Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

December 2022, Volume 35, Issue 2, Page 147-151

Biology of potato tuber moth, *Phthorimaea operculella* (Zeller) on three solanaceous host plants

Primiya R Lyngkhoi • Kennedy Ningthoujam* • Mahesh Pathak • T. Rajesh • Veronica Kadam

College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umiam, Meghalaya -793 103

ARTICLE INFO

Article history:
Received: 16 November, 2022
Revision: 25 November, 2022
Accepted: 30 November, 2022

Key words: *Potato tuber moth, Potato, Tomato, Eggplant*

DOI: 10.56678/iahf-2022.35.02.21

ABSTRACT

Potato tuber moth, *Phthorimaea operculella* (Lepidoptera: Gelechiidae), is an oligophagous pest that causes significant economic losses in potato production. Biology of *P. operculella* was studied on three hosts *viz.*, potato, eggplant and tomato under laboratory conditions. Potato was more preferred followed by eggplant and tomato for its growth and development. Fecundity of *P. operculella* on its different host ranged from 70.40 eggs (Potato) to 33.40 eggs (Tomato). The larval (9.80 days) and pupal (4.20 days) period was shorter on potato. Larval mortality was highest in tomato (7.65). Longevity of the *P. operculella* male and female adults varied significantly on its different hosts. Male and female of *P. operculella* lived longer for 11.40 and 13.40 days on potato, respectively. Irrespective of host crops, female lived longer than male moth. Total life cycle of *P. operculella* was significantly influenced by its different hosts which was shortest on potato (26.60 days) followed by eggplant (30.40 days) and tomato (34.00 days).

1. Introduction

The potato tuber moth, *Phthorimaea operculella* (Lepidoptera: Gelechiidae), is an oligophagous pest that has been found feeding on more than 60 plants in different parts of the world with the majority of the hosts belonging to the Solanaceae family (Das and Raman, 1994). It causes significant economic losses in potato production in subtropical and tropical areas (Das *et al.*, 1992). *P. operculella* caused extensive damage in East Khasi Hills, Meghalaya where more than 50 % plant infestations and 100 % damage on tubers (seed purpose) were recorded under indigenous storage conditions (Ali and Naziri, 2019).

P. operculella is a pest of both field and storage conditions. In the field, the larvae penetrate the leaves, stems and petiole causing mines. The utmost damage of tuber occurs before harvest when the tubers are exposed before digging as the adult moths prefer tubers for egg laying. The pest remains in the field after harvest and feeds on tubers or volunteer plants including other solanaceous plants such as tomato and eggplant grown in the area (Gilboa and Podoler, 1995).

The life cycle of potato tuber moth studied in different hosts will assist researchers in evaluating the contribution of the different hosts to the population and various biological parameters of PTM, as well as in answering other related questions about PTM. A shorter developmental time combined with a higher total reproduction rate of the insect host indicates that the host plant is more suitable (Van Lenteren and Noldus, 1990). Different host crops influence the overall growth, survival, reproduction and life table parameters of insect species (Morgan *et al.*, 2001). In some insect species, the quality of host plant during development of larva is a key factor of adult fecundity and fertility (Awmack and Leather, 2002) which ultimately affect the reproductive strategies like choice of site for egg laying, size and weight of egg.

Few life table studies of potato tuber moths in relation to their varied host plants have been available and only a few studies on the effect of host plants on developing stages have been carried out. As a result, understanding the effect of host plants on the biology of potato tuber moth is critical for developing a dependable pest population estimate system and management strategies that minimize the adverse effects of chemical pesticides while also providing sustainable control (Aryal and Jung, 2015).

*Corresponding author: kennedy1982@gmail.com

2. Materials and methods

2.1 Insect strain

Potato tuber moth (PTM) used in our study was collected from storage rooms of ICAR-Central Potato Research Station, Upper Shillong, Meghalaya. The insects were reared in wooden rearing cages (45 × 45 ×54 cm).

2.2 Host Plants

Biology of potato tuber moth was studied on three test hosts *viz.*, potato (Variety: Kufri Jyoti), tomato (Variety: Pusa Ruby) and eggplant (Variety: Pusa Purple Long) at an average temperature of 27±2 ºC and relative humidity 60-70 % under laboratory conditions.

2.3 Mass rearing and maintenance of the insect strains

The insects were reared in wooden rearing cages (45 × 45 × 54 cm). The infested potato tubers kept in the rearing cages were incubated at 25±2 °C with RH 70±5 %. After the completion of larval growth, the pupae were collected. Fresh tubers were introduced every twenty days to maintain the insect culture. The pupae gathered were air-dried and placed in a cylindrical container (10 ×3.5 cm) and covered with muslin cloths using a rubber band. After adults emerged, a filter paper (Whatman No. 1) was placed on the muslin cloth as a medium for egg laying. Cotton swabs with 10% sugar solution was to the adults. The filter papers with the eggs were collected and were placed in clean plastic containers until hatching. Upon hatching, the neonates were provided with fresh tubers for next generation.

Before experiment, the insect was allowed to complete one generation on respective host plants. Observation on biological parameters on test hosts was recorded on successive second and third generation. This procedure was not followed for potato as *P. operculella* was reared on the host itself. The experiment started from the egg stage of the test insect.

Observations on incubation period, hatching percentage, larval period and size, pupal period and weight, oviposition period, adult longevity and fecundity were recorded regularly. The male and female emergence % was also recorded. The experiment was carried out for three generations continuously and the data were presented as mean ± SD.

3. Results and discussion

Phthorimaea operculella female laid eggs either singly or in cluster. The highest number of eggs were laid on potato (70.40) followed by eggplant (34.20) and tomato (33.00) as shown Fig.3.2. The shortest incubation period was observed on potato (5.20 days). Variations in egg laying is because of the ability of female insects to detect differences in host plant related cues like volatiles (Karlsson *et al.*, 2009; Proffit *et al.*, 2011). The incubation period on eggplant and tomato was found to be 7.20 and 7.40 days, respectively. The larval period was significantly different on the three hosts. The longest larval period was recorded in tomato (13.20 days) followed by eggplant (11.60 days) and potato (9.80 days) (Fig.3.2).

Pupal period of *P. operculella* on its different hosts ranged from 4.20 days to 6.80 days. Pupal period on potato (4.20 days) was significantly lower than on eggplant (6.20 days) and tomato (6.80 days) which were at par with each other. Pupae turned from brown to black before adult emergence. Based on the morphological characters present on the wings, the adult male and female moth emergence percentage was calculated. The female moths have a typical black marking on the forewings which looks like 'X' whereas male moths have three dots on each of the forewings. Adult emergence was maximum in potato (86.00 %) followed by eggplant (74.00 %) and tomato (56.00 %).

The male emergence percentage was calculated by taking into consideration the adult emergence of 10 pupae in five replications on the three hosts. The percentage of male emergence in potato, tomato and eggplant was 30.00 %, 24.00 % and 30.00 % respectively. Female emergence percentage was 58.00 % in potato, 46.00 % in eggplant and 36.00 % in tomato.

The data presented in Table 3 indicated that comparatively more females emerged than males in all the three hosts. The sex ratio (female: male) in potato, eggplant and tomato was found to be 1: 1.86, 1:1.57 and 1:1.45, respectively.

Oviposition period of *P. operculella* female was longest on potato (3.20 days) followed by eggplant (2.40 days) and tomato (2.40 days). The longevity of *P. operculella* male ranged from 7.20 days to 11.40 days. The male moths obtained from the culture reared on potato lived for 11.40 days whereas the culture reared on tomato and eggplant lived for 7.20 days and 8.60 days, respectively. The average life span of *P. operculella* female ranged from 8.80 to 13.40 days. The longevity of females obtained from potato, eggplant and tomato were 13.40, 11.00 and 8.80 days, respectively. Irrespective of hosts, the longevity of female was longer than male.

Table 3: Comparative Biology of Potato tuber moth on different hosts

Host	Potato (Mean± SD) *	Tomato (Mean± SD) *	Eggplant (Mean± SD) *
Fecundity	70.40 ±5.94	33.40 ±2.92	34.20 ±3.19
Oviposition period	3.20 ±0.44	2.40 ±0.55	2.40 ±0.55
Hatching %	88.79 ±4.85	66.26 ±8.57	82.93 ±4.5
Incubation period (Days)	5.20 ±0.45	7.40 ±0.55	7.20 ±0.45
Larval period (Days)	9.80 ±0.84	13.20 ±1.64	11.60 ±0.55
Pupal period (Days)	4.20 ±0.84	6.60 ±0.89	6.20 ±0.45
Male longevity (Days)	13.40 ±1.52	8.80 ±1.30	11.00 ±1.22
Female longevity (Days)	11.40 ±1.34	7.20 ±0.84	8.60 ±0.55
Adult emergence (%)	86.00±8.94	56.00±8.94	74.00±5.48
Female emergence (%)	58.00±0.00	36.00±5.48	46.00±0.00
Male emergence (%)	30.00±8.37	24.00±5.48	30.00±5.48
Sex ratio (Male: Female)	1:1.86	1:1.57	1:1.45
Total life cycle	26.60 ±1.67	34.00 ±1.41	30.40 ±2.19

Note: (Mean± SD) * is the mean and standard deviation of three generations

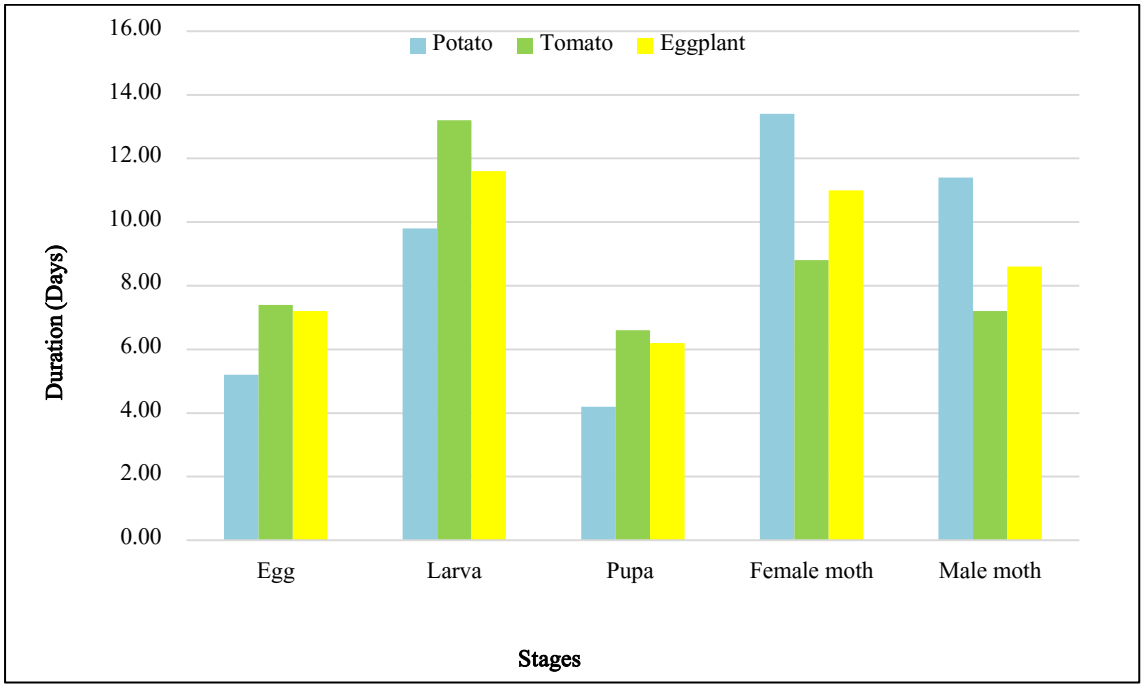

Figure 3.1. Duration of different stages of *Phthorimaea operculella* on different host plants.

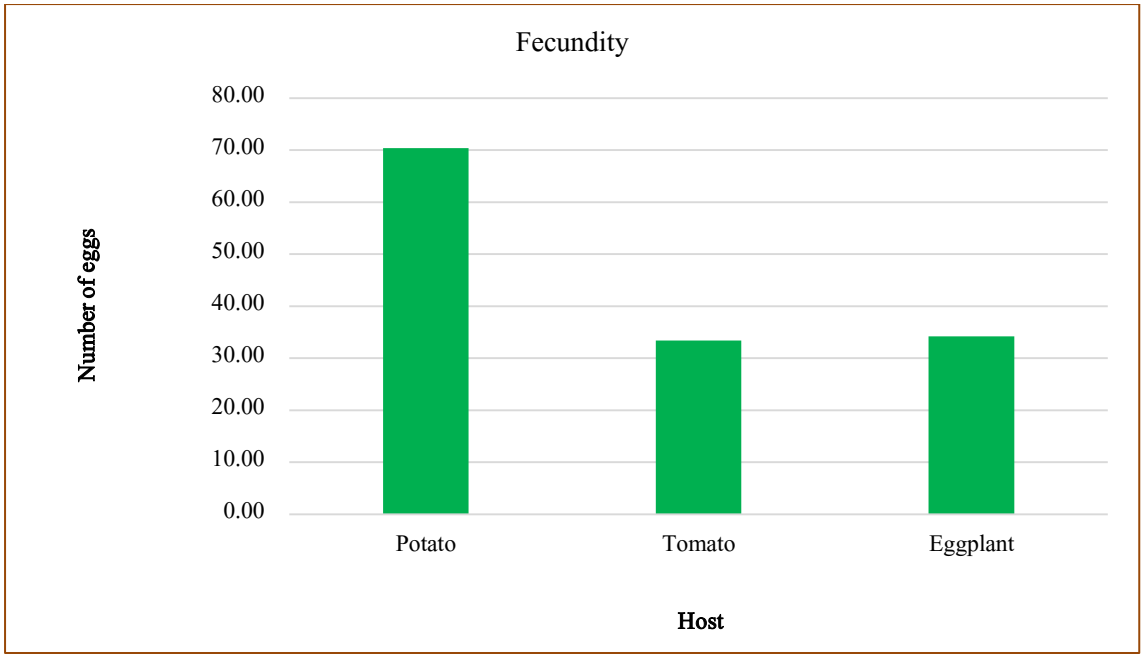

Figure 3.2. Fecundity of *P. operculella* female on three different host plants.

Comparative biology of potato tuber moth carried out in the present study showed that potato was more preferred than eggplant and tomato. Similarly, Youssef (2019) studied the life table of tuber moth on three Solanaceous hosts (potato, tomato, eggplant) and reported that the fecundity is highest in case of potato tubers (107.7 eggs/female) followed by tomato fruits (64.00) and eggplant fruits (57.30). Debnath *et al.*, (2000) also reported that the shortest larval and pupal period of *P. operculella* (12.44 and 6.52, respectively) was observed on potato whereas in case of *Solanum nigrum,* the larvae could not develop to maturity.

The life cycle of *P. operculella* on potato completed on a shorter period with a duration of 26.60 days in comparison to tomato and eggplant where the total life cycle recorded was 34.00 and 30.40 days, respectively. Aryal and Jung (2019) also reported that the total development time of *P. operculella* was shorter on potato leaves compared to tomato leaves. Youssef (2019) reported that the average generation duration was longest in tomato fruits (45.31days) followed by eggplant fruits (44.35 days) and the shortest was found in potato (29.31 days). The difference in present studies with earlier reports maybe due to differences in temperature, relative humidity and the varieties of host plant used.

4. Conclusion

The present study concluded that potato tuber moth could complete its life cycle in all the three solanaceous hosts with potato as the most preferred host. The information on biology of the pest in different hosts has a significant role in developing effective pest management strategies.

5. Acknowledgement

Authors are thankful to Head, Department of Entomology, School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, Umiam, Central Agricultural University, Imphal for providing facility to conduct present the experiment.

6. References

Ali S, Naziri D (2019). Recommended organic practices for the management of Potato Tuber Moth (PTM) in traditional country stores in Meghalaya, India. CIP (International Potato Center, Lima, Peru). https://cipotato.org/publications/recommended-organic-practices-for-the-management-of-potato-tuber-moth-ptm-in-traditional-country-stores-in-meghalaya-india/; Accessed on 27 December 2021.

Aryal S, Jung C (2015). A review on the ecological characteristics of potato tuber moth, *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae). Korean J. Soil Zool. 19: 35-41.

Aryal S, Jung C (2019). A potential threat to tomato, a congener crop to potato from invaded potato tuber moth, *Phthorimaea operculella* (Zeller). J. Asia-Pacific Entomol. 22: 77-82.

Awmack CS, Leather SR (2002). Host plant quality and fecundity in herbivorous insects. Annal. Rev. Entomol. 47: 817-844.

Das GP, Raman KV (1994). Alternate hosts of the potato tuber moth, *Phthorimaea operculella* (Zeller). Crop Prot. 13: 83-86.

Das GP, Magallona ED, Raman KV, Adalla, CB (1992). Effects of different components of IPM in the management of the potato tuber moth in storage. Agric. Ecosyst. Environ. 4: 321-325.

Debnath MC, Khaund JN, Borah BK, Sarmah PC (2000). Life table analysis of potato tuber moth, *Phthorimaea operculella* Zeller under laboratory conditions. J. Appl. Zool. Res. App., 1: 120-123.

Gilboa S, Podoler H (1995). Presence-absence sequential sampling for potato tuberworm (Lepidoptera: Gelechiidae) on processing tomatoes: selection of sample sites according to predictable seasonal trends. J. Econ. Entomol. 88: 1332-1336.

Karlsson, M.F., Birgersson, G., Cotes Prado, A.M., Bosa, F., Bengtsson, M., and Witzgall, P. (2009). Plant odor analysis of potato: response of Guatemalan moth to above-and belowground potato volatiles. J. agric. food chem., 57(13): 5903-5909.

Morgan D, Walters KFA, Aegerter JN (2001). Effect of temperature and cultivar on pea aphid, *Acyrthosiphon pisum* (Hemiptera: Aphididae) life history. Bull. Entomol. Res. 91: 47-52.

Proffit M, Birgersson G, Bengtsson M, Reis R, Witzgall P. Lima E. (2011). Attraction and oviposition of Tuta absoluta females in response to tomato leaf volatiles. J. Chem. Eco., 37(6): 565-574.

Van Lenteren JV, Noldus LPJJ (1990). Whitefly-plant relationships: behavioural and ecological aspects. In: D Gerling, (ed) Whitefly: their bionomics, pest status and management, Intercept Andover, Hampshire, England, pp. 47-89.

Youssef G (2019). Effect of host-plant on life table parameters potato tuber moth, *Phthorimaea operculella* (Zeller). Syrian J. Agric. Res. 6(3): 478-489.