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Study of Life Cycle of Ocimum Leaf Folder *Orphanostigma abruptalis* (Lepidoptera; Crambidae) on Sweet Basil in Ambient Condition

Amit Kumar [a], Manoj Kumar [a] and Heenashree Mansion [b*]

[a] Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Pusa (Bihar), 848125, India.
[b] Department of Entomology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (UP), 224229, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author AK developed idea and layout of the study, wrote up the manuscript and did the statistically analysis. Author MK reviewed and rephrased the manuscript. Authors AK and MK collected data. Author HM help in preparation of manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The Ocimum leaf folder, *Ocimum abruptalis*, is listed as a serious pest of sweet basil among all of the insect pests able to infect sweet basil (*O. basilicum*). The larvae do considerable damage to the plants by attaching to the underside of the leaf, folding it lengthwise from the midrib, and webbing it until it falls off. The findings of this experiment revealed that the total life cycle of Ocimum leaf folder were completed in 25-36 days in laboratory conditions with incubation period of 3-6 days, larval period with 9-14 days, Pupal period with 4-6 days, total developmental period was 16-25 days and adult longevity was 9-12 days on fresh sweet basil leaves.

**Corresponding author: E-mail: heenashreem@gmail.com;*

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Keywords: Sweet basil; leaf folder; ambient condition; orphano stigma; medicinal plant; aromatic; mealy bug; ovipositor; pupal stage; longevity period; pharmaceutical.

1. INTRODUCTION

Sweet basil (*Ocimum basilicum* L.) is an annual, aromatic, herbal plant, belonging to the family Lamiaceae. The word basil is derived from the Greek word "Basileus," which means "Royal" or "King," and it is often referred to as the "King of the herbs" due to its numerous applications in medicine, cosmetics, and the food and pharmaceutical industries (Calderon Bravo et al., 2021; Shilpi & Dhiman, 2010). “The aromatic basil leaves and flowers, as well as the essential oil distilled from the herb are used as aromas for food, perfume and cologne production and in medical therapy. Sweet basil is primarily grown in India's Uttar Pradesh, Maharastra, Madhya Pradesh, Rajasthan, Punjab, Haryana, Gujarat, Bihar, Jharkhand, and other regions” (Anonymous, 2014; Shilpi & Dhiman, 2011).

The major insect pests reported at different growth stages include: lace bugs (*Monanthia globulifera;* Tingidae), ocimum leaf folder (*Orphanostigma abruptalis;* Crambidae), Thrips (*Bathrips melanocornicus;* Thysanoptera), cotton aphid (*Aphis gossypii;* Aphididae), false-spider mite (*Brevipalpus californicus;* Tenuipalpidae), mealybug (*Pseudococcus* spp.; Pseudococcidae), tobacco whitefly (*Bemisia tabaci;* Aleyrodidae) and leaf miner (*Liriomyza* spp.; Agromyzidae). One of the main biotic factors that limit sweet basil yield and metabolism is insect infestations (Shivakumara et al., 2021; Wierdak & Borowski, 2011). Sathe et al. (2014) reported that *A. despursus* (Hemiptera: Aleurodidae), *Dialeurodes* sp. (Hemiptera: Aleurodidae), *C. bullita* (Hemiptera: Tingidae) and *Macrosiphum* sp. (Hemiptera: Aphididae) as the major pests on *Ocimum sanctum.*

“The ocimum leaf folder, *O. abruptalis*, is listed as a serious pest of sweet basil among all of the insect pests able to infect sweet basil (*O. basilicum*) (Olson & Bidlack, 1997)”. “The larvae seriously harm the plants by adhering to the underside of the leaf, folding them lengthwise from the midrib, and webbing them until they start falling off” (Anonymous, 2019). “The larval infestation was identified in every leaf-fold and terminal shoot, with many larvae being found per inflorescence. The caterpillars bind leaf edge to make a funnel and feed on chlorophyll” (Tigvattananont, 1990). Leaf folder insect pests can have a significantly negative impact on plant growth and production if their incidence rises (Kumar et al., 2022; Namvong & Chongrattanameteekul, 2015). The Ocimum leaf folder is becoming the major insect-pests in different growing district of Bihar (Kumari et al., 2017). However, there is a need to study on Ocimum leaf folder insect-pests on aspect such as biology or life history of Ocimum leaf-folder on sweet basil to better management.

2. MATERIALS AND METHODS

An experiment was conducted to study the biology of Ocimum leaf folder was examined in the laboratory conditions under natural settings, with larvae of foliage-feeding Ocimum leaf folder taken from the field during *Kharif* season 2021 in Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar. Fresh sweet basil leaves were fed daily to the cultures in glass jars until pupation, which was picked from an untreated basil crop. Until the moth emerged, the pupae were transferred into clean glass jars. In separate glass jars of identical capacity/size, the adults that emerged were coupled and permitted to mate. For effective egg laying, the moths were given a honey solution (10%) on a cotton swab. The eggs were then transferred into fresh glass jars and raised until they reached adulthood. The duration (in days) of the egg stage, larval and pupal stages, as well as the longevity of adult males and females, were all documented. To represent life cycle of the Ocimum leaf folder, photographs of field damage symptoms and distinct life stages were obtained.

3. RESULTS AND DISCUSSION

The biology of Ocimum leaf folder, *O. abruptalis* was observed under laboratory conditions and the details of life cycle and morphometric data are illustrated in Tables (1 and 2).

In Incubation period under ambient condition the adult female of leaf folder laid eggs singly at the under surface of leaves and tender shoots within air chamber. Freshly laid eggs are creamy white in colour and round shaped. The incubation period was studied by taking these eggs along with leaves and kept on filter paper in 5 covered petri-dishes with sufficient moisture. It was observed that the incubation period ranged between 3-6 (mean 4.0±0.89) days. The larval stage passed through five instars to complete the larval period. Five newly hatched larvae were collected and transferred carefully using a wet

camel hair brush on fresh leaves in the Petri-dishes. The newly emerged larva is pale greenish brown in colour with dark black spots and thin spines are present throughout of the body length. The 2nd instar larvae are pale brown, later becoming somewhat greenish brown, and almost similar to first instar. The duration of second larval instar was 1-2 (1.8±0.74) days. The third instar was almost similar in all respect with that of second instar it was some larger in size. It, also, lasted for 1-2 (1.6±0.80) days. The fourth instar increased in size, and it lasted for 2-3 (2.8±0.74) days. In fifth instar larvae body shape was similar to fourth instar except more elongated and the fully matured caterpillar having 16.80 mm length and 2.03 mm width. It lasted for 2-4 (3.0±0.63) days. The total larval period varied from 9 to 14 (10.4±1.72) days. The pupation of Ocimum leaf folder was occurs in the folded leaves which are webbed by the caterpillar. The pupa of leaf folder was dark brown coloured with the length of 9.40 mm and width 2.20 mm. It was lasted for 4 to 6 (5.0± 0.89) days. The total developmental period of Ocimum leaf folder was lasted for 16- 25 (20.2 ± 4.01) days. The total life cycle of *O. abruptalis* from egg to adult emergence varied from 25- 36 (30.2± 3.54) days. Adult male was brown, with three wiggly brown lines across each forewing and two across hind wings, about 6.85 mm and 14.52 mm of body length and wing span, respectively, the hind wings has dark black colored margins, and it lasted for 7- 9 days. While, the female moth was light colored, about 7.60 mm and 16.75 mm of body length and wing span with light black wing margins. It lasted for 9 to 12 days. The female can be differentiated from the male by the presence of an ovipositor. The details of life cycle and morphometric data are illustrated in Tables (1 and 2). This result comparably similar with the results of Kumar and Kumar (Kumar, 2016) who reported that the biology of Ocimum leaf folder, *O. abruptalis* in the laboratory as well as field experiments. Under The average length of eggs was 0.058 ± 0.002 mm, ranging from 0.050 to 0.067 mm and 0.041 ± 0.002 mm in width, ranging from 0.034 to 0.047 mm. The incubation period varied from 3 – 6 days (mean 4.4 ± 1.7). The first instar larvae had dark brown to black heads, while later instar larvae had dark orange heads. Larvae of *O. abruptalis* moth have five instars to complete

Table 1. Biology of ocimum leaf folder (*Orphanostigma abruptalis*) on sweet basil during 2021

Sl. No.	Developmental stage	Range (days)	Mean ± SD
1.	Incubation period	3-6	4.0±0.89
2.	Larval period		
a.	1st instar	2-3	2.4±0.48
b.	2nd instar	1-2	1.8±0.74
c.	3rd instar	1-2	1.6±0.80
d.	4th instar	2-3	2.8±0.74
e.	5th instar	2-4	3.0±0.63
3.	Total larval period	9-14	10.4±1.72
4.	Pupal period	4-6	5.0± 0.89
5.	Total developmental period	16-25	20.2 ± 4.01
6.	Adult longevity	9-12	10.4 ±1.72
7.	Total life duration	25- 36	30.2± 3.54

Table 2. Morphometric data of ocimum leaf folder, *O. abruptalis* of sweet basil

Sl. No.	Life Stages		Mean of Linear measurements (mm)
1.	Larvae		
	Length		16.80
	Width		2.03
2.	Pupa		
	Length		9.40
	Width		2.20
3.	Adult		
	Male	Body length	6.85
		Wing span	14.52
	Female	Body length	7.60
		Wing span	16.75

the larval period. The larval period was varied from 9 - 12 (mean 10.2 ± 1.2) days. The pupal period was varied from 4 to 6 (mean 5.0 ± 0.8) days. The size of male and female pupae were little different. Total developmental period (days) varies from 16 – 24 (mean 19.4 ± 2.83) days. The adult individuals reared in the laboratory survived for 9 to 11 (mean 9.9 ± 0.87) days. Total life duration was recorded as 25-35 (mean 30.1 ± 3.17) days. Tigvattnanont (Tigvattananont, 1990) also, recorded that under the laboratory condition on the biology of *Syngamia abruptalis* Walker, the hatching period of eggs was 2.19 days. He added that five different larval instars completed in 2.07, 1.24, 1.76, 1.82, and 3.46 days, pupation was done inside the leaves and the pupal period was recorded in 5.87 days. Adult female longevity period was recorded within 12-15 days when it was fed over a dilute honey solution, while males longevity period was recorded for 9-11 days. On average females deposited 134.87 eggs. These findings are partially agreement with results of Yung Keun Oh et al. (2010), who reported that the biology of the perilla leaf pyralid, *Pryausta panopealis* Walker in different range of temperature *i.e.,* 20 to 30^{0}C and the longest larval period was reported for 26.8 days. When it was reared at 20^{0}C then the shorted larval period was reported (11.3 days) and at 30 ^{0}C maximum survival rate was 82.5 %. Das et al. (2020) studied that “the freshly laid eggs were dark brown in colour and oblong in shape with slightly tapered towards opercula. The hatching period was 4-6.5 days (average 5.45±0.762 days), 4-7.5 days (average 5.60±1.22 days). The nymphal period was 8.5-15 days (average 11.85±1.749 days), and 9.5-15.5 days (average 12.5±2.160 days). The adult period was varied from 26.5-34.5 days (average 29.55±2.544 days) and 28-35.5 days (average 30.35±2.667 days)”.

4. CONCLUSION

The findings of this experiment revealed that the total life cycle of Ocimum leaf folder was completed in 25-36 days in laboratory conditions with incubation period of 3-6 days, larval period with 9-14 days, pupal period with 4-6 days, total developmental period was 16-25 days and adult longevity was 9-12 days on fresh sweet basil leaves.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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