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LIFE CYCLE AND OVIPOSITIONAL PROPENSITY OF *SITOPHILUS ORYZAE* (LIN.) (COLEOPTERA: CURCULIONIDAE) IN DIFFERENT HOUSEHOLD STORED GRAINS

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ABSTRACT
Experiments were carried to find out the ovipositional preference and developmental periods from larvae to adult stage of Sitophilus oryzae on different stored grains I.e. Rice, Pulse and Sorghum. The maximum eggs were laid on sorghum (21.8±0.60 and 392.0±2.66) in choice and no choice tests respectively. The incubation period, larval period, pupal period and total duration was short in case of sorghum also i.e. 4.94±0.75, 21.81±0.39, 10.93±0.84 and 36.04±0.33 respectively. The present study concluded that Sitophilus oryzae are more inclined towards sorghum over rice and pulse because of large surface area and hard coat for oviposition and also the developmental period of rice weevil is shorter in sorghum when compared with rice and pulse.

***Key words**: Developmental period, Incubation, Oviposition, Sitophilus oryzae, sorghum*

INTRODUCTION
Sitophilus weevils, including the granary weevil (*S. granaries*), maize weevil (*S. zeamais* Motschulsky), and rice weevil (*S. oryzae* (Linnaeus)), are well-known worldwide insect pests of stored household grains. They are nearly cosmopolitan in distribution, occurring throughout all tropical and warm zones of the world **[1]**. Normally, a adult female *Sitophilus spp.* digs a hole in the grain of cereal, lay egg, commonly one egg per individual grain and then secretes a waxy secretion and seals the hole. Consequently upon hatching, the larva grows while feeding inside the grain and then pupates. It normally leaves the grain completely hollow when it emerges out of it as an adult **[2].** As we know cereals are the nutritive and staple food, but their storage and shelf life is not protected due to the infestation of different stored grain insect pests. So, there is a compulsion to safeguard them safely from quantitative and qualitative loss of these cereals that can happen from environmental circumstances like feeding by rodents, insect pests, mites and microbes **[3].** It is approximated that about 35% of crops are destroyed by pests all over the world **[4].** Stored grain insect pest like *Sitophilus oryzae* can cause heavy reductions in seed viability, weight, quality and commercial value. It has been estimated by **[5]** that 70 % of these insect pests are Coleopterans and the most damaging and disastrous species of storage insect pests are from the genera *Trilobium and Sitophilus* **[6].** This study was designed to study the preference for oviposition and life cycle periods of *Sitophilus oryzae*, rice weevil on different stored grains.

MATERIALS AND METHODS
The Studies were carried on three different stored grains rice, pulse and sorghum during the year 2017-18 in the Department of Zoology, Govt. Holkar Science College, M.P. The procedure was carried out in accordance with **[7].**

MAINTENANCE OF STOCK CULTURE

Rice weevil was collected from the stored rice of seed technology department, Govt. Holkar Science College, M.P. The weevils were identified by using the keys of **[8].** Three different types of grains were collected from local grain stores of Indore city i.e. parboiled Rice (*Oryza sativa*), Pulse (*Plasoes mungo*) and Sorghum (*Sorghum bicolor*). All grains were sterilized at –16°C for three weeks in a freezer. After the treatment, the grains were spread on normal white papers at room temperature 27°C and 55-65 % rh for 24 hours to bring them to normal temperature and kept in sealed containers before they were used.

Stock culture of the rice weevil, *Sitophilus oryzae* was maintained in an incubator at temperature 27± 4°C and 70± 4% relative humidity (rh) to ensure their regular supply for tests throughout the experimental period. The mass rearing medium was parboiled rice. Stock cultures were maintained in five large Petri dishes (20mm D). Each Petri dish was filled with approximately equal quantities (500 g) of rice grains. 75 pairs of adult rice weevils were released into each of five Petri dishes for oviposition. A wet cotton ball was kept regularly within the Petri dishes to maintain the moisture. After 72 hours of oviposition, the adult weevils were completely sieved out from each Petri dish using a 1.5 mm sieve. The metabolic wastes were cleared in intervals or regularly to avoid microbial growth and grain dampness. Experiments were started to conduct with the insects emerged from the second generation of the rearing *S. oryzae* and so on.

OVIPOSITIONAL STUDIES

For choice test, 60 grains (not cracked or broken) from each type (Rice, Pulse, Wheat) were kept together in one Petri dish (10" diameter). Ten pairs of newly emerged adults of age group 48- 72 hrs were released in the Petri dish. Released insects were allowed to oviposit for three days. After three days, the grains were collected and the grains containing eggs were separated out by examining with magnifying glass and the numbers of eggs laid were counted. The experiment was replicated four times.

For no choice test, 120 grains (not cracked or broken) from each type (Rice, Pulse, Wheat) were kept in separate Petri dishes (10" diameter). Ten pairs of newly emerged adults of age group 48-72 hrs were released in each Petri dish. The Petri dishes were set at 27 ± 4°C and 70 ± 4% rh in incubator. Released insects were allowed to oviposit for three days. The experiment was replicated five times. After each test the grains were collected and the grains containing eggs were separated out by examining with magnifying glass and the numbers of eggs laid were counted.

DEVELOPMENTAL PERIODS

To study the life cycle of rice weevil *Sitophilus oryzae* (L.) 200 grains (not cracked or broken) from each different type of grains (Rice, Wheat and Pulse) were kept in Petri dishes (Diameter 3.5cm ×7.5cm). Fifteen pairs (male and female) of newly emerged adults of age group 24 - 72 hrs were released in each Petri dish. There were five such replications. The Petri dishes were kept at temperature 27 + 4°C and 70 ± 4% rh in incubator. Weevils were kept in petri dishes for two days to oviposit. Damaged grains were replaced regularly with un-infested grains. Grains containing eggs of *Sitophilus oryzae* were separated out by observing under microscope and were kept for further studies. Males and females were distinguished because of certain unique characteristics. The grains (rice, pulse and sorghum) on which the rice weevils laid eggs were transferred into another set of Petri dishes. To determine the incubation period 30 grains were dissected with a pair of forceps under the microscope from the day of oviposition to egg hatching. Thus, incubation period was recorded. The remaining seeds were used for the determination of larval and pupal period. On hatching the *Sitophilus oryzae* larvae were permitted to feed inside the grains individually in Petri dish. Five grains per day were dissected with a pair of forceps to see the larval period. The dissection of grains was continued until they attained the pupal stage. The period between egg hatching and pupation was observed as larval period. Within the infested grains when the larvae attained the pupal stage the seeds were allowed as such until adult emergence. The period between formations of pupae till the emergence of adult was considered as pupal period.

SEX RATIO

The Number of adults emerged on different grain varieties (Rice, Pulses and Sorghum) were counted regularly and male weevils and female weevils were kept separated inorder to determine sex ratio in different varieties.

Mean, standard error and T test were used for evaluating relative effectiveness of life cycle and oviposition of rice weevil on different varieties of grains.

RESULTS AND DISCUSSION

OVIPOSITIONAL STUDIES

The number of eggs oviposited by *Sitophilus oryzae* in choice test was 19.4±0.01 in pulse, 15.2±0.27 in rice and 21.8±0.60 in sorghum. The number of eggs oviposited by *Sitophilus oryzae* in no choice test was 399.2±2.01 in pulse, 371.3±2.32 in rice and 392.0±2.66 in sorghum. The number of eggs oviposited on different varieties varied significantly (Table 1).

The present study has concluded that rice weevil are more inclined towards sorghum which are large in size and hard for oviposition than rice and pulse in both tests. The egg laying capacity of the *Sitophilus oryzae* (weevil) increased when the preferred seeds for oviposition were provided. Similar results were obtained from the study of **[9]** who also observed that some weevil endorsed to lay eggs in large size grains and also observed that, relative hardness of the stored grain of certain sorghum varieties was a dominant factor in affecting the rates of oviposition. Similar results were recorded by **[10]** according to their study, when compared sorghum with other grains. The emergence of adults per 100 grains were significantly higher in number than split pulses at controlled (70.83 and 52.92) and room conditions (82.08) respectively. **[11]** recorded that rate of oviposition per female was maximum in sorghum (11.60/female/2 day period) at 80 per cent RH and 30ºC. It might be due to the close interaction between humidity and temperature.

DEVELOPMENTAL PERIOD

The life cycle of *Sitophilus oryzae* (L.) (Rice weevil) consists of four stages i.e egg, larva, pupa and adult in all the three different stored grains (Table 3).

Incubation period was with a mean of 6.07±0.51 days in rice, 5.45±0.39 days in pulse and 4.94±0.75 days in sorghum. The result of present study confirmed some of the experiments made by earlier workers in this regard, as per the experiment conducted by **[12],** the incubation period of eggs turned out to be 6-7 days on rice. **[13]** Who observed that the eggs of *S. oryzae* laid on maize kernals hatched in 5-6 days after oviposition. It is in accordance with the recordings of **[14]** who reported an incubation period of 5-7 days on rice.

Larval development took place inside the grains (Rice, Pulses and Sorghum). Larval period was with a mean of 25.11±0.16 days in rice, 22.01±0.72 days in pulse and 21.81±0.39 days in sorghum. The present findings are in agreement with **[15]** who also found that with an average of 25.8 days, larval period varied from 21 to 30 days. **[16]** also recorded that 25 to 34 days of larval period on sorghum genotype with 4 larval instars. **[17]** found that 16 to 20 days of larval period on maize karnals.

Pupation took place in larval tunnel. Pupal period was with a mean of 13.62±0.21 days in rice, 11.21±0.01 days in pulse and 10.63 ± 0.84 days in sorghum. **[17]** reported 2 to 9 days of pupal period at 23 - 30°C temperature and 78 - 87 per cent relative humidity on maize karnals. **[15]** found that with an average of 7.4 days at 56 to 81 per cent RH and 11.7°C - 39.5°C temperature, pupal period ranged from 7-8 days. The present findings are in agreement with **[18]** who recorded 6 to 16 days of pupal period on sorghum.

Total duration from egg to adult was with a mean of 42.10±0.05 days in rice, 39.12±0.21 days in pulse and 36.04±0.33 days in sorghum. Similar results were also reported by **[19]** in *S. oryzae* at different humidity and temperature conditions who reported 21 to 46 days of life cycle of rice

weevil. **[20]** found that egg to adult survival was highest in grains at intermediate humidities (60% RH at 30°C and 70% RH at 25°C). **[21]** found that percentage of egg to adult survival were maximum in sorghum (39.40) at 70 per cent RH and 27ºC.

The present study concluded that *Sitophilus oryzae* are more inclined towards sorghum sorghum over rice and pulse because of large surface area and hard coat for oviposition and also the developmental period of rice weevil is shorter in sorghum when compared with rice and pulse.

SEX RATIO

The sex ratio of males: females of *Sitophilus oryzae* was 1:1.16 as observed when reared in laboratory (Table 3). Thus females were more emerged as compared to males. Similar results were recorded by **[22]** where they also found emergence of more females than males.

Table 1: Number of eggs laid by *Sitophilus oryzae* in Pulse, Rice and Sorghum in choice and No choice test.

Grain	Number of observation (n)	Number of seeds	Total number of eggs laid (M± SE)	Weevil released (Pair)
CHOICE TEST				
Pulse	4	60	19.4±0.01	10
Rice	4	60	15.2±0.27	10
Sorghum	4	60	21.8±0.60	10
NO CHOICE TEST				
Pulse	4	120	399.2±2.01	10
Rice	4	120	371.3±2.32	10
Sorghum	4	120	392.0±2.66	10

Mean±SE of four replications

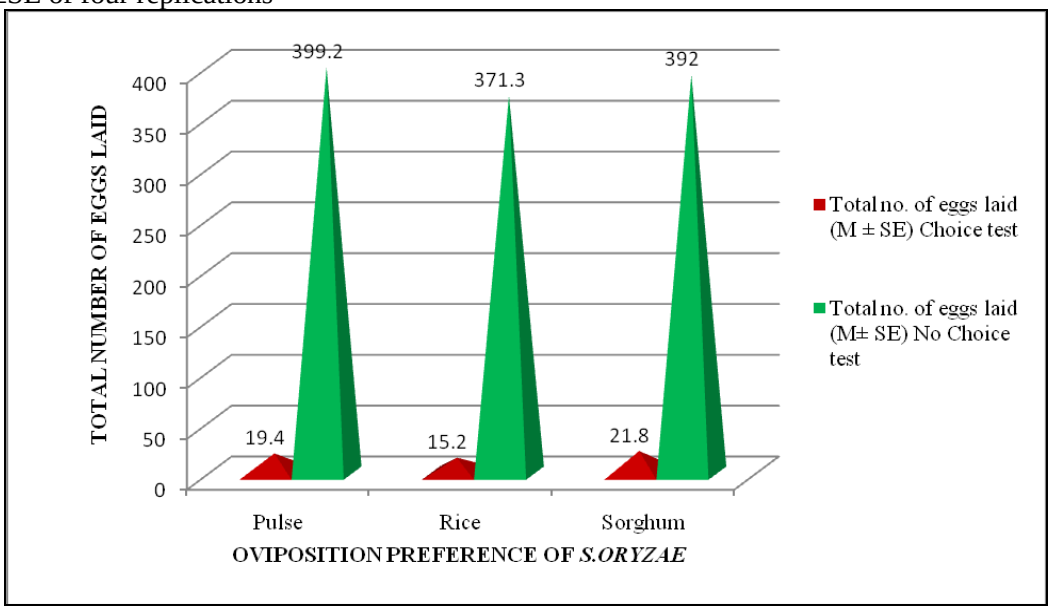

Fig 1: Number of eggs laid by *Sitophilus oryzae* in pulse, rice and sorghum in choice and no choice test

Table 2: Development period of *Sitophilus oryzae* in different stored grains Rice, Pulse and Sorghum.

Grain	No. of obs. (n)	No. of seeds	Weevil released (Pair)	Incubation period (Mean± SE) (Day)	Developmental periods		Total duration (Mean± SE) (Egg to adult) (Day)
					Larval period (Mean± SE) (Day)	Pupal period (Mean± SE) (Day)	
Rice	5	200	15	6.07±0.51	25.11±0.16	13.62±0.21	42.10±0.05
Pulse	5	200	15	5.45±0.39	22.01±0.72	11.21±0.01	39.12±0.21
Sorghum	5	200	15	4.94±0.75	21.81±0.39	10.93±0.84	36.04±0.33

Mean±SE of five replications

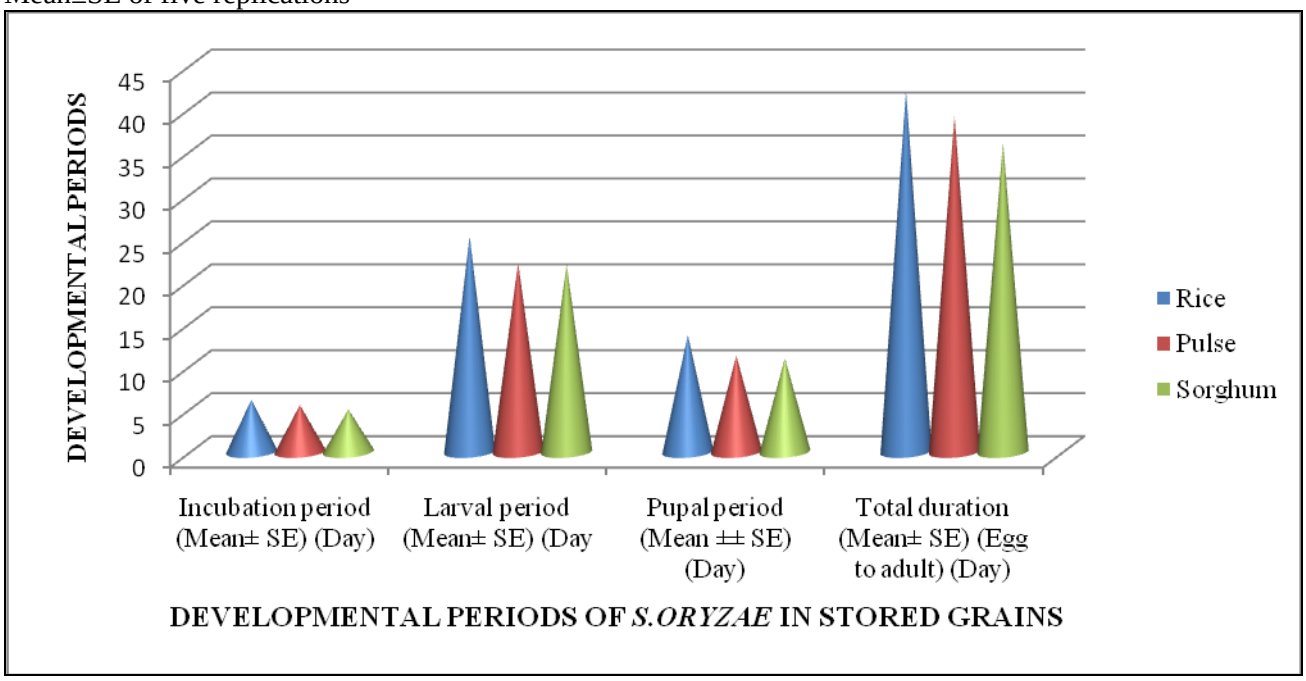

Fig 2: Development period of *Sitophilus oryzae* in different stored grains pulse, rice and sorghum.

Table 3: Sex ratio of *Sitophilus oryzae* during rearing in laboratory conditions.

Date of grouping 4th instar *Sitophilus oryzae*	Number of (fourth instar larva) kept for observation	Sex		SEX RATIO M:F
		MALE	FEMALE	
Laboratory population (Nov 2017-Jan 2018)				
01-11-2017	75	32	43	1:1.35
15-11-2017	65	31	34	1:1.10
30-11-2017	73	33	40	1:1.21
15-12-2017	59	29	30	1:1.03
30-12-2017	60	27	33	1:1.23
15-01-2018	50	24	26	1:1.08
30-01-2018	42	20	22	1:1.10
TOTAL	424	196	228	1:1.16

A. *Sitophilus oryzae* and Sorghum infested with *S. oryzae*

B. Rice infested with *S. oryzae*

C. Pulse infested with *S. oryzae*

CONCLUSION

Based on the results although *S.oryzae* is naturally thriving on stored grains especially household stored ones. The present experiments showed that stored grains support development and growth of *S.oryzae.* Among the stored grains sorghum followed by pulses and then rice were found to be supporting the development and growth of *S.oryzae* by providing them hostile conditions like hard covering and large size necessary for their survival.

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