramme was constructed

**Table 3.** Principal component scores for different traits in groundnut genotypes.

| Description | PC 1 | PC 2 | PC 3 |
|---|---|---|---|
| Eigen value | 2.76 | 1.28 | 1.02 |
| Variance (%) | 46.07 | 21.41 | 17.05 |
| Cumulative variance (%) | 46.07 | 67.48 | 84.53 |
| PCA Loadings: | | | |
| Oil content (%) | 0.33 | 0.30 | 0.81 |
| 100-kernel weight (g) | 0.40 | -0.69 | 0.47 |
| Number of eggs laid | 0.87 | 0.21 | -0.24 |
| Number of adults emerged | 0.92 | -0.06 | -0.23 |
| Damage (%) | 0.92 | -0.15 | -0.07 |
| Weight loss (%) | 0.23 | 0.81 | 0.14 |

using principal component score I and II on X and Y-axis, respectively. Among the characters studied, 100-seed weight explained maximum variation followed by weight loss indicating the larger was the seed size more would be the damage by the bruchids (Singh & Jakhmola 2011).

The vertex genotypes were GG-20, AK-303, AK-265, T-28, ALR-1 and ALR-3. These genotypes were either the best or the poorest for some or all of the traits, because they had the longest distance from the origin of the biplot (Yan *et al*., 2007). Cultivars T-28 and GG-20 were located at opposite ends and hence were diverse from each other. Cultivar GG-20 had more number of eggs, adults emerged and damage was also more whereas cultivar T-28 which was at the other end had less damage. Damage due to bruchid infestation increased as moved from left (-5) to right (4) on X-axis. Cultivars T-28, AK-159, AK-265, BG-3, LGN-2 and Kadiri-3 which were clustered together had less than 30% damage. Though cultivars TMV-10 and GG-20 were similar for seed size, oil content and seed shape (spheroidal) (Table 1) but they were situated far from each other on the scatter diagramme. This may be due to their differences in damage % and weight loss.

In order to understand the association between traits, vectors were drawn from the origin to the traits. Number of eggs laid, adults emerged and damage had acute angle between them and hence were positively related. Number of eggs laid had weak association with weight loss and 100-kernel weight. While adult emerged and damage to kernels had negative association with weight loss and weak association with 100-kernal weight.

Association studies revealed that damage due to bruchid infestation had positive association with 100-kernel weight, number of eggs laid and adults emerged whereas adults emerged had significant positive association with eggs laid. This indicates that as seed size increased eggs laid and damage increased. Interestingly oil content did not exhibit significant relationship with the other traits studied (Harish *et al.,* 2012).

The results indicated that when the seed size is small, less number of eggs will be laid / kernel thus, reducing the damage percentage. Small and harder seeds are more resistant than large seeds as they supply more food and space for insect growth (Kumar *et al*., 2008). Absence of nutritional factors and presence of toxic substances may also affect bruchid damage to seeds (Ghosal *et al.,* 2004). Association studies also revealed that genotypes with large seed size (Table 4) were more susceptible to bruchid infestation. This has significant implications in groundnut breeding because large seed was one of the requirements for a confectionary type groundnut.

Control of storage pest was possible using chemicals but this can result in presence of toxic

**Table 4.** Correlation Matrix for traits related to Bruchid infestation among groundnut genotypes.

| | 100-kernel weight (g) | No. of eggs laid | No. of adults emerged | Damege (g) | Weight loss (%) |
|---|---|---|---|---|---|
| Oil content (%) | 0.17 | 0.20 | 0.11 | 0.13 | 0.25 |
| 100-kernel weight (g) | | 0.05 | 0.30 | 0.47* | -0.16 |
| No. of eggs laid | | | 0.81** | 0.74 * * | 0.30 |
| No. of adults emerged | | | | 0.83** | 0.17 |
| Damage (%) | | | | | 0.25 |

*, **indicate significance P= 0.05 and 0.01 levels, respectively

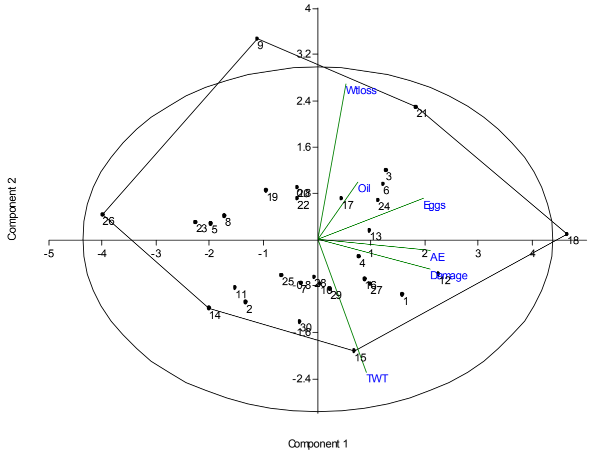


**Fig. 1.** GT-biplot drawn using PC 1 and PC 2 scores for traits related to Bruchid infestation among groundnut genotypes.



residues. Therefore, the most environmental friendly and reliable method was use of resistant sources (Mishra *et al.,* 1997). Thus, it becomes necessary to identify sources of resistance to bruchid infestation among large seeded genotypes. Results of PCA indicated that damage due to bruchid infestation as not merely dependent on seed size. For example cultivars, TMV-10 (17) and GG-20 (18) were similar in seed size but were located away from each other. This indicates that difference in damage % was not merely due to seed size and oil content but there were few more unknown kernel characters that were playing an important role in pest infestation and needs further investigation. Systematic screening of genotypes and germplasm may be undertaken for identification of resistance source against bruchid beetle.

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