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Biology of *Sitophilus zeamais* Motsch. On maize grains under laboratory condition

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Abstract
The present investigation entitled "Studies on the Biology of Maize weevil, (*Sitophilus zeamais* Motschulsky)" was conducted at Abhilashi University Mandi, Himachal Pradesh. Under laboratory condition in BOD Incubator with three replications. The result shows that the laboratory experiments and revealed that the duration of various developmental stages such as incubation period, larval period, pupal period and adult longevity. The incubation period ranged from 7 to 10 days with mean 8.21±0.025 and the total larval period ranged from 31 to 38 days with mean 37.46±0.033 days and the total pupal period ranged from 9 to 14 days with mean 11.33±0.022 days. The total life cycle from egg to adult as 87 to 102 days with mean of 92.37±0.08 days in males and 98 to 109 days with mean of 98.62±0.154 days in females during winter November 2021 to January 2022 the temperature and relative humidity ranges from 30 °C and 60-75% RH respectively.

Keywords: Biology, temprature, relative humidity, sitophilus *zeamais* Motschulsky

Introduction
Maize (*Zea mays* L.) belongs to family Poaceae and Gramineae. Maize is one of the most important cereal crops in the world and also helpful for man as well as animals and used in industrial production. Maize is the third most important cereal crop of India after wheat and rice in area and production in world. Maize is also known as queen of cereals because the maize has very high yield potential than that of other cereal crops. In India, maize occupies an area of about 9.72 million hectares with a production of around 28.64 million tonnes (DAC & FW 2020). In Himachal Pradesh, it occupies an area of 286780 ha with a total production of 725553 metric tonnes (DLR, HP. 2019).

Farmers and householder in developing countries face many problems during storage of their grains. Major problem during storage grains several species of insect pest may infest grain in storage (Suleiman and Yusuf 2011) [10]. Stored grains such as maize, wheat, rice. These crops are infested due to several species of insect pests. Major pest of stored grains such as rice weevil, maize weevil, wheat weevil, Angoumois grain moth, rice moth. Maize crop is infested by many insect pests during storage. Maize weevil and Angoumois grain moth are the most important pests of stored maize. Maize weevil (*Sitophilus zeamais* Motschulsky) comes under family curculionoidae and order coleoptera. *Sitophilus zeamais* Motsch. Are one of the serious pests of maize crop? *Sitophilus zeamais* Motsch. Cause most critical infestation in many cereal crops. *S. zeamais* Motsch. Can also survive on the other commodity. Both the grubs and adults are responsible for the damage. Larvae and pupae complete their life cycle with in the kernel and adult emerge from the kernel. *S. zeamais* Motsch. Causes qualitative and quantitative damage to stored products with grain weight loss ranging between 20-90% for untreated stored maize. Heavy infestation of adults and larva of maize weevil causes post-harvest losses with ranges from 30-40% (Sharma *et al*. 2016) [6]. The damage and losses caused by these factors have been estimated 20-30% by weight basis. These factors have been considered as the major part for the reduction of the quality and quantity of the maize (Sharma *et al*. 2016) [6].

Materials and Method
Maintenance of stock culture
The stock culture of *S. zeamais* Motsch. Was initiated in the laboratory condition on maize crop. The culture was maintained in plastic jars containing the maize grains. Maize grains were provided periodically for the development of weevil.

Maintenance of pure culture
Pure culture of the weevil was developed by infesting insect free maize grains with freshly emerged single mating pair. The culture was maintained in the plastic jars. This culture was used to study the biology of the *S. zeamais* Motsch. On maize grains.

Recording of Temperature and Relative Humidity of the experimental laboratory
The pure culture was started in BOD Incubator to maintain the temperature and relative humidity for the better development of the *S. zeamais.* The BOD Incubator temperature was 30°C and relative humidity was 60-75% for the growth of weevil.

Duration of different stages of Maize weevil
Study on the biology of Maize weevil, *S. zeamais* Motsch. The procedure followed to study the different stages of Maize weevil, *S. zeamais* Motsch. Under laboratory condition. Thirty maize weevils were enclosed with maize grains in each petri plates and petri plates kept under ambient conditions. Infested grains were replaced every morning with uninfested grains. Grains containing eggs were separated out by examining under microscope and were used for further study. Maize grains with maize weevil eggs were maintained in plastic boxes for incubation. Daily twenty grains from the day of oviposition to egg hatching were dissected to determine the incubation period. On the hatching of grub of maize weevil were allowed to feed inside the grains. Twenty grains per day were dissect out to check the different larval instars. The dissection of grains was made up to pupal stage. The period between larvae to pupal stage was observed. The pupal period of the insect was studied by observing the same larvae for pupation inside the grains. This was maintained and the observation was made upto adult emergence. The period between formations of pupae up to adult emergence was observed as pupal period. The ability of the adults of *S. zeamais* Motsch. To live in the presence of food was determined by enclosing male and female adults obtained from culture separately. Ten vials were maintained for each of the male and female with food under laboratory condtion.

Statistical analysis
Data of each experiment were subjected to suitable statistical methods of analysis. The statistical methods followed in the experiments are Analysis of Variance (ANOVA) technique Transformation of data was done wherever necessary.

Result and Discussion
Biology of the *S. zeamais* under temperature was 30oC and Relative Humidity was 60-75% during the month during winter (November 2021 to January 2022). The results along with description of brief biology of various developmental stages are presented as follow.

Egg Period
Eggs were laid inside the maize grains in petri plates. The eggs were oval in shape. Freshly laid eggs were translucent and creamy white colour. During winter the incubation period ranged from 7 to 10 days with mean of 8.21±0.025 days. These findings partially similar with the findings of Wille (1923) [8] observed 6 to 9 days of incubation period in case of *Calandra oryzae* (L.) on husked rice. But Treimen (1937) [7] reared rice weevil in laboratory condition and recorded the incubation period from 6 to 7 days which substantiates our findings. And Ojo and Omoloye (2016) [4] observed that the developmental biology of maize weevil and the incubation period ranged from 3 to 7 days.

Grub Period
Four instars were observed during winter. Grub was apodous, short, yellowish cream coloured and yellowish and light brown colour head. The total grub period 31 to 38 days with an average 37.46±0.033 days. The present study four instars were observed during winter ranged from 31 to 38 days according to Sattigi (1982) [5] the larval period ranged from 23 to 33 days during winter (February to March) and this corroborates with our findings of the study of Biology of *S. oryzae.* And Ojo and Omoloye (2016) [4] the developmental biology of maize weevil and the total larval period ranged from 23 days.

Pupal Period
Pupa was darker and yellowish white colour. Pupa was exarate type with clearly visible head thorax and abdomen. Pupal period occupied 9 to 14 days with mean of 11.33±0.022 days. The present findings were observed and acc. to Bheemanna (1986) [1] recorded the pupal period of *S. oryzae* from 8 to 11 days which substantiates report of winter study of biology. And Ojo and Omoloye (2016) [4] reported that the developmental biology of maize weevil on maize grains the total pupal period 6 to 7 days.

Adult
Newly emerged adults were yellowish brown which turned to black in due course of time. Adults were elongate sub-cylindrical with four yellowish orange-coloured patches on elytra. Externally both male and female look alike but on closer observation, the rostrum of the male was small, thick, punctured roughs curved, while in female it was elongate, smooth, slightly curved and sparsely punctured. The size of the male was larger than the female. The male adult with food ranged from 43 to 51 days with an average 46.37±0.053 days. And female adult with food ranged from 54 to 61 days with an average 58.33±0.022 days. The present studies were partially similar to the findings of the Yavoor (2003) were concluded male lived with food from 97.42 days and female lived with food from 115.76 days from our findings. But the reports of Bheemanna (1986) [1] that the adult longevity of 14 to 165 days with food supports our results.

Mating period
The mating of the weevil ranged from 20 to 55 minute with an average 46.41±0.008 min.

Total development period
The total development period from incubation period, larval period and pupal period with an average 53.33±0.003 days.

Total life cycle
the total life cycle from egg to adult occupied 87 to 102 days in males with an average of 92.37±0.08 days and in females the total life cycle from egg to adult occupied 98 to 109 days with an average 98.62±0.154 days. The present studies were partially similar to the findings of Bheemanna (1986) [1] reported that 38 to 53 days of total life cycle on sorghum

hybrib CSH-5. And Ojo and Omoloye (2016) [4] recorded that the development and life history of maize weevil under laboratory condition on maize grains. The total life cycle from egg to adult period with mean 34.7 d.

Table 1: Biology of *Sitophilus zeamais* Motsch. On Maize grains under laboratory condition**.**

Life Stages		Winter (November (2021) – January (2022)	
		Range Duration (in days)	**Range Duration (in days)**
Incubation period		7-10	8.21±0.025
Duration of each instar	1st Instar	7-9	7.75±0.012
	2nd Instar	9-11	9.54±0.017
	3rd Instar	9-12	9.87±0.022
	4th Instar	9-12	10.46±0.006
Total larval period (Days)		31-38	37.46±0.033
Pupal period		9-14	11.33±0.022
Male with Food		43-51	46.37±0.053
Female with Food		54-61	58.33±0.022
Mating per (min.)		20-55	46.41±0.008 (min.)
Total development period (Days)		52-55	53.33±0.003
Total life cycle of Male		87-102	92.37±0.08
Total life cycle of Female		98-109	98.62±0.154

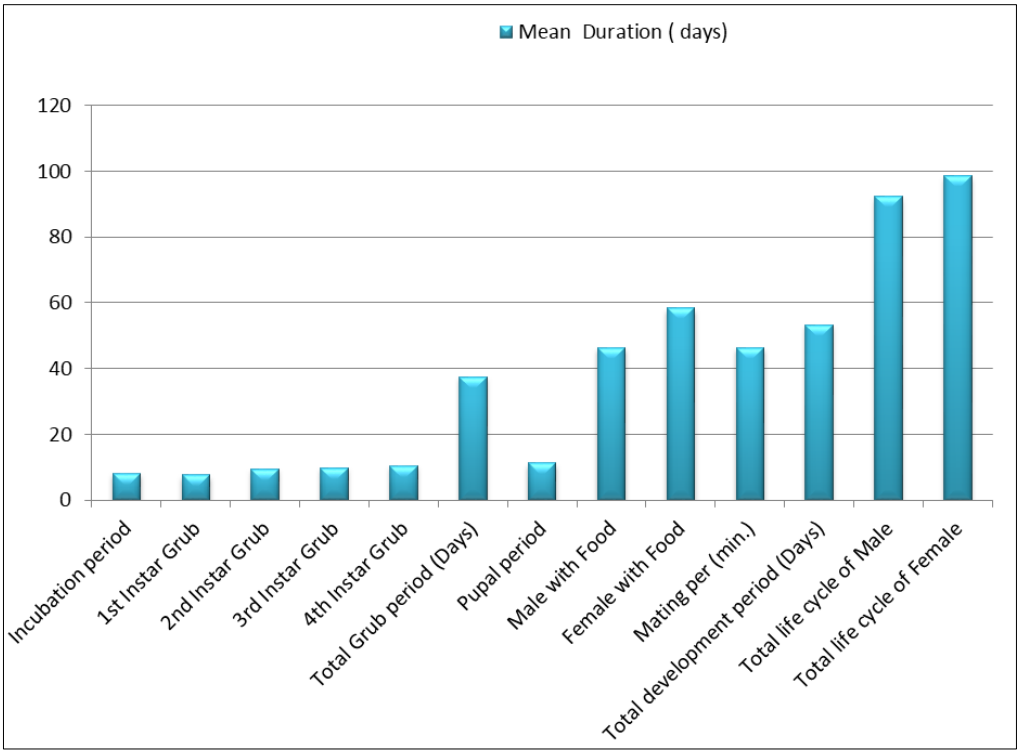

Fig 1: Biology of *Sitophilus zeamais* Motsch. On Maize grains under laboratory condition

Summary and Conclusion

Biology of the *S. zeamais* Motsch. On maize grains under laboratory condition during winter 2021-2022 (November-January) was carried out and it was recorded that the egg period of *S. zeamais* Motsch. Varied from 7 to 10 days with a mean of 8.21 ±0.025 days during winter. The total grub period ranged from 31 to 38 days with a mean of 37.46±0.033 days in winter. The 1st, 2nd, 3rd and 4th instar ranged from 7 to 9, 9 to 11, 9 to 12, 9 to 12 days with mean 7.75 ± 0.012, 9.54 ± 0.017, 9.87±0.022 and 10.46±0.006 days, respectively in winter. The pupal period occupied 9 to 14 days with an average of 11.33±0.022 days in winter. During winter when the adults were provided with food, the male lived for 43 to 51 days with mean of 46.37±0.053 days and female for 54 to 61 days, with mean of 58.33±0.022 days, respectively including mating period of 20 to 55 minutes with mean of 46.41±0.008 (min.). The total life cycle from egg to adult occupied during winter while it occupied 87 to 102 days in males with mean of 92.37±0.08 days and 98 to 109 days in females with mean of 98.62±0.154 days.

The biology of *S. zeamais* Motsch. Concluded that the incubation period, larval period, pupal period and adult longevity at November to January during 2021-2022 each having with mean of 8.21±0.025, 37.46±0.033, 11.33±0.022 and 46.37±0.053 (Male), 58.33±0.022 (Female) and complete life cycle in male 92.37±0.08 and in female 98.62±0.154 respectively. Adult longevity of female was higher than that of males with food.

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