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Morphometric variation of rice weevil, *Sitophilus oryzae* L. in varietal food commodities

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Abstract

An attempt was made in the laboratory to test the influence of selected cerealson the morphometric measurements of rice weevil *Sitophilus oryzae*. The four different cereals viz., Corn, Sorghum,Rice andWheat which belong to the family Poaeceae were selected for rearing rice weevil. The morphometric measurements of *S. oryzae* registered that the length of thorax, fore limb, mid limb, hind limb, wings and abdomen were higher in females than that of males. Among the cereals used for rearing rice weevil, the corn and *Sorghum* were found to be more susceptible to rice weevil infestation. The rice weevil emergence from wheat and rice were minimum in size in comparison with that of corn and *Sorghum*. The morphometric measurements of the rice weevil showed the higher infestation levels in corn and *Sorghum*. These two cereals need more attention during their storage since their high susceptibility to rice weevil infestation.

Rice weevil, *Sitophilus oryzae* is an internal primary feeder of all the cereals. It damages the grain by feeding the endosperm of the cereal and thus causing major damage to the food grains and makes them unfit for consumption. This pest is classed as a primary pest, cosmopolitan in nature and is known to infest sound cereal seeds[16] and causes severe loss in rice, maize, barley and wheat[21]. Morphometric analysis is useful in finding morphological differences to distinguish closely related species and propose new species[20,1].

Various authors have argued that the morphometric characteristics of kernels are not related to the susceptibility to the insect[14,28,27,22] while others assert that colour, hardness, thickness and kernel size may influence the resistance of cereals to insect storage pests[3,4,17,18]. The study on the influence of different cereals on the morphological characters of rice weevil are meagre. Therefore, an attempt was made in the laboratory to investigate the influence of different cereals on size of *S. oryzae* by traditional morphometric

measurements and also to distinguish the susceptible and resistant varieties of cereals to rice weevil.

The investigation was carried out in the laboratory to screen the morphometry of the rice weevil, *Sitophilus oryzae* in four different cereals. The methodology used in the present study is described under the following headings.

Collection of cereals :

The four different cereals were procured from the local departmental stores, cleaned manually and sun dried for 2 hours. The dried cereals were transferred to ziplock covers and tightly closed with small holes for good air circulation. The zip lock covers containing four different cereals Viz., Corn (*Zea mays*), Sorghum (*Sorghum bicolor*), Rice (*Oryza sativa*) and Wheat (*Triticum aestivum*) which belong to the family Poaeceae (Table-1).

Maintenance and rearing of test insects, Sitophilus oryzae :

A pilot study was conducted in households of Coimbatore city to find out the prevalence of cereal pest in different cereals. The study revealed the presence of *Sitophilus oryzae* in almost all the cereals. Therefore, these insects were selected as the test insect for the present study. The insect used in the present study was obtained from the Department of pulses and oilseeds, Tamil Nadu Agricultural University, Coimbatore. Hundred grams (100gm) of each cereal was weighed and ten pairs (10 pairs) of *Sitophilus oryzae* were introduced in each zip lock covers. Freshly-emerged adults of *Sitophilus oryzae* after 28-35 days of introduction were used for morphometric analysis.

Morphometric analysis :

From the selected cereals, twenty (20) individuals of both the sexes were collected for morphometric analysis. After calculating the length and weight of each individual, the parts of the insects were dissected using the scalpel, dissecting needle and forceps.

The characters to be measured were magnified and analysed using Stemi Denver 210/ Binocular Microscope. The traditional method of morphometric measurements were taken under Olympus Stereoscope Microscope equipped with an eye piece (10/100x) occulometer and stage micrometer.

The following measurements were taken and recorded :

Table -1. Cerealsselectedfortherearingofriceweevil

S.No	Binomial Name	Common name	Tamil name
1.	*Zea mays*	Corn	Makkaacholam
2.	*Sorghum bicolor*	Sorghum	Cholam
3.	*Oryza sativa*	Rice	Arisi
4.	*Triticum aestivum*	Wheat	Kothumai

i) Bodylength
ii) Thorax
iii) Abdomen
iv) Forelimb
v) Midlimb
vi) Hindlimb
vii) Rostrum
viii) Antenna

Statistical analysis :

The observation on weight, length and parts of *Sitophilus oryzae* were subjected to One Way Analysis of variance (ANOVA).

The present investigation was carried out to observe the influence of grain size on the size of rice weevil, *Sitophilus oryzae*. Significant differences could be observed between different cereals and the size of the rice weevil. The different parameters observed were body length, antenna, rostrum, thorax, fore limb, mid limb, hind limb, wing length and abdomen of male and female. In addition to that, the weight of both the male and female *Sitophilus oryzae* reared in selected cereals were recorded.

Morphometric measurements of the rice weevil, Sitophilus oryzae in selected cereals-body length :

The results of the morphometric measurements of body length of the rice weevil, *Sitophilus oryzae* in different cereals showed significant variation among different treatments. Of the different cereals used for the rearing of *Sitophilus oryzae,* male and female reared in corn recorded maximum body length (3.585mm).

The body length of the rice weevil was highest in T_7 corn male and T_8 cornfemale (3.585mm). Next to corn, the body length was maximum in T_2 *Sorghum* female and T_1 *Sorghum* male (3.490 and 3.485mm). The insect body length was moderate in T_4 rice female and T_5 wheat male (3.385 and 3.385 mm). Minimum body length was observed for T_3 rice male and T_6 wheat female (3.285 and 3.285mm).

The overall result showed that the significant variation of body length was observed in different cereals. The length of *Sitophilus oryzae* was maximum in corn female and corn male followed by *Sorghum* female and male. This shows that the susceptibility of corn and sorghum to rice weevil infestation which is evident from their maximum body length. In comparison with corn and sorghum, the body length of both male and female rice weevil in wheat and rice were minimum.

This might be attributed to the size of the rice which is smaller when compared with that of corn and sorghum while the wheat does not permit the rice weevil to attain its maximum size.

Morphometric measurements of the rice weevil, Sitophilus oryzae in selected cereals-antenna length :

Similar to the observation of body length, the antennal length was maximum in corn female and corn male followed by *Sorghum* female and male. In comparison with corn and sorghum, the antenna length of both male and female in wheat and rice were minimum.

Of the different cereals used for the rearing of *Sitophilus oryzae* both sorghum female and corn male recorded maximum antenna length (0.035mm).The antenna length of the rice weevil was highest in T_2 sorghum female and T_7 corn male (0.035mm). Next to sorghum and corn, the antenna length was maximum in T_1 sorghum male and T_8 corn female (0.034 mm). The insect antenna length was moderate in T_5 wheat male T_3 rice male and T_4 rice female(0.033, 0.032 and 0.032 mm respectively). Minimum antenna length was observed for T_6 wheat female (0.031mm).

Morphometric measurements of the rice weevil, Sitophilus oryzae in selected cereals-rostrum length :

The results of the morphometric measurements of rostrum length of the rice weevil, *S. oryzae* in different cereals showed significant variation among different treatments. The length of rostrum in *S. oryzae* was maximum in corn female and corn male followed by sorghum female and male. In comparison with corn and sorghum, the rostrum length of both male and female in wheat and rice were minimum.

The rostrum length of the rice weevil was highest in T_7 corn male and T_8 corn female (0.054 and 0.054 mm). Next to corn, the rostrum length was maximum in T_2 sorghum female T_1 sorghum male and T_4 rice female (0.053, 0.052 and 0.052 mm). The insect rostrum length was moderate in T_6 wheat female T_5 wheat male (0.051 and 0.051mm). Minimum rostrum length was observed for T_3 rice male (0.049mm).

Morphometric measurements of the rice weevil, Sitophilus oryzae in selected cereals-thorax length :

The results of the morphometric measurements of thoracic length of the rice weevil *S. oryzae* in different cereals were tabulated (Table-2). The thoracic length of all the females were significantly higher than that of males.

The thorax length of the rice weevil was highest in T8 corn female (0.072mm). Next to corn the thorax length was maximum in T4 rice female T2 sorghum female (0.068 and 0.067 mm). The insect thorax length was moderate in T6 wheat female T7 corn male (0.066 and 0.065mm). Minimum thorax length were observed for T5 wheat male and T3 rice male (0.059 and 0.058 mm). The poorest thorax length was observed in T1 sorghum male (0.057mm).

The result on thorax length of *S. oryzae* showed that the female possessed longer thorax in comparison with that of male. The thoracic length of *S. oryzae* was maximum in the females of corn, rice and sorghum and minimum in the males of wheat, rice and sorghum.

Morphometric measurements of the rice weevil, Sitophilus oryzae in selected cereals-fore limb, mid limb and hind limb lengths :

The rice weevil, *S. oryzae* possess three pairs of legs as fore limb, mid limb and hind limb which are attached to the ventral region of thorax and used for movement of the insects. Corresponding to that of thoracic

and abdominal regions, the limbs of the rice weevil were longer in female than that of male. The mean values of the fore limb, mid limb and hind limb showed that the size of the limbs gradually increased from fore limb, mid limb to hind limb and the mean values were 0.924 mm, 0.987 mm and 0.996 mm for forelimb, mid limb and hind limb respectively. Of the different cereals used for the rearing of *S. oryzae* corn female were recorded maximum fore limb length (0.102mm).

The fore limb length of the rice weevil was highest in T_8 corn female (0.102mm). Next to corn the fore limb length was maximum in T_2 *Sorghum* female and followed by T_4 rice female (0.099 and 0.098 mm respectively). The insect fore limb length was moderate in T_1 *Sorghum* male, T_7 corn male and T_5 wheat male (0.088,0.087 and 0.086 mm respectively). Minimum fore limb length were observed for T_3 rice male (0.085mm) and T_5 wheat male which were on par with each other.

The mid limb length of the rice weevil was highest in T_8 corn female (0.111mm). Next to corn, the mid limb length was maximum in T_2 *Sorghum* female followedby T_6 wheat female (0.109 and 0.106 mm). The insect mid limb length was moderate in T_7 corn male, T_1 *Sorghum* male and T_5 wheat male (0.097, 0.089 and 0.088 mm). The poorest midlimb length was observed in T_3 rice male (0.087mm).

The observation on the mid limb of the rice weevil indicated that the mid limb length of all the females were higher than that of males.

The hind limb length of the rice weevil was highest in T_4 rice female (0.108mm). Next to rice the hind limb length was maximum in T_8 corn female (0.107mm) and followed by T_2 sorghum female (0.106mm). The insect hind limb length was 0.103 mm in T_6 wheat female. The hind limb length was minimum for the males of T_1 *Sorghum* male (0.096 mm), T_5 wheat male (0.094 mm), T_3 rice male (0.087 mm) and T_7 corn male (0.093mm) treatments.

The study on morphometric measurements of the limbs indicated that the females possessed long legs than that of males. The average length of three pairs of limbs indicated that the hind limbs are longer than that of mid limb and fore limb. The increasing order of hierarchy of the length of limbs were fore limb (GM = 0.0924mm) < mid limb (GM=0.0987mm) < hind limb (GM= 0.0996 mm).

Morphometric measurements of the rice weevil, Sitophilus oryzae in selected cereals-wing length :

The wing length of the rice weevil was highest in T_8 corn female (0.098 mm). Next to corn, the wing length was maximum in T_7 corn male T_2 *Sorghum* female (0.096 and 0.092 mm respectively). This was followed by T_4 rice female (0.091mm) T_6 wheat female (0.089mm). Minimumwing length were observed for T_1 *Sorghum* male, T_5 wheat male and T_3 rice male (0.085, 0.084mm and 0.083mm respectively).

The results on the length of the wing stated that the females possess longer wing length (0.089 mm-0.098 mm) than males.

Among the different cereals used for rearing of *S. oryzae,* T_8 corn female (0.098 mm) and T_1 corn male (0.096 mm) registered the maximum length. Minimum wing length was noticed for T_3 rice male (0.083mm).

Morphometric measurements of the rice weevil, Sitophilus oryzae in selected cereals-abdomen length :

Among the three body parts measured, the abdominal size recorded the maximum length. The abdomen was elongate, subcylindrical with the apex bent downwards. Similar to thorax and wings, the abdomen length was found to be higher in females than males.

The abdomen length was highest in T_8 corn female (0.115mm). Next to corn, the abdominal length was maximum in T_2 sorghum female and T_4 rice female (0.112 and 0.111 mm respectively). The insect abdomen length was moderate in T_6 wheat female and T_7 corn male (0.109 and 0.106 mm respectively). Minimum abdomen length were observed for T_1 sorghum male and T_5 wheat male and the corresponding values being 0.104 and 0.103 mm respectively. In comparison with the *Sitophilus* reared in different cereals, T_3 male in rice recorded lowest abdominal length (0.102mm).

The data on the length of abdomen in the rice weevil reared in different cereals revealed that it possess maximum length in comparison with the remaining body parts such as head and thorax.When the females and males of *S. oryzae* were compared, the females possess the maximum abdominal length in all cereals. The highest length of the abdomen was noticed in T_8 corn female, T_2 sorghum female and T4 rice female. The length of abdomen was minimum for T_5 wheat male and T_3 rice male.

Morphometric measurements of the rice weevil, Sitophilus oryzae in selected cereals-weight of insect :

The weight of the insects after its emergence from different cereals were weighed and recorded. The egg-laden females possess maximum weight than that of males.

The weight of the rice weevil was highest in T_8 corn female (2.085 mg) followed by T_2 sorghum (1.885mg) and T_4 rice (1.790mg). The insect weight was moderate in T_7 corn male (1.385mg) and T_1 sorghum male (1.285 mg). Minimum weight were observed for T_5 wheat male (1.185mm) and the lowest weight was observed in T_3 rice male (1.090mm).

The scrutiny of all data on morphometric measurements of *S. oryzae* registered that the length of thorax, fore limb, mid limb, hind limb, wings and abdomen were higher in females than that of males. Among the cereals used for the rearing of rice weevil, the corn and sorghum were found to be more susceptible to rice weevil infestation. The rice weevil emergence from wheat and rice were minimum in size of all the parameters in comparison with that of corn and sorghum. Even though the infestation of rice weevil in wheat and rice could be observed, the infestation level of wheat and rice were minimum in comparison with that of corn and sorghum. Therefore, the

Table-2. morphometric measurements of the Rice weevil, *Sitophilus oryzae* in Selected Cereals

S.No	Treatment	Length of body (mm)	Length of rostrum (mm)	Length of antenna (mm)	Length of thorax (mm)
1.	T_1 sorghum male	3.485^{d}	0.052^{d}	0.034^{c}	0.057^{h}
2.	T_2 sorghum female	3.490^{c}	0.053^{c}	0.035^{a}	0.067^{c}
3.	T_3 Rice male	3.285^{g}	0.049^{h}	0.032^{f}	0.058^{g}
4.	T_4 Rice female	3.385^{e}	0.052^{e}	0.032^{g}	0.068^{b}
5.	T_5 Wheat male	3.385^{f}	0.051^{g}	0.033^{e}	0.059^{f}
6.	T_6 Wheat female	3.285^{h}	0.051^{f}	0.031^{h}	0.066^{d}
7.	T_7 Corn male	3.585^{a}	0.054^{a}	0.035^{b}	0.065^{e}
8.	T_8 Corn female	3.585^{b}	0.054^{b}	0.034^{d}	0.072^{a}
	Grand mean	3.436	0.052	0.033	0.064
	Sed =	0.0083	0.0003	0.0001	0.0005
	Cd(0.05%) =	0.0170	0.0007	0.0001	0.0010

*SEd=Standard Deviation

*CD=Critical difference

Mean with the same letter in each column are not significant

Table-3 Morphometric measurements of the Rice weevil, *Sitophilus oryzae* in Selected Cereals

S. No.	Treatment	Length of fore limb (mm)	Length of mid limb (mm)	Length of hind limb (mm)	Length of wing (mm)	Length of abdomen (mm)	Weight (mg)
1.	T_1 Sorghum male	0.088^{d}	0.089^{d}	0.096^{e}	0.085^{f}	0.104^{f}	1.285^{f}
2.	T_2 Sorghum female	0.099^{b}	0.109^{b}	0.106^{c}	0.092^{c}	0.112^{b}	1.885^{b}
3.	T_3 Rice male	0.085^{e}	0.087^{h}	0.093^{g}	0.083^{h}	0.102^{h}	1.090^{h}
4.	T_4 Rice female	0.098^{b}	0.105^{d}	0.108^{a}	0.091^{d}	0.111^{c}	1.790^{c}
5.	T_5 Wheat male	0.086^{e}	0.088^{g}	0.094^{f}	0.084^{g}	0.103^{g}	1.185^{g}
6.	T_6 Wheat female	0.096^{c}	0.106^{c}	0.103^{d}	0.089^{e}	0.109^{d}	1.685^{d}
7.	T_7 Corn male	0.087^{d}	0.097^{e}	0.093^{g}	0.096^{b}	0.106^{e}	1.385^{e}
8.	T_8 Corn female	0.102^{a}	0.111^{a}	0.107^{b}	0.098^{a}	0.115^{a}	2.085^{a}
	GRAND	0.092	0.098	0.099	0.089	0.107	1.549
	Mea nsed=	0.0005	0.0002	0.0002	0.0002	0.0002	0.0077
	CD(0.05%)=	0.0014	0.0003	0.0003	0.0003	0.0003	0.0158

*Sed=Standard Deviation

*CD=Critical difference

Mean with the same letter in each column are not significant

present study suggests that the corn and sorghum need more attention during their storage and the rice and wheat exhibit some sort of resistance against the rice weevil.

Stored grains are subject to losses due to a number of causes which include sphysical, sanitary and nutritional deprivation, from their maturation to the utilization. In India, the damage of stored grains by insect pests was estimated to 6.5 percent ofthe total grain storage[23]. Among the stored grain pests, the rice weevil, *Sitophilus oryzae* (Coleoptera, Curculionidae), is one of the significant pests of stored rice causing both quantitative and qualitative losses to grain imparting severe economic loss. Regardless of the accessibility of modern technologies for grains torage and pest control, some farmers still use traditional methods of storage. Grain stored under such conditions is very susceptible to heavy losses. Understanding of the pest life-cycle is thus the prerequisite for the adoption and execution of the proper management strategy. Though a considerable work on the life cycle of *S. oryzae* had been carriedout but expressed[8,9] variable results were.

Many researchers have done an experiment with the host preference, ovipositional preference, sexual dimorphism and geographical distribution of the *S. oryzae*[5,10,25,2]. However, the relationship between the different cereals and the influence of those cereals on the size of rice weevil were not done by any researcher. Therefore, an attempt has been made in the laboratory to investigate the influence and the susceptibility of the different food grains on the size of rice weevil.

In the present investigation the result of the morphometric analysis in both male and female of *S. oryzae* in different cereals showed that the body length and other parts of the insects were highest in corn and sorghum. The susceptible nature of maize to *S. oryzae* have been demonstrated by researchers[15,19]. The grain damage, weight loss and progeny production were higher on maize and maize was the most preferential grain, regardless on the rearing substrate, for both male and female weevils[15].

The productivity of maize is at risk due to the incidence of different pests and pathogens[7,6,26] attacking maize kernels both pre- and post-harvest. In particular, maize is one of the agricultural commodities susceptible to infestation by storage insects, which may cause a huge loss of quality and germination of the seeds[13]. Insect attack damages both the endosperm and the embryo. Maize endosperm is the largest domain in the kernel and represents a good source of feeding material since it accumulates starch and protein, while the embryo, which comprises root and leaf primordia, represents the succeeding plant generation[11].

In our study, the body length, length of thorax, fore limb, mid limb, hind limb, wing, abdomen and weight of females of *S. oryzae* were maximum than that of males. Variation in size and weight of rice weevil between male and female were reported[12]. A significant difference was found between the mean weight of emerged male and females adults, and the female rice weevils were heavier than males (mean weight 3.16 vs. 3.05 mg)[24].

The morphometric measurements of the rice weevil showed the higher in festation levels in corn and sorghum. These two cereals need more attention during their storage since their susceptibility to rice weevil infestation. The morphometric measurements of rice weevil definitely an useful tool for the management of rice weevil instored cereals.

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