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Role of Physical and Biochemical Characters in Groundnut Genotypes as a Basis of Resistance against Groundnut Bruchid, *Caryedon serratus* Olivier during Storage

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ABSTRACT

Background: Groundnut bruchid (*Caryedon serratus* Olivier) is the most important stored grain insect pests of groundnut that significantly lowers the quality and market acceptance of the produce. The grub of this insect causes extensive damage to the kernels by boring into undamaged shell and feeds on seeds internally. Therefore, the present study is aimed at screening of the groundnut genotypes on the basis of their physical and biochemical characters which are responsible for imparting resistance against the bruchid pest.

Methods: An experiment was conducted at the Department of Seed Science and Technology, OUAT, Bhubaneswar during 2019-20 to study the physical and biochemical characters involved for resistance in stored groundnut genotypes against groundnut bruchid, *C. serratus*. Varietal screening study was conducted in twenty groundnut genotypes and their physical and biochemical characters were assessed in the laboratory.

Result: Small pod size, less pod weight and more shell thickness attributed for resistance to *C. serratus* resulting in least percentage pod damage and weight loss. Similarly, groundnut genotypes with lower protein content and higher phenol, fiber and ash content conferred resistance against the test insect.

Key words: Biochemical parameters, Groundnut bruchid, Physical parameters, Storage.

INTRODUCTION

Groundnut or peanut (*Arachis hypogaea* L.), is a major oilseed crop in many tropical and sub-tropical countries of the world. The kernel consists of 48 to 50 per cent oil and 26 to 28 per cent protein, rich in oleic and linoleic acid which is about 75 to 80 per cent of the total fatty acid and carbohydrate content ranging from 10 to 20 per cent (Sakhare *et al.,* 2018). During storage groundnut is infested by over one hundred species of insect pests. Of these, few pests are economically important, among which groundnut bruchid or groundnut seed beetle, *Caryedon serratus* Olivier (Bruchidae: Coleoptera), is a primary feeder. It causes both quantitative and qualitative loss to groundnut during storage. The first instar bruchid larvae bore into the kernel and feed on the embryo and the endosperm. Final instar larvae come outside of the pod/kernel through the exit holes for pupation.

This insect damage reduces the quality and marketability of seed and oil, reduces its weight and nutritive value. The weight loss caused by *C. serratus* in shelled and unshelled groundnut is 70 and 80%, respectively and the extent of damage in tamarind is up to 79% (Oaya *et al.,* 2012). Storage of the pods and kernels after harvesting for a period of 5 to 6 months is very difficult due to the hidden infestation of this bruchid. The infestation by stored grain insect pests also stimulates the growth of fungus as the moisture content of the seeds increases which in turn reduces the quality and viability of the seeds (Rao *et al.*, 2017). Traditionally these insect pests have been managed with use of synthetic insecticides in the forms of fumigants and seed protectants. However, application of synthetic chemicals and fumigants to stored commodities is associated with several health hazards such as headache, dizziness, diarrhea, skin irritation, liver damage, nerve damage and some are carcinogenic. Hence, there is a need for a substantial reduction in the use of chemical pesticides, encourage more eco-friendly,

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safe and non-toxic approaches such as use of resistant varieties. Considering the above facts, an experiment was conducted to determine the physical and biochemical characters of groundnut pods responsible for imparting resistance against the bruchid.

MATERIALS AND METHODS

The present investigations were carried out in the Department of Seed Science and Technology, Odisha University of Agriculture and Technology, Bhubaneswar during 2019-20 in a completely randomized design with three replications. Twenty groundnut genotypes were obtained from AICRP (All India Co-ordinated Research Project) on groundnut, OUAT, Bhubaneswar *viz*., ICGV-15396, ICGV-15398, ICGV-15400, ICGV-15404, ICGV-15412, ICGV-15416, ICGV-15417, ICGV-15421, ICGV-15423, ICGV-15424, ICGV-15425, ICGV-15432, ICGV-97115, ICGV-06423, ICGV-00350, ICGV-00351, ICGV-07220, ICGV-02266, Smruti, Devi.

Estimation of physical characters of test genotypes

The physical bases of resistance *viz*., pod size, pod weight, shell thickness and inter granular space were recorded for each genotype. The average size and thickness of ten pods was measured using vernier caliper and expressed in millimeter. The weight of hundred pods from each genotype was noted per replication and expressed in grams. Inter granular space present between the pods of each genotype was measured using one 100cc measuring cylinder which was filled with groundnut pods and the level of the pods was adjusted up to 100cc mark. Another 100cc measuring cylinder was filled with water and poured slowly into the measuring cylinder containing the groundnut pods until the water level reaches to its 100 cc mark. The quantity of water poured into the cylinder gives the volume of inter granular space contained in 100 cc of groundnut pods.

Estimation of biochemical characters of test genotypes

The experiments on the biochemical constituents of the test genotypes *viz*., protein, fiber and ash percentage were carried out in the Department of Seed Science and Technology, OUAT, Bhubaneswar. These chemical constituents were estimated by using an instrument namely Instalab 700 NIR seed analyser or Automatic seed analyser. This instrument gives more accurate, rapid and consistent readings than the conventional laboratory methods used for determination of the above parameters. For the analysis 5 g of kernels from each test genotypes were grounded with a mixer to fine powder and these powders were loaded on a circular black metal cup of 5 g capacity present inside the drawer of the analyser. The basement on which the cup was attached was cleaned neatly with the help of a fine brush to remove the extra particles and the drawer was closed. After 30 seconds the exact quantity of the chemical constituents were displayed on the screen present at the top of the analyser.

Estimation of phenol content

Total phenol content was estimated following the methodologies given by Bray and Thorpe (1954). One gram of groundnut seed was homogenized in ten times volume of 80 per cent ethanol with the help of mortar and pestle followed by centrifugation at 10000 rpm for twenty minutes. The supernatant was collected and it was evaporated to dryness. The residue obtained was dissolved in 5ml of distilled water. Different aliquots (0.2-2 ml) were taken and made to 3 ml by adding distilled water. 0.5 ml of 0.1 N Folin-Ciocalteau reagent was added and incubated for three minutes. Then 2 ml of 20 per cent Na_2CO_3 was added and this mixture was incubated in boiling water bath for one minute. The absorbance of the samples was taken at 650 nm against blank and a standard curve represented the amount of phenol content, expressed in mg per gram of the samples.

Biological parameters of *C. serratus* in different groundnut genotypes

Fecundity

Hundred numbers of healthy and disinfested pods of twenty groundnut test genotypes were kept in glass jars of 500 g capacity separately. Each treatment was replicated for three times. Two pairs of freshly emerged adult groundnut bruchid were released into each of the jars and the mouth of the jars were covered with muslin clothes and secured through rubber bands. The adult bruchids were removed from the test genotypes after 10 days and then the number of eggs laid on the surface of the pods of each treatment was counted. The average number of eggs laid by the test insect on each treatment was calculated and indicated as fecundity.

Adult emergence

The F1 adults emerged from each of the treatments were counted on daily basis and discarded to prevent further mating and egg laying. This procedure was carried out till the adult bruchids discontinued emerging from all the treatments. The mean adult emergence was calculated by pooling the data.

Mean developmental period

The mean developmental period of the bruchid in each of 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 from each treatment based on the formula by Howe (1971).

$$D = \frac{\sum (A \times B)}{C}$$

Where,

A= Number of adults emerged on n^{th} day.

B= 'n' days required for their emergence.

C= Total number of adults emerged during the experimental period.

D= Mean developmental period (days).

Growth index

The growth index was calculated by the following formula:

$$\text{Growth index} = \frac{N}{AV}$$

Where,
N = Percentage of adult emergence.
AV = Average total developmental period (days).

Index of susceptibility

The index of susceptibility was calculated on the basis of the data obtained from the adult emergence and mean developmental period of the test insect by using the formula suggested by Dobie (1977).

$$I = \frac{LOG_e F}{D} \times 100$$

Where,
I = Index of susceptibility.
F = Total number of adults emerged.
D = Mean developmental period.

Survival rate (%)

Survival rate (%) of the test insect was calculated by using the formula suggested by Howe (1971).

$$\text{Survival rate (\%)} = \frac{\text{Total number of adults emerged}}{\text{Total number of eggs laid}} \times 100$$

Pod damage (%)

The number of damaged pods in each replication was counted after the adults completely stopped emerging from all the treatments and it was converted to per cent pod damage.

$$\text{Pod damage (\%)} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

Weight loss (%)

The initial weight and final weight of the pods was recorded and weight loss due to bruchid infestation was calculated by deducting the final weight from the initial weight and then it was converted to per cent weight loss.

$$\text{Weight loss (\%)} = \frac{\text{Initial weight of the sample - Final weight of the sample}}{\text{Initial weight of the sample}} \times 100$$

The effect of physical and biochemical characters were correlated with different biological characters of *C. serratus*. The data was analysed by completely randomized design with three replications with the help of SPSS, version 24.

RESULTS AND DISCUSSION

Ovipositional preference

The data presented in Table 1 and Table 2 revealed that *C. serratus* exhibited differential preference for oviposition to the test genotypes. The number of eggs laid by the test insect on the groundnut pods of different genotypes varied from 18.33 to 93.67. Significantly, the lower number of eggs were observed on ICGV-00351 (18.33 eggs) and ICGV-02266 (22.50 eggs) whereas the higher number of eggs were recorded on ICGV-15400 (93.67 eggs) and ICGV-15417 (86.67 eggs) and Devi (82.33 eggs).

The genotypes ICGV-00351, ICGV-02266 and ICGV-15412 were least preferred by *C. serratus* for egg laying whereas Devi, ICGV-97115 and ICGV-15416 were most preferred. The results corroborate with the findings of Sakhare *et al.* (2019) who reported that the number of eggs laid by the bruchid on ten different groundnut varieties varied from 81.75 to 105.50.

Adult emergence

The number of adults emerged from different test groundnut genotypes ranged from 11.67 to 77.67 (Table 1). Significantly, minimum number of adult emergence was noticed in the genotypes ICGV-02266 (11.67) and ICGV-00351 (11.67) whereas, the maximum adult emergence was recorded from ICGV-15400 (77.67). The results revealed that the test varieties which were least preferred by the bruchid for egg laying and took longer time to complete its development rendered less adult emergence whereas the varieties where more egg laying occurred recorded more adult emergence. Differential response of adult emergence in different varieties of groundnut pods was also recorded by Rekha *et al.* (2017) and Sakhare *et al.* (2019).

Mean developmental period

The mean developmental period of *C. serratus* observed in the twenty test genotypes ranged from 42.74 to 53.88 days (Table 1). The shortest developmental period of the bruchid was noticed in ICGV-15400 (42.74 days) followed by Devi (43.58 days) whereas it took maximum time to complete the development in ICGV-00351 (53.88 days).The results are in agreement with Sreedhar *et al.* (2020) where they reported that the mean development period of *C. serratus* in different groundnut varieties ranged between 39.00 and 48.67 days. Similarly, differential response of mean development period of *C. serratus* in different varieties of groundnut was also reported by Biradar *et al.* (2021).

Growth index

The growth index of *C. serratus* on different test groundnut genotypes varied from 0.22 to 1.82 (Table 1). Groundnut growth index (0.22) whereas the highest growth index was found with ICGV-15400 (1.82). Biradar *et al.* (2021), who reported growth index on different groundnut genotypes varied from 0.95 to 1.43.

Index of susceptibility

The results pertaining to index of susceptibility of twenty groundnut genotypes to *C. serratus* were presented in Table 1. Out of these genotypes, which were least preferred for egg laying and development exhibited the lowest index of susceptibility whereas varieties more suitable for egg laying and development manifested higher index of

susceptibility. The variety ICGV-00351 had lowest index of susceptibility (4.56) whereas, the highest index of susceptibility was observed in ICGV-15400 (10.18). These results are in agreement with Sreedhar *et al.* (2020) who reported that the susceptible groundnut variety K 1715 recorded the highest index of susceptibility (8.69), whereas resistant varieties *viz.*, Harithandra and K 1809 registered less index of susceptibility (0.08 and 0.33, respectively).

Survival rate (%)

The results pertaining to survival rate of *C. serratus* on different test genotypes were presented in Table 1. Significantly, the least survival rate of the bruchid was observed in ICGV-15398 (51.76%) which was at par with ICGV-02266 (51.85%). The highest survival rate was recorded in highly susceptible variety ICGV-15400 (82.92 %). The results are in accordance with Sreedhar *et al.* (2020) who reported the maximum survival percentage in the susceptible groundnut variety K 1715 (92.80 per cent) and the resistant variety Harithandra recorded the least survival of the insect (38.90 per cent).

Pod damage (%)

The least pod damage was observed in ICGV-15398 (26.84%) which was at par with ICGV-15423 (30.21%). ICGV-15417, Devi and ICGV-15400 recorded cent per cent pod damage (Table 1). These results are in accordance with the findings of Sreedhar *et al.* (2020) and as per their findings pod damage by *C. serratus* was maximum in heavily infested groundnut variety K 1715 (97.33 per cent) and minimum pod damage was found in resistant variety Harithandra (0.08 per cent).

Weight loss (%)

Moderately resistant varieties *viz.*, ICGV-15398, ICGV-15423 and ICGV-15412 which exhibited less oviposition and pod damage also manifested less weight loss (2.98%, 4.27% and 5.64%, respectively) (Table 1). The highest weight loss was noticed in ICGV-15400 (25.16%) which was at par with ICGV-15417 (24.76%) and Devi (21.48%). The results are in conformity withthe findings of Prasad *et al.* (2012) who reported that treatments *viz.*, GG3 and TAG 24 which recorded less number of eggs, adult emergence and less pod damage also resulted inless reduction in weight loss of 9.70 per cent as against the highly preferred groundnut variety ICG (FDRS)10 which recorded a maximum weight loss of 56.70 per cent.

Assessment of physical characters of the test groundnut genotypes

Pod size

The variety ICGV-15404 (43.17 mm) was found with significantly higher pod size whereas small pod size was observed in ICGV-02266 (20.48 mm) (Table 3). The small sized pods were not preferred for egg laying and subsequent development whereas the bold sized pods

Table 1: Biological characters of *C. serratus* in different groundnut genotypes.

Treatment	No. of eggs laid (100 no. of pods)	No. of adults emerged (N)	Mean develop-mental period in days (AV)	Growth Index (N/AV)	Index of susceptibility (IS)	Surv rate (%)	Pod damage (%)	Weight loss (%)
ICGV-15396	34.00 (5.91)	24.00 (5.00)	52.13	0.46	6.10	70.59	51.92	8.38
ICGV-15398	28.33 (5.42)	14.67 (3.96)	53.77	0.27	4.99	51.76	26.84	2.98
ICGV-15400	93.67 (9.73)	77.67 (8.87)	42.74	1.82	10.18	82.92	100.00	25.16
ICGV-15404	46.00 (6.86)	34.33 (5.94)	50.88	0.67	6.95	74.64	54.97	7.31
ICGV-15412	23.33 (4.93)	14.33 (3.91)	53.87	0.27	4.94	61.43	40.47	5.64
ICGV-15416	71.33 (8.50)	56.33 (7.57)	45.32	1.24	8.90	78.97	63.97	13.27
ICGV-15417	86.67 (9.36)	66.67 (8.23)	44.04	1.51	9.54	76.92	100.00	24.76
ICGV-15421	48.67 (7.05)	36.33 (6.11)	49.16	0.74	7.31	74.66	56.80	12.38
ICGV-15423	25.00 (5.10)	14.00 (3.87)	53.44	0.26	4.85	56.00	30.21	4.27
ICGV-15424	41.33 (6.51)	31.00 (5.66)	50.91	0.61	6.75	75.00	37.70	6.57
ICGV-15425	52.67 (7.33)	37.67 (6.22)	47.32	0.80	7.67	71.52	95.57	21.22
ICGV-15432	59.00 (7.75)	48.67 (7.05)	46.88	1.04	8.29	82.49	83.96	19.76
ICGV-97115	74.67 (8.70)	56.33 (7.57)	44.65	1.26	6.75	75.45	79.91	23.34
ICGV-06423	36.33 (6.11)	27.00 (5.29)	51.38	0.53	6.41	74.31	74.63	17.41
ICGV-00350	28.33 (5.42)	20.33 (4.62)	52.30	0.39	7.71	71.76	52.76	8.23
ICGV-00351	18.33 (4.40)	11.67 (3.56)	53.88	0.22	4.56	63.64	45.07	6.67
ICGV-07220	49.00 (7.07)	40.33 (6.43)	50.43	0.80	7.33	82.31	60.38	12.73
ICGV-02266	22.50 (4.76)	11.67 (3.56)	53.36	0.22	4.60	51.85	49.67	10.01
Smruti	60.67 (7.85)	46.00 (6.86)	46.83	0.98	8.18	75.82	98.63	19.79
Devi	82.33 (9.13)	63.33 (8.02)	43.58	1.45	9.52	76.92	100.00	21.48
SE(m) ±	0.072	0.087	0.081	0.032	0.121	2.110	1.323	1.350
CD (P=0.05)	0.21	0.25	0.24	0.10	0.36	6.05	3.80	3.87

Figures in parentheses are square root transformed values.

possessed by ICGV-15400, ICGV-15404 were comparatively more preferred by the beetle for feeding and oviposition. According to Sreedhar *et al.* (2020) groundnut genotypes having bruchid infestation were in positive relation with length and width of the pods.

Pod weight

The lowest pod weight was recorded in ICGV-02266 (79.22 g) (Table 3). Similarly, the highest pod weight was observed in ICGV- 15400 (112.32 g) followed by ICGV- 15396 (102.27 g). The genotypes having higher pod weight were susceptible, promoting the development of bruchid as it derived more food and nutrition for its growth. The results corroborate with the findings of Rekha *et al.* (2017) recorded groundnut genotypes with less pod weight of 0.83 g per pod exhibited resistance reaction against *C. serratus*.

Shell thickness of pods

The shell thickness of groundnut pods of the test genotypes ranged from 0.74 to 1.57 mm. The highest shell thickness was observed in the variety ICGV-00351 (1.57 mm) whereas ICGV-15400 (0.74 mm) recorded the least shell thickness which was at par with ICGV- 15432 (Table 3). The genotypes with higher pod shell thickness considered as resistant factor against the bruchid and less infestation was noticed as it was difficult for the insect to enter and feed inside the pods whereas the genotypes with minimum shell thickness were more prone to bruchid infestation (Sreedhar *et al.,* 2020).

Table 2: Correlation coefficients between the physico-chemical characters of groundnut pods of the test varieties and the biological characters of *C. serratus*.

Biological characters → Physical and biochemical characters ↓	No. of eggs laid	No. of adults emerged	Mean developmental period	Index of susceptibility	Growth index	Pod damage (%)	Weight loss (%)	Survival rate (%)
Pod size	0.48*	0.42	-0.29	0.44*	0.46*	0.49*	0.45*	0.41
Weight of 100 pods	0.34	0.37	-0.27	0.34	0.37	0.47*	0.46*	0.29
Shell thickness	-0.69**	-0.69**	0.54*	-0.63**	-0.61**	-0.68**	-0.67**	-0.52*
Inter-granular space	0.23	0.25	-0.15	0.35	0.24	0.13	-0.14	0.40
Protein (%)	0.84**	0.86**	-0.86**	0.95**	0.85**	0.83**	0.78**	0.84**
Fibre (%)	-0.82**	-0.83**	0.84**	-0.91**	-0.83**	-0.77**	-0.75**	-0.70**
Ash (%)	-0.79**	-0.81**	0.79**	-0.92**	-0.80**	-0.77**	-0.71**	-0.80**
Phenol content	-0.63**	-0.64**	0.65**	-0.71**	-0.66**	-0.65**	-0.67**	-0.66**

*Significant at 5% level, **Significant at 1% level.

Table 3: Physical characters analysed in the groundnut genotypes.

Treatment	Pod size (mm)	Weight of 100 pods (g)	Shell thickness (mm)	Inter-granular space (cc)
ICGV-15396	35.83	102.27	1.28	54.67
ICGV-15398	28.27	91.54	1.41	53.34
ICGV-15400	39.41	112.32	0.74	57.76
ICGV-15404	43.17	97.67	1.41	59.19
ICGV-15412	24.83	84.53	0.86	48.87
ICGV-15416	30.08	89.02	1.32	52.68
ICGV-15417	34.67	94.23	1.37	54.14
ICGV-15421	25.71	81.55	1.12	49.27
ICGV-15423	26.33	93.45	1.18	50.58
ICGV-15424	27.77	94.81	1.03	52.23
ICGV-15425	28.50	93.23	1.10	51.84
ICGV-15432	27.45	90.12	0.81	50.41
ICGV-97115	25.82	85.27	0.88	48.32
ICGV-06423	30.15	80.35	0.95	53.82
ICGV-00350	37.64	101.31	0.91	60.24
ICGV-00351	21.27	85.88	1.57	47.37
ICGV-07220	29.87	92.29	0.86	51.25
ICGV-02266	20.48	79.22	1.07	46.26
Smruti	24.11	88.58	0.91	49.44
Devi	25.34	83.47	0.97	48.33
SE(m) ±	0.480	0.843	0.046	0.286
CD(P=0.05)	1.44	2.53	0.14	0.86

Inter granular space between pods (cc)

Among the twenty groundnut genotypes, the lowest inter granular space was recorded in ICGV-02266 (46.26 cc) whereas, the highest was noticed in ICGV-00350 (60.24 cc) (Table 3). The genotypes having high inter granular spaces were susceptible to bruchid attack as they promoted easy mobility of the test insect whereas the genotypes with less inter granular spaces offered resistance to bruchid. The results are in line with the findings of Manjunath *et al.* (2020) who reported that less inter granular space was found with least susceptible groundnut varieties.

Assessment of biochemical characters of groundnut test genotypes

Protein content

The data presented in Table 4 revealed that among the different genotypes, the highest protein content was observed in highly susceptible variety ICGV-15400 (25.80 per cent). The lowest protein content was recorded in moderately resistant variety ICGV-15398 (22.18 per cent). The genotypes with higher protein content were more preferred by the bruchid as higher amount of protein supplemented its growth and development, whereas less protein content was recorded in moderately resistant genotypes which were comparatively less preferred by the test insect. Lower protein content might have acted as ovipositional deterrents leading to less egg laying. The results are in concurrence with Sreedhar *et al.* (2020) revealed that cultivars with lower protein content had a lower level of damage.

Fibre content

The highest fibre content was recorded in moderately resistant varieties *viz.,* ICGV-00351 (2.68%) which was at par with other moderately resistant varieties *viz*., ICGV-15398 (2.65%), whereas the lowest fibre content was recorded in susceptible variety ICGV-15417 (2.12%) which was at par with ICGV-15416 (2.18%) (Table 4). High fibre content found in moderately resistant varieties might interfere with the feeding and oviposition by the bruchid rendering it unsuitable for survival and development. The results are in accordance with Jyothsna (2014). She reported high percentage of crude fibre in moderately resistant varieties *viz*., K9 (2.72%) and ICGV86015 (2.70%) and these varieties were comparatively less preferred by the bruchid.

Ash content

The highest ash content was noticed in moderately resistant variety ICGV-02266 (0.34%) while the lowest ash content was recorded in the highly susceptible variety ICGV-15400 (0.19%) (Table 4). High ash content in the kernels might leave some toxic effect on the test insect and also injure digestive as well as respiratory organs. This might

Table 4: Biochemical parameters analysed in groundnut varieties before infestation.

Treatments	Biochemical parameters analysed before infestation			
	Protein (%)	Fibre (%)	Ash (%)	Phenol (mg/100 g fw)
ICGV-15396	23.74	2.58	0.30	579.45
ICGV-15398	22.18	2.65	0.31	612.34
ICGV-15400	25.80	2.24	0.19	530.58
ICGV-15404	23.94	2.54	0.25	587.32
ICGV-15412	23.28	2.50	0.30	548.78
ICGV-15416	24.97	2.18	0.20	541.25
ICGV-15417	25.54	2.12	0.21	518.75
ICGV-15421	24.65	2.42	0.25	548.24
ICGV-15423	22.77	2.61	0.31	614.75
ICGV-15424	23.85	2.56	0.28	536.24
ICGV-15425	24.75	2.39	0.23	530.65
ICGV-15432	24.89	2.28	0.26	594.12
ICGV-97115	24.18	2.44	0.27	579.12
ICGV-06423	23.53	2.52	0.22	518.09
ICGV-00350	24.75	2.35	0.24	548.78
ICGV-00351	22.53	2.68	0.33	612.74
ICGV-07220	24.44	2.48	0.24	594.12
ICGV-02266	22.96	2.62	0.34	587.27
Smruti	25.30	2.27	0.22	541.25
Devi	25.08	2.33	0.21	548.24
SE(m) ±	0.037	0.071	0.021	0.763
CD (P=0.05)	0.11	0.20	0.06	2.29

fw- fresh weight.

also play an important role in delaying the developmental period of the bruchid by interfering with digestion and making it a non-preferred host for development and provide unfavourable conditions for feeding, growth and development (Nagaswathi, 2014).

Phenol content

The phenol content of the moderately resistant genotypes ICGV-15423 (614.75 mg/100 g fw) was maximum whereas less phenol content was found in the susceptible genotypes ICGV-15400 (530.58 mg/100 g fw) (Table 4). The observations on higher amount of phenol content in resistant genotypes is in agreement with Sreedhar *et al.* (2020) who reported that varieties having high phenol content imparted resistance to *C. serratus* where as low phenol content in kernels contributed to susceptibility.

Correlation study between physical and biochemical characters of groundnut varieties and the biological characters of groundnut bruchid

Among the different physical characters of groundnut varieties, pod size exhibited significant positive relation with number of eggs laid (0.48), index of susceptibility (0.44), growth index (0.46), pod damage (0.49) and weight loss (0.45) while non-significant positive relation with number of adults emerged (0.42), survival rate (0.41) and non-significant negative relation with mean developmental period (-0.29) (Table 4). Pod weight showed significant positive relation with pod damage(0.47), pod weight loss(0.46) whereas positive non-significant relation with number of eggs laid (0.34), number of adults emerged (0.37), index of susceptibility (0.34) and survival rate (0.29) and non-significant negative relation with mean developmental period (-0.27). Shell thickness of groundnut genotypes showed negative significant relationship with number of eggs laid (-0.69), number of adults emerged (-0.69), index of susceptibility (-0.63), growth index (-0.61), pod damage (-0.68), weight loss (-0.67) and survival rate (-0.52) whereas positive significant relation with mean developmental period (0.54). Results were in line with Jyothsna (2014) who reported that weight of 100 pods (0.47) showed significant positive relation with pod damage.

Protein content of the test varieties showed significant positive relation with the number of eggs laid (0.84), adult emergence (0.86), index of susceptibility (0.95), growth index (0.85), pod damage (0.83), weight loss (0.78) and survival rate (0.84), whereas it exhibited negative significant relation with mean developmental period (-0.86). The fibre content of the varieties had a significant negative influence on number of eggs laid (-0.82), number of adults emerged (-0.83), index of susceptibility (-0.91), growth index (-0.83), pod damage (-0.77), weight loss (-0.75) and survival rate (-0.70) while, significant positive relation was obtained between the fibre content of test varieties and mean developmental period (0.84). The ash content of the genotypes showed significant and negative correlation with number of eggs laid (-0.79), number of adults emerged (-0.81), Index of susceptibility (-0.92), growth index (-0.80), pod damage (-0.77), weight loss (-0.71) and survival rate (-0.80) whereas, the ash content had a positive significant relation with mean developmental period (0.79). The phenol content of the test genotypes significantly and negatively influenced the number of eggs laid (-0.63), number of adults emerged (-0.64), index of susceptibility (-0.71), growth index (-0.66), pod damage (-0.65), weight loss (-0.67) and survival rate (-0.66) while its relation with developmental period (0.65) was positive and significant. These results are more and less similar with the finding of Sreedhar *et al.* (2020).

The bold sized pods, higher pod weight, lesser shell thickness and more inter granular space between pods were in positive relation with bruchid infestation as these characters are favourable for its growth and development. Likewise, groundnut genotypes having higher protein content and lesser fibre, ash and phenol content showed positive relation to bruchid infestation.

CONCLUSION

It was concluded from the results of the present studies that pod size and pod weight contributed towards susceptibility whereas shell thickness contributed to resistance. Small pod size, less pod weight and more shell thickness attributed for resistance to *C. serratus* resulting in least percentage pod damage and weight loss. Similarly groundnut varieties with lower protein content and higher phenol, fiber and ash content conferred resistance against the test insect.

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Authors' contribution

Rashmirekha Singh: Data curation investigation and original drafts preparation, Prabhat Ranjan Mishra: Supervision, Formal analysis, review editing, Kamal Ravi Sharma: Drafts preparation, Formal analysis, review editing, Satyabrata Mangaraj, Deepak Kumar Behera, Sameer Kumar Singh: Drafts preparation and editing.

Conflict of interest

On behalf of all the authors, I wish to confirm that there is no conflict of interest in the publication of this manuscript.

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