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Effect of genotypes of sorghum seed on population growth of rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae)

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Abstract
The investigation was conducted to evaluate the effect of twenty three sorghum genotypes on population growth of rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) under laboratory condition during 2016-2017. Among the tested genotypes, less ovipositional preference (3.00 to 5.00 eggs/100 seeds) by *S. oryzae* to small to medium size seeds with higher incubation period (6.33 to 5.67 days/100 seeds), less corneousness score (1.23 to 2.17), maximum hardness of seed (9.17 to 7.89 kg/seed), less percent adult emergence (5.00 to 10.00 %) and maximum developmental period (38.67 to 34.13 days) with less growth index (0.05 to 0.16) were recorded in the genotypes *viz*., IS 2305, IS 2205, M 35-1 and IS 18551. It indicated that the minimum growth index in least preferred varieties in which *S. oryzae* have longer developmental period and maximum growth index in most preferred varieties of sorghum.
As regards the correlation coefficient studies, the seed corneousness was significantly positively correlated with eggs laid by female weevil (r= 0.721**), adult emergence (r= 0.638**) and growth index (r= 0.725**) and it was significantly negatively correlated with the incubation period (r= -0.672**), larval-pupal period and adult developmental period (r= -0.746**). Adult emergence was found positively correlated with growth index (r= 0.937**) and negatively correlated with incubation period (r= -0.974**) and adult developmental period (r= -0.865**). Adult developmental period was significantly negatively correlated with number of eggs (r= -0.923**) and growth index (r= -0.951**). Growth index was significantly positively correlated with number of eggs laid (r= 0.971**) and it was significantly negatively correlated with incubation period (r= -0.956**).

Keywords: Screening, sorghum seed, rice weevil

Introduction
Sorghum, *Sorghum bicolor* (Linnaeus), is known as ‘Jowar’ in India and ‘Milo’ in the Central United States. Sorghum has a multiple uses as food, feed, fodder and fuel.It has an excellent source of energy, containing about 75% complex carbohydrate, iron, zinc and is rich in vitamin ‘B’ complex. Storage insect pests are one of the obstacles to reduce the quantity as well as quality of the sorghum during storage. Out of store grain pests, rice weevil, *Sitophilus oryzae* (Linnaeus.) is most destructive insect pest of the stored raw cereal grains in the world (Champ and Dyte, 1976) [5]. This species has a relatively short developmental period and high populations can easily be built up. Thus, unless control measures are taken, the losses of grains due to weevils are estimated to an average of 25 to 40 percent after 100 days of storage (Ladang *et al.*, 2008) [11]. It causes substantial losses to stored grain amounting 18.30 percent (Adams, 1976) [1]. Keeping the above facts in view, the investigations were carried out to study the biology of rice weevil reared on different sorghum genotypes which are necessary to have thorough understanding of the situation favourable to the pest and to know the weak links which should be taken advantage for the effective management of the pest.

Material and methods
Five hundred grams seed of twenty three genotypes of sorghum were procured from All India Co-ordinated Sorghum Improvement Project, MPKV, Rahuri and were cleaned for studied conducted on biology of rice weevil reared on seeds each genotype for their morpho-physical bases of resistance as per the standard methods.

A) Morpho-physical characters

a. Seed colour

Seed coat colour of sorghum genotype was recorded with the help of Methuen Hand book of colour(Kornerup and Wanscher, 1978) [10].

b. Seed size

Seed size was taken by visual observation as small, medium and bold sized seed.

c. Hardness of seed

Hardness of the seed was recorded with the help of Tablet Hardness Tester developed by Indian Equipment Corporation. Ten seeds were randomly selected from each entry for testing this character. Hardness of the seed was tested by putting the individual seed in Tablet Hardness Tester, wherein the pressure is applied on the seed gradually till it breaks with cracking sound. The reading (pressure applied in kg) was noted and average of pressure applied was calculated.

d. Seed corneousness

Seed corneousness score of the entry was calculated and rated as 1. Completely corneous, 2.Almost corneous, 3.Moderately corneous, 4.Moderately starchy and 5. Almost starchy as method suggested by House (1980) [8].

e. Hundred seeds weight

The samples of hundred seeds was taken from each genotype and weighed out with the help of mono pan micro analytical balance.

B) Biology of rice weevil

a. Rice weevil culture

The culture of rice weevil, *Sitophilus oryzae* was obtained from Seed Technology Research Unit, MPKV Rahuri and the culture was further maintained in jars.

b. Rearing of rice weevil

The rice weevil culture obtained from the infested sorghum seeds was introduced and multiplied on disinfested susceptible genotype Phule Yashoda in 28 x 18 cm rearing jars to obtain similar aged weevils for the experiment. After the new adult emergence, the weevils were introduced into sorghum seeds kept in series of cylindrical jars for building up a homogenous population and jars were placed in the rearing cage at a temperature of 30 ^{0}C and relative humidity of 75%. Singh *et al*. (1974) [17] reported that oviposition and development was best of rice weevil at 75% relative humidity. To initiate the culture, healthy seed of sorghum was kept into cylindrical jars and ten pairs of adult weevils were isolated and released into jars. Density of population per jar was standardized to prevent overcrowding which was reported to give rise to less reproductive active forms. Such conditioning was deemed necessary to prevent short term changes in insect behaviour or biology associated with changes in host grain (Dobie, 1974) [6].

c. Biology of *S. oryzae*

Hundred healthy and sound seeds from each of the twenty three genotypes were counted and transferred to plastic containers of 150 g capacity for biology study. Thirty adults (1 day old) of *S. oryzae* from maintained culture were transferred in plastic containers. The containers were covered with the pieces of muslin cloth, fastened with rubber bands and kept in laboratory at room temperature. The insects were placed for one week to lay eggs. After one week, insects were removed and discarded.

Development from egg to pupa is within the seed. The female creates cavities in the seed, inserts small white eggs into them and seals it with glue called egg plug. The egg plugs can be detected by staining the seed with acid fuschin as they are invisible under normal observation. The stain was prepared by mixing 50 ml glacial acetic acid in 950 ml of distilled water and adding 0.5 g acid fuschin. The egg plugs of weevils are stained bright cherry red and feeding punctures including mechanical injuries in light pink (Sharifi, 1972) [18]. The seeds were stained using acid fuschin to expose egg plugs and dried on tissue paper for 12 hours before examination. Above set with 100 seeds after staining was kept as such and the seeds were observed daily upto 80 days as suggested by Borikar and Tayade (1979) [4] for emergence of adults in sorghum. The observations were recorded on number of progeny adults emergence, number of eggs laid per 100 seeds and the period required for incubation, total larval-pupal, Average developmental period. Growth index was worked out by using following formula.

$$\text{Growth Index} = \frac{\text{Percent adult emergence}}{\text{Average developmental period in days}}$$

Statistical analysis

The data was transformed to arc sin values wherever necessary. The different parameters were correlated with each other by applying the method of simple correlation coefficient (r) suggested by Snedecor and Cochran (1967) [19]. Wherever the results were significant, the critical difference at 5 and 1 percent level of significance was calculated.

Results and discussion

The results of present investigations on morphological characteristics of sorghum seed and biological parameters of rice weevil and also their correlation coefficient are studied as under.

A) Morphological character of seeds

The morphological characteristics of seeds of twenty three different sorghum genotypes were categorized into seed colour, seed size, seed corneousness, seed hardness and 100 seeds weight was recorded of each genotype. The data on seed characters are presented in Table 1.

a. Seed colour

Out of twenty three genotypes, twenty one genotypes had white shades in their colour. Shades of white colour ranged from pearl white to white chalky, cream white, yellowish white, light yellow and two genotypes i.e. Phule Rohini and Phule Uttara were dark red and dull red; respectively. It was observed that least preferred genotypes *viz*., IS 2312, IS 2205 and IS 18551, showed creamy white and M 35-1 and SSV 84 showed pearly white and white colour shades of seeds, respectively. Most preferred genotypes *viz*., Phule Maulee, Phule Chitra and Phule Suchitra showed pearly white and Phule Madhur and Phule Panchami showed pale green and white chalky, respectively. These results are found similar with Bhoge (2010) [3] who reported that most preferred germplasms *viz*., RSLG-611, RSLG-704, RSLG-737, RSLG-756 and CSH-15R showed pale yellow, yellowish white, yellowish white and yellowish white, respectively and the least preferred by *S. oryzae* i.e. RSLG-743, RSLG-755,

RSLG-779, RSLG-848, M-35-1 showed cream, light yellow, pale yellow and cream colour shades of the seed, respectively.

b. Seed size

Seed size of tested genotypes was grouped into three categories i.e. bold, medium and small. Out of 23 genotypes, 7 genotypes *viz*., Phule Vasudha, Phule Anuradha, Phule Suchitra, Phule Godhan, RSE 03, SSV 84 and ICSV 745 showed bold size seeds. Medium seed size was observed in Phule Yashoda, Phule Chitra, Phule Maulee, Phule Rohini, Phule Revati, Phule Panchami, Phule Madhur, Phule Uttara, Phule Amruta, Phule Vasundhara, CSV 19SS, CSV 22, IS 2312 and M 35-1. The genotypes IS 18551 and IS 2205 had shown small seeds. These results are found similar with the result of Bhoge (2010) [3] who reported M35-1, Phule Maulee, Phule Swati, Phule Chitra and Phule Yashoda have medium size seed. Result shows that *S. oryzae* preferred medium and bold size seed and least preferred for small size seeds which is confirmed with the result of Russell (1962) [15] who reported least ovipositional preference to smaller seeds by *S. oryzae*.

c. Hundred seed weight

The hundred seeds weight of different sorghum genotypes ranged from 2.17 to 4.32g. The maximum hundred seed weight was observed in Phule Vasudha (4.32 g) which was at par with Phule Suchitra (4.31 g) and Phule Anuradha (4.13 g). The minimum hundred seed weight of seed was observed in IS 2205 (2.17 g) and it was at par with IS 18551 (2.24 g). Bhoge (2010) [3] reported that the hundred seed weight of sorghum ranged from 2.88 to 4.29 g.

d. Hardness of seed

The significantly maximum (12.06 kg/seed) seed hardness was recorded in the genotype Phule Uttara followed by CSV 19 SS (9.39 kg/seed), SSV 84 (9.28 kg/ seed) and IS 2205 (9.17 kg/seed), whereas, Phule Madhur resulted significantly less hardness (4.89 kg/seed) followed by Phule Godhan (7.11 kg/seed). The seed hardness in rest of the genotypes ranged between 7.89 to 9.39 kg/seed. Bhoge (2010) [3] reported that the seed hardness in different germplasms ranged from 5.70 to 11.51 kg/seed and Subbarayudu *et al.* (2013) [20] recorded the hundred weight of sorghum cultivars ranged from 12.00 to 35.9 kg/cm^2. Ladang *et al.* (2008) [11] who reported that seed hardness was found to be overall factor responsible for resistance to *S. oryzae.*

e. Seed corneousness

The seed corneousness score in different genotypes of sorghum ranged from 1.23 to 3.80. The highest seed corneousness score (3.80) was recorded in Phule Madhur followed by Phule Rohini (3.53), RSE 03 (3.50) and CSV 22 (3.43). The lowest corneousness score was recorded in IS 2312 (1.23) followed by M 35-1 (1.30), IS 2205 (1.80) and IS 18551 (2.17). The seed corneousness of the rest of the genotypes was recorded in between 2.20 and 3.30. These findings are found close to the results of Bhoge (2010) [3] who reported seed corneousness score in different germplasms of sorghum ranged from 1.1 to 4.9. The results revealed that genotypes which had completely or almost corneous endosperm were more susceptible to the attack by rice weevil, *S. oryzae.*

Influence of rice weevil reared on seeds of different sorghum genotypes

Adults of rice weevil were reared on different seed size and colour of sorghum genotypes for their host preference and the observations were recorded on number of eggs laid per 100 seeds, incubation period, larval-pupal period, adult emergence, developmental period and growth index. The results are presented in Table 2.

a. Ovipositional preference

The data on the ovipositional preference indicated that the weevils showed marked variation for oviposition in all sorghum genotypes. The adult female laid eggs on different genotypes recorded in the range of 3.00 to 28.00 eggs per 100 seeds. However, among the genotypes tested, IS 2312 was less preferred (3.00 eggs/100 seeds) for oviposition followed by IS 2205 and IS 18851 (4.00 eggs/100 seeds) and M 35-1 (5.00 eggs/100 seeds). These findings are similar with the results of Reddy *et al.* (2002) [14] who reported that greater levels of antixenosis for oviposition on genotype M 35-1 and IS 2312 and also Russell (1962) [15] reported that least ovipositional preference to smaller seeds by *S. oryzae*. Whereas, genotype Phule Maulee was recorded highest number of eggs (28.00 eggs/100 seeds) and it was statistically at par with Phule Madhur (26.00 eggs/100 seeds), Phule Chitra (23.00 eggs/100 seeds), Phule Vasudha (19.00 eggs/100 seeds), Phule Suchitra (23.00 eggs/100 seeds), Phule Panchami and Phule Godhan (20.00 eggs/100 seeds). The eggs laid by female in rest of the genotypes ranged from 13.00 and 15.00 eggs/100seeds. Subbarayudu *et al*. (2013) [20] reported maximum eggs laid in genotypes of CSH 14 (39.1), CSH 13 (39.1) and NSS 104 (38.6) indicating maximum susceptible to *S. oryzae*.

These results showed that more the eggs laid more the adult emerged and more the damaged. The variability in the rate of oviposition in different genotypes may be due to different degrees of antixenosis for oviposition. These results amply support findings reported earlier workers (Russell, 1962 and Adetunji, 1988) [15].

b. Incubation period

It was observed that there was variation in incubation period, the highest incubation period was observed in IS 2312 and IS 2205 (6.33) followed by M 35-1 (6.00 days), IS 18551 (5.67 days), CSV 19 SS (5.67 days), SSV 84 (5.33 days), CSV 22 (5.33 days) and ICSV 745 (5.33 days). The least incubation period was observed in Phule Maulee and Phule Madhur (3.00 days) followed by Phule Chitra (3.67 days), Phule Panchami and Phule Suchitra (4.00 days). It was ranged from 4.33 to 5.00 days in rest of the genotypes. The variability in the incubation period was due to differential degrees of antixenosis and antibiosis.

c. Larval-pupal period

The results on larval-pupal period of rice weevil in different genotypes of sorghum ranged from 31.00 in Phule Maulee to 43.00 in IS 2205 and IS 2312. There was significant relationship found in between morphological characters of seed with the larval-pupal period. Jadhav (2006) [9] reported that rice weevil on pop sorghum seed variety Talakal-6 revealed that the larval and pupal period of 25.8 ± 3.70 and 7.4 ± 0.54 days, respectively. The larval-pupal period was observed more in less preferred seed for oviposition.

d. Adult emergence

The data on percent adult emergence indicated that there was also marked variation (5.00 to 27.00%) in adult emergence of *S. oryzae* in different sorghum genotypes. The percent adult emergence was significant less observed in IS 2312 (5.00 %)

which was found statistical at par with IS 2205 (6.00 %), M 35-1 (7.00 %) and IS 18551 (8.00 %), CSV 19SS (9.00%), SSV 84 and ICSV 745 (10.00 %). The highest adult emergence was observed in Phule Maulee (27.00 %) followed by Phule Madhur (25.00 %), Phule Chitra (22.00 %) and Phule Suchitra (21.00 %). The adult emerged in rest of the genotypes ranged from 11.00 to 18.00 percent. The results revealed that smaller the seed lesser the egg laid and less the adult emerged which is confirmed by the Russell (1962) [15] who reported that smaller the seeds, the shorter and lighter were the weevils that emerged. The mortality of adult weevils feeding on seed samples in no choice tests can be attributed either to high levels of antixenosis for feeding and it also confirmed by the earlier study conducted by Reddy *et al.* (2002) [14] and Adetunji (1988) [2].

e. Developmental period

The observations was pertaining to average developmental period required for the emergence of adult from different genotypes of sorghum indicated that there was much variation in total number of days required for emergence of adult in the tested genotypes. The average total number of days required to complete the life cycle ranged from 27.13 to 38.67 days. The least developmental period was observed in 27.13 days in Phule Maulee which was at par with Phule Madhur (28.10 days), Phule Chitra (28.30 days), Phule Suchitra (28.53 days), Phule Panchami (28.73 days), Phule Vasudha (28.80 days) and Phule Vasundhara (29.10 days). The maximum developmental period was observed in IS 2312 (38.67 days) and it was significantly at par with IS 2205 (38.60 days) followed by M 35-1 (36.40 days) and IS 18551 (34.13 days). The developmental period in other of the genotypes ranged from 29.30 to 33.33 days.

Genotype in which developmental period was longer than the rest of the genotype was not favourable for the growth and development of *S. oryzae.* The fewer eggs laid, longer average larval-pupal period and developmental period of sorghum genotypes indicated clear evidence of non-preference and antibiosis as consequences of resistance of sorghum genotype. Results are in conformity with Adetunji (1988) [2] indicating that one effect of resistance is a prolongation of the developmental period of *S. oryzae* on different cultivars of sorghum. It can be concluded that if resistant sorghum varieties extend the developmental period and because a high mortality of the developing *S. oryzae*, the post-harvest loss incurred during storage of farm produce will be greatly minimized.

f. Growth index

The growth index ranged from 0.05 to 1.02 in different genotypes of sorghum. Phule Maulee proved to be most nutritious to *S. oryzae* recorded high (1.02) growth index followed by Phule Madhur (0.98), Phule Chitra (0.84), Phule Suchitra (0.82) and Phule Panchami (0.79). The least nutritious genotype was IS 2312 which was recorded 0.05 growth index followed by IS 2205 (0.06), M 35-1 (0.07) and IS 18551 (0.16). These findings are similar with the result of Bhoge (2010) [3] who reported growth index ranged from 0.06 to 1.28.

The result reveals that sorghum genotypes having maximum developmental period provided minimum growth index and varieties having minimum developmental period provided maximum growth index. The results are in conformity with Gupta *et al*. (1999) [7] who observed minimum growth index in least preferred varieties in which *S. oryzae* have longer developmental period and maximum growth index in most preferred varieties of maize.

C) Correlation coefficient 'r' between seed characters and biological parameters of rice weevil

The data on correlation coefficient 'r' between seed characters and biological parameters of rice weevil are presented in Table 3, it was observed that the seed corneousness was significantly positively correlated with eggs laid by female weevil (r= 0.721**), adult emergence (r= 0.638**) and growth index (r= 0.725**) and it was significantly negatively correlated with the incubation period (r= -0.672**), larval-pupal period and adult developmental period (r= -0.746**). Russell (1966) [16] reported that a short adult life with increasing hardness of grains of sorghum to reaction of rice weevil. Borikar and Tayade (1979) [4] revealed that developmental period of the weevil showed no significant differences. Adetunji (1988) [2] found that developmental period were significantly longer in resistant than in susceptible cultivars. There was a significant positive linear relationship between developmental periods and larval mortality due to antibiosis.

Adult emergence was found positively correlated with growth index (r= 0.937**) and negatively correlated with incubation period (r= -0.974**) and adult developmental period (r= -0.865**). These results are confirmed by Wongo (1990) [21] who reported larger seeds produce larger insects. Adult developmental period was significantly negatively correlated with number of eggs (r= -0.923**) and growth index (r= -0.951**). Ramalho *et al*. (1977) [13] found no significant differences in number of adult weevils emerging from different sorghum seeds but found development period differed significantly. Growth index was significantly positively correlated with number of eggs laid (r= 0.971**) and it was significantly negatively correlated with incubation period (r= -0.956**). Pradeep *et al.* (2015) [12] reported that the grain hardness was significantly negatively correlated with oviposition, adult emergence and grain weight loss and was significantly positively correlated with median development period of *S. oryzae*.

Table 1: Morpho-physical characteristics of seeds of different sorghum genotypes

Sr. No.	Genotypes	Seed colour	Seed size	100 seed Weight (g)	Seed hardness (kg/seed)	Seed corneousness
1	Phule Yashoda	Pearly White	Medium	3.83	8.55	3.20
2	Phule Chitra	Pearly White	Medium	3.58	8.22	3.30
3	Phule Maulee	Pearly White	Medium	3.76	9.05	3.13
4	Phule Vasudha	Pearly White	Bold	4.32	8.05	2.50
5	Phule Anuradha	Pearl White	Bold	4.13	8.89	2.40
6	Phule Suchitra	Pearl White	Bold	4.31	7.89	2.87
7	Phule Rohini	Dark Red	Medium	2.46	8.77	3.53
8	Phule Revati	Pearl White	Medium	3.91	8.39	3.17
9	Phule Panchami	White Chalky	Medium	2.41	8.72	2.70

10	Phule Madhur	Pale Green	Medium	2.71	4.89	3.80
11	PhuleUttara	Dull Red	Medium	2.40	12.06	2.20
12	Phule Godhan	White	Bold	3.71	7.11	3.27
13	Phule Amruta	Pearly White	Medium	3.38	8.22	3.10
14	Phule Vasundhara	Light Yellow	Medium	3.82	8.06	2.40
15	RSE 03	Yellowish White	Bold	3.65	7.94	3.50
16	CSV 19SS	White	Medium	3.34	9.39	2.50
17	CSV 22	Yellowish White	Medium	3.94	8.61	3.43
18	IS 18551	Creamy White	Small	2.24	8.72	2.17
19	IS 2205	Creamy White	Small	2.17	9.17	1.80
20	IS 2312	Cream White	Medium	2.86	7.89	1.23
21	SSV 84	White	Bold	3.52	9.28	2.60
22	ICSV 745	Pale Yellow	Bold	3.09	8.44	2.60
23	M 35-1	Pearly White	Medium	4.05	8.67	1.30
S.E.±				0.07	0.08	0.05
C.D. at 5%				0.20	0.23	0.14
CV (%)				3.62	1.64	3.21

Table 2: Biological parameters of rice weevil reared on seeds of different sorghum genotypes

Sr. No.	Genotypes	No. of eggs laid/100 seeds	Incubation period (Days)	Total larval-pupal period (Days)	Adult emergence (%)	Development period (Days)	Growth index
1	Phule Yashoda	16.00	5.00	34.00	15.00 (22.77)*	30.20	0.62
2	Phule Chitra	23.00	3.67	32.00	22.00 (27.95)	28.30	0.84
3	Phule Maulee	28.00	3.00	31.00	27.00 (31.28)	27.13	1.02
4	Phule Vasudha	19.00	4.33	33.00	18.00 (25.09)	28.80	0.77
5	Phule Anuradha	17.00	5.00	34.00	14.00 (21.93)	30.80	0.60
6	Phule Suchitra	23.00	4.00	32.00	21.00 (27.25)	28.53	0.82
7	Phule Rohini	14.00	5.00	34.00	14.00 (21.96)	30.13	0.64
8	Phule Revati	17.00	4.67	34.00	15.00 (22.77)	29.43	0.68
9	Phule Panchami	20.00	4.00	32.00	18.00 (25.05)	28.73	0.79
10	Phule Madhur	26.00	3.00	32.00	25.00 (29.98)	28.10	0.98
11	Phule Uttara	15.00	5.00	35.00	11.00 (19.33)	30.57	0.45
12	Phule Godhan	20.00	4.33	33.00	14.00 (21.96)	29.30	0.73
13	Phule Amruta	15.00	5.00	34.00	12.00 (20.23)	30.87	0.57
14	Phule Vasundhara	18.00	4.33	33.00	16.00 (23.56)	29.10	0.73
15	RSE 03	19.00	4.67	33.00	13.00 (21.09)	29.40	0.70
16	CSV 19SS	8.00	5.67	37.00	9.00 (17.45)	32.57	0.23
17	CSV 22	13.00	5.33	36.00	11.00 (19.35)	33.20	0.31
18	IS 18551	4.00	5.67	42.00	8.00 (16.40)	34.13	0.16
19	IS 2205	4.00	6.33	43.00	6.00 (14.14)	38.60	0.06
20	IS 2312	3.00	6.33	43.00	5.00 (12.87)	38.67	0.05
21	SSV 84	12.00	5.33	37.00	10.00 (18.41)	33.33	0.29
22	ICSV 745	15.00	5.33	35.00	10.00 (18.41)	32.93	0.43
23	M 35-1	5.00	6.00	42.00	7.00 (15.31)	36.40	0.07
S.E.±		0.54	0.28	0.38	0.69	0.26	0.01
C.D. at 5%		1.53	0.79	1.08	1.97	0.74	0.02
CV (%)		6.06	9.98	1.87	5.57	1.44	1.74

* Figures in parentheses are arc sin transformed values

Table 3: Correlation coefficient 'r' between seed characters of different sorghum genotypes and biological parameters of rice weevil

Particulars	100 seed weight	Seed Hardness	Seed corneousness	No. of eggs/100seeds	Incubation period	Total larval-pupal period	Percent Adult emergence	Adult development period	Growth index
100 seed weight	1.000								
Seed Hardness	-0.177	1.000							
Seed corneousness	0.160	-0.386	1.000						
No. of eggs/ 100 seeds	0.354	-0.349	0.721**	1.000					
Incubation period	-0.239	0.411	-0.672**	-0.961**	1.000				
Total larval- pupal period	-0.369	0.233	-0.773**	-0.945**	0.870**	1.000			
Percent Adult emergence	0.288	-0.395	0.638**	0.936**	-0.974**	-0.833**	1.000		
Adult development Period	-0.328	0.224	-0.746**	-0.923**	0.905**	0.960**	-0.865**	1.000	
Growth index	0.303	-0.393	0.725**	0.971**	-0.956**	-0.941**	0.937**	-0.951**	1.000

* Significant at 5% = 0.413 and **Significant at 1% = 0.527

References

1. Adams JM. Weight loss caused by development of *S. oryzae*. J Stored Produc. Res. 1976; 12:269-272.
2. Adetunji JF. A study of resistance of some sorghum seedcultivars to *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). J stored products Res. 1988; 24(2):67-71.

3. Bhoge RS. Screening of different sorghum germplasm against rice weevil, *Sitophilus oryzae* (L.). M. Sc. (Agri.) thesis submitted to MPKV, Rahuri, Maharashtra, India, 2010.
4. Borikar PS, Tayade DS. Resistance in sorghum to *Sitophilus oryzae* Linn. In: Proceeding in Indian Academic Science. 88(B) Part I. 1979; (4):273-276.
5. Champ BR, Dyte CE. Global survey of pesticide susceptibility of stored grain pests. FAO Pl. Protec. Sci., No. 5, FAO, Rome, 1976.
6. Dobie P. The laboratory assessment of the inherent susceptibility of maize varieties to post harvest infestation by *Sitophilus zeamais* Motsch (Coleoptera: Curculionidea) infesting field corn. J Ent. Sci. 1974; 21:367-375.
7. Gupta AK, Behal SR, Awasthi BK, Verma RA. Screening of some maize varieties against *Sitophilus oryzae*. Indian J Ent. 1999; 61(3):265-268.
8. House LR. A guide to sorghum breeding, ICRISAT, Patencheru, Andhra Prades, India, 1980, 238.
9. Jadhav K. Biology and management of rice weevil, *Sitophilus oryzae* L. in pop sorghum. M. Sc.(Agri.) thesis submitted to U.A.S., Dharwad, 2006.
10. Kornerup A, Wanscher JH. Methuen Handbook of colour, Eyre Methuen Ltd., London, 1978, 252.
11. Ladang YD, Ngama LTS, Ngassoum MB, Mapongmestsem PM, Hance T. Effect of sorghum grain cultivars on population growth and grain damage by the rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). African J Agric. Res. 2008; 3(2):255-258.
12. Pradeep, Jagginavar SB, Yogesh KJ, Harshakumar SS. Screening of sorghum genotypes against rice weevil (*Sitophilus oryzae* Linn.) for resistance/ susceptibility. J Agric. Sci. 2015; 28(4):614-615.
13. Ramalho PS, Nagai V, Angeluci E. Behaviour of sorghum varieties in relation to *Sitophilus oryzae* L. Sorghum Newsl. 1977; 20:5.
14. Reddy KPK, Singh PU, Reddy KD. Sorghumresistance to the rice weevil, *S. oryzae* (L.): Antixenosis Sci. and Appl. 2002; 22:1-19.
15. Russell MP. Effect of sorghum varieties on the lesser rice weevil, *Sitophilus oryzae* (L.): oviposition, immature mortality and size of adults. Ann. Ent. Soc., America. 1962; 55:678-685.
16. Russell MP. Effects of four sorghum varieties on the longevity of the lesser rice weevil, *Sitophilus oryzae* (L.). J Stored Prod. Res. 1966; 2:75-79.
17. Singh K, Agrawal NS, Girish GK. The oviposition and development of *Sitophilus oryzae* (L.) in different high yielding varieties of wheat. J Stored Products Res., 1974; 10:105-111.
18. Sharifi S. Oviposition site and egg plug staining related to development of two species of *Sitophilus* in wheat kernels. Angew Ent. 1972; 71:428-431.
19. Snedecor GW, Cochran WG. Statistical method. Oxford and IBH Publishing Company, Calcutta, 1967.
20. Subbarayudu B, Kalaisekar A, Prasad G, Shyam Bhagwat, Babu VR, Srinivas K *et al*. Sorghum resistance to rice weevil, *Sitophilus oryzae* : Antibiosis and Antixenosis. Indian J Pl. Protec. 2013; 41(1):1-5.
21. Wongo LE. Factors of resistance in sorghum against *Sitotroga cerealella* (Oliv.) and *Sitophius oryzae* (L.). Insect Sci. Appl. 1990; 11:179-188.