Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(6): 1482-1489

Received: 28-08-2020
Accepted: 17-10-2020

**J Manjunath**
Regional Agricultural Research Station, Nandyal, Kurnool, Andhra Pradesh, India

**K Manjula**
SV Agricultural College, Tirupati, Chittoor Andhra Pradesh, India

**RP Vasanthi**
Institute of Frontier Technologies, Regional Agricultural Research Station, Andhra Pradesh, India

**KSS Naik**
Agricultural Research Station, Kadiri, Ananthapuramu Andhra Pradesh, India

**KV Hariprasad**
SV Agricultural College, Tirupati, Chittoor Andhra Pradesh, India

**T Muralikrishna**
Institute of Frontier Technologies, Regional Agricultural Research Station, Andhra Pradesh, India

**TNVKV Prasad**
Institute of Frontier Technologies, Regional Agricultural Research Station, Andhra Pradesh, India

**B Ravindra Reddy**
SV Agricultural College, Tirupati, Chittoor Andhra Pradesh, India

**Corresponding Author:**
**J Manjunath**
Regional Agricultural Research Station, Nandyal, Kurnool, Andhra Pradesh, India

# Studies on physical parameters and classification of groundnut genotypes/varieties against groundnut bruchid (*Caryedon serratus* O)

**J Manjunath, K Manjula, RP Vasanthi, KSS Naik, KV Hariprasad, T Muralikrishna, TNVKV Prasad and B Ravindra Reddy**

**Abstract**
The present studies on damage and infestation by *Caryedon serratus* over 52 genotypes/varieties and were classified or categorized (grouping) into least susceptible, moderately susceptible and highly susceptible based on physical parameters at Regional Agricultural Research station, Nandyal during 2015-16. The physical parameters of groundnut pods were shown to influence infestation by *C.serratus.* Pod reticulation seems to have played a negative role in oviposition preference by the bruchid. Other physical parameters like shell thickness also influences the infestation. The Vemana variety recorded less thickness (0.73mm) and recorded more per cent weight loss (28.24% )whereas shell thickness was comparatively more in the varieties K 2075 (2.01mm) and K7 (1.74mm) which recorded less per cent weight loss from 1.97 and 3.60. Least susceptible varieties i.e. K2075, K1677 and Dharani possess 2.22 to 2.82 kg $m^{-2}$ shell hardness. Least susceptible and moderately susceptible lines consists of good shell thickness, hardness, low inter granular space and prominent reticulation.

**Keywords:** Groundnut, *Caryedon serratus*, genotypes, Physical parameters

## Introduction
Groundnut (*Arachis hypogaea* L.) is a leguminous oilseed crop. It is grown in developing countries in Asia, Africa and South America account for over 97 per cent of world groundnut area and 95 per cent of total production. However, the productivity of Asia (2217 kg $ha^{-1}$) and Africa (929 kg $ha^{-1}$) is very poor as compared to America (3632 kg $ha^{-1}$) [4]. It is truly said that' a grain saved is a grain produced". At present, the only solution for stabilizing per capita availability is to reduce storage losses. About two thirds of world production is crushed for oil and the remaining one third is consumed as food. Its cake is used as feed or for making other food productsand haulms provide quality fodder [9] Groundnut is stored as both pods and kernels and, both of these are susceptible to insects, fungi and mites in storage. One hundred insect species are reported to attack the stored groundnuts [16]. Of these, eight insect species are of major importance and six are of minor importance. Among them, the groundnut borer/ groundnut bruchid, *Caryedon serratus* (Olivier) is a well known pest of economic importance. Groundnut stored in godowns was attacked by the bruchid, *C. serratus* causing approximately 17-47 per cent of the pods damage [19] "Recently, some consignments of Indian groundnuts were facing difficulty due to the presence of infestation of 'Olivier' bugs on huge level. The port authorities in Vietnam were not clearing this cargo exports of groundnut of 5.92 lakh tonnes and value of shipment was 38,304 crores [1].
The physical parameters like seed size, colour, texture, seed thickness and seed coat influence for the attach of pests [15] stated that the chickpea cultivar's susceptibility was influenced by several seed factors, like seed size, testa texture and chemical composition of the seed [5]. observed more number of eggs by *C. chinensis* in small seeded varieties of urdbean [7]. reported that thickness of groundnut shell reported that the thickness of the shell had positive and significant correlation with mean development period (0.604) of *C. serratus* and had negative non-significant correlation with the index of susceptibility and weight loss [20]. reported that seed coat thickness of pigeonpea does not have any influence on the development of *C. chinensis*. The present study was undertaken to study the physical parameters were influence to damage of infestation levels of *C.serratus* in different groundnut genotypes.

## Materials and Methods

The experiment was conducted in the laboratory of Entomology at Regional Agricultural Research Station, Nandyal, Kurnool District during 2015-16

Twenty eight genotypes/varieties *viz.*, K1452, K1501, K1535, K1677, K1699, K1702, K1706, K1719, K1725, K1787, K1789, K1800, K1801, K1802, K1805, K1809, K1811, K1813, K1847, K1951, K2014, K2074, K2075, K6, K9, Kadiriharithaandhra, Anantha, and K7 (BOLD) were procured from Agricultural Research Station, Kadiri. Whereas 22 genotypes/varieties *viz.* TCGS1073, TCGS1157, TCGS1270, TCGS1273, TCGS1278, TCGS1323, TCGS1327, TCGS1330, TCGS1333, TCGS1335, TCGS1337, TCGS1345, TCGS1346, TCGS1349, TCGS1375 ISK2014-9, Narayani, Dharani, Abhaya, Prasuna, Greeshma and Vemana were procured from Regional Agricultural Research Station, Tirupati, Andhra Pradesh.

TAG-24 (Thrombay-Akola Groundnut-24) and TAG-51 (Thrombay-Akola Groundnut-51) which are popular entries grown in Rayalaseema region were purchased from local market and included as test entries.

All the genotypes/varieties procured were kept in an almirah and subjected to fumigation with one 3g aluminium phosphide tablet for disinfestations. Each genotype/ variety was considered as treatment replicating thrice with 1.5 kg for each replication. At every 15 days, from 100 g representative sample, the no of eggs laid on selected pods and adults emerging from different treatments were counted. Adults were removed at every time. This process was continued upto 180 days and also at every 15 days, from selected 100 gm pods, from each treatment, the data was collected on number of damaged pods and healthy pods. Weights of both damaged and healthy pods were also recorded. The per cent damage of pods by count and weight were calculated with the help of following formulae [12].

$$\text{Per cent pod damage (by count)} = \frac{\text{Number of bored pods}}{\text{Total number of pods}} \times 100$$

$$\text{Per cent pod damage (by weight)} = \frac{\text{Weight of bored pods}}{\text{Total weight of pods}} \times 100$$

Weight loss was calculated by deducting the final weight of sample at the period of termination of the experiment i.e., at 180 days after the initiation of the experiment and from initial weight taken during initiation of the experiment and the data was converted to the percentage by the formula.

$$\text{Weight loss} - \frac{W1 - W2}{W1} \times 100$$

W1 = initial weight of pods
W2 = final weight of pods

The oviposition and adult emergence was subjected to square root transformation and per cent pod damage (by count and by weight), weight loss were transformed in to angular transformed values; The data was then subjected to complete randomized design analysis [21] and then subjected to statistical analysis by SPSS, 2012 for DMRT.

From each genotype, for each replication, 1.5 kg pods were taken into fresh cloth bags. Five pairs of newly emerged *C. serratus* bruchids were released into these cloth bags. The mouth of cloth bag was tied. Three replications were maintained for each treatment. The adults were removed after 15 days from the bags. For data recording through destructive sampling every time 100 g pods were taken up to six months.

### Categorization of the Test Genotypes

The test genotypes were grouped into three classes *viz.* highly susceptible, moderately susceptible and least susceptible based on the following parameters [19].

1. No. of eggs laid
2. Per cent adult emergence
3. Per cent pod damage
4. Per cent weight loss

Values exceeding the sum of mean and standard deviation were grouped into highly susceptible and values less than the difference of mean and standard deviation into least susceptible. Moderately susceptible group comprised the values which fall in between the highly and least susceptible.

### Physical Parameters of the Test Varieties

The physical parameters *viz.*, pod beak, pod reticulation, pod constriction, kernel size, kernel colour, kernel shape, kernel texture, and kernel beak were recorded by visual observation [8]. The other physical parameters *viz.*, pod length, pod width, kernel length, kernel width, pod and kernel circumference, shell thickness, shell hardness and inter granular space of pods/kernels were recorded by adopting the following methodologies.

### Length and width of pods and kernel

Five pods/kernels of each variety were taken to record the pod/kernel size. The pod/kernel size was measured with the help of digital Verniercaliper and mean of five pods/kernels for calculation of circumference with length, width of pod and kernel and express in mm

### Thickness of the shell

The thickness of the shell of the five pods of each variety was measured with the help of digital Screw gauge and the average was expressed in mm.

### Shell hardness

The shell hardness of each variety was tested by using grain hardness tester (Kiya Seisa Kusho Ltd., Japan). Ten pods of each variety were tested for hardness the shell. The hardness of the shell was obtained by calculating the stress required to break the shells and expressed in kg $m^{-2}$.

### Inter granular space

For measuring inter granular space present between the pods, of each test entry, a 100 cc measuring cylinder was filled with groundnut pods and the level of the pods was adjusted to 100 cc mark. In a separate measuring cylinder 100 cc of water was taken and poured slowly into the measuring cylinder, containing the groundnut pods until the water level reaches to 100 cc mark. The quantities of water poured into the pods gave the volume of inter granular space contained in 100 cc of groundnut pods.

All physical characters of pods and kernels studied were applied for explaining the relative susceptibility or resistance.

## Results and Discussions

In the present studies, the groundnut 52 genotypes / varieties

were classified or categorized (grouping) into least susceptible, moderately susceptible and highly susceptible to *C. serratus* based on their preference for oviposition, adult emergence, pod damage (by count and weight) by *C. serratus* as per the protocol developed and followed by [19] and the results are presented in Table 1.

Based on the oviposition preference (no. of eggs laid/10 females) by *C. serratus*, the genotypes K1787, K2075 and K1805 were grouped as least susceptible and K1677, Ananatha, K1452, Narayani, K1725, TCGS1345, K1802, K1951, K1719, K1535, Kadiri Harithaandhra, Vemana, K6, TCGS1327, K1702, Greeshma, TCGS1323, K2014, K1468, TAG24, K9, TCGS1349, TCGS1333, TCGS1157, TCGS1346, K1801, K1706, TCGS1073, TAG51, K7, TCGS1270, TCGS1278, TCGS1335, K1699, TCGS1273, K1809, Dharani, TCGS1330, Prasuna, ISK2014-9 and K1789 were grouped as moderately susceptible whereas the genotypes K1847, TCGS1375, Abhaya, K1501, K1811, K1813, K2074 and K1800 were grouped as highly susceptible. Out of the 52 varieties/genotypes screened, Dharani, K1677 and TCGS1073 were categorized as least susceptible based on the no. of emerged adults of *C. serratus* whereas the genotypes K6, K1719, K2014, K9, K1452, Kadiri Harithaandhra, K1706, K1951, Greeshma, Ananatha, K1787, TCGS1349, TAG51, K2075, TCGS1327, K1725, K1801, TCGS1270, K1809, Narayani, TCGS1375, K1702, K7, K1699, K1535, TCGS1345, K1468, Vemana, TCGS1346, TCGS1278, TAG24, K1789, Prasuna, TCGS1157, Abhaya, K1805, K2074, K1813, TCGS1273, K1800 and TCGS1335 were categorized as moderately susceptible. However, the genotypes K1802, TCGS1333, TCGS1330, TCGS1323, K1501, ISK2014-9, K1811 and K1847 lines were categorized as highly susceptible which recorded higher no. of emerged adults. The genotypes K2074, TCGS1330, K1811, TCGS1073, K1501, Vemana, K1847, K1800 and K1813 were more prone to attack by *C. serratus* and recorded higher mean per cent pod damage by count which were categorized as highly susceptible whereas the genotypes TCGS1327, TAG24, K1468, TCGS1346, Greeshma, K2014, TCGS1345, Prasuna, TCGS1335, TCGS1157, Narayani, TCGS1333, TCGS1323, K1725, K1699, TCGS1278, K1706, K1452, ISK2014-9, K1801, TAG51, TCGS1270, K1809, Abhaya, TCGS1375, K1787, TCGS1273, K1951, K1789, Ananatha, K9, K6 and Kadiri Harithaandhra were categorized as moderately susceptible for damage by C. serratus. However, the genotypes K2075, K7, K1805, K1677, K1802, TCGS1349, K1535, K1719, Dharani and K1702 were less preferred and were categorized as least susceptible.

The genotypes K7, Dharani, K1677, TCGS1349, K2075, K1802, K1702, K1719, K1535 and TCGS1327 were categorized as least susceptible for attack by *C. serratus* based on the per cent pod damage (by weight) whereas the genotypes TAG24, Greeshma, K1468, K1452, TCGS1345, TCGS1335, TCGS1346, Prasuna, K1805, TCGS1157, K2014, TCGS1333, K1706, TAG51, K1725, Narayani, TCGS1270, TCGS1323, K1699, K1801, K1787, ISK2014-9, K1809, TCGS1278, K1789, Abhaya, K1951, TCGS1273, TCGS1375, Kadiri Harithaandhra and K9 were categorized as moderately susceptible and the genotypes Ananatha, K6, TCGS1330, TCGS1073, K 2074, K1811, Vemana, K1501, K1847, K1800 and K 1813 were categorized as highly susceptible based on the damage by *C. serratus*.

The per cent weight loss was more in the genotypes TCGS1157, TCGS1137, TCGS1073, K1789, K1809, K1802, K2074, K1813, K1535, TCGS1273, K1951, K1847 and TAG24 which were categorized as highly susceptible. The genotypes K7, Abhaya, K6, K1725, K1800, TCGS1346, K1501, K2014, K1787, TCGS1278, TCGS1335, TCGS1345, K1677, K1699, K1702, Kadiri Harithaandhra, TCGS1349, ISK2014-9, K1801, Greeshma, TCGS1330, K1719, TAG51, Prasuna, TCGS1333, K1805, Vemana, TCGS1327, K1811, TCGS1270 and TCGS1323 were categorized as moderately susceptible whereas, the genotypes Anantha, K2075, K9, Narayani, K1452, TCGS1375, Dharani and K1706 were categorized as least susceptible for attack by *C. serratus* based on the per cent weight loss (Table 1).The varieties K2075, Dharani and K1677 were categorized as least susceptible while the varieties K1847, K1813 and TCGS1073 were categorized as highly susceptible based on the ovipositional preference, adult emergence, per cent pod damage (both by count and weight) and weight loss [14]. classified Abhaya, Kadiri-5, K-1621, Greeshma, K-1535, K-1563 and TCGS-1043 varieties as least susceptible while the varieties K-1641 and Kadiri 008 Bold as highly susceptible based on number of eggs laid on pods, pod damage and weight loss.

**Table 1:** Grouping of genotypes /varieties of groundnut based on reaction against *C. serratus* infestation

| Character | Least susceptible Mean-SD | Moderately Susceptible Mean-SD to Mean + SD | Highly Susceptible Mean + SD |
|---|---|---|---|
| Fecundity Eggs /10 females Mean : 55.48 SD : 43.50 | K1787, K1805, K2075 | K6, K7, K9, K1452, K1468, K1535, K1677, K1699, K1702, K1706, K1719, K1725, K1789, K1801, K1802, K1809, K1951, K2014, TCGS1073, TCGS1157, TCGS1270, TCGS1273, TCGS1278, TCGS1323, TCGS1327, TCGS1330, TCGS1333, TCGS1335, TCGS1345, TCGS1346, TCGS1349, ISK2014-9, Anantha, Dharani, Greeshma, Kadiri Harithaandhra, Prasuna, Narayani, Vemana, TAG24, TAG51 | K1501, K1800, K1811, K1813, K1847, K2074, TCGS1375, Abhaya |
| Adult emergence/ 10 females Mean : 29.55 SD : 15.34 | K1677, TCGS1073, Dharani | K6, K7, K9, K1452, K1468, K1535, K1699, K1702, K1706, K1719, K1725, K1787, K1789, K1800, K1801, K1805, K1809, K1813, K1951, K2014, K2074, K2075, TCGS1157, TCGS1270, TCGS1273, TCGS1278, TCGS1327, TCGS1335, TCGS1345, TCGS1346, TCGS1349, TCGS1375, Abhaya, Anantha, Kadiri Harithaandhra, Greeshma, Narayani, Prasuna, Vemana, TAG24, TAG51 | K1501, K1802, K1811, K1847, TCGS1323, TCGS1330, TCGS1333, ISK2014-9 |
| Per cent pod damage by count (100g/pods) Mean : 19.04 SD : 10.56 | K7, K1535, K1677, K1702, K1719,K1802, K1805, K1813, K2075, TCGS1349, Dharani | K6,K9, K1452, K1468, K1699, K1706, K1725, K1787, K1789, K1801, K1809, K1951, K2014, TCGS1157, TCGS1270, TCGS1273, TCGS1278, TCGS1323, TCGS1327, TCGS1333, TCGS1335, TCGS1345 TCGS1346, TCGS1375, ISK2014-9, Abhaya, Anantha, Greeshma, Kadiri Harithaandhra, Narayani, | K1501, K1800, K1811, K1847, K2074, TCGS1073, TCGS1330, Vemana |

| | | | |
|---|---|---|---|
| | | Prasuna, TAG24,TAG51 | |
| Per cent pod damage by weight (100 g / pods) Mean : 16.59 SD : 8.02 | K7, K1535, K1677, K1702, K1719, K1802, K2075,TCGS1327, TCGS1349,Dharani | K9, K1452, K1468, K1699, K1706, K1725, K1787, K1789, K1801, K1805, K1809, K1951, K2014, TCGS1157, TCGS1270, TCGS1273, TCGS1278, TCGS1323, TCGS1333, TCGS1335, TCGS1345, TCGS1346, TCGS1375, ISK2014-9, Abhaya, Greeshma, Kadiri Harithaandhra, Narayani, Prasuna, TAG24, TAG51 | K6, K1501, K1800, K1811, K1813, K1847, K2074, TCGS1073, TCGS1330, Anantha, Vemana |
| Weight loss (%) Mean : 6.38 SD : 19.96 | K9, K1452,K1706, K2075, TCGS1375, Anantha, Dharani, Narayani | K6, K7, K1468, K1501, K1677, K1699,K1702, K1719, K1725, K1787, K1800, K1801, K1805, K1811, K2014, TCGS1270, TCGS1323, TCGS1278, TCGS1327, TCGS1330, TCGS1333, TCGS1335, TCGS1345, TCGS1346, TCGS1349, ISK2014-9, Abhaya, Greeshma, Kadiri Harithaandhra, Prasuna,Vemana, TAG51 | K1535, K1789, K1802 K1809 K1813, K1847, K1951, K2074, TCGS1073, TCGS1137, TCGS1157, TCGS1273, TAG24 |

## Physical Parameters of Pods of Groundnut Varieties

The various physical parameters studied in fifty two lines of groundnut pods are presented in Table 2.

**Table 2:** Physical parameters assessed in the pods and kernels of groundnut 52 genotypes / varieties

| S. No. | Genotypes / Varieties | Pod Beak | Pod reticulation | Pod Constriction | Kernel size | Kernel colour | Kernel shape | Kernel texture | Kernel beak |
|---|---|---|---|---|---|---|---|---|---|
| 1 | K 1719 | Moderate | Prominent | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 2 | K 1725 | Absent | Prominent | Absent | Medium | Pink | Oval | Smooth | Short |
| 3 | K 1789 | Slight | Moderate | Moderate | Medium | Pink | Oval | Smooth | Very short |
| 4 | K 1801 | Moderate | Moderate | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 5 | K 1805 | Moderate | Prominent | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 6 | K 2014 | Moderate | Moderate | Moderate | Medium | Pink | Elongate | Smooth | Very short |
| 7 | K 2074 | Absent | Prominent | Absent | Medium | Pink | Round | Variegated | Short |
| 8 | K 2075 | Slight | Moderate | Absent | Medium | Pink | Round | Smooth | Short |
| 9 | K 6 | Very Prominent | Prominent | Deep | Medium | Brown | Oval | Variegated | Short |
| 10 | K 9 | Moderate | Very Prominent | Slight | Bold | Dark brown | Oval | Smooth | Short |
| 11 | Kadiri Harithaandhra | Slight | Moderate | Moderate | Medium | Pink | Elongate | Variegated | Short |
| 12 | Anantha | Slight | Moderate | Moderate | Bold | Pink | Elongate | Variegated | Very short |
| 13 | K 1809 | Slight | Moderate | Slight | Medium | Pink | Elongate | Smooth | Short |
| 14 | K 1452 | Slight | Moderate | Slight | Medium | Pink | Oval | Smooth | Short |
| 15 | K 1468 | Absent | Prominent | Absent | Medium | Pink | Round | Smooth | Very short |
| 16 | K 1501 | Absent | Prominent | Absent | Medium | Pink | Round | Smooth | Short |
| 17 | K 1535 | Absent | Very Prominent | Slight | Medium | Pink | Round | Smooth | Prominent |
| 18 | K 1677 | Absent | Prominen | Absent | Medium | Pink | Round | Smooth | Short |
| 19 | K 1699 | Slight | Moderate | Slight | Medium | Pink | Oval | Smooth | Short |
| 20 | K 1702 | Slight | Prominent | Slight | Medium | Pink | Oval | Smooth | Short |
| 21 | K 1706 | Slight | Moderate | Moderate | Medium | Pink | oval | Smooth | Short |
| 22 | K 1787 | Moderate | Moderate | Slight | Medium | Pink | Elongate | Smooth | Short |
| 23 | K 1800 | Moderate | Moderate | Slight | Medium | Pink | Elongate | Smooth | Short |
| 24 | K 1802 | Prominent | Moderate | Moderate | Medium | Pink | Elongate | Smooth | Prominent |
| 25 | K 1811 | Prominent | Moderate | Prominent | Medium | Pink | Elongate | Smooth | Prominent |
| 26 | K 1813 | Moderate | Prominent | Prominent | Medium | Pink | Elongate | Smooth | Very short |
| 27 | K 1847 | Slight | Very Prominent | Slight | Medium | Pink | Elongate | Smooth | Very short |
| 28 | K 1951 | Absent | Prominent | Absent | Medium | Pink | Round | | Short |
| 29 | K 7 | Absent | Moderate | Slight | Bold | Rose brown | Elongate | Variegated | Very short |
| 30 | Narayani | Prominent | Prominent | Very Deep | Medium | Red | Elongate | Smooth | Prominent |
| 31 | Dharani | Moderate | Very Prominent | Very Deep | Medium | | Elongate | Smooth | Short |
| 32 | Abhaya | Slight | Slight | Slight | Medium | Pink | Oval | Smooth | Prominent |
| 33 | TCGS1073 | Moderate | Very Prominent | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 34 | TCG 1157 | Prominent | Prominent | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 35 | Prasuna | Moderate | Prominent | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 36 | ISK 2014-9 | Moderate | Moderate | Prominent | Medium | Pink | Round | Smooth | Short |
| 37 | TCGS1375 | Moderate | Prominent | Slight | Medium | Pink | Elongate | Smooth | Short |
| 38 | TCGS1330 | Absent | Prominent | Absent | Medium | Pink | Oval | Smooth | Prominent |
| 39 | TCGS1273 | Slight | Prominent | Absent | Medium | Pink | Oval | Smooth | Prominent |
| 40 | TCGS1278 | Moderate | Moderate | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 41 | TCGS1333 | Moderate | Prominent | Slight | Medium | Pink | Elongate | Smooth | Short |
| 42 | TCGS1345 | Absent | Prominent | Moderate | Medium | Pink | Oval | Smooth | Short |
| 43 | TCGS1349 | Moderate | Prominent | Slight | Medium | Pink | Elongate | Smooth | Prominent |
| 44 | TCGS1346 | Slight | Moderate | Prominent | Medium | Pink | Oval | Smooth | Very short |
| 45 | TCGS1335 | Prominent | Moderate | Deep | Medium | Pink | Elongate | Variegated | Short |
| 46 | TCGS1270 | Moderate | Moderate | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 47 | TCGS1323 | Slight | Prominent | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 48 | TCGS1327 | Prominent | Moderate | Moderate | Medium | Pink | Elongate | Smooth | Short |
| 49 | Greeshma | Slight | Moderate | Moderate | Medium | Pink | Oval | Smooth | Short |
| 50 | Vemana | Slight | Moderate | Moderate | Medium | Rose | Oval | Smooth | Short |
| 51 | TAG 24 | Slight | Moderate | Moderate | Medium | Pink | Round | Variegated | Very short |
| 52 | TAG 51 | Moderate | Moderate | Slight | Medium | Pink | Round | Smooth | Short |

**Pod beak**

The groundnut varieties used in the present study were grouped into three categories based on the pod constriction as slight, medium and deep. The pods of K1468, K1725, K2074, K1501, K1535, K1677, K1951, K7, TCGS1330 and TCGS1345 have not possessed any beak and the pods of K1789,K 2075, Kadiri Harithaandhra, Ananatha, K1809,K1452, K1699, K1702, K1706, K1847, Abhaya, TCGS1273, TCGS1346, TCGS1323, Greeshma, Vemana and TAG 24 have possessed slight beak and the moderate beak was noticed in varieties like K1719, K1801, K1805, K2014, K9, K1787, K1800, K1813, Dharani, TCGS1073, Prasuna, ISK 2014-9, TCGS1375, TCGS1278, TCGS1349, TCGS1270, TAG51 and TCGS1333. The prominent beak was noticed in varieties like K1802, K1811, Narayani, TCGS1157, TCGS1335, TCGS1327 and where as very prominent beak was noticed in K6.

**Pod reticulation**

The groundnut varieties used in the present study were grouped in to four categories *viz.*, slightly reticulated, medium reticulated, reticulated and deeply reticulated based on the pod reticulation. Among the treatments, Abhaya, were classified as slightly reticulated, whereas K1789, K1801, K2014, K2075, Kadiri Harithaandhra, Ananatha, K1809, K1452, K1677, K1699, K1706, K1787, K1800, K1802, K1811, K7, ISK2014-9, TCGS1278, TCGS1346, TCGS1335, TCGS1270, TCGS1327, Greeshma, Vemana, TAG24 and TAG51 possessed moderate reticulation. Prominent reticulated type of pods were present in K1719, K1725, K1805, K2074, K6, K1468, K1501, K1702, K1813, K1951, Narayani, Abhaya, TCGS1157, Prasuna, TCGS1375, TCGS1330, TCGS1273, TCGS1333, TCGS1345, TCGS1349 and TCGS1323. The varieties K9, K1847, TCGS1073, K1535 and Dharani had possessed deep reticulation. The pod reticulation seems to have played a role in ovipositional preference by the bruchid. Moderately resistant varieties K9, K1847, TCGS1073, K1535 and Dharani possessing deep and prominent pod reticulation were less preferred for egg laying. Similarly most of the susceptible varieties possessing slight to less reticulation were preferred for oviposition. Similar findings were observed by [7]. Recorded the lowest fecundity in ICGV86590 and ICGS76 groundnut varieties which possessed prominent pod reticulation. Rama [15] observed that the genotypes TCGS61 and TPT3 with moderate to prominent reticulations were less. The results are in agreement with [18] who reported that the genotypes Narayani and K9 were found to be less preferred by the bruchids for oviposition (20.33 and 21.0 eggs/100 g pods respectively) and resulted in emergence of significantly lower number of adults (13.67 and 14.33 adults respectively). Whereas, the highly susceptible genotype, ICGV 350 that possessed smooth reticulation received 47.33 eggs/100 g pods and resulted in emergence of 40.33 adults.

**Pod constriction**

The pods of Narayani, Dharani, K6 and TCGS1335 possessed very deep constriction, while prominent constriction was noticed K1811, K1813, ISK2014-9, TCGS1346 and moderate constriction was observed in K1719, K1789, K1801, K1805, K2014, Kadiri Harithaandhra, Ananatha, K1706, K1802, TCGS1073, TCGS1157, Prasuna, TCGS1278, TCGS1345, TCGS1270, TCGS1323, TCGS1327, Greeshma, Vemana and TAG24. Slight constriction was noticed in K9, K1809, K1452, K1535, K1699, K1702, K1787, K1800, K1847, K7, Abhaya, TCGS1375, TCGS1333, TCGS1349 and TAG51 whereas no constriction was seen K1725, K2074, K2075, K1468, K1501, K1677, K1951, TCGS1330 and TCGS1273. The pod constriction of varieties did not seem to play any role in resistance/susceptibility against *C. serratus.*

**Kernel size, kernel colour, kernel shape, kernel texture and kernel beak**

With respect to kernel size in majority of the test entries *i.e.* 49 entries, it was medium. Likewise, majority of test lines possess pink colour kernel. The shape of kernel recorded in 52 entries was elongate, oval and round. The kernel texture observed was smooth in almost all the entries. The kernel beak ranged from very short to prominent. The above all characters of kernel did not show any impact on the preference of the kernel by groundnut bruchid *C. serratus*.

**Measurements of Physical Characters of Pod and Kernel in Test Entries of Groundnut**

The pod and kernel length and width, shell thickness, shell hardness and inter granular space are presented in Table 3

**Table 3:** Physical parameters assessed in the pods and kernels of 52 groundnut genotypes / varieties

| S.No. | Genotypes/ Varieties | Pod length (mm) | Pod width (mm) | Kernel length (mm) | Kernel width (mm) | Circumference (mm) | Shell thickness (mm) | Shell hardness (kg $m^{-2}$) | Inter granular space (cc) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | K 1719 | 30.81 | 15.01 | 14.23 | 8.29 | 9.86 | 1.10 | 1.92 | 62.34 |
| 2 | K 1725 | 30.55 | 13.62 | 13.56 | 7.65 | 11.02 | 0.88 | 2.09 | 52.13 |
| 3 | K 1789 | 32.90 | 11.60 | 12.32 | 5.95 | 14.93 | 0.88 | 1.33 | 59.73 |
| 4 | K 1801 | 29.84 | 12.15 | 14.49 | 5.96 | 9.16 | 1.49 | 1.40 | 57.37 |
| 5 | K 1805 | 27.82 | 11.22 | 12.85 | 7.16 | 10.91 | 1.02 | 1.00 | 58.13 |
| 6 | K 2014 | 26.82 | 11.69 | 13.26 | 6.65 | 8.52 | 0.88 | 2.13 | 53.53 |
| 7 | K 2074 | 21.88 | 11.87 | 13.50 | 7.62 | 4.13 | 0.78 | 1.33 | 58.43 |
| 8 | K 2075 | 28.19 | 14.30 | 14.69 | 8.78 | 7.98 | 2.01 | 2.82 | 60.24 |
| 9 | K 6 | 29.74 | 11.37 | 13.27 | 7.86 | 12.96 | 0.81 | 2.13 | 59.46 |
| 10 | K 9 | 25.16 | 12.90 | 11.71 | 8.99 | 9.54 | 0.89 | 2.30 | 50.11 |
| 11 | Kadiri harithaandhra | 28.10 | 14.26 | 13.24 | 8.39 | 8.99 | 0.82 | 3.10 | 66.57 |
| 12 | Anantha | 28.00 | 12.72 | 12.90 | 7.89 | 10.27 | 1.06 | 2.22 | 58.13 |
| 13 | K 1809 | 24.70 | 11.20 | 10.54 | 6.28 | 9.24 | 0.89 | 1.89 | 53.53 |
| 14 | K 1452 | 28.16 | 14.28 | 13.80 | 7.83 | 7.91 | 1.04 | 1.97 | 58.43 |
| 15 | K 1468 | 26.47 | 13.47 | 13.27 | 7.41 | 7.14 | 0.92 | 2.45 | 57.18 |
| 16 | K 1501 | 29.52 | 14.95 | 13.81 | 6.40 | 7.16 | 0.84 | 1.89 | 55.41 |
| 17 | K 1535 | 28.20 | 13.94 | 13.23 | 6.65 | 7.68 | 0.80 | 2.03 | 69.47 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18 | K 1677 | 28.46 | 14.91 | 14.25 | 7.76 | 7.06 | 0.95 | 2.37 | 54.93 |
| 19 | K 1699 | 28.84 | 13.89 | 13.49 | 7.65 | 9.11 | 1.12 | 1.33 | 59.73 |
| 20 | K 1702 | 28.55 | 13.14 | 14.86 | 8.15 | 8.7 | 1.08 | 1.40 | 57.37 |
| 21 | K 1706 | 27.55 | 13.81 | 14.12 | 8.18 | 7.8 | 0 | 1.00 | 58.13 |
| 22 | K 1787 | 30.10 | 13.44 | 13.38 | 5.77 | 9.05 | 0.88 | 2.13 | 53.53 |
| 23 | K 1800 | 29.68 | 13.79 | 13.98 | 6.12 | 8.03 | 0.78 | 1.33 | 58.43 |
| 24 | K 1802 | 28.56 | 11.69 | 13.09 | 6.66 | 10.44 | 0.99 | 3.30 | 61.17 |
| 25 | K 1811 | 29.13 | 11.36 | 13.53 | 5.87 | 10.11 | 0.86 | 2.13 | 60.67 |
| 26 | K 1813 | 29.01 | 11.84 | 13.52 | 6.63 | 10.28 | 0.76 | 1.33 | 58.12 |
| 27 | K 1847 | 27.68 | 14.06 | 14.01 | 6.80 | 6.41 | 0.82 | 1.84 | 59.13 |
| 28 | K 1951 | 25.80 | 14.87 | 11.92 | 7.58 | 6.59 | 0.86 | 1.37 | 57.03 |
| 29 | K 7 | 26.06 | 13.21 | 13.06 | 7.24 | 7.03 | 1.74 | 3.17 | 65.53 |
| 30 | Narayani | 28.22 | 12.54 | 12.62 | 7.82 | 10.88 | 0.80 | 2.43 | 53.06 |
| 31 | Dharani | 25.02 | 12.16 | 12.96 | 7.08 | 6.98 | 0.94 | 2.22 | 58.12 |
| 32 | Abhaya | 26.26 | 11.79 | 13.28 | 6.72 | 7.91 | 0.98 | 1.97 | 53.50 |
| 33 | TCGS 1073 | 28.44 | 13.70 | 15.27 | 7.21 | 6.68 | 1.13 | 0.87 | 58.13 |
| 34 | TCGS 1157 | 27.75 | 13.25 | 15.61 | 8.50 | 7.39 | 0.85 | 2.23 | 53.53 |
| 35 | Prasuna | 33.15 | 11.86 | 13.45 | 7.22 | 15.06 | 0.98 | 2.37 | 58.43 |
| 36 | ISK 2014-9 | 31.52 | 14.08 | 13.47 | 6.44 | 10.41 | 1.07 | 1.33 | 56.73 |
| 37 | TCGS 1375 | 28.95 | 13.86 | 14.37 | 7.57 | 8.29 | 1.23 | 1.40 | 54.93 |
| 38 | TCGS 1330 | 28.40 | 14.38 | 15.20 | 8.06 | 6.88 | 0.92 | 1.00 | 59.73 |
| 39 | TCGS 1273 | 26.11 | 13.73 | 13.97 | 7.70 | 6.11 | 0.89 | 2.13 | 57.37 |
| 40 | TCGS 1278 | 25.98 | 11.13 | 12.74 | 6.42 | 8.53 | 1.07 | 1.33 | 58.13 |
| 41 | TCGS 1333 | 28.05 | 11.76 | 11.92 | 6.38 | 10.75 | 1.01 | 3.30 | 53.53 |
| 42 | TCGS 1345 | 27.35 | 12.47 | 12.57 | 6.07 | 8.38 | 0.87 | 2.13 | 58.43 |
| 43 | TCGS 1349 | 26.60 | 13.24 | 12.17 | 6.20 | 7.39 | 0.96 | 1.33 | 61.17 |
| 44 | TCGS 1346 | 26.93 | 11.68 | 11.68 | 7.00 | 10.57 | 0.77 | 3.30 | 60.67 |
| 45 | TCGS 1335 | 28.81 | 11.17 | 12.36 | 6.03 | 11.31 | 1.24 | 1.33 | 62.12 |
| 46 | TCGS 1270 | 26.11 | 11.39 | 12.78 | 7.00 | 8.94 | 1.98 | 1.40 | 58.13 |
| 47 | TCGS 1323 | 29.40 | 11.37 | 12.01 | 6.05 | 12.07 | 1.10 | 1.00 | 53.53 |
| 48 | TCGS 1327 | 24.73 | 12.25 | 14.25 | 6.20 | 4.43 | 1.32 | 2.13 | 58.43 |
| 49 | Greeshma | 28.44 | 12.01 | 11.67 | 6.06 | 10.82 | 1.13 | 1.33 | 61.24 |
| 50 | Vemana | 29.42 | 11.48 | 15.22 | 7.21 | 9.93 | 0.73 | 1.37 | 51.50 |
| 51 | TAG 24 | 24.71 | 11.90 | 12.46 | 8.09 | 8.44 | 1.45 | 1.12 | 58.54 |
| 52 | TAG 51 | 26.71 | 11.63 | 12.97 | 6.40 | 8.51 | 0.98 | 1.10 | 56.17 |
| | SEm ± | 1.59 | 1.28 | 0.40 | 0.42 | 2.09 | 0.08 | 0.08 | 0.41 |
| | CD(P=0.05) | 4.56 | 3.32 | 1.44 | 1.21 | 5.60 | 0.22 | 0.22 | 1.17 |

**Pod length (mm)**

The length of the pod in 52 entries was varied from 21.88 mm to 33.15 mm. Significantly, the highest pod length size was observed in Prasuna (33.15 mm) while small pod size was observed in K2074 (21.88), K1809 (24.70 mm), TAG 24 (24.71 mm), TCGS1327 (24.73 mm) and Dharani (25.02 mm) which were on par with each other. In rest of the varieties pod size varied from 25.16 to 32.90 mm.

**Pod width (mm)**

The width of pods in 52 entries was ranged from 11.13 to 14.95 mm. The lowest of 11.13 mm in TCGS1278, highest in 15.01 mm. in remaining entries 11.17 to 14.95 mm

**Kernel length (mm)**

The length of the kernel was ranged from 10.54 to 15.61 mm. Significantly highest kernel length was noticed in TCGS1157 (15.61) followed by TCGS 1073 (15.27 mm) and Vemana (15.22 mm) while the lowest kernel width size K1809 (10.54 mm) and other entries/varieties were ranged from 11.67 to 15.20 mm.

**Kernel width (mm)**

Significantly, lower kernel width was noticed K1787 (5.77 mm) followed by K1789 and K1811 with kernel width 5.95 and 5.87 mm, respectively. The highest kernel width is in K9 (8.99 mm) followed by K2075 and TCGS1157 and Kadiri harithaandra (8.78, 8.5 and 8.39 mm respectively).

**Pod and Kernel Circumference**

The Pod and Kernel circumference measured in different groundnut treatments varied from 4.13 mm to 15.06. Significantly, the highest pod and kernel circumference was observed in Prasuna (15.06) while small was observed in K2074 (4.13) TCGS1327 (4.43) and TCGS1273 (6.11) which were on par with each other. In rest of the lines it was 3.89 to 14.93. The less susceptible variety K2074 (4.13) was not preferred for egg laying and subsequent development while the larger circumference possessed by the Prasuna was comparatively more preferred by the beetle for oviposition and feeding.

**Shell thickness (mm)**

Significantly, less thickness of shells was recorded in Vemana (0.73) followed by K1813 (0.76), TCGS1346 (0.77), K2074 (0.78), K1800 (0.78) and K1535 (0.80) while the highest thickness was observed in K2075 (2.01) followed by TCGS1270 (1.98), K7 (1.74) and K1801 (1.49) respectively and were on par with each other. The shell thickness measured in the rest of the varieties varied from 0.81 mm to 1.45 mm. Vemana recorded less thickness (0.73) and recorded more per cent weight loss (28.24) may be due to easy penetration of grub and successful development of larva and emergence of adults whereas shell thickness was comparatively more in the varieties K2075 (2.01) and K7 (1.74) which recorded less per cent weight loss of 1.97 and 3.60 respectively. These results are in agreement with the

findings of [10]. She reported that more shell thickness of pods observed in moderately resistant varieties *viz.*, K9, K1271 and ICGV05100 while comparatively less thickness of shell was observed in susceptible varieties *viz.*, TMV2, JCG88, ICGV86015 and Vemana may be due to easy penetration of tiny first instar grub into the pod. The results are also in agreement with the findings of [7] who reported that more thickness of groundnut shells of resistant varieties resulted in significantly lowest adult emergence and prolonged development period of the *C. serratus* [6]. Reported that seed surface and thickness of the seed coat of bengalgram were appeared to be the most important factors for the differential preference by *C. chinensis*. Similarly [11] also reported that pigeon pea seed coat thickness did play a major role in adult emergence of *C. chinensis.*

**Shell hardness (kg m$^{-2}$)**

The lowest shell hardness was recorded in TCGS 1073 (0.87 kg m$^{-2}$) which was on par with K1706, K1805, TCGS 1323 and TCGS 1330 (1.00 kg m$^{-2}$). The highest shell hardness was observed in TCGS 1346 (3.30 kg m$^{-2}$) which was on par with TCGS 1333 and K1802 The shell hardness recorded in rest of the varieties varied from 1.10 kg m$^{-2}$ to 3.17 kg m$^{-2}$. In the present study, moderately resistant varieties TCGS 1333, TCGS 1346, K7 and Kadri Harithaandhra had comparatively more shell hardness whereas susceptible varieties K1809, K2074 recorded less shell hardness. The high thickness and hardness of shell as observed in moderately resistant varieties might had prevented the penetration of larva in to the pod and adversely affected the development and adult emergence. On the other hand, TCGS 1333, TCGS 1346 and K7 in spite of possessing significantly high shell hardness of 3.30, 3.30 and 3.17 kg m$^{-2}$ respectively, they were moderately susceptible to the pest attack showing the role of other factors in the susceptibility reaction. These results are in accordance with the findings of [10] reported that variety TCGS1073 in spite of possessing significantly high shell hardness of 3.30 kg m$^{-2}$, it was moderately susceptible [22]. Reported that the resistant pigeonpea varieties PRG-158 and PRG-100 recorded more seed hardness (24.83 and 21.17 kg m$^{-2}$, respectively) than the moderately susceptible varieties Durga and LRG-30 which recorded the lowest seed hardness of 17.00 and 14.50 kg m$^{-2}$, respectively [2]. Stated that the seed of pigeonpea genotype Nsukka local was resistant to *C. chinensis* and was harder than the other susceptible varieties.

**Inter granular space (cc)**

The lowest inter granular space was recorded in K9 (50.11 cc) followed by Vemana (51.50 cc), K1725 (52.13 cc), Narayani (53.06 cc), Abhaya (53.5 cc) and K1787 (53.53 cc) while the highest inter granular space was recorded in K1535 (69.47 cc). The inter granular space recorded in rest of the varieties varied from 53.53 to 66.57 cc. These results are in accordance with the findings of [10], who reported that less inter granular space recorded in moderately resistant varieties of K9 and K1271 seemed to have restricted the free movement of grubs between the kernels there by adversely affecting the oviposition and development. The results are in agreement with the findings of [7] reported that the lowest adult emergence of groundnut bruchid and minimum weight loss recorded in moderately resistant variety ICGS11 might be due to low inter granular space.

**Correlation Studies between Physical Characters of Pods of Groundnut Varieties and Biological Parameters of Test Insect**

The pod characters of different groundnut varieties and biological parameters of test insect are presented in Table 4.

Among the physical parameters shell thickness (-0.36) and (-0.32) showed negative and significant effect on oviposition and adult emergence, respectively. The shell hardness was significant and positively correlated (0.29, 0.30 and 0.36) with per cent pod damage by count, weight and weight loss, respectively. The intergranular space (0.29) also significant and positive relation with per cent weight loss. Whereas, pod width (-0.31) is significant but shown negative correlation with per cent weight loss. Kernel width is significant and negative correlation with oviposition, adult emergence and per cent weight loss and shell hardness is also significant and shown negative relationship with per cent pod damage by count as well as weight and the similar results were coincidence with [13].

**Table 4:** Correlation studies between physical characters of pods of groundnut genotypes /varieties and biological parameters of *C. serratus*

| Biological Parameter Physical Parameter | Oviposition | Adult emergence | Per cent pod damage by count | Per cent pod damage by weight | Per cent weight loss |
|---|---|---|---|---|---|
| Pod length (mm) | 0.01 | 0.18 | 0.12 | 0.11 | 0.00 |
| Pod width (mm) | -0.07 | -0.11 | 0.05 | 0.01 | -0.31 |
| Kernel length (mm) | 0.09 | 0.05 | 0.19 | 0.15 | 0.14 |
| Kernel width (mm) | -0.29 | -0.33 | -0.08 | -0.04 | -0.29 |
| Circumference | -0.11 | 0.08 | -0.04 | 0.01 | -0.01 |
| Shell thickness (mm) | -0.36** | -0.32* | 0.15 | 0.12 | 0.13 |
| Shell hardness (kg m$^{-2}$) | -0.26 | -0.07 | 0.29* | 0.30* | 0.36** |
| Inter granular space (cc) | -0.01 | 0.03 | -0.22 | -0.26 | 0.29* |
| r (0. 05) = 0.279<br>r (0. 01) = 0.361 | | | | | |

* Significant at 5% level

** Significant at 1%

**Conclusion**

Groundnut pod shell thickness, hardness and prominent reticulation are directly and indirectly involved to penetration of grub inside the pods. Inter granular space in between the seeds of pod restricted the free movement of grubs between the kernels there by adversely affecting the oviposition and development, Hence, some breeding lines showing least susceptible and moderately susceptible.

**Acknowledgment**

First author highly thankful to the authorities of Acharya N.G. Ranga Agricultural University for the financial help in the form of deputation during my study period.

**References**


1. Anonymous. http://krishijagran.com/commodity-news national/2016/02/Vietnam Lifts-Ban-on-Import-of-Indian-Groundnut 2016.
2. Dasbak MA, Echezona BC and Asiegbu JE.. Pigeonpea grain physical characteristics and resistance to attack by the bruchid storage pests. International Agrophysics 2009;23:19-26.
3. Davey PM. The groundnut bruchid, *Caryedon gonagra*. Bull. Entomological Res 1958;49:385-404.
4. FAOSTAT. http://www.faostat.fao.org 2015.
5. Gopalaswamy SVS, Ramana MV, Radha Krishna Y. Screening of Urdbean cultivars against *Callosobruchus chinensis*. Indian Journal of Plant Protection 2010;38(1):53-56.
6. Gupta DS, Mishra RC. Further studies on the relative resistance of some important varieties of bengalgram (*Cicer arietinum* L.) to pulse beetle (*Callosobruchus chinensis* L.). Bulletin of Grain Technology 1970;8:14-17.
7. Haritha V. Biology and relative preference of *Caryedon serratus* (Olivier) and *Corcyra cephalonica* Stainton to selected groundnut genotypes. M.Sc. (Ag). Thesis. Acharya N.G. Ranga Agricultural University, Bapatla 1998.
8. IBPGR. Descriptors for groundnut, Rome, Italy and Patancheru, AP, India: International Board of Plant Genetic Resources and International Crops Research Institute for the Semi-Arid Tropics 1992.
9. Jayalakshmi P, Suvarnalatha Devi P, Prasanna ND, Revathi G, Shaheen SK. Morphological and physiological changes of groundnut plants by foliar application with salicylic acid. The Bioscan 2010;5(2):193-195
10. Jyothsna M. Biorational approaches for the management of groundnut bruchid (*Caryedon serratus* Olivier). Doctoral dissertation, Professor Jayashankar Telangana State Agricultural University. Hyderabad 2015.
11. Khokhar KS, Singh D. Relative susceptibility of different genotypes of pigeonpea to pulse beetle, *Callosobruchus chinensis* (Linnaeus). Bulletin of Grain Technology 1987;25(3):244-251.
12. Lal SR. Studies on qualitative and quantitative losses in wheat due to insects at farm level storage. Bulletin of Grain Technology 1990;28:210-220.
13. Mohammad Abbas Ahmad, Khan MS, Meena Agnihotri. Evaluation of resistance in different chickpea varieties to *Calloso bruchus* chinensis L. (Coleoptera: bruchidae) under Linnaeus condition. The Bioscan 2017;12(4):2011-2015.
14. Najitha U, Madhumathi T, Krishnayya PV, Ratna Babu D. Relative Susceptibility of Groundnut Varieties to Groundnut Bruchid, *Caryedon serratus* in Storage. Indian Journal of Plant Protection 2013;41(3):267-269.
15. Rama Devi D, Rao NV. A note on reaction of groundnut varieties to the bruchid, *Caryedon serratus* (Olivier). Journal of Research ANGRAU 2000;28:41-43.
16. Rani CS, Lakshmi KV. Reaction of chickpea varieties to the pulse beetle, *Callosobruchus chinensis* L. on the basis of biological parameters and physicochemical characters. Pest Management and Economic Zoology 2004;12(2):123-129.
17. Redlinger LM, Davis R. Insect control in post harvest peanuts. Peanut Science and Technology Yoakum Texas, USA. American Peanut Research and Education Society 1982, 520-571.
18. Rekha G, Gopala Swamy SVS, Sandeep Raja D. Morphological and biochemical basis of tolerance to bruchid, *Caryedon serratus* (Olivier) in groundnut pods. Journal of Entomology and Zoology Studies 2017;5(3):373-376.
19. Shivalingaswamy TM, Balasubramanian R. Studies on the susceptibility of groundnut varieties to infestation by *Caryedon serratus* (Olivier) (Coleoptera: Bruchidae). Bulletin of Grain Technology 1992;30:137-140.
20. Shukla A and Rathore SS. Incidence of bruchid, Caryedon *serratus* (Olivier) on groundnut in Jaipur, Rajasthan. Entomon 2007;32(3):225-226.
21. Snedecor GW, Cochran WG. In**:** *Statistical Methods*, 6th Edition. Iowa State College Press, New Delhi 1967.
22. Vishwamitra V. Varietal preference and eco-friendly management of *Callosobruchus chinensis* L. in pigeonpea. M.Sc. (Ag.) Thesis. Acharya N.G. Ranga Agricultural University, Hyderabad 2011.