International Journal of Economic Plants

https://ojs.pphouse.org/index.php/IJEP

IJEP August 2024, 11(3): 222-227

Crossref

Article IJEP5277a

Full Research

Doi: HTTPS://DOI.ORG/10.23910/2/2024.5277a

Biology of Plassey Borer, *Chilo tumidicostalis* (Hampson) (Crambidae: Lepidoptera)

Vishwajeet[1] and Anil Kumar[2*]

[1]Dept. of Entomology, Post Graduate College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar (848 125), India

[2]Dept. of Entomology, Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar (848 125), India

Corresponding Author

Anil Kumar

e-mail: anil.kumar@rpcau.ac.in

Article History

Received on 02nd March, 2024

Received in revised form on 10th June, 2024

Accepted in final form on 19th June, 2024

Abstract

The experiment was conducted during June to November of 2023 at Bio-control laboratory of Sugarcane Research Institute, Pusa, Samastipur, Bihar, India. The infestation of the Plassey borer started in the month of June and remained prevalent till November month in the field. The infested canes were brought to the laboratory for biological studies. Biological studies of *Chilo tumidicostalis* Hampson (Crambidae; Lepidoptera) revealed that the female lays eggs in 3–4 batches which averaged 410.64±45.21 eggs per female. The adult female preferred to lay eggs on the live plants only. The incubation period of the eggs was 7.05±0.60 days with hatching percentage as 97.56±0.90%. There was a total of 5 larval instars and the duration of first, second, third, fourth and fifth larval instars were 3.20±0.52, 3.7±0.47, 4.75±0.79, 6.05±0.69 and 6.35±0.67 days, respectively. The pupa and adult showed sexual dimorphism and variation in duration of pupal and adult period. The length of the male and female pupa was26.78±0.10 and 32.85±0.07 mm, respectively. The length of the adult male and female was 11.62±0.15 and 12.74±0.24 mm, respectively. The width of the adult male and female was 24.31±0.63 and 28.73±0.78 mm, respectively. The average pupal period of male and female was 7.25±1.21 and 8.1±1.37 days, respectively. Also, the adult male and female longevity was 3.9±0.64 and 4.8±0.77 days, respectively. The sex ratio was found to be 1:1.24 (male:female).

Keywords: Bihar, sugarcane, morphometry, sexual dimorphism, life cycle

1. Introduction

Sugarcane crop is grown worldwide in tropical and subtropical climates (Guo et al., 2021; Kumar et al., 2024). The crop is primarily grown for sugar, however, other products such as jaggery, khandsari, ethanol, etc. also have a huge demand in the Indian market (Formann et al., 2020, Sinha et al., 2024). The by-products of sugarcane mills such as bagasse, molasses and filter muds are used in agriculture and various other industries such as electricity generation, and paper industry (Solomon, 2011, Mann, 2016, Raza et al., 2021, Shelar et al., 2023). Next to the textiles industry, the sugar industry is the second largest agriculture-based industry which produces employment opportunities for millions of farmers in India (Singh, 2016, Bathla and Jha, 2020).

The Plassey borer, *Chilo tumidicostalis* (Hampson, 1919) (Lepidoptera: Crambidae) is a stem boring pest of sugarcane which once was considered a minor pest of sugarcane has now gained the status of major pest in the region of its prevalence (Kumar et al., 2023). The pest is mainly found in Uttar Pradesh, Bihar, West Bengal, Assam, and other northeastern states and other countries such as Nepal, Bangladesh, Vietnam, Thailand, Burma, and Australia (Hoang, 2016; Karim and Islam, 1977; David et al., 1986; Suasa-Ard, 2000, Gupta and Sarma, 2007). The pest was monophagous and sugarcane was the only recorded host (Rahman et al., 2013). In India, the name Plassey borer was given by Gupta (1957) when the pest occurred in epidemic form in Plassey, West Bengal. It was a pest of regional importance in the Gangetic Plain and north-eastern India and the incidence of Plassey borer had not been reported from other sugarcane growing parts in India (Baitha et al., 2016).

There were two major concerns about this pest, first the degree of damage and second the lengthy duration of infestation. The pest assumed two forms viz. primary and secondary infestation (Nath et al., 2018). The earlier instars were gregarious and damaged the upper internode of the

sugarcane. As many as 60 larvae had been found in just two to three internodes in a single cane (Khanna et al., 1957). The later instars came out of the internode and spread to the other healthy portion of the cane and neighbouring canes (secondary infestation). The secondary infestation, however, was not solitary, as many as 5–10 larvae and pupae had been found in single cane (Khanna et al., 1957). Due to feeding the internal tissue was destroyed and sawdust-like frass was left in the internode. The second major concern was the duration of infestation. The pest was known to complete as many as 5 generations in a year before hibernating in winter (Nath et al., 2018). The loss in yield due to infestation was heavy, Gupta and Avasthy (1959) reported 25–70% and 12–60% yield loss due to primary and secondary infestation, respectively. Also, 100% crop loss was reported in Setabgonj Sugar Mills in Bangladesh during the 1973–1974 cropping season (Karim and Islam, 1977). Chand et al. (2013) assessed the damage intensity on qualitative and quantitative parameters and found the reduction of cane, juice and bagasse weight upto 35.71, 44.00 and 40.74 %, respectively.

The biology of the pest helped us to understand the life cycle and feeding strategy by the pest, duration of each stage in the life cycle and the behaviour of the pest. The current study was designed by keeping in view the present status of the biology and behaviour of the pest which will help in the effective management of the pest.

2. Materials and Methods

The present study was carried out in the biocontrol laboratory of Sugarcane Research Institute, Pusa, Samastipur, Bihar, India in the year 2023. The observation was carried out from June to November month when the Plassey borer was active in the field. The larvae of Plassey borer *C. tumidicostalis* were collected from Agricultural Research Station, Kalyanpur, Samastipur, Bihar, India. The location of the study area is at latitude of 25.96124 and longitude of 85.78801 situated at an altitude of 53.64 m from mean sea level. All the experiments were carried out at 27±1°C temperature, 70±5% RH and 12 L:12D h photoperiod.

Plassey borer-infested canes were brought to the laboratory. On opening the cane, the larvae and the pupae were separated. Biological studies were done on CoP 16437 (Rajendra Ganna-1). Larvae were again transferred to the cane for growth while pupae were sexed and kept in different Petri plates and two different insect-rearing cages for the emergence of the adults. On emergence of male and female adults, they were paired and kept inside the oviposition chamber.

The fecundity of the female Plassey borer was determined by counting the eggs laid on the sugarcane plant inside the oviposition chamber. The eggs were continuously monitored for hatching and the duration between egg laying and hatching (incubation period) was noted. The viability of the eggs was determined by counting the hatched eggs and expressed as percent hatching.

On hatching, 20 larvae were transferred to a softer internode taken from the upper portion of the cane. The first and the second instars were reared collectively on the single cane to mimic the gregarious phase of the pest. From the third to fifth instar, the larvae reared in the individual single cane. The cane was split into half and a groove was made with the help of a knife. The larvae transferred into this groove closed with the other half of the cane and held in place with the help of a rubber band. Careful observations were made on the number of larval instars and molting. Molting of the larvae was confirmed with the presence of the head capsule and changing of the colour of the larvae into pale white colour. The cane was changed as and when required to provide a continuous food supply to the larvae.

Pupation took place inside the cane and the pupae were separated and sexed. Daily observations were made for the survival of the pupa until adult emergence and the pupal period was noted. The sex ratio was also calculated. The emerged adults were given 20% honey solution and observations on the survival, longevity, pre-oviposition period, oviposition period, and post-oviposition period were noted.

A gravid female mostly prefers its host plant for oviposition to ensure the survivability of its progeny (Salgado and Saastamoinen, 2019, Volp et al., 2022). However, the fresh leaves was kept for the oviposition soon dried up and the female did not oviposit on the dried leaf. Different materials were tested for the oviposition by the female. Live sugarcane plant, dried sugarcane leaf, maize leaf, and brown paper were used to test the ovipositional preference of the female. For every material, three replications were prepared and kept in the oviposition chamber and paired male and female Plassey borer were left for 48 hours. After 48 hours, the presence of egg was searched on the material.

3. Results and Discussion

3.1. Biology of the plassey borer

3.1.1. Egg

The eggs were usually laid on the abaxial surface of the leaf in 3–4 rows. A single gravid female laid eggs at 3–4 different egg masses. The average number of eggs laid by the female was found to be 410.64±45.21. The freshly laid eggs appeared dirty white in colour and as it matured the center of the egg started turn blackish in colour. The larvae emerged from the egg by cutting a hole in the chorion of the egg. The empty egg shell remained attached to the leaf after emergence. Not all the eggs hatched in the egg mass, in that case the hatching percentage was calculated. The hatching percent was found to be 97.56±0.90%. The incubation period ranged between 6–8 days and the mean value was 7.05±0.60 days. The present result was in confirmatory to the findings of Khanna et al. (1957) who found the incubation period to range from 8–11

days. He observed the hatching to take place for up to 3 days in the same cluster, however, in the present study, the hatching took place in the morning hour within a period of 2–3 hours. According to Hoang et al. (2016) the average number of eggs varied from 27–370 in each batch. Also, the findings of Rahman et al. (2013) show that the number of eggs laid by the female in entire life range between 500–800. In yet another study conducted in Thailand, the female laid an average of 287 eggs with an average incubation period of the egg to be 4.6 days (Sallam and Allsopp, 2002) (Table 1).

Table 1: Developmental biology of *C. tumidicostalis* on sugarcane stalk in laboratory

Developmental stage (days)	Range (days)	Mean number of days ±SE
Incubation period of egg	6–8	7.05±0.60
First larval instar	2–4	3.20±0.52
Second larval instar	3–4	3.70±0.47
Third larval instar	4–6	4.75±0.79
Fourth larval instar	5–7	6.05±0.69
Fifth larval instar	5–7	6.35±0.67
Total larval period	19–28	24.05±3.14
Pupal period		
Male	6–9	7.25±1.21
Female	6–10	8.1±1.37
Egg to adult emergence (total developmental period)	31–45	39.2±5.11
Adult parameters		
Male longevity	3–5	3.90±0.64
Female longevity	3–6	4.80±0.77
Fecundity	410.64±45.21	
Sex ratio (M:F)	1:1.24	

3.1.2. Larvae

The larvae of *C. tumidicostalis* moulted four times and had five larval instars. The total duration of the larvae ranged from 19–28 days with an average of 24.05±3.14 days.The duration of the first instar larvae ranged from 2–4 days with an average of 3.20±0.52 days. The second instar larvae took 3–4 days and 3.7±0.47 days on an average. The third instar larvae completed within 4–6 days with an average of 4.75±0.79 days. The fourth and fifth instar took 5–7 days with an average of 6.05±0.69 and 6.35±0.67 days, respectively. After the completion of fifth instar, the larvae became sluggish, stopped feeding and turned into prepupa. The prepupa finally became pupa (Figure 1).

The findings of Suasa-Ard (2000) agree with that of present study who noted the total larval period to be about 26 days in Thailand and the larvae molted 5–7 times before pupation.

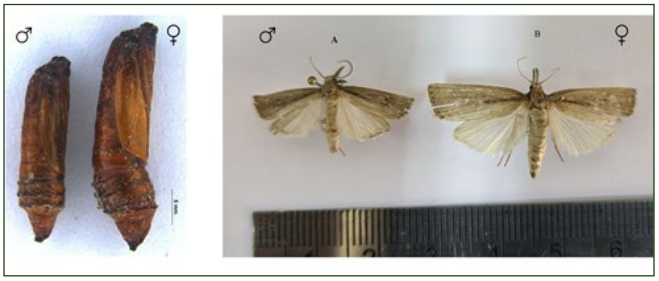

Figure 1: The size difference in pupal and adult form

Also, the findings of Rahman et al. (2013) states that the larval period varied from 27–70 days in Bangladesh. The study conducted by Khanna et al. (1957) in Bihar shows that the total larval period may vary anywhere from 61–121 days. The first, second and the third molts were shed after 3–5 days whereas the fourth and fifth molts were shed in 2–3 weeks or even longer. The findings of Hoang (2016) were in accordance with the present findings who observed 5 larval molts with total larval duration ranging from 17–26 days in Vietnam.

3.1.3. Pupa

The duration of the pupal stage varied in male and female. The male and female completed the pupal period in the range of 6–9 and 6–10 days, respectively. The average duration of the male and female pupal period was found to be 7.25±1.21 and 8.1±1.37 days, respectively. Initially, the colour of the pupa was light yellow which later turned into brownish red.

The male and female pupa showed sexual dimorphism. In terms of size, the female was bigger in size than the male pupa. The length (measured from caudal tip to the anterior most tip; n=20) of the male pupa was found to be in the range of 26.63–26.99 mm the average length was 26.78±0.10 mm. Whereas, the length of female pupa was recorded to be in the range of 32.76 and 32.98 mm and the average length was found to be 32.85±0.07 mm. The width of the male pupa was found in the range of 6.35–6.43 mm and the average width was was found to be 6.38±0.02 mm. The width of the female pupa was found in the range of 7.94–8.02 mm and the average of the width was 7.97±0.02 mm. The genital opening of the male and female located on 8th and 9th abdominal segment, respectively; the space between genital pores differed in case of male and female (Table 2 and Figure 2). Also, the genital opening in male was in the form of a circular lobe, whereas in case of female it was slit like aperture.

The larvae pupate within the gallery created by the feeding in the cane. Before pupation, a small hole was created by the larvae and covered with frass to facilitate the emergence of the adult. Pupae when touched, showed rapid movement by rotating its abdomen. The present findings were in accordance with Khanna et al. (1957) who observed the marked difference between male and the female pupa. He observed the male and the female pupa to be in the range of 10–12 mm and 15–17 mm, respectively. They found the average pupal duration to last around 8–12 days in the month of September to October

Table 2: Sexual dimorphism in *C. tumidicostalis*

Characters	Male	Female
Pupa		
Size	Smaller than female Length: 26.78±0.10 mm (26.63-26.99 mm) Width: 6.38±0.02 mm (6.35-6.43 mm)	Larger Length: 32.85±0.07 mm (32.76-32.98 mm) Width: 7.97±0.02 mm (7.94-8.02 mm)
Genital pores	Genital opening situated on 8th segment and in the form of a circular lobe.	Genital opening situated on 9th abdominal segment and in the form of slit like aperture.
Adult		
Size	Smaller than female Length: 11.62±0.15 mm (11.4-11.9 mm) Width: 24.31±0.63 mm (23.7-25.4 mm)	Larger Length: 12.74±0.24 mm (12.4-13.2 mm) Width: 28.73±0.78 mm (27.8-29.7 mm)
Variation in anal part	Absence of tuft of hair	Tuft of hair present

Figures in the parentheses are ranges

Figure 2: Sexual dimorphism in *C. tumidicostalis* a. Male Pupa b. Female pupa c. Abdomen (dorsal) of adult male d. Abdomen (dorsal) of adult female

and 18–26 days in the month of January to February. Rahman et al. (2013) found that the average pupal duration to vary 7–15 days which may extend upto 22 days in cool weather. The findings of Suas-Ard (2000) support the present findings who noted the pupal duration to be 7.5 days. Hoang (2016) found the pupal period to range between 5–9 days.

3.1.4. Adult

The emergence of the adult usually takes place in the night. The moth being nocturnal shows maximum activity in the night and during the daylight the adults did not show much activity. Mating takes place in the night. The preoviposition period of the moth was less than a day. A gravid female keeps laying the egg for 1–2 days in 3–4 egg masses. After egg laying, the female dies within a period of 1–2 days. The longevity of the adult male was found to be lesser than the female. An adult male lived for 3–5 days with an average of 3.90±0.64 days and the adult female lived for 3–6 days with an average of 4.80±0.77 days. The sex ratio of Plassey borer was found to be 1:1.24.

The adult of Plassey borer showed a marked difference in the size, the males were smaller than the female. The length (head to last abdominal segment, excluding snout) of the male varied from 11.5 to 11.9 mm with an average of 11.62±0.15 mm. Whereas, the female being larger, the length varied from 12.3 to 13.2 mm with an average of 12.74±0.24 mm. The width (from leftmost tip to the rightmost tip of a stretched moth) of adult male moth varied from 23.7 to 25.4 mm with an average of 24.31±0.63. The width of the female varied from 27.8 to 29.7 mm with an average of 28.73±0.78 mm. The length of the male varied from 11.4 to 11.9 mm with an average of 11.62±0.15 mm. The length of the female moths varied from 12.4 to 13.2 mm with an average of 12.74±0.24 mm. The sex ratio (male: female) of Plassey borer were lesser than that of findings of Rahman et al. (2013) who confirmed the sex ratio to be 1:1.42. Khanna et al. (1957) noted the sexual dimorphism in adult stage and noted the wing span of the male and female moths to be in the range of 21–26 mm and 28–31 mm, respectively. Rahman et al. (2013) noted the adult period to be in the range of 3–8 days. He also noted the sexual dimorphism in adult form, the wingspan of the male and female was found to be 18–30 and 25–40 mm, respectively. Suasa-Ard (2000) noted the adult period was to be within 5–7 days.

The study on the ovipositional preference of the Plassey borer moth showed that the female did not lay the eggs on any non-living surface. The female preferred only live sugarcane plant (Figure 3, 4 and 5) and did not prefer brown paper, maize leaf and dried sugarcane leaf for oviposition.

4. Conclusion

Oviposition occurs in 3–4 batches which an averaged 410.64±45.21 eggs per female with incubation period 7.05±0.60 days. A total of 5 larval instars and the duration of first, second, third, fourth and fifth larval instars were 3.20±0.52, 3.7±0.47, 4.75±0.79, 6.05±0.69 and 6.35±0.67 days, respectively. The pupal duration of male and female was 7.25±1.21 and 8.1±1.37 days, respectively and the longevity of male and female was 3.9±0.64 and 4.8±0.77 days, respectively.

Figure 3: Moth rearing cage containing live plant for the oviposition of Plassey borer

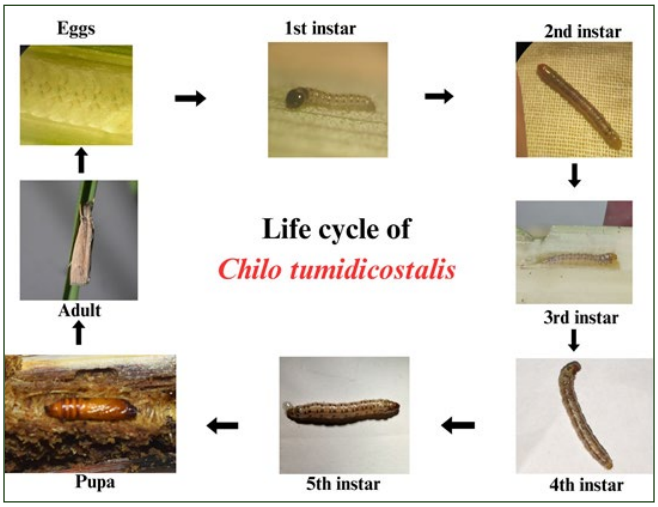

Figure 4: Life cycle of *C. tumidicostalis*

Figure 5: Primary infestation of Plassey borer, a. the newly hatched larvae cut the tissue in the form of ring just below the rind b. advanced stage of primary infestation

5. References

Baitha, A., Singh, M.R., Singh, B.D., 2016. Biological notes on Plassey borer *Chilo tumidicostalis* Hampson (Lepidoptera: Crambidae) in sugarcane. Journal of Sugarcane Research 6(2), 123–126.

Bathla, S., Jha, A., 2020. Indian agriculture and agro-processing in the global value chains. In: Transforming Agriculture in South Asia, 257–277.

Chand, H., Kumar, A., Dwivedi, G.P., Paswan, S., 2013. Influence of damage intensity of *Chilo tumidicostalis* Hampson on quantitative and qualitative parameters of sugarcane. Journal of Insect Science 26(1), 63–66.

David, H., Easwaramoorthy, S., Jayanthi, R., 1986. Sugarcane entomology in India. Sugarcane Breeding Institute, Indian Council of Agricultural Research, p. 564.

Formann, S., Hahn, A., Janke, L., Stinner, W., Sträuber, H., Logrono, W., Nikolausz, M., 2020. Beyond sugar and ethanol production: value generation opportunities through sugarcane residues. Frontiers in Energy Research 8, 579577.

Guo, H., Huang, Z., Tan, M., Ruan, H., Awe, G.O., Are, K.S., Liu, D., 2021. Crop resilience to climate change: a study of spatio-temporal variability of sugarcane yield in a subtropical region, China. Smart Agricultural Technology, 1, 100014.

Gupta, B.D., 1957. A note on the scientific and common names of sugarcane pests in India. Indian Journal of Sugarcane Research and Development 2, 9–13.

Gupta, B.D., Awasthy, P.N., 1959. Biology and control of the stem borer, *Chilo tumidicostalis* Hampson. Proc. International Society of Sugarcane Technologies 10, 886–901.

Gupta, M.K., Sarma, A.K., 2007. Plassey borer, *Chilo tumidicostalis* Hampson damage in sugarcane. Annals of Plant Protection Sciences 15(1), 12–14.

Hampson, G.F., 1919. A classification of Pyralidae. Annals and Magazine of Natural History, 3, 53–68.

Hoang, G.A., 2016. New record of Sugarcane moth borer *Chilo tumidicostalis* (Hampson) (Lepidoptera: Pyralidae) from the Southeast Vietnam. The Journal of Tropical Asian Entomology 5(1).

Karim, M.A., Islam, M.N., 1977. Stem borers of sugarcane in Bangladesh. Proc 22nd A Sci Conf, Bangladesh Ass Advmt Sci, 29–30.

Khanna, K.L., Nigam, L.N., Puri, V.D., 1957. *Chilo tumidicostalis* Hampson—A serious stem borer pest of sugarcane in Bihar. In Proceedings/Indian Academy of Sciences 46(2), 75–95. New Delhi: Springer India.

Kumar, A., Meena, S.K., Singh, S.K., Sinha, S.K., Singh, A.K., 2024. Carbon sequestration in sugarcane plant - soil system as influenced by nutrient integration practices under Indo-Gangetic plains of India. Journal of Advances in Biology & amp; Biotechnology 27(5), 116–125. DOI:10.9734/jabb/2024/v27i5769.

Kumar, A., Rai, C.P., Kumar, N., Rana, L., 2023. Plassey borer, *Chilo tumidicostalis* as an emerging threat on sugarcane. Krishi Science–eMagazine for Agricultural Sciences 4, 27–30.

Mann, A.P., 2016. Cogeneration of sugarcane bagasse for renewable energy production. Sugarcane-Based Biofuels and Bioproducts, 235–258.

Nath, R.K., Saikia, D.K., Ahmed, P., 2018. Field studies on the nature of damage caused by sugarcane plassey borer *Chilo tumidicostalis* Hampson (Lepidoptera: Pyralidae). International Journal of Plant Protection 11(1), 76–79.

Rahman, M.A., Noman, M.S., Maleque, M.A., Alam, M.Z., Afroz, S., Chowdhury, M.K.A., 2013. Identification and distribution of sugarcane stem borer in Bangladesh. SAARC Journal of Agriculture 11(2), 103–116.

Raza, Q.U.A., Bashir, M.A., Rehim, A., Sial, M.U., Ali Raza, H.M., Atif, H.M., Geng, Y., 2021. Sugarcane industrial byproducts as challenges to environmental safety and their remedies: A review. Water 13(24), 3495.

Salgado, A.L., Saastamoinen, M., 2019. Developmental stage-dependent response and preference for host plant quality in an insect herbivore. Animal Behaviour 150, 27–38.

Sallam, M.S., Allsopp, P.G., 2002. Bureau of Sugar Experiment Stations Queensland, Australia.

Shelar, M.N., Matsagar, V.K., Patil, V.S., Barahate, S.D., 2023. Net energy analysis of sugarcane based ethanol production. Cleaner Energy Systems 4, 100059.

Singh, S.P., 2016. Technical change and productivity growth in the Indian sugar industry. Procedia Economics and Finance 39, 131–139.

Sinha, S.K., Kumar, A., Kumari, A., Singh, A.K., 2024. The integrated effect of organic manure, biofertilizer and inorganic fertilizer on soil properties, yield and quality in sugarcane plant-ratoon system under calcareous soil of Indo gangetic plains of India. Journal of Scientific Research and Reports 30(5), 193–206. DOI: 10.9734/jsrr/2024/v30i51934

Solomon, S., 2011. Sugarcane by products based industries in India. Sugar Tech 13, 408–416.

Suasa-Ard, W., 2000. Chilo tumidicostalis (Hampson) (Lepidoptera: Pyralidae) and its natural enemies in Thailand. In Sugarcane pest management in the New Millennium. 4th sugarcane entomology workshop international society of sugar cane technologists, Khon Kaen, Thailand, 7–10 February 2000 10–16. International Society of Sugar Cane Technologists, c/o Bureau of Sugar Experiment Stations.

Volp, T.M., Zalucki, M.P., Furlong, M.J., 2022. What defines a host? Oviposition behavior and larval performance of Spodoptera frugiperda (Lepidoptera: Noctuidae) on five putative host plants. Journal of Economic Entomology 115(6), 1744–1751.