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## Biology of angoumois grain moth, *Sitotroga cerealella* (Olivier) (Gelechiidae: Lepidoptera) on paddy

**Basavanjali, Sushila Nadagouda, A Prabhuraj, Basavegowda and Shivaleela**

**Abstract**

The angoumois grain moth, *Sitotroga cerealella* (Olivier) is one of the most serious pests of paddy at post-harvest level. This experiment was conducted during 2018- 2019 at Department of Agricultural Entomology, UAS, Raichur. The study revealed that the female moth lays 110 eggs on rice grains and develops through five larval instars, pupa and adult stages. The ovipositional period, incubation period, larval period and pupal period of angoumois grain moth on paddy were  $2.5 \pm 0.53$  days,  $4.1 \pm 0.70$  days,  $24.3 \pm 2.25$  days and  $6.3 \pm 0.95$  days, respectively; male and female longevity of moth were  $6.1 \pm 1.10$  and  $8.5 \pm 0.85$  days, respectively. The total life cycle was  $41.4 \pm 3.54$  days. The length of male and female moth was  $10.1 \pm 0.29$  and  $11.2 \pm 0.33$  mm respectively. The morphometric measurements of all stages were measured using stereo- orisome microscope.

**Keywords:** angoumois grain moth, biology, fecundity, life cycle, morphometry and paddy

**Introduction**

Paddy, *Oryza sativa* L. is an important staple food crop for more than 60 per cent of the world's production. India has the largest area under paddy in the world and ranks second in the production after China. The per capita food intake in India is 2,234 calories per day of which 30 per cent comes from rice. Grain production has been steadily increasing due to advancement in production technology, but improper storage results in high loss of grains. Stored-product insects can cause postharvest losses, estimated up to 9 per cent in developed countries to 20 per cent or more in developing countries. A large portion (more than 65 % of the production) of the rice produced is stored up to the next season to ensure food, feed and seed. During storage, paddy is highly vulnerable to infestation by a variety of insect pests and diseases. Among various pests commonly infesting stored grains, angoumois grain moth /paddy moth, *S. cerealella* (Olivier) (Gelechiidae: Lepidoptera) is the most serious primary feeder and cosmopolitan pest <sup>[1]</sup>. It attacks various cereals like wheat, rice, barley, maize and jowar <sup>[2]</sup>. Its infestation starts in standing field crop and additional damage to the grain can then occur through the attack of secondary insect pests <sup>[3]</sup>. Infestation by *S. cerealella* may penetrate quite deeply into bag stacks, but in bulk storage they are usually localized on the top 10-20 cm.

Larval feeding inside the grain caused an appreciable amount of damage which has been stated about 8.1 per cent <sup>[4]</sup>. Heavily infested grain smells bad and is less attractive for consumption. Infestations produce abundant heat and moisture that may encourage mould growth and attract secondary pests <sup>[5]</sup>. So, it is necessary to know the biology of *S. cerealella* as it is the serious damaging pest of paddy.

**Materials and Methods**

The experiment was carried out during 2018-19 under laboratory condition at Department of Agricultural Entomology, College of Agriculture, Raichur and paddy seeds (Gangavati sona) procured from Seed unit, UAS, Raichur were used for present study.

**Maintenance of pure culture of angoumois grain moth on paddy seeds**

Angoumois grain moth was collected from the infested paddy seeds and the culture was further maintained in plastic jars of two kg capacity containing paddy seeds (Gangavati sona).

The plastic jars were covered with muslin cloth and fastened tightly with the help of rubber band. Fresh seeds were provided regularly and exposed separately for the multiplication of insects at room temperature of 27 °C. The insects emerged from this culture were used throughout the period of experimentation.

#### Ovipositional period, Incubation period and fecundity

Male and female moths were identified based on external characters that is males are comparatively shorter than females and the male abdomen is thinner, pointed and blackish when viewed from the ventral side where as in females; the abdomen is bulky, longer without any blackish coloration and larger in size. A pair of freshly emerged male and female adults were released into plastic vials (7.5×2.5 cm) mouth of vials was covered by muslin cloth and tightened with rubber band containing a strip of black paper at bottom of the vials to enable egg laying. The honey dew solution was given for adult as food. The numbers of egg laid by angoumois grain moth were recorded by removing paper strip after a week. The period from first egg laying to till the last egg laid was recorded as ovipositional period. The period of laying till hatching was recorded as incubation period.

#### Larval period and pupal period

A sample of 50 sound grains from paddy was taken and mixed with 50 fertile eggs in plastic jars measuring 10×5 cm. Observations were recorded at 24 hours interval to study the number of instar, size of the larvae and behavior at every instar. Different instar was identified by the presence of head capsule or cast skin as indicator. Larval period was taken as the time period between the days of egg hatching to two days after the formation of silken capping on the grains. The time period from two days after the formation of silken capping up to the emergence of adults was noted as pupal period.

#### Adult longevity

Individual pair of moths was maintained separately in plastic

jars for their longevity along with 10 per cent honey solution and without honey solution. The daily observations were made on longevity of both male and female. Morphometric measurements of egg, five instars, pupa and adult moth of female and male were done using stereo-oriosome microscope.

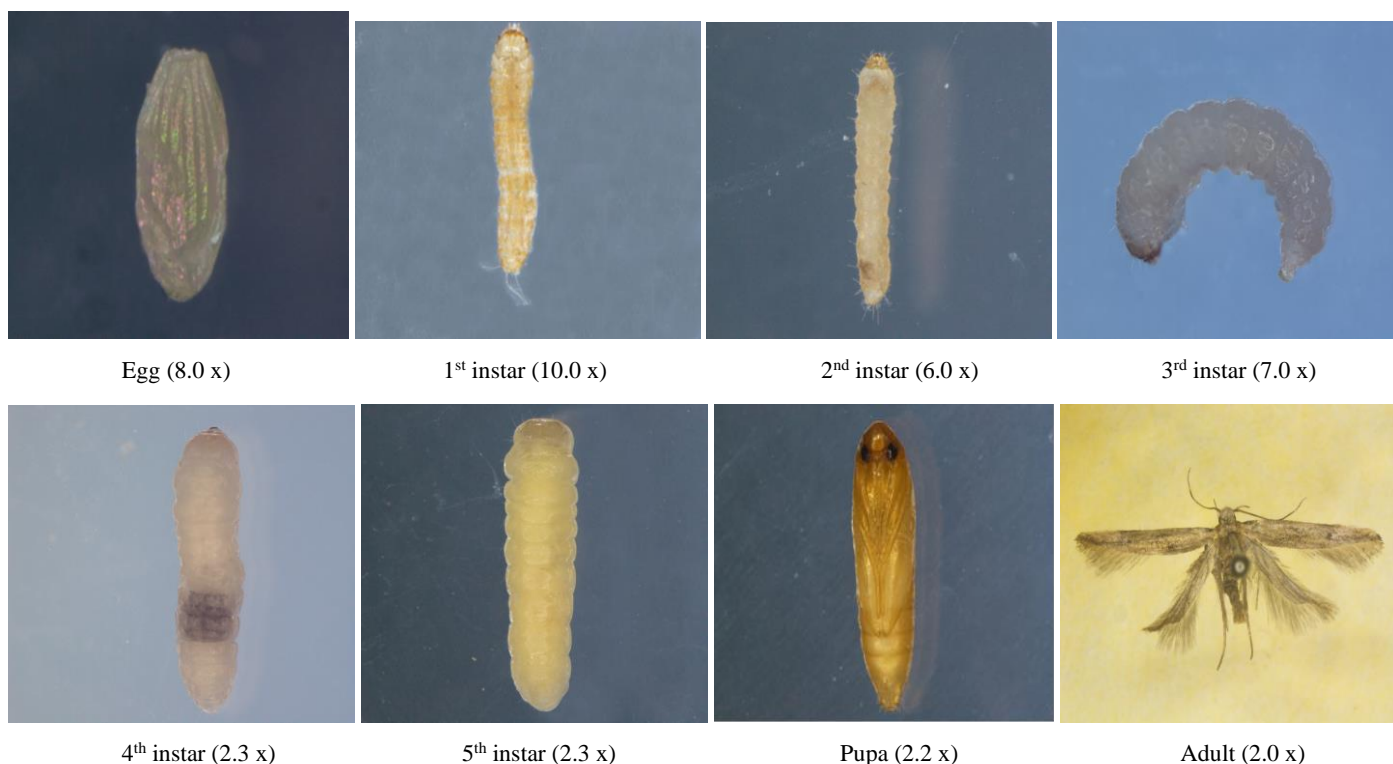
#### Results and discussion

##### Fecundity, oviposition period and incubation period

The angoumois grain moth, *S. cerealella* adults started mating after 24 hr. of emergence. On a black strip of paper the female moth laid 70 to 180 eggs with an average of 110 eggs (Fig 1). The newly hatched egg was oval shaped, creamy white but gradually changed to pinkish with age. The ovipositional period and incubation period was found to be 2.4 to 2.6 days and 3.9 to 4.26 days, respectively with an average of  $2.5 \pm 0.53$  days and  $4.1 \pm 0.70$  days, respectively. The average fecundity and incubation period of *S. cerealella* on maize, ranged from 106.7 to 146.3 numbers and 4.3 to 5.7 days, respectively [6] and the mean incubation period and mean fecundity observed were  $6.23 \pm 0.07$  days and 100.57 eggs per female, respectively [7].

##### Larval period

The larvae had five instars and the newly hatched larvae of all instars were yellowish white with a light brown head. The duration of the first, second, third, fourth and fifth instar larvae on an average were  $2.5 \pm 0.47$ ,  $3.2 \pm 0.59$ ,  $9.6 \pm 0.70$ ,  $4.1 \pm 0.52$  and  $4.9 \pm 0.74$  days, respectively (Fig 2, 3, 4, 5 and 6) (Table 1). The total larval period ranged from 23.4 to 27.5 days. The tiny larva lives inside a grain, after entering the grain, the larva often turns and practically closes the entry hole with a silken web. The larval life then begins in an environment of plenty of food and safety and continues in that state till it is fully grown to about 5 mm within two or three weeks. The total larval periods of *S. cerealella* was 25.2 days on paddy [8] and the mean development period of 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> larval instars lasted 3.0, 4.1, 4.4 and 4.5 days respectively in rice [9].



**Plate 1:** Development stages of *S. cerealella* on paddy

### Pupal period, adult longevity and total life cycle

The pupa is brown colored, develops inside the silken cocoon and total of  $6.3 \pm 0.95$  days were required for the pupal stage under the laboratory condition (Fig 7). The longevity of females was more than that of males. The adult longevity was  $8.5 \pm 0.85$  days for female and  $6.1 \pm 1.10$  days for male. The adult was gray or buff-colored moth, darker spots on forewings. The apex of hind wings was fringed with hairs, which was sharply pointed towards the tips and widely separated so that the abdomen is partially visible (Fig 8). The total life cycle of *S. cerealella* from egg to adult occupied 35 to 45 days with an average of  $41.4 \pm 3.54$  days.

The pupal period ranged from 7.2 to 8.2 days and adult longevity period ranged from 7.2 to 8.4 days for female, 6.8 to 7.6 days for male, respectively on maize <sup>[10]</sup>. The development cycle varied from 37 days to 45 days on wheat <sup>[11]</sup> and total life cycle was completed in 27 to 40 days <sup>[2]</sup>.

The length of the egg measured was  $0.51 \pm 0.01$  mm and width was  $0.23 \pm 0.01$  mm. The length of all five larval instars were  $0.71 \pm 0.02$ ,  $2.00 \pm 0.05$ ,  $2.6 \pm 0.07$ ,  $3.69 \pm 0.10$  and  $4.00 \pm 0.11$  mm and the widths were  $0.15 \pm 0.01$ ,  $0.32 \pm 0.01$ ,  $0.56 \pm 0.02$ ,  $0.98 \pm 0.02$  and  $1.1 \pm 0.03$  mm, respectively and the pupa were  $3.83 \pm 0.10$  mm in length and  $1.00 \pm 0.11$  mm in width, respectively. The length and width of female was  $11.2 \pm 0.33$  and  $2.2 \pm 0.06$  mm, respectively and male was  $10.1 \pm 0.29$  and  $2.0 \pm 0.07$  mm, respectively (Table 2).

The length and width of the pupa was  $4.0 \pm 0.02$ ,  $3.5 \pm 0.01$  mm and  $1.20 \pm 0.05$ ,  $1.50 \pm 0.03$  mm respectively <sup>[8]</sup>. The length of male and female was  $11.2 \pm 0.09$  and  $12.07 \pm 0.06$  mm respectively. The lengths of all five larval instars were  $4.52 \pm 0.03$ ,  $6.03 \pm 0.04$ ,  $7.27 \pm 0.04$ ,  $8.64 \pm 0.03$  and  $11.63 \pm 0.03$  mm, respectively and the widths were  $1.31 \pm 0.15$ ,  $1.97 \pm 0.05$ ,  $2.20 \pm 0.06$ ,  $2.39 \pm 0.07$  and  $2.43 \pm 0.10$  mm, respectively <sup>[12]</sup>.

**Table 1:** Development periods of different life stages of *S. cerealella* on Paddy

Development periods	Duration ( days)			
	Mean± SD		Range	
Oviposition period	2.5±0.53		2.4-2.60	
Incubation period	4.1±0.70		3.9-4.2	
<b>Larval period</b>				
1 <sup>st</sup> instar	2.5±0.47		2.4- 2.6	
2 <sup>nd</sup> instar	3.2±0.59		3.4-3.6	
3 <sup>rd</sup> instar	9.6±0.70		9.0-11.0	
4 <sup>th</sup> instar	4.1±0.52		3.9-4.2	
5 <sup>th</sup> instar	4.9±0.74		4.7-5.1	
Total larval period	24.3±2.25		23.4-27.5	
Pupal period	6.3±0.95		6.1-6.5	
Adult longevity	Without food	With food	Without food	With food
Male	4.5± 0.62	6.1±1.10	4.0-5.5	5.0-7.0
Female	6.05±0.64	8.5±0.85	5.0-7.0	8.0-10.0
Fecundity ( Number)	110±38.87		70-180	
Total life cycle	41.4±3.54		35-45	

\*N= Average of 10 insects

**Table 2:** Morphometry of different life stages of *S. cerealella* on Paddy

Life stages	Length (mm)		Breadth (mm)	
	Mean ±SD	Range	Mean ± SD	Range
Egg	0.51±0.01	0.48-0.52	0.23±0.01	0.22-0.24
<b>Larval instars</b>				
1 <sup>st</sup> Instar	0.71±0.02	0.70-0.74	0.15±0.01	0.15-0.16
2 <sup>nd</sup> Instar	2.00±0.05	1.94-2.08	0.32±0.01	0.32-0.34
3 <sup>rd</sup> Instar	2.6±0.07	2.52-2.70	0.56±0.02	0.52-0.56
4 <sup>th</sup> Instar	3.69±0.10	3.58-3.84	0.98±0.02	0.95-1.02
5 <sup>th</sup> Instar	4.00±0.11	3.88-4.16	1.1±0.03	1.07-1.14
Pupa	3.83±0.10	3.72-3.98	1.00±0.11	0.97-1.00
<b>Adult</b>				
Female	11.2±0.33	11.09-11.65	2.2±0.06	2.13-2.29
Male	10.1±0.29	9.7- 10.4	2.0±0.07	1.94- 2.08

\*N= Average of 10 insects

### Conclusion

The Angoumois grain moth, *S. cerealella* (Olivier) was the most destructive internal pest and one of most serious pest of stored rice (unhusked) at post-harvest level. The moth develops through egg, five larval instars, and pupa, pre-pupa and adult stages. The total life cycle of *S. cerealella* from egg to adult occupied 35 to 45 days.

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