

Original Research Article

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Biology of *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) on Stored Rice Grains during Different Seasons in Terai Agro-Ecology of West Bengal

Supriya Okram* and T.K. Hath

Department of Agricultural Entomology, Uttar Banga Krishi Vishwavidyalaya, UBKV,
Pundibari, West Bengal, India

*Corresponding author

ABSTRACT

Laboratory experiments were carried out to study the biology of *Sitophilus oryzae* on stored rice grains in different seasons during 2016-17. The results of the laboratory experiments revealed that the duration of various developmental stages *i.e.* incubation period, larval period, pupal period and adult longevity varied from one season to another season. The longest incubation period, larval period and pupal period of 5.85 ± 0.31 , 21.33 ± 0.99 and 10.20 ± 0.50 days was registered during February. And the longest adult longevity of male with food of 58.72 ± 3.44 days and without food of 12.98 ± 0.98 days and adult longevity of female with food of 77.23 ± 3.11 days and without food of 14.47 ± 0.69 days were also recorded during February. Total life cycle of male with food (96.09 ± 3.81), without food (50.35 ± 1.85) and total life cycle of female with food (114.61 ± 2.98), without food (51.84 ± 1.56) were also longest during February when the temperature and relative humidity ranges from 12.39°C to 27.89°C and 58.33 to 88.81% R.H. respectively. The longevity of adult female was always higher than the males irrespective of season and food.

Keywords

Sitophilus oryzae,
Biology, Rice,
Seasons

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Introduction

Rice, *Oryza sativa* (Linn.), an economically important cereal is the most important staple food for half of the world's population and it is grown in over 100 countries of the world (Oko *et al.*, 2012). More than 90% of the world's rice is produced and consumed in Asia. Every year nearly 25 to 30% crop yields are destroyed both in field and stores by different insect pests (Lal and Srivastava, 1985) and post harvest losses of food grains

in India is estimated at 12 to 16 million MT/year (Singh, 2010) and pests devour about 6.5% of total grains stored in India (Raju, 1984).

The rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae), is one of the most important destructive primary pests attacking many common stored cereals including rice, wheat, maize and split peas and has a worldwide distribution (Longstaff, 1981; Gomes *et al.*, 1983 and Grenier *et al.*,

1997). Stored and milled rice grains are prone to attack by *Sitophilus oryzae* and the latter grains are mostly preferred causing heavy economic losses and both the adults and larvae feed on the carbohydrates in rice grains causing weight loss and contamination (Park *et al.*, 2003). In absence of control, the stored grains can be destroyed even up to 100% (Ofuya and Credland, 1995). Enhancing the temperature and humidity of the infested grains, *Sitophilus oryzae* activity also induces accelerated growth of the secondary pests and creates most favourable conditions for pathogens and further infestation (Hardman, 1977; Longstaff, 1981 and Hill, 2002).

Terai region of West Bengal is a vast rice growing tract of the state and organised modern storage structure for storing of rice and other cereal crops is absent both at individual and Government level for which huge amount loss of food grains occur every year. However, there is no reference of work on the damage/loss of rice due to rice weevil in this region. Since huge loss is associated with all the four larval stages and adults and all the biological stages (egg, larva, pupa and adult) occur inside the grains, the study on the biology of the pest was undertaken.

Materials and Methods

The study was conducted in the Department of Agricultural Entomology of the varsity located at Pundibari, Coochbehar, West Bengal (India) during five different seasons *viz.*, February, April, June, August and November in two consecutive years 2016 and 2017. For initiation of the experiment, in a plastic container (600 ml) about 200g of sterilized healthy rice grains of variety Phoolpakri were taken into which approximately 50 pairs of freshly emerged adults (with a ratio of 1:1 male and female) were introduced. The mouth of the container was covered with muslin cloth and tied with

rubber band for proper aeration and placed in dark condition by wrapping with a black polythene sheet. This was kept in an open shelf at room temperature to facilitate maximum biological activities and oviposition. The culture was periodically inspected with due precautions and was used throughout the period of study. Pure culture of the weevil was then prepared by infesting insect free, properly cleaned pre-weighted rice grains with freshly emerged single mating pair. The culture was maintained in the plastic container of 5cm×4.5cm size and about 25g of rice grains were put in each clean plastic container. Three such sets were maintained.

Egg stage

Thirty pairs of adult rice weevils (with male and female ratio of 1:1) were identified as per Halstead (1963) and introduced in each plastic container measuring 5cm×4.5cm containing 25g of rice grains which was kept in dark ambient conditions at room temperature. Damaged grains were identified under microscope and were replaced every morning with sound un-infested healthy grains for observing the egg laying. Grains containing eggs were separated out and were used for further study.

Incubation period

The rice grains with rice weevil eggs so obtained were maintained in a plastic container measuring 5cm×4.5cm for incubation. Ten grains exposed to the paired adults were daily dissected from the day of oviposition to egg hatching to determine the incubation period.

Larval period

On hatching, the larvae of rice weevil were allowed to feed individually inside the rice

grains and 10 grains were dissected daily until the formation of pupa for recording the larval period. The period between egg hatching and pupation was considered as the larval period.

Pupal period

The pupal period was recorded daily by dissecting 10 rice grains containing the larva developing for pupation inside the grains. Observations were made till the emergence of adult. The period between formation of pupae till the adult emergence was noted as pupal period.

Adult longevity

The ability of the adult weevils to live in presence of food was determined by enclosing the newly emerged male and female adults into a plastic container of 5cm×4.5cm size containing sterilized uninfested healthy rice grains. The same procedure was followed for observing the adult longevity of the weevils in the absence of food.

The studies were conducted during February, April, June, August and November of 2016 and 2017 in the laboratory and the temperature and humidity prevailed during the course of study are furnished in table 6.

Descriptive statistics was applied to study the biology *viz.*, incubation period, larval period, pupal period, adult longevity, *etc* performed under laboratory.

Results and Discussion

A perusal of data furnished in Table 1, 2, 3, 4 and 5 revealed that the different developmental stages of *Sitophilus oryzae* varied according to different seasons. The incubation period varied from 2.62-5.85 days and was found to be 5.85, 3.62, 2.71, 2.62 and 5.19 days during February, April, June,

August and November respectively. It is evident that egg stage lasted longer (5.19 to 5.85 days) during November and February while it was shorter (2.62 to 3.62 days) during April to August *i.e.*, during summer/hotter months. The temperature and humidity during February ranged from 12.39 to 27.89°C and 58.33- 88.81% R.H. respectively; during April it was 20.90 to 30.91°C and 69.47 to 85.38% R.H.; during June it was 24.14 to 33.19°C and 77.52 to 90.47% RH; during August it was 25.81 to 33.19 and 79.50 to 91.44% R.H. and during November the temperature and humidity ranged from 16.10 to 30.32 and 62.25 to 84.83% R.H. respectively. Though the result of the present study is in conformity with reports of earlier workers, it was in contradiction to some others too. Devi *et al.*, (2017) observed 5.5 days of egg stage when *Sitophilus oryzae* were reared at 24-30°C and 70-80% R.H. on wheat. Singh (2017) obtained incubation period of 6-7 days while Barbuiya (2002) found 5-7 days of egg period when the weevils were reared on rice. Yevoor (2003) noted incubation period of 5 days on maize grains at 14-34°C and 55-88% R.H. Okuni (1924) observed the incubation period of 3-4 days under normal condition while Newman (1927) obtained 3-5 days of egg stage from Australia. Lefevre (1953) also obtained an average of 2.65 days of egg stage in laboratory studies. The result of Wille (1923) contradicted our findings by the note that during summer the incubation period of *Calandra oryzae* (L.) lasted for 6-9 days.

The larval period and pupal period varied greatly in different seasons. Larval period ranged from 12.20 to 21.33 days while pupal stage lasted for 4.80 to 10.20 days in different seasons (Table 1, 2, 3, 4 and 5). Larval and pupal duration was highest during February followed by November; shortest larval stage was noted during August while for pupal period it was during June. Das Chaudhury *et*

al., (2014) noted 22-29 days of larval period and 7-8 days of pupal period of *S. oryzae* at 30.7°C and 23.7°C temperature and 86 and 69% R.H. Singh (2017) recorded 21-27 days as larval period and 7-8 days as pupal period when rice weevils were reared on rice at 22.18°C to 32.8°C and 68% to 85% R.H. Wille (1923) reported 12-17 days of larval period. Bhuiyan *et al.*, (1990) and Treiman (1937) recorded 16-20 days and 18-20 days of larval period on maize and rice respectively. The result of the present study is in consonance with the above works. Lower larval and pupal durations during April to August may be accounted for prevalence of higher temperature (Table 6) causing accelerated biological activities for Eastham and Segrove (1947) reported that in general the developmental periods of the weevils were shorter as the temperature and the relative humidity increases.

The adult longevity was found to vary with seasons and duration of adult sexes varied greatly when reared with food. The adult males survived for 42.63 to 58.72 days while the females lived for 60.69 to 77.23 days when they were reared with food (Table 1, 2 and 4). When the adults were kept in absence of food, the longevity of males ranged from 7.69 to 12.98 days whereas the females survived for 9.75 to 14.47 days. Thus, the longevity of adult females irrespective of supply of food and season was greater than the males.

The present findings are in agreement with some earlier workers while in contradiction to others. Devi *et al.*, (2017) observed that female adult longevity of rice weevil was greater (83.70 days) than males (61.30 days) (adult longevity ratio of male: female, 1:1.4) when weevils were reared on wheat. In this study long duration of adult sexes may be due to variation in rearing condition (reared at 24°C-30°C and 70-80% R.H.) and food.

Singh (2017) also obtained higher duration of adult female (81-105 days) compared to males (57 -63 days). Vijay and Bhuvanewari (2017) revealed 7 and 8 weeks of adult male longevity and 12.43 and 12.50 weeks of adult female longevity of rice weevil on lentil and fried gram respectively at room temperature. Das Choudhury *et al.*, (2014) reported that adult female rice weevil survived for 85–109 days while adult male survived for 59–64 days when reared on rice. Prolonged adult longevity was reported by Bhuiya *et al.*, (1990) with 114-115 days for males and 119-120 days for females. Narayana Swamy *et al.*, (2014) recorded 97.86 days and 116.33 days of longevity of adult males and females respectively with food. However, Okuni (1924) reported adult longevity of 160 days. Howe (1952) observed adult longevity of 15 weeks for *Sitophilus oryzae* in uncontrolled condition with the difference in sexes. In the present study, in absence of food, the adult males survived for 7.69–12.98 days while the females, survived for 9.75–14.47 days. This is corroborated with the findings of Narayana Swamy *et al.*, (2014) who reported that without food adult males lived for 6–11 days while females survived for 8–16 days. Bheemanna (1986) revealed adult longevity of 7-11 days in absence of food.

The total life cycle of male and female was worked out with and without food. It was found that the total life cycle of male was 96.09, 74.27, 65.23, 62.64, 77.57 days and 50.35, 35.95, 27.97, 28.20 and 40.37 days during the month of February, April, June, August and November with and without food respectively. Similarly the females had 114.61, 85.93, 84.33, 86.93 and 96.97 days of total life cycle with food and 51.84, 38.14, 30.69, 29.82 and 40.39 days without food during February, April, June, August and November respectively. Total life cycle for male lasted for 62.64 to 96.09 days while in case of female it ranged from 84.33 to 114.61

days respectively when food was supplied.

However, without food (to adults) the life cycle varied from 27.97 to 50.35 days and 29.82 to 51.84 days respectively. Total life

cycle was noted to be highest in February followed by November, April, June and August (Table 1, 2, 3, 4 and 5). The life cycle of females was always higher than males irrespective of seasons and food.

Table.1 Duration of various developmental stages of *S. oryzae* reared on rice during February 2016 and 2017

Sl. No.	Different stages	Days (pooled mean of 2016 and 2017)		
		Min	Max	Mean ± SD
1	Incubation period	5.17	6.33	5.85±0.31
2	Larval period	19.67	22.83	21.33±0.99
3	Pupal period	9.33	11.50	10.20±0.50
4	Adult longevity of male with food	53.50	64.33	58.72±3.44
5	Adult longevity of female with food	71.33	84.17	77.23±3.11
6	Adult longevity of male without food	11.83	16.00	12.98±0.98
7	Adult longevity of female without food	13.17	15.50	14.47±0.69
8	Total life cycle of male with food	90.33	102.50	96.09±3.81
9	Total life cycle of female with food	110.00	122.17	114.61±2.98
10	Total life cycle of male without food	47.67	54.67	50.35±1.85
11	Total life cycle of female without food	48.83	54.33	51.84±1.56
12	Total developmental period (egg to adult)	34.83	39.67	37.38±1.32

***Observations based on 3 replications

Table.2 Duration of various developmental stages of *S. oryzae* reared on rice during April

Sl.No.	Different stages	Days (pooled mean of 2016 and 2017)		
		Min	Max	Mean ± SD
1	Incubation period	3.33	4.00	3.62±0.22
2	Larval period	12.67	15.83	14.33±0.92
3	Pupal period	6.50	7.83	7.28±0.41
4	Adult longevity of male with food	46.17	52.67	49.03±1.88
5	Adult longevity of female with food	55.67	66.37	60.69±3.18
6	Adult longevity of male without food	9.33	12.50	10.67±0.71
7	Adult longevity of female without food	11.83	14.17	12.91±0.61
8	Total life cycle of male with food	69.83	77.83	74.27±.20
9	Total life cycle of female with food	80.83	91.67	85.93±3.00
10	Total life cycle of male without food	33.50	38.00	35.95±1.30
11	Total life cycle of female without food	36.17	40.33	38.14±1.13
12	Total developmental period (egg to adult)	23.17	27.00	25.23±1.07

***Observations based on 3 replications

Table.3 Duration of various developmental stages of *S. oryzae* reared on rice during June

Sl.No.	Different stages	Days (pooled mean of 2016 and 2017)		
		Min	Max	Mean ± SD
1	Incubation period	2.17	3.17	2.71±0.26
2	Larval period	11.00	14.83	12.77±1.09
3	Pupal period	4.17	5.50	4.80±0.29
4	Adult longevity of male with food	39.17	55.33	44.95±3.94
5	Adult longevity of female with food	60.17	70.00	64.39±2.34
6	Adult longevity of male without food	6.83	8.67	7.69±0.52
7	Adult longevity of female without food	9.83	11.17	10.42±0.37
8	Total life cycle of male with food	58.00	75.33	65.23±4.39
9	Total life cycle of female with food	80.17	87.67	84.33±1.97
10	Total life cycle of male without food	26.17	30.33	27.97±1.20
11	Total life cycle of female without food	28.83	32.50	30.69±1.00
12	Total developmental period (egg to adult)	18.83	22.17	20.28±0.96

***Observations based on 3 replications

Table.4 Duration of various developmental stages of *S. oryzae* reared on rice during August

Sl.No	Different stages	Days (pooled mean of 2016 and 2017)		
		Min	Max	Mean ± SD
1	Incubation period	2.33	3.17	2.62±0.22
2	Larval period	11.00	13.00	12.20±0.54
3	Pupal period	4.33	5.67	5.19±0.38
4	Adult longevity of male with food	39.00	46.33	42.63±1.77
5	Adult longevity of female with food	63.83	72.17	66.93±2.24
6	Adult longevity of male without food	7.50	8.83	7.88±0.40
7	Adult longevity of female without food	9.33	10.67	9.75±0.30
8	Total life cycle of male with food	58.83	66.83	62.64±1.95
9	Total life cycle of female with food	83.83	92.50	86.93±2.08
10	Total life cycle of male without food	26.33	29.50	28.20±0.83
11	Total life cycle of female without food	28.17	31.17	29.82±0.79
12	Total developmental period (egg to adult)	18.33	21.17	20.01±0.67

***Observations based on 3 replications

Table.5 Duration of various developmental stages of *S. oryzae* reared on rice during November

Sl.No.	Different stages	Days (pooled mean of 2016 and 2017)		
		Min	Max	Mean ± SD
1	Incubation period	4.67	5.83	5.19±0.27
2	Larval period	14.67	17.17	15.99±0.69
3	Pupal period	7.50	8.17	7.88±0.22
4	Adult longevity of male with food	44.50	54.17	48.32±2.52
5	Adult longevity of female with food	61.17	74.83	67.91±3.65
6	Adult longevity of male without food	10.33	12.83	11.31±0.71
7	Adult longevity of female without food	9.17	13.17	11.33±1.37
8	Total life cycle of male with food	73.17	82.83	77.57±2.47
9	Total life cycle of female with food	90.33	104.67	96.97±3.90
10	Total life cycle of male without food	38.83	42.67	40.37±1.07
11	Total life cycle of female without food	37.83	43.33	40.39±1.71
12	Total developmental period (egg to adult)	27.17	31.00	29.06±0.91

***Observations based on 3 replications

Table.6 Monthly distribution of maximum and minimum temperature (°C) and Relative Humidity (%) for the year 2016 and 2017 (Pooled mean)

Months	Temperature (°C)		Relative humidity (%)	
	Min	Max	Min	Max
February	12.39±1.94	27.89±2.02	58.33±13.45	88.81±11.41
April	20.90±2.43	30.91±3.06	69.47±15.21	85.38±9.03
June	24.14±3.10	32.79±2.61	77.52±10.44	90.47±9.08
August	25.81±1.14	33.19±2.17	79.50±7.91	91.44±7.89
November	16.10±1.99	30.32±1.57	62.25±9.82	84.83±11.01

Variable durations of life cycle with 45 days in summer and to a maximum of five months in cool autumn and winter was reported by Wille (1923). Singh (2017) and Narayana Swamy *et al.*, (2014) noted total life cycle of 42 days on rice and wheat respectively. Kavita Yadav (2006) obtained total life cycle of 35–46 days from egg to adult while Howe (1952) reported 25–46 days of egg to adult stage. Bheemanna (1986) noted that total life cycle of rice weevil ranged from 38–53 days on sorghum.

In conclusion, from the biology studies of *S. oryzae* on rice at different seasons *viz.*, February, April, June, August and November

during 2016 and 2017, it was found that various developmental stages of rice weevil varied according to seasons. The developmental period of different stages (egg to adult) and total life cycle was always higher during November and February whereas shorter duration was recorded during April, June and August. Adult longevity of females was higher than that of males irrespective of season and food.

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