

## BIBLIOGRAPHY

SANGGOY, MERIAM A. OCTOBER 2012. Life History of Fruitworm (*Helicoverpa zea* Boddie) on Tomato (*Lycopersicon esculentum* Mill). Benguet State University, La Trinidad, Benguet.

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## ABSTRACT

The study was conducted at the Mites Predatory Rearing House from October 2011 to March 2012 to determine the duration of development and morphological characteristics of the different growth stages of fruitworm; to determine the larval feeding behavior and nature of damage; to determine the adult's mating and oviposition behavior, and the fecundity of the adult female.

The developmental stages and duration of the different growth stages were as follows; egg, 7-8 days with a mean of  $7.13 \pm 0.35$  days; first instar, 6-7 days with a mean of  $6.56 \pm 0.50$  days; second instar, 3-4 days with a mean of  $3.20 \pm 0.41$  days; third instar, 3-6 days with a mean of  $4.33 \pm 0.84$  days; fourth instar, 3-5 days with a mean of  $4.26 \pm 0.58$  days; fifth instar, 3-5 days with a mean of  $3.66 \pm 0.71$  days; pre-pupa, 3-4 days with a mean of  $3.13 \pm 0.35$  days; pupa, 20-26 days with a mean of  $23.76 \pm 1.85$  days; adult male, 12-15 days with a mean of  $13.40 \pm 0.97$  days and 12-15 days with a mean of  $13.70 \pm 1.06$  days for the female.



The eggs were light yellow and hemispherical in shape, 0.4-0.8 mm long with a mean of 0.75 mm and 0.2-0.4 mm in width with a mean of 0.37 mm. The first instars were light yellowish green and measured 9-10 mm long with a mean of 9.37 mm and 1.0 mm in width with a mean of 1.00 mm.

The second instars measured 11-15 mm in length with a mean of 14.57 mm and 2-3 mm width with a mean of 2.10 mm. The third instars were morphologically the same with the second instars except in size; they measured 18-21 mm in length with a mean of 16.27 mm and 3-4 mm in width with a mean of 3.13 mm. The fourth instars measured 22-25 mm in length with a mean of 24.40 mm and 3-4 mm in width and a mean of 3.37 mm. The fifth instars head were light green or light brown in color. The larvae measured 33-40 mm in length with a mean of 34.87 mm and 5-6 mm in width with a mean of 5.13 mm. Just after pupation, the pupae were yellowish green in color and changed to greenish brown after 1-2 days and mahogany brown before it emerged to adult. The pupa measured 19-20 mm in length with a mean of 19.87 mm and 5-6 mm in width with a mean of 5.03 mm. The adults were brown or grayish brown in color. The abdomens of the females were stout and measured 21-25 mm in length (from the tip of the head to the tip of abdomen) with a mean of 22.40 mm and 5-6 mm in width with a mean of 5.40 mm. The abdomens of the males were elongated and measured 19-22 mm in length with a mean of 20.30 mm and 5-6 mm width with a mean of 5.20 mm.

The larvae immediately fed by chewing as they emerged from the eggs causing irregular notches and holes on the leaves. The fully grown larvae fed and burrowed on the green tomato fruit. The adults laid eggs in any parts but preferred the leaves of tomato plants. A single mother laid as many as 343-460 eggs.



## RESULTS AND DISCUSSION

### Duration of the Different Growth Stages of Fruitworm

The mean duration of the different growth stages of fruitworm at different growth stages is presented in Table 1.

Table 1. Mean duration (days) of the different life stages of fruitworm under room temperature

GROWTH STAGES	RANGE (Days)	MEAN (Days)
Egg	7-8	7.13 ± 0.35
Larva		
First instar	6-7	6.56 ± 0.50
Second instar	3-4	3.20 ± 0.41
Third instar	3-6	4.33 ± 0.84
Fourth instar	3-5	4.26 ± 0.58
Fifth instar	3-5	3.66 ± 0.71
Pre-pupa	3-4	3.13 ± 0.35
Pupa	20-26	23.76 ± 1.85
Adult		
Male	12-15	13.40 ± 1.06
Female	12-15	13.70 ± 0.97



Egg. The result showed that the duration of this stage ranged from 7-8 days and relatively shorter than the 7-10 days as reported by Valentine (1998).

First instar. The first instars developed from 6-7 days which were longer than the 2-3 days as observed by Campbell et. al (1956).

Second instar. It took 3-4 days to complete the second instar stage of the fruitworm. The result showed that it was one day longer than the 2-4 days as reported by the DPI& F (2012).

Third instar. The development of the third instars ranged from 3-6 days which were shorter than the 4-8 days as observed by the DPI& F (2012).

Fourth instar. The duration of the fourth instars took 3-5 days which were relatively longer than the 2-4 days as observed by Campbell et. al (1956).

Fifth instar. The duration for the fifth instars ranged from 3-5 days, a result similar with the 3-5 days findings of Campbell et.al (1956).

Pre-pupa. The duration of the pre-pupae took 3-4 days, results which were shorter than the 2-3 days observation of Campbell et. al (1956).

Pupa. The developmental days of the pupae ranged from 20-26 days which were longer than the 10-25 days observation of Mayer (1914). The duration for the pupal stage may be prolonged during cold weather according to Metcalf (1951).

Adult. The duration of the adult took 12-15 days which were relatively longer than that 12-14 days observation of Riley and Spark (2005).

The longevity of both sexes ranged from 12-15 days. However, the adult females were observed to live slightly longer with a mean of  $13.70 \pm 0.97$  days than those of males



with a mean of  $13.40 \pm 1.06$  days. The mean duration of the different stages of fruit worm is presented in Table 1.

Morphological Characteristics of the Different Growth Stages of the Fruitworm

The body length and width of the fruitworm at the different growth stages is presented in Table 2.

Table 2. The length and width (mm) of the fruitworm at different growth stages under room temperature

GROWTH STAGES	LENGTH (mm)		WIDTH (mm)	
	RANGE	MEAN	RANGE	MEAN
Egg	0.4-0.8	0.75	0.2-0.4	0.37
Larva				
First instar	9-10	9.37	1.0	1.00
Second instar	11-15	14.57	2-3	2.10
Third instar	18-21	16.27	3-4	3.13
Fourth instar	22-25	24.40	3-4	3.37
Fifth instar	33-40	34.87	5-6	5.13
Pre-pupa	23-25	24.83	4-5	4.87
Pupa	19-20	19.87	5-6	5.03
Adult				
Female	21-25	22.40	5-6	5.40
Male	19-22	20.30	5-6	5.20



Egg. The eggs of fruitworm were hemispherical in shape and light yellow in color (Figure 3.a). It changed to creamy brown after 2 to 3 days. The color changed to reddish brown before emerging to adult (Figure 3.b). The eggs were laid anywhere on the plants and on the cages but the leaves were preferred.

The eggs measured from 0.4-0.8 mm in length with a mean of 0.75 mm and 0.2-0.4 mm in width with a mean of 0.37 mm.

First instar. After a few days of incubation, larvae hatched out from the eggs. The first instars were light green spotted with black (Figure 4.a). The heads were black. They changed in color to yellowish green after 3 to 4 days and the presence of hair around the body was evident. The body length of the first instars measured from 9-10 mm in length with a mean of 9.37 mm and 1.0 mm in the width with a mean of 1.00 mm.

Second instar. The second instars larvae (Figure 4.a) changed to green in color and with hair around the body. The second instars measured 11-15 mm in length with a mean of 14.57 mm and 2-3 mm in width with a mean of 2.10 mm.

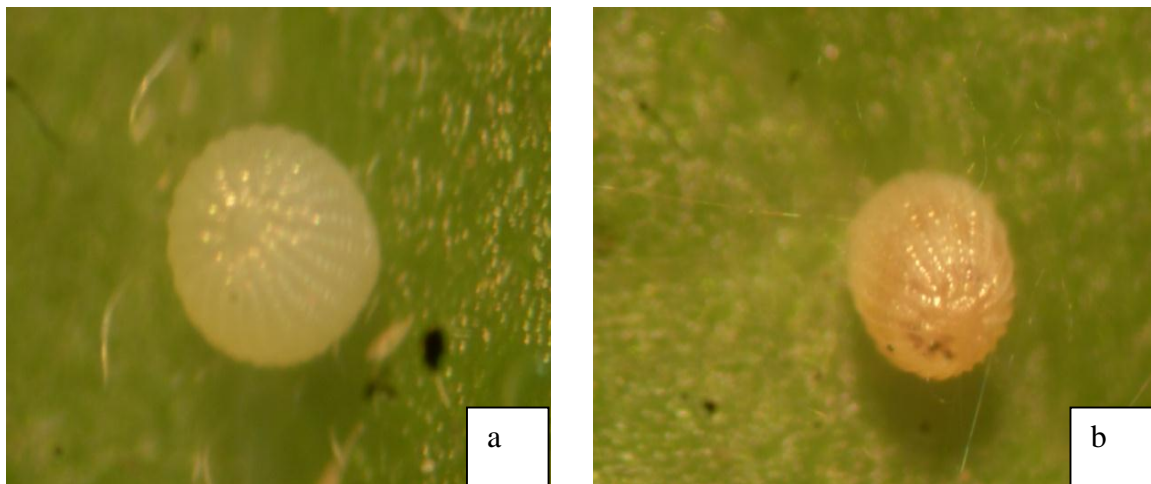


Figure 3. The newly laid fruitworm egg (a) and the egg when nearly to hatch about 5-8 days (b). Images taken at 40x magnification

Third instar. The third instars (Figure 4.c) were morphologically similar with the second instars except on size. The color of the head changed to light brown although some larvae still possess darker head in color. The body length of the larvae measured from 18-20 mm in length with a mean of 16.27 mm and 3-4 mm in width with a mean of 3.13 mm.



Figure 4. The first (a), second (b), third (c) and the fourth (d) instar larva of the fruit worm taken at 40x magnification

Fourth instar. The fourth instars larvae (Figure 4.d) were morphologically similar with the third instars larvae except in body size. The color of the head changed to green and light brown. The body had a margin of darker green on the center and on both sides. The body length of the fourth instars measured 22-25 mm with a mean of 24.40 mm and 3-4 mm in width with a mean of 3.37 mm.

Fifth instar. The larvae (Figure 5.a) were margined with broader and lighter green color. The fifth instars measured 33-40 mm in length with a mean of 34.87 mm and 5-6 mm in width with a mean of 5.13 mm.

The larvae underwent five instars, a result similar with the observation of Pedigo (2002) that took five instars before it underwent pupation stage.

Pre-pupa. The pre- pupae were alligator-like in shape. The body margins were more distinct, immobile and cease from eating. The body color were whitish green (Figure 5.b).

The pre-pupa body lengths were 23-25 mm with a mean of 24.83 mm and 4-5 mm in width with a mean of 4.87 mm.

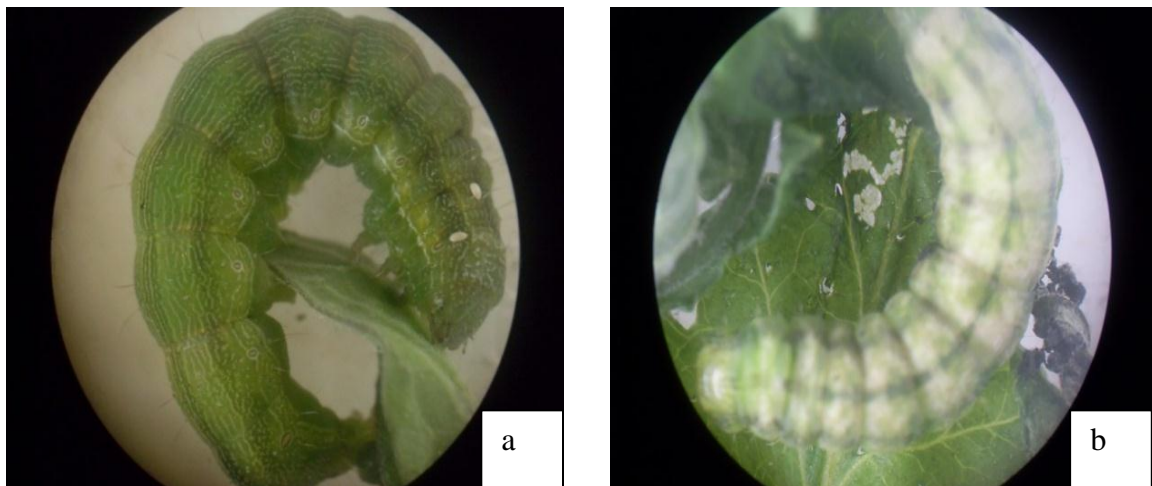


Figure 5. The fifth instar larva (a) and the pre-pupa (b) that indicates the start of pupal stage of fruitworm. Images taken at 40x magnification



Pupa. The newly developed pupae were yellowish green in color just after pupation (Figure 6.a). The color changed to greenish brown (Figure 6.b) after one day and changed to mahogany brown (Figure 6.c) after two to three days before it emerge to adult. The pupae had a pointed abdominal projection with three pairs dots on the sides of the body. The dots served as the occurrence of the legs when emerged to adults. The pupa lengths measured from 19-20 mm with a mean of 19.87 mm and 5-6 mm in width with a mean of 5.03 mm.



Figure 6. The newly emerged pupa within 24 hours (a), after 1 day (b) and the 18-26 day old pupa before emerging to adult (c). Images taken at 40x magnification

Adult. The adult fruitworms were brown to greyish brown with a series of dark and irregular lines across the forewings. The hind wings were margined with black and spotted with black near the margin. The antennae were simply long and hairy segmented. The eyes were green. The moths were active from 6:00 pm to 10: 00 pm.

The female. The length from the tip of head to tip of abdomen measured 21-25 mm with a mean of 22.40 mm. The abdomens were stout (Figure 7.a). The wingspan of the forewings measured 35-40 mm with a mean of 35.80 mm and 24-26 mm width with a mean of 25 mm. The antennae measured 10-11 mm long with a mean of 10.20 mm.

The male. The male (Figure 7.b) abdomens were elongated. The length of the male from tip of head to tip of abdomen measured 19- 22 mm with a mean of 20.30 mm. The wingspan of the forewings measured 34-36 mm with a mean of 34.70 mm and 24-25 mm width with a mean of 24.70 mm. The antennae ranged 10-11 mm long with a mean of 10.10 mm.



Figure 7. The dorsal view (at 40x magnification) of the adult female (a) and male (b) fruit worms

### Feeding Behavior of Fruitworm

The newly emerged larvae fed by chewing on any part of plants. Generally, they fed on the leaves, buds, shoots and green fruits of tomato. The larvae bore the base of the fruit. As the larva matured, they became more voracious and they settled inside the fruit. They only moved out when the fruit began to rot. The adults injected their proboscis on the cotton with diluted honey and siphoned the diluted honey on the cotton. The proboscis rolled and formed a C-shaped while feeding on the cotton.

### Nature of Damage of the Fruitworm

The larvae fed on the any part of the tomato plant. The leaves damaged by the larvae showed irregular notches or holes on the leaves and holes on the tomato fruits (Figure 8). The fruit with holes that were created by the larvae were detached easily on the plant and the leaves eaten by the larvae were yellowish in color.



Figure 8. The damages on the tomato (encircled) caused by the fruitworm larvae

### Mating Behavior of Fruitworm

The male flied around for several times before it approached the female. The male curled its abdomen towards the female's ovipositor part. The female stayed on one side before it was approached by the male for mating. The female adult spread its wings a little while they mated. The female was mated twice for duration of two to three seconds. Mating occurred from 6:00 pm-10:00 pm.

### Oviposition Behavior of Fruitworm

The total number of eggs laid by the adult fruitworm is presented in Table 3. The oviposition behavior of the adult fruitworm took place by curling its abdomen and places its ovipositor on the preferred area and released its eggs. The eggs were laid singly (Figure 9). The female spreads its wings while it lays the eggs.



Figure 9. The adult female fruitworm on the cage ovipositing its eggs

### Fecundity of the Adult Female Fruitworm

The total eggs laid by the female are shown in Table 3. A female can lay eggs as many as 343 to 460 eggs lower than the 500 to 3000 eggs as reported by Metcalf (1951).

Table 3. Total number of eggs laid by the adult fruitworm

SAMPLE NO.	TOTAL NO. OF EGGS LAID
1	354
2	460
3	353
4	369
5	343
Total	1879
Mean	375.5



## SUMMARY, CONCLUSION AND RECOMMENDATION

### Summary

The life history of the tomato fruitworm (*Helicoverpa zea* Boddie) was observed and studied at the Mites Predatory Rearing House from October 2011 to March 2012 to determine the duration of development and morphological characteristics of the different growth stages of fruitworm; to determine the larval feeding behavior and nature of damage; to determine the adult's mating and oviposition behavior, and the fecundity of the adult female.

The fruitworm underwent 9 developmental stages, namely; egg, larva (first instar, second instar, third instar, fourth instar, fifth instar), pre-pupa, pupa and adult stage. The incubation periods of the eggs were from 7-8 days with a mean of  $7.13 \pm 0.53$  days. The duration of development of the first instars was from 6-7 days with a mean of  $6.56 \pm 0.50$  days. The second instars were from 3-4 days with a mean of  $3.20 \pm 0.41$  days. The duration of development of the third instars was from 3-6 days with a mean of  $4.33 \pm 0.84$  days. The fourth instars developed from 3-5 days with a mean of  $4.26 \pm 0.58$  days. The duration of development of the fifth instars ranged from 3-5 days with a mean of  $3.66 \pm 0.71$  days. The pre-pupae duration of development ranged from 3-4 days with a mean of  $3.13 \pm 0.35$  days. The pupae developed from 20-26 days with a mean of  $23.76 \pm 1.85$  days. The adult female developed from 12-15 days with a mean of  $13.70 \pm 1.06$  days while the male developed from 12-15 days with a mean of  $13.40 \pm 0.97$  days.

The eggs were light yellow and changed to reddish brown in color after 2-3 days. The eggs were hemispherical in shape and measured 0.4-0.8 mm in length and 0.2-0.4 mm in width with a mean of 0.75 mm. The first instars were a yellowish green. The colors of



the heads were black and they measured 9-10 mm in length with a mean of 9.37 mm and 1.0 mm in width with a mean of 1.00 mm.

The second instars were light green and measured from 11-15 mm in length with a mean of 14.57 mm and 2-3 mm in width with a mean of 2.10 mm. The third instars were the morphologically same with the second instars. The larvae measured 18-20 mm in length with a mean of 16.27 mm and 3-4 mm in width with a mean of 3.13 mm. The fourth instars measured 22-25 mm with a mean of 24.40 mm and 3-4 mm in width with a mean of 3.37 mm. The fifth instars changed to yellowish green and measured 33-40 mm in length with a mean of 5.13 mm. The pupae were yellowish green just after pupation and changed to greenish brown after one to two days. They turned to mahogany brown two to three days before they emerged to adult.

The pupae measured 19-20 mm in length with a mean of 19.87 mm and 5-6 mm in width with a mean of 5.03 mm.

The adults were brown to greyish brown. The females measured 21-25 mm in length with a mean of 22.40 mm and 5-6 mm in width with a mean of 5.40 mm. The male adults measured 19-22 mm in length with a mean of 20.30 mm and 5-6 in width with a mean of 5.20 mm.

The fruitworm larvae fed on any part of the leaves and on the tomato fruits causing damage to the infested parts of the plants.

Before mating, the male flied around the preferred mate and curled its abdomen towards the female's ovipositor while the female slightly spread its wings. The mating was very quick lasting for 2 to 3 seconds from 6:00 pm to 10:00 pm.



The oviposition period of the female was indicated by curling its abdomen and placing its ovipositor on the preferred area. As it released its eggs, its wings were spread. A female can lay as many as 343 to 460 eggs on any part of the tomato plants. By observations, majority of the eggs laid observed on the leaves.

### Conclusion

The life cycle of fruitworm (*Helicoverpa zea* Boddie) on tomato under laboratory condition undergoes several stages with unique morphological characteristics. In terms of the fruit worms' feeding behavior, the worms consume large amount of food in the larval stage giving the worst damage to the tomato plants. Finally, the adult displays distinct characteristics and behavior during the mating and oviposition processes.

### Recommendation

It is recommended that all farmers engaged in a wide scale production of tomato be knowledgeable on the biology of fruitworm as these information serves as the guide in selecting control methods that are appropriate for the effective control of the insect.





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