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Biology of *Sitophilus oryzae* (L.) on Stored Rice

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ABSTRACT: The rice weevil (*Sitophilus oryzae* L.) is a very destructive pest common in stored grains because of its polyphagous behaviour. For the effective management of the insect, its biology should be understood. So, the present study aimed to evaluate the biology of rice weevil was studied on stored rice variety "Lajawab" under laboratory conditions during 2023-2024. The weevil completed its life cycle in four distinct stages *viz*., egg, larva, pupa and adult. Female rice weevils laid eggs in rice grains, which hatched in 5-6 days. Larvae moult three times over 19-22 days, and the pupal stage lasted 9-11 days. Adults lived 60-82 days. The complete life cycle average 107 days under controlled lab conditions of temperature 27±1°C and relative humidity of 70±5 percentage. The duration of different stages of the life cycle of the weevil may be useful in managing the rice weevil effectively.

Keywords: Rice, Rice weevil, Biology, Morphometry.

INTRODUCTION

Rice, a fundamental food source for nearly half of the global population, and staple food for majority of Indian. It is the major cereal of India as a source of income and lively hood with large share of rice production worldwide contributing to 25.27 % of the worlds production (APEDA, 2023). The area under rice production was 46.38 million hectares with production of 130.20 million metric tons and productivity of 2809 kg per ha. Rice is stored in bag and bins for future consumption purpose, this stored rice faces significant damage from insect pests during storage (Ahmad *et al*., 2021). In India, annual storage losses have been estimated 14 million tonnes worth of Rs. 7000 crores in which insects alone account for nearly Rs. 1300 crores (IGMRI, 2019). Over 70 insect pests infest grains and cereal products that are stored (Deb, 2019). Rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae) is a very destructive pest to stored grains (Sharma *et al*., 2024), with the grain weight loss of about 11.57% in stored grain (Subedi *et al*., 2009). Rice weevil is polyphagous and has been found to infect a wide range of cereals, including rice, sorghum, wheat, barley, oats, maize, and others (Subedi *et al*., 2009; Suiter *et al.,* 2017). These weevils mainly feed on endosperms, reducing the carbohydrate content while the larvae feed on the germ of the grain, thus reducing the large percentage of protein and vitamins along with germination loss as well. Both the larvae and adult rice weevils damage grains (Chandaragi *et al.*, 2022) by consuming them voraciously and under heavy infestation only the pericarp of the kernel is left behind (Sinha *et al.*, 2010), which decreases both the quality and quantity of the grains besides, makes them susceptible to secondary infections, rendering them unsuitable for consumption. The primary method for controlling stored grain pests has been the repeated use of synthetic chemical insecticides (Rajashekar *et al.,* 2012). However, this frequent application has led to issues such as insect resurgence and resistance (Siddiqui *et al*., 2023). Hence, alternative methods of pest control are necessary. Therefore, this study was conducted to gain a comprehensive understanding of the biology of *S. oryzae* (L.) and to accurately identify its immature and adult stages, which is essential for developing effective integrated pest management strategies.

MATERIALS AND METHODS

The study on the biology of the rice weevil, *S oryzae* (L.), was conducted on the rice variety "Lajawab" under a laboratory from January to April 2024. The culture of rice weevil was maintained with weevils collected from contaminated seed samples from a local market in Varanasi. A pure culture was developed by infesting insect-free rice grains with a morphologically identical mating population in a BOD incubator at a temperature of 27±1ºC and 70±5 % relative humidity. The culture was subsequently maintained in rice grain, in a glass jar with a capacity of 2 kg. The container was closed with muslin cloth and sealed with a rubber band. The culture, kept in a 2-liter glass jar with healthy rice grains, was used for the study. Twenty pairs of weevils of seven to 10 days old with male female ration of 1:1 infested to 100g of rice grains, stored at room temperature were used to assess egg-laying potential and reproductive potential. Grains were replaced daily,

and eggs were separated and examined under a stereo zoom microscope to determine their shape, size, and colour. The biometric calculation was further observed under ocular micrometre. The incubation period was calculated by observing the eggs until hatching.

After hatching, larvae were allowed to feed on rice grains, and different larval stages were examined by dissecting grains at two days interval. The number of larval instars was determined by measuring the length, breadth and head capsule size of the larvae daily. The duration and characteristics of each larval stage were recorded.

Observations on the pupal duration, colour and size were also recorded until adult emergence from stationary position of the pupae. Weevils were identified by their colour, pronotum markings, large snout, and genital curvature.

RESULTS AND DISCUSSIONS

During the experiment it was observed that the weevils were laid egg singly inside rice grain cavities. The weevils chew hole by the rostrum and plug by the gelatinous material. The eggs were oval, translucent, and white, turning opaque before hatching, with an average size of 0.36 mm in length and 0.16 mm in breadth (Table 2). Under laboratory conditions of 27±1ºC, the incubation period was 5-6 days (Table 1). Subhadarsini *et al.* (2023) reported the mean length and breadth of the egg was 0.36 and 0.19mm with the incubation period of 4.5 days at 30±1ºC and 6.93 days at 20±1ºC. Choudhary and Chakraborty (2014) reported that the incubation period for eggs was 6-7 days on Samba Masuri rice.

Grubs were apodous, short, stout and yellowish to whitish in colour with brown head capsule. The larvae had undergone three larval moulting and attained four larval instars feeding inside the grain contents. The first instar measured 0.24 mm in length and 0.08 mm in breadth, lasting 5-6 days. The second instar measured 0.42 mm in length and 0.12 mm in breadth, lasting 6-7 days. The third instar, significantly larger, measured 0.91 mm in length and 0.49 mm in breadth, lasting 8-9 days. The fourth and final instar, the largest, measured 1.71 mm in length and 0.94 mm in breadth, being the most damaging due to its voracious feeding. The total larval period lasted for 19-22 days. The current findings are in proximity with the finding of Devi *et al*. (2017). He reported the total larval period of weevil lasted for 24.2 days and Kaundal *et al.* (2023) also reported the larval period lasted for 22 to 29 days. While Swamy *et al*. (2014) reported the larval period with wider range between 23-33 days on Sorghum and 22-34 days on maize.

Pupation occured inside the grain kernel, with the pupa being white to yellowish-white, and lasted 9-11 days with the average pupal size was observed to be 2.92 mm in length and 1.53 mm in breadth. Kaundal *et al.* (2023) observed the pupal length of about 6-9 days at 25±1ºC and humidity 70-75%. Subhadarsini *et al.* (2023) also reported the pupa length and breadth was 2.87 mm and 1.62 mm with pupal period of 5.6 days. Similarly, Rojasara and Patel (2020) reported the pupal length of weevil 6-7 days in rice at 27±1ºC and humidity of 70±5% with the pupal length (2.24-2.40 mm) while the width (1.53-1.68 mm). Adult weevils start off reddish-brown, turning black as they age.

Adults were dark brown to reddish brown in colour, elongated with four orange patches on the elytra with males having a thicker and short rostrum while the females having a longer, broad and smoother rostrum. Adults lived for 60-82 days. This finding is in line with Kaundal *et al.* (2023) who reported the adult life of male weevils to be 54-65 days while that of female adult to be 72-87 days. The total life cycle from egg to adult ranged from 93 to 121 days, averaging 107 days under controlled laboratory conditions. The body dimension of weevil was measured to be 3.13±0.49 mm and a breadth of 1.24 mm. These findings align with (Sahoo and Sahoo 2021), who reported that the complete life cycle of male rice weevils ranges from 87 to 102 days during winter, while females have a life cycle lasting from 98 to 109 days. Similarly, they align with Okram and Hath (2019), who observed that the rice weevil's life cycle, from egg to adult, spans 97 to 123 days during winter.

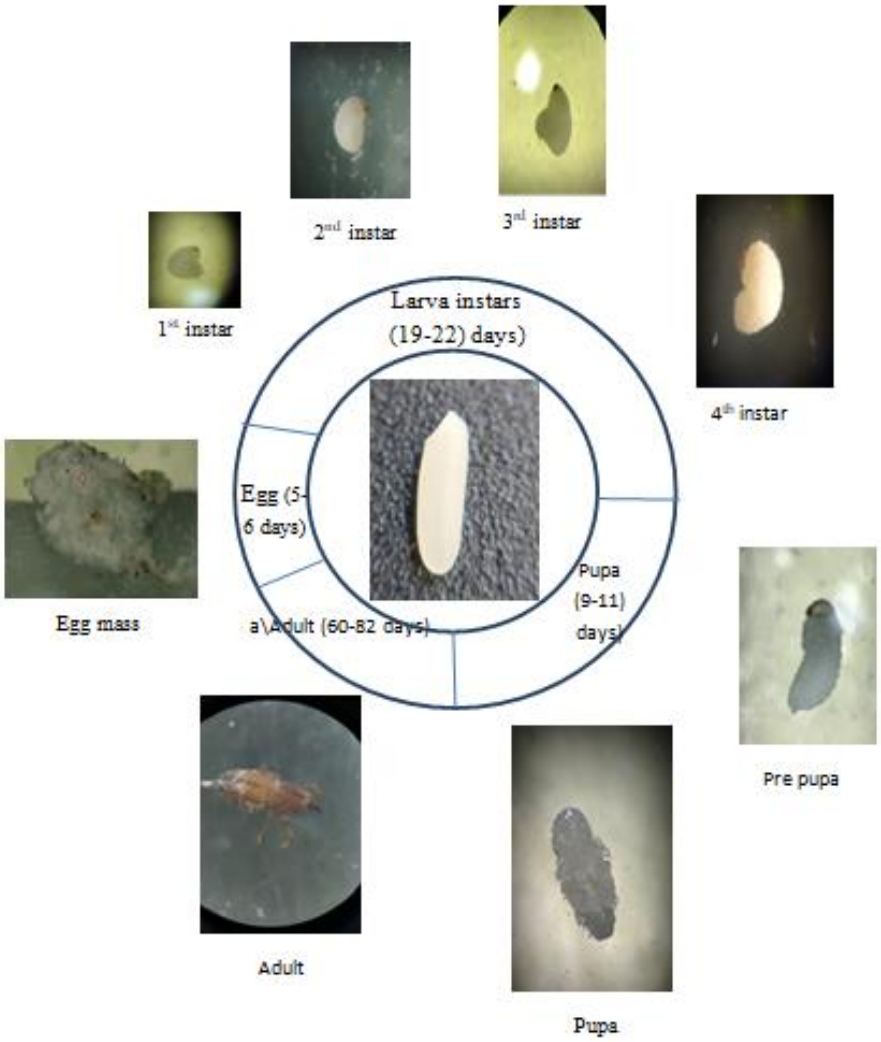
Table 1: Biology of *Sitophilus oryzae* (L.) on rice grains.

Development stage	No. of observation	Range(days)	Mean ± SD
Egg	10	5-6	5.5±0.7
larva	10	19-22	20.5±2.12
Pupa	10	9-11	10± 1.4
Adult	10	60-82	71±15.55
Total duration		93-121	107±19.79

Table 2: Morphometry of *Sitophilus oryzae* (L.) on stored rice grain.

Insect stage	Length (mm)		Breadth(mm)	
	Range	Mean ± SD	Range	Mean ± SD
Egg	0.34-0.40	0.36±0.01	0.13-0.19	0.16±0.01
Larva instars				
1st	0.21-0.3	0.24±0.03	0.06-0.1	0.08±0.01
2nd	0.38-0.45	0.42±0.22	0.12-0.15	0.12±0.01
3rd	0.12-1.15	0.19±0.29	0.42-0.55	0.49±0.04
4th	1.4-2.12	1.17±0.32	0.48-1.58	0.94±0.49
Pupa	1.9-3.55	2.92±0.68	1-1.7	1.53±0.26
Adult	2.5-3.9	3.13±0.49	1.05-1.46	1.23±0.12

Life cycle of *Sitophilus oryzae* (L.) on stored rice



CONCLUSIONS

The developmental biology of *Sitophilus oryzae*, a significant pest of stored rice, was studied by closely examining its various life stages. The life cycle of *S. oryzae* consisted of four stages, starting with the egg, followed by four distinct larval instars (1st, 2nd, 3rd, and 4th), pupal stage and the adult. Each larval stage involved feeding on the inner grain content, leading to gradual development and eventual pupation. The pupal stage marks the transition from the larval phase to the emergence of the adult weevil, which then actively participates in reproduction and infestation of stored grains. The time required for *S. oryzae* to complete its full life cycle typically ranged between 93 and 121 days.

FUTURE SCOPE

Future research can concentrate on the effects of climate variability these impacts will enhance pest management tactics and aid in infestation prediction. Furthermore, investigating biological control strategies like parasitoid wasps and entomopathogenic fungi may provide long-term substitutes for chemical pesticides. Besides, research on pesticide resistance mechanisms is also essential for creating alternative control methods, including pheromone traps, plant-based insecticides, and RNA interference (RNAi)-based approaches.

Further studies on the mating habits, host preferences, and dispersal tendencies of *S. oryzae* may result in improved techniques for pest control and storage. Grain protectants based on nanotechnology, controlled environment methods, and hermetic storage may help mitigate losses caused by the pest. Better protection of stored grains can also be achieved by incorporating artificial intelligence (AI) and the Internet of Things (IoT) into grain storage facilities. This integration can improve automated pest treatment, early infestation detection, and real-time monitoring. Addressing these research areas will contribute to the development of sustainable and efficient solutions to minimize economic losses due to *S. oryzae* infestations.

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