Research Article
TheScientificWorldJOURNAL (2011) 11, 2330–2338
ISSN 1537-744X; doi:10.1100/2011/753484

TheScientificWorldJOURNAL
www.thescientificworld.com

Seasonal Abundance and Suppression of Fruit-Piercing Moth *Eudocima phalonia* (L.) in a Citrus Orchard in Sarawak

Stephen Chan Teck Leong and Roland Jui Heng Kueh

Faculty of Agriculture and Food Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus, 97008 Bintulu, Sarawak, Malaysia

Received 28 May 2011; Accepted 6 October 2011

Academic Editor: Robert A. Pastorok

Seasonal population of the fruit-piercing moths *Eudocima* spp. was monitored throughout the citrus growing seasons in a citrus orchard and in site adjacent to secondary forest from July 2007 to June 2009. The moth was detected practically throughout the year with activity lowest during the wet months (September-February) when fruits are still available and while highest during the dry months (May-June) which also coincided with the main fruiting season. The effects of an nC24 horticultural mineral oil (HMO) on the citrus fruit damage caused by fruit-piecing moths was also determined. The percent fruit damage was significantly lowest ($P \leq 0.05$) in HMO-treated plots (8.4), followed by Dimethoate-treated plots (11.6) and untreated plots (22.5). However, there was no significant difference between HMO and Dimethoate treated plots indicating HMO is effective in reducing percent fruit damage.

KEYWORDS: Fruit-piercing moth, seasonal population, citrus fruit damage, nC24 horticultural mineral oil, conventional pesticide.

Correspondence should be addressed to Stephen Chan Teck Leong, sctleong@btu.upm.edu.my

Published by TheScientificWorldJOURNAL; http://www.tswj.com/

1. INTRODUCTION

Adult fruit-piercing moths (FPMs) are serious pests of fruit crops throughout tropical and subtropical belt from Africa through Southeast Asia and Australia to the Pacific Islands [1, 2]. These large noctuid moths are serious adult pests of ripe and ripening fruits for a wide range of commercial fruits such as citrus, carambola, guava, mango, papaya, banana, fig, persimmon, longan, kiwifruit, egg plants, and tomato [2]. The FPM complex is one of the most important insect groups attacking many kinds of fruits in Thailand and worldwide [2, 3]. Bänziger [1] reported 86 species in Thailand that are capable of feeding on fruit, and the most damaging of these are species of *Eudocima* and *Oraesia* which are largely confined to the old world [1, 4]. The most important fruit-piercing moth is *Eudocima phalonia* (L.) [Lepidoptera : Noctuidae : Catocalinae], a species widely distributed in Africa, the Indian Islands, Asia, Australasia, and the Pacific Islands [5] where adults feed on a wide variety of commercial fruits, including citrus [2, 4]. The adult moth by its feeding habitat is destructive while the larvae are not. The larvae feed only on Menispermaceae, and eggs of this moth are laid on coral trees (*Erythrina* spp.) [6, 7]. The larvae tend to feed on foliage of wild host, typically tree, shrubs, and veins within the families of Menispermaceae and Fabaceae [8–10].

Susceptibility of citrus fruits to attack by fruit-piercing moths increases as fruit near maturity and in early maturing varieties. Navel oranges (*Citrus* × *aurantium* L. [Sapindales : Rutaceae]) and certain mandarins (*C. reticulata* Blanco) are more susceptible than other species and cultivars [11]. In a study in which *E. phalonia* was the dominant species of fruit-piercing moth, Fay and Halfpapp [11] reported that grapefruit (*Citrus* × *aurantium* L.) and sweet orange crops started to be attacked at least 8 weeks before picking. Attacks on green fruit are reported to be more prevalent when moth populations are high [4, 8], but there are no published data to support these observations.

Unlike most noctuid moths that feed on nectar, both sexes of adults can pierce ripening fruit, penetrate the skin and pulp of fruit with their modified mouthparts (proboscis) to withdraw juice, and can cause crop losses of more than 50%. Microorganisms introduced by feeding moths cause rotting and premature fruit fall [12]. Damaged fruits are unmarketable and, if undetected and packed, pose a threat to sound fruit through pathogenic breakdown [11]. Recorded crop damage caused by fruit-piercing moths in citrus orchard can vary from 10–15% in Fiji [8], 20–30% in China [13], 10–55% in India [14], and up to 95% in New Caledonia [2]. Some of these reports indicate that these are losses of ripe fruit, with ripe and ripening fruit to be preferred by fruit-piercing moths. However, there appears to be no detailed studies of fruit-piercing feeding in relation to the maturity or soundness of fruit in citrus crops. The moths are difficult to control with insecticides because they spend only a short time on the fruit, and very few parasitoids of larvae of *Eudocima* spp. are known [12]. In Papua New Guinea and Guam, two egg parasitoids, *Telenomus* spp., and *Ooencyrtus* spp. has been met with some considerable success [12], and a parasite which can efficiently control this pest in Hawaii was reported by Heu et al. [15]. Despite their widespread occurrence and severe damage, relatively few effective control methods are available locally against this pest. Application of insecticides is undesirable particularly at harvest time in fruit crops. The objectives of this study were to test the hypothesis whether an *n*C24 HMO is as effective as the conventional pesticide for the control of the fruit-piercing moth populations in citrus orchard. We report the results of a study in East Sarawak, Malaysia in which we studied (a) the seasonal incidence of *E. phalonia* and two other fruit-piercing moth species in a Honey Mandarin (*Citrus reticulata*) orchard and in site adjacent to secondary forest and (b) suppression of *E. phalonia* damage by mineral oil deposits on the mandarin fruit following application of sprays of 0.35% (v/v) aqueous emulsions of an horticultural mineral oil.

2. METHODS

Experiments were conducted from July 2007 to June 2009 in a 2 ha 5-year-old honey mandarin (*Citrus reticulata* Blanco) citrus orchard in Tondong (N01°26′59″ E110°08′2″), Kuching Division, and Sarawak in Malaysia. It was comprised of 180 marcotted trees that were planted in January 2002. The experiments were consisted of seasonal moth population fluctuation throughout the citrus growing seasons and control of fruit-piercing moths using horticultural mineral oils and conventional pesticide. Maturity of citrus fruit in commercial crops is normally assessed on the Brix : acid ratio of the juice [16]. However, peel colour is regarded as a reliable indicator of fruit maturity in most citrus varieties and offers the easiest means to judge ripeness in the field without destructive sampling [17, 18].

2.1. Seasonal Moth Population Fluctuation in Citrus Orchard

The seasonal fruit-piercing moth populations were monitored weekly by trapping throughout the citrus growing seasons from July 2007 to June 2009 in a 2 ha 5-year-old citrus orchard in Kuching Division, Sarawak, and Malaysia. Four ultra violet light traps were also placed in the citrus orchard through observation at night in June 2008 to identify the moth species that are attracted or repelled by the light. Fresh ripe bananas that were used as baits were kept inside the 4 wire net cages (1.8 m × 1.8 m × 1.8 m) for trapping and monitoring seasonal adult moth population. Fresh ripe bananas were replaced at 3-day intervals, and caught moths were recorded on the same day. The mean number of caught moths were combined and expressed on a monthly basis.

2.2. Effect of Horticultural Mineral Oils on Fruit Damage

The experiment was conducted in September to November 2007 and April to May 2008 in a citrus orchard. The two treatments included horticultural mineral oil at 0.35%, and the untreated control was conducted in a randomized complete block design with 5 replications. Each replicate was comprised of 10 trees. Citrus fruits were sprayed with 0.35% HMO thoroughly to run off at weekly intervals during fruit maturing till ripening. A motorised Fuji FP-25 knapsack sprayer was used to apply all sprays.

2.3. Comparison of the Effect of Horticultural Mineral Oil and Conventional Pesticides on Fruit Damage

The experiment was conducted in December 2008 and March 2009 using randomized complete block design with 3 treatments. The 3 treatments included HMO at 0.35%, dimethoate at 0.1% a.i., and untreated control with 5 replications and each replicate comprising of 10 trees. Citrus fruits were sprayed with the systemic insecticide dimethoate, within 1 hour before dust at weekly intervals during fruit ripening season. Citrus fruits were sprayed with 0.35% HMO thoroughly to run off at weekly interval during fruit maturing until ripening.

2.4. Fruit Damage Assessment

During the fruiting seasons, the citrus fruits reaching full size with skin-colour changes from green to greenish-yellow are considered as maturing fruits while yellow-to-orange colour changes are considered as ripening fruits. The level of maturity was based on rind colour. The crop was not monitored throughout the entire fruiting period. However, maturing and ripening citrus fruits were assessed during the two fruiting season from April to June and from September to December. An assessment of FPM-damaged fruits was carried out for two fruiting seasons. The first harvest assessment was conducted during September–November 2007, and the second was done during April–May 2008.The feeding puncture site on the citrus fruit's surface became discoloured and resulted in the fruit dropping prematurely. The number of dropped fruits with the FPMs damage symptoms showing a 2 mm diameter hole due to moth attack was counted once a week. Percent of fruit damage was evaluated and compared between 2 harvest seasons.

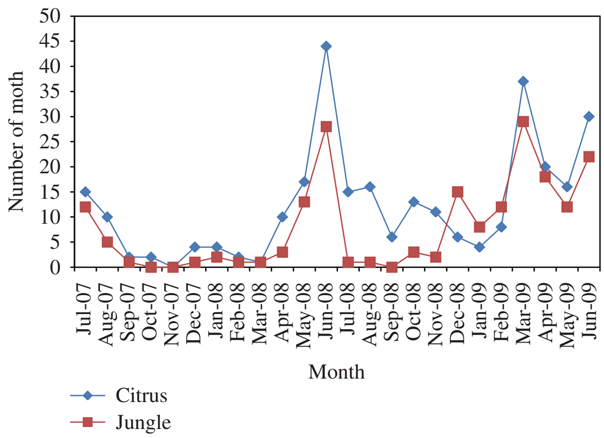

FIGURE 1: Flight activity of adult *Eudocima* moths during July 2007 to June 2009 in citrus orchard and secondary forest.

2.5. Statistical Analysis

Data was subjected to one-way analysis of variance (ANOVA). The NCSS computer package was used for the ANOVA. For significant F values, the differences between the means were separated using the Fisher's least significant difference test at $P \leq 0.05$.

Similarly, the percentages of attacked fruit for each period prior to trial completion were arcsine-transformed and compared by ANOVA. The least significant difference test was used to differentiate between means at $P \leq 0.05$.

3. RESULTS

3.1. Seasonal Moth Population Fluctuation

The seasonal abundance of trapped adult FPMs (all species) is shown in Figure 1. Despite the differences in numbers of trapped moths, two general annual periods of adult activity was recorded. One major peak occurred in June 2008, and one minor peak occurred in March 2009. In 2007, moth activity started to decline from July onwards. After March 2008 the number of moths began to increase and peaked in May-June then declined again from July onwards. Moth numbers started to increase from February onwards and peaked in March 2009. Moth was detected in citrus orchard and nearby secondary forest practically throughout the year with activity lowest during the wet months (September–February) while highest during the dry month in May-June as shown in Figure 1. The number of moths trapped in the citrus orchard was relatively higher than in the forest site. It has been observed that some species of *Eudocima* moths were either attracted or repelled by the light traps. This implies that light trap can only be used for monitoring the moth population and may reduce certain species of *Eudocima* moths numbers to some extent but not used as a tool to suppress the moths. Suitable toxicant to incorporate in the baits can provide better moth control than the light repulsion technique in citrus orchards [11].

3.2. Feeding Activities and Citrus Fruit Damage

Three species of *Eudocima* moths were found to feed on citrus fruits. *E. phalonia* occurs in mixed populations with other *Eudocima* species. *E. phalonia* months were actively piercing and feeding on the citrus fruits and caused average crop loss of less than 40% (ranging from 16.8% to 39.2% for the first harvest and 28.7% to 32.9% for the second harvest) as shown in Table 1. An adult pierces ripening fruit with its proboscis to extract juice leaving puncture that wounds cause premature ripening, fruit drop, and

TABLE 1: Influence of nC24 horticultural mineral oils (HMOs) deposits on damage by *Eudocima fullonia* on Honey Mandarin during September–November 2007 and April-May 2008.

Treatment	Mean percentage of fruit damage (%) Date of fruit sampling						
	30/9/07	7/10/07	21/10/07	4/11/07	29/4/08	6/5/08	27/5/08
HMOs	8.9 ± 5.2^a	7.3 ± 6.5^a	18.4 ± 9.6^a	4.8 ± 1.8^a	13.7 ± 3.0^a	14.5 ± 1.5^a	21.8 ± 9.8^a
Control	16.8 ± 4.1^a	23.3 ± 5.8^b	23.9 ± 6.8^a	39.2 ± 9.8^b	32.9 ± 2.2^b	29.6 ± 9.6^b	28.7 ± 9.2^a

Value with the same within a column are not significantly different at $P = 0.05$ by Fisher's LSD Test.

TABLE 2: Influence of nC24 Horticultural Mineral Oils (HMOs) Deposits and Synthetic Pesticide on Damage by *Eudocima fullonia* on Honey Mandarin during December 2008 and March 2009.

Treatment	Mean percentage of fruit damage (%) Date of fruit sampling		
	26/12/08	31/12/08	14/3/09
HMOs	15.7 ± 3.4^a	5.7 ± 3.1^a	3.9 ± 2.6^a
Dimethoate	16.7 ± 5.2^a	10.2 ± 3.5^a	8.0 ± 3.1^a
Control	18.7 ± 4.8^a	29.6 ± 6.7^b	19.2 ± 5.1^b

Value with the same within a column are not significantly different at $P = 0.05$ by Fisher's LSD Test.

rot. Therefore, adult feeding can reduce the quantity and quality of marketable fruits. After feeding, the moth immediately returns to it's host in the secondary forest. Larvae tend to feed on foliage of a wild shrub, *Leea indica* of family Leeaceae. The moth will complete its life cycle on this wild shrub.

3.3. Effect of Oils and Dimethoate on Fruit Damage

There was a significant decrease ($P \leq 0.05$) in the percent fruit damage caused by *E. phalonia* between HMO-treated and- untreated control plots during the first fruit harvest from September to November 2007 and second harvest from April to May 2008 as shown in Table 1. There was a significant decrease ($P \leq 0.05$) in the percent fruit damage between HMO-plots and dimethoate-plots and untreated control plots (Table 2). However, there was no significant difference in the percent fruit damage between HMO and dimethoate-treated plots.

4. DISCUSSION

4.1. Seasonal Moth Population Fluctuation

Annual moth population density was variable. Low activity may be due to climatic factors such as rainfall, humidity, and temperature which can influence the abundance of FPM outbreaks as reported by Ngampongsai et al. [19] in Thailand as well as minimal breeding and feeding especially during wet season. The adult moth population was small between September and February, increased in March/April, and peaked in May-June which coincided with the main fruiting season (April–July) before declining as reported in 2007 and 2008. The increase in adult moth population may be associated with stage of fruit development during fruiting seasons and favourable weather condition. The availability of host is essential to the survival and development of newly hatched FPM caterpillars.

Schreiner (n.d.), cited by Ngampongsai et al., [19] reported that *O. fullonia* populations in Guam are generally higher during the rainy season. However, FPM population was reported lower in our present study during rainy season. Boonyarat et al. [20] reported that a large number of the FPMs species *O. Coronata* were collected during mid-July to early September in China province, while the majority of the moths were trapped between March and June in the present study. Fay [21] reported that a large FPM population occurred in January/February in Summer in Queensland, Australia. In our study, the occurrence of higher moth numbers was observed in March, and May-June (Figure 1) was likely attributed to the end of rainy season (October–March), followed by the onset of dry season (April–September). The wide range of fruit crops has increased the quantity, and length of time fruit is available for FPMs attack and oviposition as reported by Fay [21]. He further reported that moth populations were higher in citrus orchard than the secondary forest which may be due to the feeding habitat of the adult moths as they were attracted to feed on mature and ripened citrus fruits instead of the foliage of wild hosts. Similar results were observed in our present study where the moth numbers were found relatively higher in the citrus orchard than the nearby forest throughout the year. This implies that adult moths were alternating between citrus orchard and nearby forest. Probably after feeding in citrus orchard, they immediately return to their breeding site in the forest.

4.2. Feeding Activities and Citrus Fruit Damage

E. phalonia occured in mixed populations with other two *Eudocima* species. This moth comprised nearly 90% of moths causing damage to fruit has been reported by Fay and Halfpapp [11]. *E. phalonia* is considered an important pest of citrus and numerous commercial fruits and vegetables [2, 22]. Therefore, adult feeding can reduce the quantity and quality of marketed fruit. Direct and indirect damage in this study by the adult moths has resulted in less than 40% as compared with up to 50% crop loss for citrus, carambolae, and lychees reported in Northeast Australia [23]. Damage caused by *E. phalonia* adults in citrus orchards can vary dramatically over years, rising and falling from very low ($<5\%$) to very high levels ($>90\%$) [13, 14, 24, 25]. Waterhouse and Norris [2] reported that most FPMs likely preferred to attack fruits that were ripe or nearly ripe. The data in Figure 1 suggests that some FPMs outbreaks occur during fruiting season from April–June and September–December (Table 1). In Sarawak, the larvae were found to feed on foliage of bandicoot berry, *Leea indica* of family Leeaceae. In Africa, India, and Australia, eggs are laid and larvae develop almost exclusively on leaves of species of several genera of woody tropical vines or lianes [Menispermaceae : Ranunculales] [26]. Nonmenispermaceous larval host includes coral trees (*Erythrina* spp [Fabales : Leguminosae]) in New Guinea and the Pacific Islands [10, 24, 27, 28] and bandicoot berry (*Leea indica* Meer. [Vitales : Vitaceae]) in Thailand [1]. Around 60% of the Australian menisperm species are now known to support fruit-piercing moth larvae to various extents. This separation of resources for larvae and adults allows *Eudocima* spp. to extend its period of reproduction and maintain population densities, even during unfavorable climatic conditions [29] and limited food resources. The moth will complete its life cycle on this bandicoot berry, *L. indica* in the secondary forest which has some medicinal value [30–34].

4.3. Effect of Oils and Dimethoate on Fruit Damage

HMO and dimethoate were significantly effective against *E. phalonia* infestation and fruit damage (Table 2). When given a choice, moths strongly preferred untreated fruits to HMO-treated and dimethoate-treated fruits as feeding sites. HMO have recently become increasingly important for the control of a wide range of insect pests of citrus. In Australia, China, and Malaysia, they are recommended for the control of armoured scales, soft scales, mites [35, 36], citrus leafminer [37], and citrus psyllid [38, 39]. In California, oils are used to control scales, mites, mealy bugs, aphids, psylla, and fruit-feeding Lepidoptera [40]. Our results indicate significant potential for using 0.35% HMO spray to reduce fruit damage through behavioural effects of oil deposits on feeding by moths. Recent publications dealing with behavioural effects of HMO on arthropods have indicated that this mode of action is more important than hypoxia. It has an important implication for the development of IPM programs for a wide range of crops.

5. CONCLUSION

Fruit-piercing moths *(Eudocima* spp.*)* are important pests of citrus and are active throughout the year as they are alternating among citrus and hosts including *Leea indica* of family Leeaceae in a secondary forest of Sarawak. The moth activities are influenced by the seasonal weather, host availability, and fruiting pattern. It is difficult to control with insecticide because they spend only a short time on the fruits and do not breed on the affected crops due to the alternation of host plant in nearby secondary forest areas. Bagging fruits or netting trees in an orchard neither practical nor cost effective. This field trial has demonstrated that HMO could reduce fruit damage as effective as conventional to feeding by the adult fruit-piercing moths which can be incorporated in the Integrated Pest Management programs. Baits incorporating with some toxicant and potential biocontrol agents should also be explored.

ACKNOWLEDGMENT

This research was funded by Universiti Putra Malaysia Research University Grant Scheme (05-01-07-0217 RU).

REFERENCES

[1] H. Bänziger, “Fruit-piercing moths (Lep., Noctuidae) in Thailand: a general survey and some new perspectives,” *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, vol. 55, pp. 213–240, 1982.

[2] D. F. Waterhouse and K. R. Norris, *Biological Control: Pacific Prospects*, Inkata Press, Melbourne, Australia, 1987.

[3] K. Jumroenma, S. Sudhi-Aromna, and C. Unawut, “Fruit piercing moth: key insect pest of fruit tree,” *Kasikorn*, vol. 71, pp. 428–432, 1998, (in Thailand).

[4] H. A. C. Fay, “Fruit piercing moths and fruitspotting bugs: intractable pests of tree fruits in a reduced-insecticide environment,” *Acta Horticulturae*, vol. 575, pp. 485–493, 2002.

[5] E. E. Davis, S. French, and R. C. Venette, *Mini risk assessment: Fruit piercing moth: Eudocima fullonia Green [Lepidoptera: Noctuidae]*, CAPS PRA: Eudocima fullonia, 2005.

[6] D. P. A. Sands and M. Schotz, “Biology and prospects for control of fruit piercing moths in the Pacific,” in *Proceedings of the 1st Asia-Pacific Conference of Entomology (APCE ’91)*, The Entomology and Zoology Association of Thailand, Chiang Mai, Thailand, 1991.

[7] D. P. A. Sands and R. R. Chan, “Survivorship of Australian *Othreis fullonia* on Erythrina variegata: hypotheses for development of host-plant biotypes in the Pacific,” *Entomologia Experimentalis et Applicata*, vol. 80, no. 1, pp. 145–148, 1996.

[8] K. Kumar and S. N. Lal, “Studies on the biology, seaonal abundance and host parasite relationship of fruit sucking moth *Othreis fullonia* (Clerk) in Fiji,” *Fiji Agricultural Journal*, vol. 45, pp. 71–77, 1983.

[9] J. L. Martin Kessing and R. F. L. Mau, *Othreis Fullonia (Clerk) Pacific Fruit-Piercing Moth*, University of Hawaii Department of Entomology, Honolulu, Hawaii, USA, 1993.

[10] R. Muniappan, I. U. Silva-Krott, and T. S. Lali, “Distribution of larval host plants of the fruit piercing moth, *Othreis fullonia*,” *Chemoecology*, vol. 5-6, no. 2, pp. 75–77, 1994.

[11] H. A. C. Fay and K. H. Halfpapp, “Fruit maturity and soundness relevant to feeding choice by fruit-piercing moths (Lepidoptera: Noctuidae) in citrus crops in northeast Australia,” *International Journal of Pest Management*, vol. 52, no. 4, pp. 317–324, 2006.

[12] D. P. A. Sands, W. J. M. M. Liebregts, and R. J. Broe, “Biological control of the fruit piercing moth, *Othreis fullonia* (Clerk) (Lepidoptera: Noctuidae) in the Pacific,” *Micronesica Series*, vol. 4, pp. 25–31, 1993.

[13] H. Cai and Z. T. Geng, “Occurrence and control of *Ophideres fullonica* Linneaus,” *Plant Protection*, vol. 23, pp. 33–34, 1997.

[14] S. M. Dadmal and N. P. Pawar, “The fruit sucking moth, *Eudocima* (=*Othreis*) fullonica on Nagpur mandarin in Vidarbha Region,” *Insect Environment*, vol. 6, p. 167, 2001.

[15] R. Heu, K. Teramoto, E. Shiroma, B. Kumashiro, and R. Dinker, *Hawaii Pest Report*, vol. 5, pp. 4–5, 1985.

[16] R. W. Kilburn, "The taste of citrus juice I. Relationship between Brix, acid and pH," *Proceedings of the Florida State Horticultural Society*, vol. 71, pp. 251–254, 1958.

[17] F. W. Liu, S. M. Hsueh, and T. H. Hung, "Selecting optimum harvest date by calendar or by fruit coloration for 'Ponkan' mandarins (*Citrus reticulata* Blanco) for storage," *Journal of the Chinese Society for Horticultural Science*, vol. 47, pp. 377–382, 2001 (Chinese).

[18] Y. Ying, X. Rao, and J. Ma, "Thodology for nondestructive inspection of citrus maturity with machine vis," *Transactions of the Chinese Society of Agricultural Engineering*, vol. 20, no. 2, p. 144, 2004 (Chinese).

[19] A. Ngampongsai, B. Barrett, S. Permkam, N. Suthapradit, and R. Nilla-or, "A preliminary study on some ecological aspects of the fruit piercing moths in Songkhla Province of Southern Thailand," *Songklanakarin Journal of Science and Technology*, vol. 27, no. 6, pp. 1135–1145, 2005.

[20] M. Boonyarat, M. Reucha, A. Upanissakorn et al., *Fruit Piercing Moths and Trapping Cases*, Plant protection Division. Department of Agricultural Extension, Bangkok, 1986.

[21] H. A. C. Fay, *Fruit piercing moth on citrus: a perspective including control developments*, DPI's agency for Food and Fiber Sciences, Horticulture. The State of Queensland, 2004.

[22] P. Cochereau, *Biologie et ecologie des populations en Nouvelle-Caledonie d'un piqueur de fruits: Othreis fullonia Clerck*, Travaux et Documents de L'O.R.S.T.O.M. No. 71.O.R.S.T.O.M.: Paris, France, 1977.

[23] H. A. C. Fay, "The relative acceptabilities of three Australian Menispermaceae as food plants for larvae of the fruitpiercing moth, *Othreis fullonia*," *Entomologia Experimentalis et Applicata*, vol. 72, no. 1, pp. 67–75, 1994.

[24] P. Cochereau, "Population management of the fruit-sucking moth *Othreis fullonia* (Clerck) in New Caledonia," in *Abstracts of the 14th International Congress of Entomology*, pp. 210–211, Canberra, Australia, August 1972.

[25] J. F. Dodia, D. N. Yadav, and R. C. Patel, "Management of fruit sucking moth, *Othries fullonica* Cl. (Lepidoptera: Noctuidae) in citrus orchards at Anand (Gujarat)," *Gujarat Agricultural University Research Journal*, vol. 11, no. 2, pp. 72–73, 1986.

[26] D. Sands and W. Liebregts, "Biological control of fruit piercing moth (*Eudocima fullonia* [Clerck]) (Lepidoptera: Noctuidae) in the Pacific: exploration, specificity, and evaluation of parasitoids," in *Proceeding of the 2nd International Symposium on Biological Control of Arthropods*, M. S. Hoddle, Ed., vol. 1 of *USDA Forest Service Publication FHTET-2005-08*, pp. 267–276, Davos, Switzerland, September 2005.

[27] H. A. C. Fay, "Evolutionary and taxonomic relationships between fruit-piercing moths and the Menispermaceae," *Australian Systematic Botany*, vol. 9, no. 2, pp. 227–233, 1996.

[28] G. V. P. Reddy, Z. T. Cruz, and R. Muniappan, "Attraction of fruit-piercing moth *Eudocima phalonia* (Lepidoptera: Noctuidae) to different fruit baits," *Crop Protection*, vol. 26, no. 4, pp. 664–667, 2007.

[29] H. A. C. Fay and K. H. Halfpapp, "Differential habitat affinities of five species of fruitpiercing moths (Lepidoptera: Noctuidae) in their utilization of *Tinospora smilacina* Benth. as a larval host plant in north Queensland," *Australian Journal of Ecology*, vol. 18, no. 4, pp. 451–462, 1993.

[30] G. V. Srinivasan, C. Ranjith, and K. K. Vijayan, "Identification of chemical compounds from the leaves of *Leea indica*," *Acta Pharmaceutica*, vol. 58, no. 2, pp. 207–214, 2008.

[31] N. D. Prajapati, S. S. Purohit, A. K. Sharma, and T. Kumar, *A Handbook of Medicinal Plants—A Complete Source Book, Agrobios (I)*, Jodhpur, India, 2003.

[32] I. H. Burkill, *A Dictionary of the Economic Products of the Malay Peninsula*, Crown Agents, London, UK, 1966.

[33] A. Chatterjee and S. C. Prakashi, *The Treatise on Indian Medicinal Plants. Vol. III*, NISCAIR, New Delhi, India, 1994.

[34] A. G. Lattif, I. M. Omar, I. M. Said, and A. Kadri, "A multi-variate approach to the study of medicinal plants in Malaysia," *Journal of the Singapore National Academy of Science*, vol. 13, pp. 101–105, 1984.

[35] G. A. C. Beattie, *Citrus Petroleum Spray Oils*, Agfact H2.AE.5, NSW Agriculture and Fisheries, 1990.

[36] C. T. S. Leong, H. L. Ng, G. A. C. Beattie, and D. M. Watson, "Comparison of a horticultural mineral oil and two pesticide-based programs for control of citrus pests in Sarawak, Malaysia," in *Spray Oils Beyond 2000: Sustainable Pests and Disease Management*, G. A. C. Beattie, D. M. Watson, M. L. Stevens, D. J. Rae, and R. N. Spooner-Hart, Eds., pp. 432–443, Sydney, Australia, October 1999.

[37] G. A. C. Beattie and D. Smith, "Integrated pest management: sustainable pest control for the future based on the past?" in *Proceedings of International Society of Citriculture*, vol. 1, pp. 51–58, Sun City, South Africa, 1996.

[38] D. J. Rae, W. G. Liang, D. M. Watson, G. A. C. Beattie, and M. D. Huang, "Evaluation of petroleum spray oils for control of the Asian citrus psylla, *Diaphorina citri* (Kuwayama) (Hemiptera: Psyllidae), in China," *International Journal of Pest Management*, vol. 43, no. 1, pp. 71–75, 1997.
[39] C. T. S. Leong, *Spread of Huanglongbing, population dynamics and control of Diaphorina citri Kuwayama, the Asiatic citrus psyllid in Sarawak*, Ph.D. thesis, Universiti Malaysia Sarawak, 2006.
[40] N. A. Davidson, J. E. Dibble, M. I. Flint, P. J. Marer, and A. Guy, "Managing insects and mites with Spray Oils," Publication No. 3347, University of California, 1991.

This article should be cited as follows:

Stephen Chan Teck Leong and Roland Jui Heng Kueh , "Seasonal Abundance and Suppression of Fruit-Piercing Moth ***Eudocima phalonia*** (L.) in a Citrus Orchard in Sarawak," *TheScientificWorldJOURNAL*, vol. 11, pp. 2330–2338, 2011.