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BIOECOLOGY OF RICE LEAFFOLDER, Cnaphalocrocis medinalis Guenee (LEPIDOPTERA: PYRALIDAE)

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BIOECOLOGY OF RICE LEAFFOLDER, *Cnaphalocrocis medinalis* Guenee (LEPIDOPTERA: PYRALIDAE)

By

MARINA BINTI ROSELI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirement for the Degree of Doctor of Philosophy

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DEDICATION

I wish to dedicate this work to my beloved parents (Roseli bin Ali and Jam binti Sanawi), my wonderful sister (Maryani binti Roseli) and brothers (Muhammad Naser bin Roseli and Muhammad Rashid bin Roseli), my lovely grandmother (Yah binti Chat), inlaws, nephews, nieces and friends for their patience, support and prayers during my study period.

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Doctor of Philosophy

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Chairman : Associate Professor Nur Azura binti Adam, PhD
Faculty : Agriculture

Rice leaffolder, *Cnaphalocrocis medinalis* Guenee is amongst the most destructive pests for rice causing significant damage of rice yield in many Asian countries including Malaysia. However, the information on biology and ecology on this pest in Malaysia is still lacking. Therefore, this study was conducted to i) determine the major lepidopteran rice pest and its associated parasitoids, ii) investigate population fluctuation of *C. medinalis*, iii) determine the life cycle of *C. medinalis*, and iv) construct life table and demographic parameters of *C. medinalis*. The distribution and abundance of lepidopteran rice pests and associated parasitoids were studied at four rice stages (30, 45, 60 and 75 days after sowing, DAS) in four locations namely Beseri (Perlis), Parit Buntar (Perak), Semanggol (Perak) and Tanjung Karang (Selangor). Population fluctuation of *C. medinalis* was studied in weekly interval during two consecutive seasons (main and off season) by picking the larvae from 10 hills which randomly selected in each three plots. Life cycle of *C. medinalis* was studied for determination of larval instar as well as the life table of *C. medinalis*. Results showed that *C. medinalis* was the most dominant species (88.00 ± 8.92 larvae) in all sampling locations. Its associated parasitoids were identified as *Apanteles cypris, Apanteles* sp., *Bracon* sp., *Macrocentrus philippinensis* and *Argyrophylax cinerella*. There was no significant difference in abundance of *C. medinalis* between main and off season. The population trend was similar in both seasons as the population was low at the beginning of season (vegetative phase) and gradually increase until the peak during reproductive phase. This is due to the morphology of rice plant during reproductive phase offers great suitability for larvae feeding. All three abiotic factors namely relative humidity, temperature and rainfall have contributed to the changes in population of *C. medinalis* with relative humidity contributed more than others. The factors greatly influence the insect population directly by limiting or expanding their distribution, growth, reproduction, diapause and dispersal. *Cnaphalocrocis medinalis* undergoes five larval instars with developmental period for egg, larva, prepupa and pupa ranged from 3-5, 17-26, 1-2 and 6-12 days, respectively. Age-specific survival (l_x) indicated that 32.26% of *C. medinalis* eggs has successfully reached adult stage with average sex ratio of 0.96:1.00 (Female: Male). The highest mortality was recorded in first instar larvae

(22.58%) with K-value of 0.125 and can be concluded as the key factor in regulating *C. medinalis* population. The pattern of survivorship curve falls into type III. Age-specific fecundity (m_x) shows the earliest egg laying was on day 30 and the last female died on day 43. The female laid on average 104.33 ± 5.43 eggs. The intrinsic rate of natural increase (r_m) was 0.08, net reproduction rate (R_o) of 14.48 and doubling time of 8.19 days. It shows that the population has built up in short time period. In conclusion, the rice leaffolder, *Cnaphalocrocis medinalis* was the major lepidopteran rice pests in Malaysian rice fields. The knowledge gained on the population fluctuation, natural enemies, life cycle and life table will facilitate farmers into better management on this lepidopteran rice pests.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

BIOEKOLOGI PELIPAT DAUN PADI, *Cnaphalocrocis medinalis* Guenee (LEPIDOPTERA: PYRALIDAE)

Oleh

MARINA BINTI ROSELI

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Pengerusi : Profesor Madya Nur Azura binti Adam, PhD
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Pelipat daun padi, *Cnaphalocrocis medinalis* Guenee merupakan antara perosak yang paling menyebabkan kerosakan besar terhadap tanaman padi yang menyebabkan kehilangan hasil padi yang signifikan di kebanyakan negara Asia termasuk Malaysia. Walau bagaimanapun, maklumat biologi dan ekologi serangga perosak ini masih kurang. Oleh itu, kajian ini dijalankan bertujuan untuk i) menentukan perosak padi Lepidoptera utama dan parasitoid, ii) menyiasat turun naik populasi *C. medinalis*, iii) menentukan kitar hidup *C. medinalis*, dan iv) membina jadual hayat dan parameter demografi *C. medinalis.* Taburan dan kelimpahan species *C. medinalis* dan parasitoidnya dikaji pada empat peringkat umur padi (30, 45, 60 dan 75 hari lepas tabur, HLT) di empat lokasi iaitu Beseri (Perlis), Parit Buntar (Perak), Semanggol (Perak) and Tanjung Karang (Selangor). Kajian turun naik populasi *C. medinalis* telah dijalankan secara mingguan dalam dua musim berturutan (musim utama dan luar musim) dengan mengutip larva dari 10 rumpun padi yang dipilih secara rawak dalam setiap tiga plot. Kitar hidup *C. medinalis* telah dikaji untuk penentuan instar larva begitu juga dengan jadual hayat *C. medinalis*. Hasil menunjukkan bahawa *C. medinalis* merupakan species paling dominan (88.00 ± 8.92 larva) di semua lokasi kajian. Parasitoidnya telah dicamkan sebagai *Apanteles cypris, Apanteles* sp., *Bracon* sp., *Macrocentrus philippinensis* dan *Argyrophylax cinerella.* Tidak terdapat perbezaan yang signifikan dalam kelimpahan *C. medinalis* di antara musim utama dan luar musim. Aliran populasi *C. medinalis* dalam dua musim tersebut sama iaitu populasi rendah pada awal musim (fasa vegetatif) dan meningkat secara berkala hingga ke puncak semasa fasa reproduktif. Hal ini disebabkan oleh morfologi pokok padi semasa fasa reproduktif memberi kesesuaian terhadap pemakanan larva. Ketiga-tiga faktor abiotik iaitu kelembapan relatif, suhu dan hujan menyumbang kepada perubahan populasi *C. medinalis* dengan kelembapan relatif menyumbangkan lebih banyak berbanding faktor lain. Faktor-faktor tersebut sangat mempengaruhi populasi serangga secara langsung dengan menghadkan atau mengembangkan taburan, pertumbuhan, pembiakan, diapaus dan penyebaran. *Cnaphalocrocis medinalis* mengalami lima peringkat instar larva dengan julat tempoh perkembangan untuk telur, larva, prepupa dan pupa masing-masing adalah 3-5, 17-26, 1-2 dan 6-12 hari. Kemandirian spesifik umur (l_x) menunjukkan bahawa 32.26% telur *C. medinalis* berjaya mencapai tahap dewasa dengan purata nisbah jantina 0.96:1.00 (Betina: Jantan). Kematian tertinggi direkodkan pada instar larva pertama (22.58%) dengan nilai K sebanyak 0.125 dan boleh disimpulkan sebagai faktor utama yang mengawal populasi *C. medinalis*. Corak lengkung kemandirian tergolong dalam jenis III. Fekunditi umur spesifik (m_x) menunjukkan telur paling awal dihasilkan adalah pada hari ke-30 dan individu betina terakhir yang mati adalah pada hari ke-43. Betina menghasilkan telur secara purata sebanyak 104.33 ± 5.43 telur. Kadar pertambahan semula jadi intrinsik (r_m) adalah sebanyak 0.08, kadar pembiakan bersih (R_o) sebanyak 14.48 dan masa gandaan berlaku dalam 8.19 hari. Ia menunjukkan bahawa populasi meningkat secara pantas dalam masa yang singkat. Kesimpulannya, pelipat daun padi, *Cnaphalocrocis medinalis* merupakan perosak padi Lepidoptera utama di sawah padi Malaysia. Pengetahuan yang diperolehi terhadap turun naik populasi, musuh semula jadi, kitar hidup dan jadual hayat akan dapat membantu para petani ke arah pengurusan perosak padi lepidoptera yang lebih baik.

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This thesis was submitted to the Senate of University Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

a.i.	Active ingredient
ANOVA	Analysis of Variance
BLAST	Basic Local Alignment Search Tool
BOLD	Barcode of Life Data
cm	centimeter
COI	cytochrome oxidase subunit 1
DAS	day after sowing
DAT	day after transplanting
DNA	Deoxyribonucleic acid
DOA	Department of Agriculture of Malaysia
DOSM	Department of Statistics Malaysia
FAO	Food and Agriculture Organization
FGG	Federal Government Gazette
g	gram
h	hour
ha	hectare
IADA	Integrated Agricultural Development Area
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
KADA	Kemubu Agricultural Development Authority
kg	kilogram
L.	Linnaeus
L:D	Light: Dark
m	meter
MADA	Muda Agricultural Development Authority
MARDI	The Malaysian Agricultural Research and Development Institute
mg	milligram
mm	millimeter
mM	milimolar
NCBI	National Centre for Biotechnology Information
ng	nanogram
NPK	Nitrogen Phosphorus Kalium
PCR	Polymerase Chain Reaction
r	correlation coefficient
R^2	coefficient of determination
RH	Relative humidity
SE	standard error
SSL	self-sufficiency level
UPM	Universiti Putra Malaysia
ºC	degrees Celsius
µl	microliter
µM	micromolar

CHAPTER 1

INTRODUCTION

Rice, *Oryza sativa* which belongs to family Poaceae is the most important staple food and plays a vital role for the food security of over half of the world population. It is due to the nutrition supply to worldwide population including Asia, parts of Latin America and the Caribbean, and Africa (FAO, 2018). More than 90% of the world's rice is produced and consumed in Asia. There are eight countries that become major producers namely China (198.471 million tonnes), India (123.012 million tonnes), Indonesia (50.632 million tonnes), Bangladesh (28.183 million tonnes), Vietnam (26.397 million tonnes), Thailand (21.280 million tonnes), Myanmar (18.900 million tonnes) and Philippines (11.269 million tonnes) with 55% of the production was accounted by only China and India (Papademetriou, 2000; Milovanovic and Smutka, 2017).

Malaysia is not listed as major rice producer country as the national production was only between 0.915 to 1.685 million tonnes per year recorded from 1970 until 2013 (Rajamoorthy et al., 2015). In 2015, the production increased to the value of 1.767 million tonnes which was produced from 681, 559 hectares of total area under rice cultivation (DOA, 2016). However, the production only catered about 72% of rice self-sufficiency level (SSL) while the rest was imported. The similar SSL value was reported from year 2013 until 2016 (DOSM, 2015; Hamzah, 2016). This result shows that national rice production is not enough for sustainable consumption due to yield losses which was contributed by several factors including insect pests. According to DOA (2016), a total of 61% of rice crop area damage in Peninsular Malaysia throughout 2015 has been reported due to insects' infestation. The value was generated with regards to only area damage caused by three major pests namely insect, weed and disease.

Among rice insect pests, rice leaffolder, *Cnaphalocrocis medinalis* is particularly important and become a major threat to rice production in many Asian countries including China, Sri Lanka, Vietnam Pakistan, Japan, Korea, Malaysia and India (Padmavathi et al., 2017). Shanmungam et al. (2006) stated that *C. medinalis* is one of the most serious pest among various rice pests in India. The pest was categorized into the most destructive lepidopteran larvae besides yellow stem borer, *Scirpophaga incertulas* (Khan et al., 1991). According to Bhatti (1995), *C. medinalis* has been reported to gain the major pest status in some important rice growing areas of India. In Malaysia, there has been no record of its outbreak in the last 20 years but the risk of the outbreak is possible. This is because its existence in local paddy field has been reported in many reports (Chang, 1993; KADA, 2011; "Kerjasama KADA-ACM", 2011; "Kawalan Perosak Tanaman Padi", 2015).

Cnaphalocrocis medinalis has history of outbreak in Sekinchan as reported by Ooi and Yazid (1982) and considered as minor pest before evolving as major pest in late 1980's in many parts of the world including Malaysia due to increase in abundance (Hafeez et al., 2010). The evolvement was influenced by the agricultural practices used by farmers, climatic conditions and pest management regimes (Bergé and Ricroch, 2010). According to Nayak et al. (2017), heavy use of pesticides and high fertilizer rates have influenced the outbreaks of leaffolder. In other insect pests, Kumar et al. (2014) reported that the ever-increasing degree of anthropogenic changes to the environment has caused the outbreak of a looper (*Perixera illepidaria*) on litchi trees. The intensive insecticide use to control cotton bollworm (*Helicoverpa armigera*) had contributed to the evolvement of cotton aphid (*Aphis gossypii*) as a primary pest of cotton in the mid-1970s (Wu and Guo, 2005). These evidences show that there is high possibility of *C. medinalis* outbreak reoccur in Malaysia if their population are not been properly managed. They will cause significant economic losses.

Many reports on significant rice yield losses that caused by heavy damage and infestation of *C. medinalis* has been reported in other Asian countries. A range of 30 to 80% of rice yield losses was assessed from severely damage fields under epidemic situation in India (Kushwaha, 1988; Nanda and Bisoi, 1990; Satish et al., 2007) while Shanmungam et al. (2006) have reported the losses amount of 11.18% in paddy crop. Finding from Chhavi et al. (2017) study revealed that *C. medinalis* caused leaf damage of 5.3 to 8.1% at reproductive stage while the damage ranged from 47.1 to 77.2% at maturity stage in different varieties. The damage has affected rice yield with range of 11.9 to 37.9% losses. Pandya et al. (1987) have found rice yield decrease at 14% with every unit of infestation increase during summer season while 1.46% in wet season. According to Padmavathi et al. (2013a), the rice plants able to compensate for leaffolder infestation in tillering stage. However, the rice yield has lost with 20% unfilled grains as the result of larval densities at more than three larvae per hill at the maximum tillering stage. A total of 50% unfilled grains resulted from more than 25% flag leaf damage at flowering stage.

The economic importance of *C. medinalis* has triggered almost all farmers to use chemical insecticides even in early rice crop season (vegetative stage) as folded leaves was visible regardless the amount. They decided to apply chemical insecticides as control action because of the fast and short-term result (Asghar et al., 2013). Thus, they mostly rely on pesticides which the practice lead to insecticide misuse and overuse (Bandong et al., 2002). The situation had contributed to resistance development in the pest to major insecticides group. High level of resistance percentage of chemical chlorpyriphos, cartap hydrochloride and profenophos to *C. medinalis* has been reported by Nayak (2017). Therefore, reliance only on chemical insecticides has negative impact to the ecosystem diversity, human health and environment (Aktar et al, 2009). Moreover, the misuse of pesticides is one of major constraints on Integrated Pest Management (IPM) practicability (Grzywacz et al., 2014).

Integrated Pest Management is a system that encourage and increase the utilization of non-chemical control methods and reduce the reliance of chemical pesticides at the same time (Norton et al., 1999). It has several components namely cultural control, mechanical and physical control, chemical control, host plant resistance and biological control (Karim and Riazuddin, 1999). The components are applied together in a compatible manner in IPM in order to keep the pest populations below economic injury levels (Elakkiya and Sujeetha, 2014). However, the uptake of IPM in most regions was slow due to several reasons include poor knowledge of IPM and lack of information on pests (Nyamwasa et al., 2018). According to Nyamwasa et al. (2018), the information on pest population dynamics is vitally important in selection of IPM strategies.

Hence, many studies on ecology and biology of *C. medinalis* were conducted by previous researchers in many countries. Alvi et al. (2003) have studied the population trends and chemical control of *C. medinalis* population, Chakraborty and Deb (2011b) studied on incidence of the adults in rice crop in India, Islam and Karim (1997) has conducted research on leaf folding behaviour while Kaushik (2010) studied the extent of damage by *C. medinalis* population in India. The effect of abiotic factor namely temperature on development of *C. medinalis* was studied by Padmavathi et al. (2013b) in India, Park et al. (2014a) in Korea and Liao et al. (2017) in China. The effect of nutrients on *C. medinalis* growth was investigated by Xu et al. (2011; 2012) in China. However, the study on *C. medinalis* population in Malaysia is very limited especially on its biology and ecology.

Therefore, the main objectives of this study were:

1. To determine the major lepidopteran rice pest and its associated parasitoids
2. To investigate population fluctuation of *C. medinalis*
3. To determine the life cycle of *C. medinalis*
4. To construct life table and demographic parameters of *C. medinalis*

REFERENCES

Abd Hafis Abd Rahim, Abu Hassan Ahmad and Abdul Hafiz Ab Majid. (2016). Life table analysis of *Cimex hemipterus* F. (Hemiptera: Cimicidae) reared on different types of human blood. *Asian Pacific Journal of Tropical Disease*, 6(4): 272-277.

Abdulhay, H.S. and Rathi, M.H. (2014). Effect of Some Insecticides on the Egg Parasitoid, *Trichogramma evanescens* Westwood (Hymenoptera: Trichogrammatidae). *Journal of Al-Nahrain University*, 17(3): 116-123.

Abenes, M. L.P. and Khan, Z.R. (1993). Spinning behaviour of two species of rice leaffolders, *Cnaphalocrocis medinalis* (Guenee) and *Marasmia patnalis* Bradley (Lepidoptera: Pyralidae). *Insect Science and Application,* 14 (2): 135-140.

Acosta, L.G., Jahnke, S.M., Redaelli, L.R. and Pires, P.R.S. (2017). Insect diversity in organic rice fields under two management systems of levees vegetation. *Brazilian Journal of Biology*, 77(4): 731-744.

Ahmad, M.J. and Zaki, F.A. (2008). Natural parasitism of the rice skipper, *Parnara guttata* (Bremer and Grey) (Lepidoptera: Hesperiidae) infesting paddy at Anantnag, Kashmir. *Journal of Biological Control*, 22(1): 113-117.

Aktar, M.W., Sengupta, D. and Chowdhury, A. (2009). Impact of pesticides use in agriculture: their benefits and hazards. *Interdisciplinary Toxicology*, 2(1): 1-12.

Ali, A. and Rizvi, P.Q. (2010). Age and stage specific life table of *Coocinella septemounctata* (Coleoptera: Coccinellidae) at varying temperature. *World Journal of Agricultural Sciences*, 6 (3): 268-273.

Altieri, M.A. and Nicholls, C. (2004). *Biodiversity and pest management in agroecosystems*. New York: Food Products Press.

Alvi, S.M., Ali, M.A., Chaudhary, S. and Iqbal, S. (2003). Population Trends and Chemical Control of Rice Leaf Folder, *Cnaphalocrocis medinalis* on Rice Crop. *International Journal of Agriculture and Biology*, 5(4): 615 – 617.

Amiri, A., Talebi, A.A., Zamani, A.A. and Kamali, K. (2010). Effect of temperature on demographic parameters of the hawthorn red midget moth, Phyllonorycter corylifoliella, on apple. *Journal of Insect Science*, Vol. 10.

Ane, N.U. and Hussain, M. (2016). Diversity of insect pests in major rice growing areas of the world. *Journal of Entomology and Zoology Studies*, 4(1): 36-41.

Ankit, K., Maan, S., Ram, S. and Banvir, S. (2016). Life Cycle of Rice Leaf Folder, *Cnaphalocrocis medinalis* (Guenee) on Rice Cultivar HKR-47. *International Journal of Agriculture Sciences*, 8(52): 2488-2490.

Arshad, M.A., Suhail, A., Majeed, M.M., Bilal, H., Gogi, M.D. and Abdin, Z. (2012). Determination of economic threshold level (ETL) for the chemical control of rice leaffolder, *Cnaphalocrocis medinalis* Gn. (Pyralidae: Lepidoptera). *Pakistan Entomology*, 34: 79-81.

Asghar, M., Arshad, M., Fiaz, M., Suhail, A. and Sabir, A.M. (2013). A survey of rice farmers' farming practices posing threats to insect biodiversity of rice crop in the Punjab, Pakistan. *International Journal of Biodiversity and Conservation*, 5(10): 647-654.

Askew, R.R. and Shaw, M.R. (1986). Parasitoid communities: their size, structure and development. In: Waage, J. and Greathead, D. (Eds.). *Insect Parasitoids*. Academic Press: London. 225-264.

Awmack, C.S. and Leather, S.R. (2002). Host plant quality and fecundity in herbivorous insects. *Annual Review of Entomology*, 47:817–844.

Ayres, J.S., Schneider, D.S. (2009). The role of anorexia in resistance and tolerance to infections in Drosophila. *PLoS Biology*, 7:1000- 1005.

Baby Rani, W., Amutha, R., Muthulakshmi, S., Indira, K. and Mareeswari, P. (2007). Diversity of rice leaf folders and their natural enemies. *Research Journal of Agriculture and Biological Sciences*, 3(5): 394-397.

Bale, J.S., Masters, G.J., Hodkinson, I.D., Awmack, C., Bezemer, T.M., Brown, V.K., Butterfield, J., Buse, A., Coulson, J.C., Farrar, J., Good, J.E.G., Harrington, R., Hartley, S., Jones, T.H, Lindroth, R.L., Press, M.C., Symioudis, I., Waltt, A.D. and Whittaker, J.B. (2002). Herbivory in global climate change research: direct effects of rising temperature on insect herbivores. *Global Change Biology*, 8(1): 1-16.

Bandong, J.P., Canapi, B.L., dela Cruz, C.G. and Litsinger, J.A. (2002). Insecticide decision protocols: a case study of untrained Filipino rice farmers. *Crop Protection*, 21:803-816.

Baskaran, R.K.M., Sharma, K.C. and Kumar, J. (2017). Seasonal and relative abundance of stem-borer and leaf-folder in wet land rice eco-system. *Journal of Entomology and Zoology Studies*, 5(2): 879-884.

Beggs, J.R., Rees, J.S., Toft, R.J., Dennis, T.E. and Barlow, N.D. (2008). Evaluating the impact of a biological control parasitoid on invasive *Vespula* wasps in a natural forest ecosystem. *Biological Control*, 44: 399-407.

Bergé, J.B. and Ricroch, A.E. (2010). Emergence of minor pests becoming major pests in GE cotton in China: What are the reasons? What are the alternatives practices to this change of status? *Genetically Modified Crops*, 1(4): 214-219.

Bhattacharyya, B., Basit, A. and Saikia, D.K. (2006). Parasitoids and predators of rice insect pests of Jorhat districts of Assam. *Journal of Biological Control*, 20(1): 37-44.

Bhatti, M.N. (1995). Rice leaf folder (*Cnaphalocrosis medinalis*): A review. *Pakistan Entomology*, 17:126-131.

Bhumireddy, S., Simon, S. and Nagar, S. (2018). Seasonal incidence of rice leaf folder, *Cnaphalocrocis medinalis* (Guen) in Allahabad region. *Journal of Pharmacognosy and Phytochemistry*, 7(4): 2528-2530.

Bodlah, M.A., Zhu, A.X. and Liu, X.D. (2016). Host choice, settling and folding leaf behaviors of the larval rice leaf folder under heat stress. *Bulletin of Entomological Research*, 106: 809–817.

Calvo, D. and Molina, J.M. (2005). Fecundity-body size relationship and other reproductive aspects of *Streblote panda* (Lepidoptera: Lasiocampidae). *Annals of the Entomological Society of America,* 98(2): 191-196.

Cao, H.S., Huang, P.S., Miao, B.S., Lu, S.L. and Cheng, J.T. (1992). The analysis of nitrogen uptake and the study on fertilization technique in two types of japonica rice. *Journal of University Science and Technology Suzhou,* 9(1): 35–41.

Carey, J.R. (1993). *Applied Demography for Biologist with Special Emphasis on Insects*. New York: Oxford University Press.

Carvalho, M. (2018, June 12). Bernas: Some form of rice import monopoly needed. The Star. Retrieved from https://www.thestar.com.my/news/nation/2018/06/12/bernas-some-form-of-rice-import-monopoly-needed/.

Chakraborty, K. and Deb, D.C. (2011a). Extent of suppression of leaf folder, *Cnaphalocrocis medinalis*, Guenee. Population by some selected insecticides in the field of scented local paddy cultivar *Tulaipanji* at Raiganj, Uttar Dinajpur, West Bengal, India. *International Journal of Plant, Animal and Environmental Sciences*, 1(3): 142-149.

Chakraborty, K. and Deb, D.C. (2011b). Incidence of Adult Leaf Folder, Cnaphalocrocis medinalis (Lepidoptera: Pyralidae) on Paddy Crop in the Agro Climatic Conditions of the Northern Parts of West Bengal, India. *World Journal of Agricultural Sciences*, 7(6): 738-742.

Chang, P.M. (1993). Rice leaffolder and brown planthopper occurrence in FELCRA Seberang Perak, Malaysia. pp. 14–15 in Research on rice leaffolder management in China. In *International Workshop on Economic Threshold Level for Rice Leaffolder*, China, Beijing, March 1–2, 1992.

Chantaraprapha, N., Ratanyukui, W., Semapetch, U. and Seetanun, W. (1980). Influence of ammonium phosphate levels on rice leaf roller incidence. *International Rice Research Newsletter*, 5: 21.

Chen, C., Son, N.T. and Chang, L. (2012). Monitoring of rice cropping intensity in the upper Mekong Delta, Vietnam using time-series MODIS data. *Advances in Space Research*, 49: 292–301.

Chhavi, Srivastava, A. and Sharma, P.K. (2017). Assessment of yield losses of rice caused by paddy leaf folder, *Cnaphalocrocis medinalis* Guenee. *Agricultural Science Digest*, 37 (1): 72-74.

Clem, C.S. and Held, D.W. (2015). Species richness of eruciform larvae associated with native and alien plants in the southeastern United States. *Journal of Insect Conservation*, 19: 987-997.

Danks, H.V. 2000. Measuring and reporting life-cycle duration in insects and arachnids. *European Journal of Entomology*, 97: 285-303.

Deka, S. and Barthakur, S. (2010). Overview on current status of biotechnological interventions on yellow stem borer, *Scirpophaga incertulas* (Lepidoptera: Crambidae) resistance in rice. *Biotechnology Advances*, 28(1): 70-81.

Desenux, N., Decourtye, A. and Delpuech, J.M. (2007). The sublethal effects of pesticides on beneficial arthropods. *Annual Review of Entomology*, 52: 81-106. Dhaliwal, G.S. and Arora, R. (1996). An estimate of yield losses due to insect pests in Indian Agriculture. *Indian Journal Ecology*, 23(1):70-73.

Dix, M.E., Cunningham, R.A., King, R.M. (1996). Evaluating spring cankerworm (Lepidoptera: Geometridae) preference for Siberian elm clones. *Environmental Entomology*, 25:56–62.

DOA. (2016). *Perangkaan padi Malaysia (Paddy statistics of Malaysia) 2015*. Kuala Lumpur: Jabatan Pertanian Semenanjung Malaysia.

DOSM. (2015). Supply and Utilization Accounts Selected Agricultural Commodities, Malaysia 2010-2014. www.dosm.gov.my.

Du, J.W. (2001). Plant insect chemical communication and its behavior control. *Acta Phytophysiologica Sinica*, 27: 193-200.

Dunand, R. and Saichuk, J. (2009). Rice growth and development. In J. Saichuk (6th Ed.), *Louisiana Rice Production Handbook* (pp. 41-53). Louisiana State: Louisiana State University Agricultural Center.

Dutta, S. and Roy, N. (2018). Population dynamics and host preference of a major pest, *Scirpophaga incertulas* Walker (Pyralidae: Lepidoptera). *International Journal of Advanced Science and Research*, 3(2): 120-127.

Ehsanullah, Iqbal, I., Ahmad, A. and Randhawa, S.A. (2000). Effect of direct seeding and transplanting methods on the yield and quality of fine rice Basmati-370. *International Journal of Agricultural Biology,* 2(3): 251-252.

Elakkiya, P. and Sujeetha, J.A.R.P. (2014). Validation of Integrated Pest Management (IPM) modules against rice leaf folder complex in the coastal region of Puducherry. *Journal of Rice Research*, 4(1 & 2): 1-4.

Esperk, T., Tammaru, T. and Nylin, S. (2007). Intraspecific variability in number of larval instars in insects. *Journal of Economic Entomology*, 100(3): 627-645.

FGG. (2016). *Notification of application for registration of new plant variety and grant of breeder's right*. Kuala Lumpur: Attorney General's Chambers.

Folmer, O., Black, M., Hoeh, W., Lutze, R., Vrijenhoek, R. (1994). DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology*, 33: 294-299.

Food and Agriculture Organization of the United Nations (FAO). (2018). Rice Publication. Rice International Commodity Profile. www.fao.org.

Foster, S.P., and Howard, A.J. (1999). Adult female and neonate larval plant preferences of the generalist herbivore, *Epiphyas postvittana*. *Entomology Experimental and Applied*, 2:53–62.

Fukai, S. (1999). Phenology in rainfed lowland rice. *Field Crops Research*, 64: 51-60.

Gangwar, R.K. (2015). Life cycle and abundance of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) - A review. *Journal of Natural Sciences Research*, 5(15): 103-105.

Gautam, S., Schreinemachers, P., Uddin, M.N. and Srinivasan, R. (2017). Impact of training vegetable farmers in Bangladesh in integrated pest management (IPM). *Crop Protection*, 102: 161-169.

Ge, L.Q., Wan, D.J., Xu, J., Jiang, L.B. and Wu, J.C. (2013). Effects of nitrogen fertilizer and magnesium manipulation on the *Cnaphalocrocis medinalis* (Lepidoptera: Pyralidae). *Journal of Economic Entomology*, 106(1):196-205.

Ghafoor, M.S.M. (2011). Determination of Larval Instars of Black Cutworm *Agrotis ipsilon* (Hufnagel) (Lepidoptera: Noctuidae). *Jordan Journal of Biological Sciences*, 4(3):173-176.

Ghahari, H., Hayat, R., Tabari, M., Ostovan, H. and Imani, S. (2008). A contribution to the predator and parasitoid fauna of rice pests in Iran, and a discussion on the biodiversity and IPM in rice fields. *Linzer Biologische Beitrage*, 40(1): 735-764.

Girod, P., Lierhmann, O., Urvois, T., Turlings, T.C.J., Kenis, M. and Haye, T. (2018). Host specificity of Asian parasitoids for potential classical biological control of *Drosophila suzukii*. *Journal of Pest Science*, 91(4): 1241-1250.

Godfray, H.C.J. (1994). *Parasitoids: Behavioural and Evolutionary Ecology*. Princeton: Princeton University Press.

Gogoi, H. and Bora, D. (2012). Spatial distribution of *Nymphula depunctalis* Guenée larvae (Lepidoptera: Pyralidae), an early vegetative pest of *Oryza sativa* L. *Academic Journal of Entomology*, 5(1): 41-46.

Golizadeh, A., Kamali, K., Fathipour, Y. and Abbasipour, H. (2009). Effect of temperature on life table parameters of *Plutella xylostella* (Lepidoptera: Plutellidae) on two brassicaceous host plants. *Journal of Asia-Pacific Entomology*, 12: 207–212.

Google Maps. (2019). Retrieved on 25th July 2019 from https://www.google.com/maps.

Grant, M.D. (1982). Feeding preferences of larvae of *Herpetogramma licarsisalis* (Walker) (Lepidoptera: Pyralidae) and *Spodoptera mauritia* (Boiduval) (Lepidoptera: Noctuidae), two lawn pests common about Brisbane. *Australian Journal of Entomology*, 21(3): 201-205.

Grzywacz, D., Stevenson, P.C., Mushobozi, W.L., Belmain, S. and Wilson, K. (2014). The use of indigenous ecological resources for pest control in Africa. *Food Security*, 6(1): 71–86.

Guarneri, A.A., Lazzari, C., Diotaiuti, L. and Lorenzo, M.G. (2002). The effect of relative humidity on the behaviour and development of *Triatoma brasiliensis*. *Physiological Entomology*, 27:142–147.

Gurr, G. M., Read, D. M. Y., Catindig, J. L. A., Cheng, J., Liu, J., Lan, L. P. & Heong, K. L. (2012). Parasitoids of the rice leaffolder *Cnaphalocrocis medinalis* and prospects for enhancing biological control with nectar plants. Review Article. *Agricultural and Forest Entomology* 14: 1-12.

Hafeez, A., Khan, R.B., Sharma, D., Jamwal, V.V.S., Gupta, S. (2010). Seasonal incidence, infestation and trap catch of *Cnaphalocrocis medinalis* (Guenee) in rice. *Annals of Plant Protection Science*, 8(2): 38-383.

Hall, J.P.W. and Harvey, D.J. (2002). A survey of androconial organs in the Riodinidae (Lepidoptera). *Zoological Journal of the Linnean Society*, 136(2): 171-197.

Hamzah, A. (2016). Reducing Paddy Postharvest Losses. *Scientia MARDI*, 9: 8.

He, Z., Li, S., Wang, Y., Dai, L. and Lin, S. (2018). Monitoring rice phenology based on backscattering characteristics of multi-temporal RADARSAT-2 datasets. *Remote Sensing*, 10(340): 1-17.

Heinrichs, E. A. (1994). *Biology and management of rice insect*. Philippines: International Rice Research Institute.

Heong, K.L. (1990). Feeding rates of the rice leaffolder, *Cnaphalocrocis medinalis* (Lepidoptera: Pyralidae) on different plant stages. *Journal of Agricultural Entomology*, 7(2): 81-90.

Heong, K.L., Manza, A., Catindig, J., Villareal, S. and Jacobsen, T. (2007). Changes in pesticide use and arthropod biodiversity in the IRRI research farm. *Outlooks Pest Management*, 18: 229–33.

Hill, M.P., Macfadyen, S. and Nash, M.A. (2017). Broad spectrum pesticide application alters natural enemy communities and may facilitate secondary pest outbreaks. *Peer Journal*, 5: 1-24.

Hole, D.G., Perkins, A.J., Wilson, J.D., Alexander, I.H., Grice, P.V. and Evans, A.D., (2005). Does organic farming benefit biodiversity? *Biological Conservation*, 122: 113-130.

Hossain, M.F., Salam, M.A., Uddin, M.R., Pervez, Z. and Sarkar, M.A.R. (2002). A comparative study of direct seeding versus transplanting method on the yield of Aus rice. *Pakistan Journal of Agronomy*, 1(2-3): 86-88.

Huzaifah, (2012). Gempar! Jutaan ulat ratus menyerang sawah Kedah. Retrieved on 10 April 2012 from http://melayukini.net/2012/02/gempar-jutaan-ulat-ratus-menyerang-sawah-kedah/

Ibrahim, M., Juraimi, A.S., Hakim, M.A., Aslani, F., Karim, S.M.R. and Alam, M.A. (2017). Residual effect of imidazolinone herbicide used in clearfield rice on non-clearfield rice. *Bangladesh Journal of Botany*, 46(1): 335-341.

Ikeuchi, Y., Suetsugu, K. and Sumikawa, H. (2015). Diurnal skipper *Pelopidas mathias* (Lepidoptera: Hesperiidae) pollinates *Habenaria radiate* (Orchidaceae). *Entomological News*, 125(1): 7-11.

Iranipour, S., Pakdel, A.K. and Radjabi, G. (2010). Life history parameters of the Sunn pest, *Eurygasterintegriceps*, held at four constant temperatures. *Journal of Insect Science*, 10(106): 1-9.

IRRI. (2015). *Steps to successful rice production*. Los Banos: International Rice Research Institute.

Ishida, H., Izumi, M., Wada, S. and Makino, A. (2014). Roles of autophagy in chloroplast recycling. *Biochimica et Biophysica Acta*, 1837: 512-521.

Islam, Z. and Karim, A.N.M.R. (1997). Leaf folding behaviour of *Cnaphalocrocis medinalis* (Guenee) and *Marasmia patnalis* Bradley, and the influence of rice leaf morphology on damage incidence. *Crop Protection*, 16(3): 215-220.

Jaworski, T. and Hilszczański, J. (2013). The effect of temperature and humidity changes on insects development their impact on forest ecosystems in the expected climate change. *Leśne Prace Badawcze (Forest Research Papers)*, 74(4): 345-355.

Jordan, A.T. and Conner, W.E. (2007). Dietary basis for developmental plasticity of an androconial structure in the salt marsh moth *Estigmene acrea* (Drury) (Lepidoptera: Arctiidae). *Journal of the Lepidopterists' Society*, 61(1): 32–37.

Justin, C.G.L and Preetha, G. (2014). Survey on the occurrence, distribution pattern and management of stem borers on rice in Kanyakumari District, Tamil Nadu. *Journal of Entomology and Zoology Studies*, 2 (6): 86-90.

KADA. (2011). *Buku Panduan Pengurusan Perosak, Penyakit & Rumpai Padi Mengikut Pengalaman Ladang Merdeka KADA*. Bahagian Industri Padi Lembaga Kemajuan Pertanian Kemubu: Kota Bharu, Kelantan.

Kakde, A.M., Patel, K.G. and Shailesh Tayade. (2014). Role of life table in insect pest management--A review. *IOSR Journal of Agriculture and Veterinary Science*, 7(1): 40-43.

Kakde, A.M. and Patel, K.G. (2015). Seasonal incidence of rice leaf folder in relation to SRI and conventional methods of planting and its correlation with weather parameters. *Plant Archives*, 15(1): 121-126.

Karim, S and Riazuddin, S. (1999). Rice insect pests of Pakistan and their control: A lesson from past for sustainable future integrated pest management. *Pakistan Journal of Biological Sciences*, 2(2): 261-276.

Karl, I., Stoks, R., De Block, M., Janowitz, S.A. and Fischer, K. (2011). Temperature extremes and butterfly fitness conflicting evidence from life history and immune function. *Global Change Biology*, 17: 676-687.

Karuppaiah, V. and Sujayanad, G.K. (2012). Impact of climate change on population dynamics of insect pests. *World Journal of Agricultural Science*, 8: 240-246.

Kaushik, C. (2010). Extent of damage by leaf folder, *Cnaphalocrocis medinalis* (Guenee) in paddy cultivars at Raiganj, Uttar Dinajpur, West Bengal. *Current Biotica*, 4: 365-367.

Kawalan perosak tanaman padi. (2015, July 13). Kosmo. Retrieved from http://ww1.kosmo.com.my/kosmo/content.asp?y=2015&dt=0713&pub=Kosmo&sec=Varia&pg=va_03.htm.

Kerjasama KADA-ACM tingkat hasil tanaman padi. (2011, July 26). *Utusan Malaysia*. Retrieved from http://ww1.utusan.com.my/utusan/info.asp?y=2011&dt=0726&pub=Utusan_Malaysia&sec=Timur&pg=wt_05.htm.

Khaliq, A., Javed, M., Sohail, M., and Sagheer, M. (2014). Environmental effects on insects and their population dynamics. *Journal of Entomology and Zoology Studies*, 2(2): 1-7.

Khan, Z.H. and Ramamurthy, V.V. (2004). Influence of weather factors on the activity of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee). *Annals of Plant Protection Science*, 12(2):263-266.

Khan, Z.R., Barrion, A.T., Litsinger, J.A., Castilla, N.P., Joshi, R.C. (1988). A bibliography of rice leaffolders (Lepidoptera: Pyralidae). *Insect Science Application*, 9: 129-174.

Khan, Z.R., Litsinger, J.A., Barrion, A.T., Villanueva, F.F.D., Fernandez, N.J. and Taylor, L.D. (1991). *World bibliography of rice stem borers*. Philippines: IRRI.

Khuhro, S.A., Solangi, A.W. and Lanjar, A.G. (2014). Efficacy of insecticides on rice crop against rice leaf folder, *Cnaphalocrocis medinalis* Guenee (Pyralidae: Lepidoptera). *Food Science and Quality Management*, 26: 39-46.

Kim, D.S. and Lee, J.H. (2002). Egg and larval survivorship of *Carposina sasakii* (Lepidoptera: Carposinidae) in apple and peach and their effects on adult population dynamics in orchards. *Environmental Entomology*, 31: 686–692.

Kocourek, F., Havelka, J., Berankova, J. and Jarosik, V. (1994). Effect of temperature on development rate and intrinsic rate of increase of *Aphis gossypii* reared on greenhouse cucumber. *Entomologia Experimentalis et Applicata*, 71: 59–64.

de Kraker, J., van Huis, A., Heong, K.L., van Lenteren, J.C. and Rabbinge, R. (1999). Population dynamics of rice leaffolders (Lepidoptera: Pyralidae) and their natural enemies in irrigated rice in the Philippines. *Bulletin of Entomological Research*, 89: 411-421.

de Kraker, J., Rabbinge, R., Huis, A.V., Lenteren, J.C.V. and Heong, K.L. (2000). Impact of nitrogenous-fertilization on the population dynamics and natural control of rice leaffolder (Lepidoptera: Pyralidae). *International Journal of Pest Management*, 46:225–235.

Krebs, C.J. (1999). *Ecological Methodology*. California: Benjamin Cummings.

Krechemer, F.S. and Foerster, L.A. (2015). Temperature effects on the development and reproduction of three *Trichogramma* (Hymenoptera: Trichogrammatidae) species reared on *Trichoplusia ni* (Lepidoptera: Noctuidae) eggs. *Journal of Insect Science*, 15(1): 1-6.

Kudoh, H. (2015). Molecular phenology in plants: *in natura* systems biology for the comprehensive understanding of seasonal responses under natural environments. *New Phytologist*, 210: 399-412.

Kumar, V., Reddy, P.V.R., Anal, A.K.D. and Nath, V. (2014). Outbreak of the Looper, *Perixera illepidaria* (Lepidoptera: Geometridae) on Litchi, *Litchi chinensis* (Sapindales: Sapindaceae) - A New Pest Record from India. *Florida Entomologist*, 97(1): 22-29.

Kushwaha, K.S. (1988). Leaffolder (LF) epidemic in Haryana (India). *International Rice Research Newsletter,* 13(3): 16-17.

Lakshmi, J.V., Sunil, V., Kumar, S.M., Bentur, J.S., Katti, G.R. and Vennila, S. (2018). Population dynamics of rice insect pests in Yadagirigutta Mandal (Nalgonda District) - under climate change perspective. *Journal of Rice Research*, 10(2): 70-74.

Li, X.H., Yao, H.W. and Ye, G.Y. (2011). Effects of parasitization by *Cotesia chilonis* (Hymenoptera: Braconidae) on larval immune responses of *Chilo suppressalis* (Lepidoptera: Pyralidae). *Acta Phytophylacica Sinica*, 38: 313–319.

Li, S.W., Yang, H., Liu, Y.F., Liao, Q.R., Du, J. and Jin, D.C. (2012). Transcriptome and gene expression analysis of the rice leaffolder, *Cnaphalocrocis medinalis*. *PLoS One*, **7**: e47401.

Li, S., Xiao, J., Ni, P., Zhang, J., Wang, H. and Wang, J. (2014). Monitoring paddy rice phenology using time series MODIS data over Jiangxi Province, China. *International Journal of Agriculture & Biological Engineering*, 7: 28–36.

Liao, C.T. and Chen, C.L. (2017). Oviposition preference and larval performance of *Cnaphalocrocis medinalis* (Lepidoptera: Pyralidae) on rice genotypes. *Journal of Economic Entomology*, 110(3): 1291–1297.

Liao, Q.J., Yang, Y.J., Wang, J., Pang, X., Xu, C.M., Peng, C.L., Lu, Z.X. and Liu, Y.H. (2017). Temperature dependent development and reproduction of rice leaffolder, *Marasmia exigua* (Lepidoptera: Pyralidae). *PLoS ONE*, 12(11): 12pp.

Liu, F., Cheng, J-J., Jiang, T., Su, W. and Xu, S. (2012). Selectiveness of *Cnaphalocrocis medinalis* to host plants. *Rice Science*, 19(1): 49–54.

Liu, K., Zhu, P.Y., Lu, Z.X., Chen, G.H., Zhang, J.M., Lu, Y.B. and Lu, Y.H. (2017). Effects of sesame nectar on longevity and fecundity of seven Lepidoptera and survival of four parasitoid species commonly found in agricultural ecosystems. *Journal of Integrative Agriculture*, 16(11): 2534-2546.

Liu, Q., Wu, X., Ma, J., Chen, B. and Xin, C. (2015). Effects of delaying transplanting on agronomic traits and grain yield of rice under mechanical transplantation pattern. *PLoS ONE*, 10(4): 1-18.

Lu, Z.X., Yu, X.P., Heong, K.L. and Hu, C. (2007). Effect of nitrogen fertilizer on herbivores and its stimulation to major insect pests in rice. *Rice Science*, 14(1): 56-66.

Lu, Z.X., Zhu, P.Y., Gurr, G.M., Zheng, X.S., Chen, G.H. and Heong, K.L. (2015). Rice pest management by ecological engineering: A pioneering attempt in China. In Heong, K.L., Cheng, J.A. and Escalada, M.M. (Eds.), *Rice Planthoppers*: *Ecology*, *Management*, *Socio Economics and Policy* (pp. 163-180). China: Springer and Zhejiang University Press.

Luo, L.Z., Jiang, X.F., Li, K.B. and Hu, Y. (1999). Influences of flight on reproduction and longevity of the oriental armyworm, *Mythimna separata* (Walker). *Acta Entomologia Sinica*, 2: 150–158.

Ma, L., Wang, X., Liu, Y., Su, M-Z. and Huang, G-H. (2017). Temperature effects on development and fecundity of *Brachmia macroscopa* (Lepidoptera: Gelechiidae). *PLoS ONE*, 12(3): 12pp.

Macfadyen, S., Davies, A.P. and Zalucki, M.P. (2015). Assessing the impact of arthropod natural enemies on crop pests at the field scale. *Insect Science*, 22: 20–34.

Madden, T. (2002). The BLAST sequence analysis tool. In McEntyre, J. and Ostell, J. (Eds.) *The NCBI Handbook*. United States: National Center for Biotechnology Information.

Magurran, A.E. (2004). Measuring biological diversity. *African Journal of Aquatic Science*, 29: 285-296.

Mainali, R.P., Dangi, N., Aryal, S., Bhandari, G. and Bajracharya, A.S.R. (2014). Management of armyworm outbreak in rice field of Chitwan district. Asian Journal of Science and Technology, 5(12): 774-776.

Meena, S.K., Sharma, A.K. and Aarwe, R. (2018). Seasonal incidence and population dynamics of major insect pest species of paddy collected in light trap in relation to weather parameters. *International Journal of Current Microbiology and Applied Sciences*, 7(8): 1705-1715.

Menéndez, R. (2007). How are insects responding to global warming. *Tijdschrift voor Entomologie*, 150: 355-365.

Milovanovic, V. and Smutka, L. (2017). Asian countries in the global rice market. *Acta Universities Agriculture et Silviculturae Mendelianae Brunensis*, 65(2): 679-688.

Min, K.J., Jones, N., Borst, D.W. and Rankin, M.R. (2004). Increased juvenile hormone levels after long-duration flight in the grasshopper, *Melanoplus sanguinipes*. *Journal of Insect Physiology*, 50: 531–537.

Mishra, B. K. and Senapati, B. (1998). Biology and life table studies of *Apanteles cypris* Nixon (Hymenoptera: Braconidae), a larval parasitoid of *Cnaphalocrocis medinalis* (Guenee). *Journal of Biological Control,* 12 (1): 7-10.

Mohandass, S., Arthur, F.H., Zhu, K.Y. and Throne, J.E. (2007). Biology and management of *Plodia interpunctella* (Lepidoptera: Pyralidae) in stored products. *Journal of Stored Product Research*, 43: 302–311.

Mohd Noor, M.A.Z., Nur Azura, A. and Muhamad, R. (2013). Determination of larval instar of *Bactrocera papaya* (Diptera: Tephritidae) on guava, *Psidium guajava*, Linn. based on morphometric characters. *Serangga*, 18(1): 75-92.

Moldenhauer, K., Counce, P. and Hardke, J. (2013). Rice growth and development. In J. Hardke (Ed.), *Rice Production Handbook* (pp. 9–20). Arkansas: University of Arkansas Division of Agriculture Cooperative Extension Service.

Mondal, S. and Mandal, S. (2017). Effect of insecticide application on leaf folder (*Cnaphalocrocis medinalis* Guenee) incidence associated with summer paddy in lateritic soil. *European Journal of Biomedical and Pharmaceutical Sciences*, 4(9): 524-526.

Munir, S., Dosdall, L.M. and Keddie, A. (2018). Selective effects of floral sources and honey on life-history traits of a pest-parasitoid system. *Entomologia Experimentalis et Applicata*, 1-8.

Nakamatsu, Y. and Tanaka, T. (2003). Venom of ectoparasitoid, *Euplectrus* sp. near *plathypenae* (Hymenoptera: Eulophidae) regulates the physiological state of *Pseudaletia separata* (Lepidoptera: Noctuidae) host as a food resource. *Journal of Insect Physiology*, 49: 149–159.

Nanda, V.K. and Bisoi, R.C. (1990). Bionomics of rice leaf folder, *Cnaphalocrocis medinalis*. *Orissa Journal of Agricultural Research*, 3: 130-135.

Narayanasamy, M., Kennedy, J.S. and Vellingiri, G. (2014). Life history and population dynamics of rice leaffolder at different temperatures. *An International Biannual Journal of Environmental Sciences*, 8(3&4); 315-320.

Nasiruddin, M. and Roy, R.C. (2012). Rice field insect pests during the rice growing seasons in two areas of Hathazari, Chittagong. *Bangladesh Journal of Zoology*, 40(1): 89-100.

Nathan, S.S., Kalaivani, K. and Murugan, K. (2006). Behavioural responses and changes in biology of rice leaffolder following treatment with a combination of bacterial toxins and botanical insecticides. *Chemosphere*, 64: 1650–1658.

Nayak, S. B., Manoharan, T. and Sound, R.P. (2017). Monitoring insecticide resistance to leaffolder, *Cnaphalocrocis medinalis* (Guenee) (Lepidoptera: Pyralidae) in rice growing regions of Tamil Nadu. *Journal of Entomology and Zoology Studies*, 5(6): 23-26.

Newell, P.D., Fricker, A.D., Roco, C.A., Chandrangsu, P. and Merkel, S.M. (2013). A small-group activity introducing the use and interpretation of BLAST. *Journal of Microbiology and Biology Education*, 14(2): 238-243.

Nirala, Y.S., Sahu, C.M., Ghirtlahre, S.K., Painkra, K.L. and Chandraka, G. (2015). Studies on seasonal incidence of leaf folder, *Cnaphalocrocis medinalis* in Midland Sri and normal transplanted rice ecosystem. *International Journal of Tropical Agriculture*, 33: 547-551.

Nisha Pradeepa K, Ramaraju K and Chitra N. (2017). Biology studies of *Melanitis leda* (Linnaeus, 1758) using Dyar's law. *Journal of Entomology and Zoology Studies*, 5(3): 1886-1890.

Norhisham, A.R., Abood, F., Rita, M. and Hakeem, K.R. (2013). Effect of humidity on egg hatchability and reproductive biology of the bamboo borer (*Dinoderus minutus* Fabricius). *SpringerPlus*, 2: 9.

Norton, G.A. and Heong, K.L. (1988). An approach to improving pest management: Rice in Malaysia. *Crop Protection*, 7(2): 273-278.

Norton, G.W., Rajotte, E., and Gapud, V. (1999). Participatory research in integrated pest management: lessons from the IPM CRSP. *Agriculture Human Values*, 16: 431–439.

Nur Athiqah M.Y., Nur Azura A. and Lau W.H. (2015). Larval instar determination of Mythimna Venalba (Moore) (Lepidoptera: Noctuidae), a rice pest of Malaysia. *Australian Journal of Basic and Applied Science*, 9(20): 8-10.

Nyamwasa, I., Lia, K., Rutikanga, A., Rukazambuga, D.N.T., Zhang, S., Yin, J., Ya-zhong, C., Zhang, X.X. and Sun, X.X. (2018). Soil insect crop pests and their integrated management in East Africa: A review. *Crop Protection*, 106: 163–176.

Oftadeh, M., Sendi, J.J. and Khosravi, R. (2015). Life table parameters of *Glyphodes pyloalis* Walker (Lepidoptera: Pyralidae) on four varieties of mulberry *Morus alba* L. (Moraceae). *Journal of Asia-Pacific Entomology*, 18: 315–320.

Ooi, P.A.C. (2015). Common insect pests of rice and their natural biological control: An illustrated guide to the insect pests that feed on rice plants and the organisms that feed on and control those pests. *UTAR Agriculture Science Journal*, 1(1): 49-59.

Ooi, P.A.C. and Yazid, M.E. (1982). An outbreak of the rice leaffolder in Sekinchan, Selangor. *MAPPS Newsletter*, 6(3): 5-6.

Padhan, S. and Raghuraman, M. (2018). Bio-efficacy of newer insecticides against rice leaf folder (*Cnaphalocrocis medinalis* Guenee) in Varanasi region. *Journal of Pharmacognosy and Phytochemistry*, 7(3): 2219-2221.

Padmavathi, C., Katti, G., Padmakumari, A.P. and Pasalu, I.C. (2008). Mortality and fertility life tables of leaf folder *Cnaphalocrocis medinalis* Guenee (Lepidoptera: Pyralidae) in rice. *Entomon*, 33: 1-13.

Padmavathi, C., Gururaj, K., Padmakumari, A.P., Voleti, S.R. and Subba Rao, L.V. (2013a). Effect of leaffolder, *Cnaphalocrocis medinalis* (guenee) injury on leaf physiology and yield loss in rice. *Journal of Applied Entomology*, 137 (4): 249-256.

Padmavathi, C., Katti, G., Sailaja, V., Padmakumari, A.P., Jhansilakshmi, V., Prabhakar, M. and Prasad, Y.G. (2013b). Temperature thresholds and thermal requirements for the development of the rice leaf folder, *Cnaphalocrocis medinalis. Journal of Insect Science*, 13(96): 1-14.

Padmavathi, C., Katti G., Sailaja, V. and Prasad, Y. (2015). Physiological age status of female adults and off-season survival of rice leaffolder *Cnaphalocrocis medinalis* in India. *Rice Science*, 22(5): 237−244.

Padmavathi, C., Javvaji, S. and Gururaj, K. (2017). A Rapid Field Screening Method for Evaluation of Resistance to Leaffolder, *Cnaphalocrocis medinalis* Guenee in rice. *Journal of Rice Research*, 10(1): 67-70.

Pandya, H.V., Shah, A.H. and Purohit, M.S. (1987). Yield loss caused by leaf folder damage alone and combined with yellow stem borer damage. *International Rice Research Newsletter*, 12: 28.

Paoletti, M.G. (2005). Ecological engineering for pest management - Advances in habitat manipulation for arthropods. *Australian Ecology,* 30: 613-614.

Papademetriou, V.K. (2000). Rice production in the Asia-Pasific region: Issues and perspectives. Bridging the Rice Yield Gap in the Asia-Pacific Region.

Park, H.H., Ahn, J.J. and Park, C.G. (2014a). Temperature-dependent development of *Cnaphalocrocis medinalis* Guenée (Lepidoptera: Pyralidae) and their validation in semi-field condition. *Journal of Asia-Pacific Entomology*, 17: 83–91.

Park, H.H., Park, C.G. and Ahn, J.J. (2014b). Oviposition model of Cnaphalocrocis medinalis Guenée (Lepidoptera: Pyralidae). *Journal of Asia-Pacific Entomology*, 17: 781–786.

Parolin, P., Bresch, C., Poncet, C. and Desneux, N. (2012). Functional characteristics of secondary plants for increased pest management. *International Journal of Pest Management*, 58: 369–377.

Pasinelli, G., Schaub, M., Hafliger, G., Frey, M., Jakober, H., Muller, M., Stauber, W. Tryjanowski, P., Zollinger, J.L. and Jenni, L. (2011). Impact of density and environmental factors on population fluctuations in a migratory passerine. *Journal of Animal Ecology*, 80 (1): 225-234.

Pasuquin, E., Lafarge, T. and Tubana, B. (2008). Transplanting young seedlings in irrigated rice fields: Early and high tiller production enhanced grain yield. *Field Crops Research*, 105: 141–155.

Patel, H.N., Kadu, R.V. and Landge, S.A. (2011). Study on seasonal incidence of rice leaf folders (*Cnaphalocrocis medinalis* Guen. and *Pelopidas mathias* Fb.) of paddy and its correlation with weather parameters. *International Journal of Plant Protection*, 4 (1): 175-180.

Pathak, M.D. and Khan, Z.R. (1994). *Insect pests of rice*. Los Banos: International Rice Research Institute.

Poveda, K., Gomez, M.I. and Martinez, E. (2008). Diversification practices: their effect on pest regulation and production. *Revista Colombiana de Entomologia*, 34(2): 131-144.

Puech, C., Baudry, J., Joannon, A., Poggib, S. and Aviron, S. (2014). Organic vs. conventional farming dichotomy: Does it make sensefor natural enemies? *Agriculture, Ecosystems and Environment*, 194: 48–57.

Punithavalli, M., Muthukrishnan, N.M. and Rajkumar, M.B. (2011). Influence of rice leaf morphology on the folding characteristics of rice leaf folder, *Cnaphalocrocis medinalis*. *Indian Journal of Plant Protection*, 39(2): 93-99.

Punithavalli, M., Muthukrishnan, N.M. and Rajkumar, M.B. (2013). Influence of rice genotypes on folding and spinning behaviour of leaffolder (*Cnaphalocrocis medinalis*) and its interaction with leaf damage. *Rice Science*, 20(6): 442−450.

Qi, G.J., Lu, F., Gao, Y., Liang, J.L., Ri, Q., Zhang, X.X., Di, B.P. and Lu, L.H. (2011). Analysis of a migration process and the source population of *Cnaphalocrocis medinalis* (Guenée) (Lepidoptera: Pyralidae). *Acta Entomologia Sinica*, 54(10): 1194–1203.

Rajamoorthy, Y., Rahim, K.A. and Munusamy, S. (2015). Rice Industry in Malaysia: Challenges, Policies and Implications. *Procedia Economics and Finance*, 31: 861 – 867.

Ram, M., Sachan, S.K. and Singh, G. (2014). Study on population build up of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) in relation to weather factors. *International Journal of Advanced Research*, 2(10): 75-77.

Ramachandran, R. and Khan, Z.R. (1991). Mechanisms of resistance in wild rice *Oryza brachyantha* to rice leaffolder *Cnaphalocrocis medinalis* (Guene´e) (Lepidoptera: Pyralidae). *Journal of Chemical Ecology*, 17: 41–65.

Ramya, M., Kennedy, J.S., Lakshmi, V.G., Lakshmanan, A., Manikandan N. and Sekhar, N.U. (2012). Impact of elevated temperature on major pests of rice. *CLIMARICE Technical Brief*, 10: 1-6.

Razazzian, S., Hassani, M.R., Imani, S. and Shojai, M. (2015). Life table parameters of *Plodia interpunctella* (Lepidoptera: Pyralidae) on four commercial pistachio cultivars. *Journal of Asia-Pacific Entomology*, 18: 55–59.

Reeman, M.U., Rashid, H., Shahid, A.A., Bashir, K., Hussain, T. and Riazuddin, S. (2007). Insect resistance and risk assessment studies of advanced generation of basmati rice expressing two genes of *Bacillus thuringiensis*. *Electronic Journal of Biotechnology*, 10:1-13.

Reissig, W.H., Heinrichs, E.A., Litsinger, J.A., Moody, K., Fiedler, L., Mew, T.W., and Barrion, A.T. (1986). *Illustrated guide to integrated pest management in rice in tropical Asia*. Manila (Philippines): International Rice Research Institute.

Ren, J.L., Tub, X.B., Ge, J., Zhao, L. and Zhang, Z.H. (2016). Influence of temperature on the development, reproduction, and life table of *Calliptamus italicus* (L.) (Orthoptera: Acridoidea). *Journal of Asia-Pacific Entomology*, 19: 203–207.

Rockwood, L.L. (2006). *Introduction to population ecology*. Malden: Blackwell Publishing.

Romeis, J., Stadler, E. and Wackers, F.L. (2005). Nectar- and pollen-feeding by adult herbivorous insects. In F.L. Wackers, P.C.J. van Rijin and J. Bruin (Ed.), *Plant-provided food for carnivorous insects*. London: Cambridge University Press.

Rubia-Sanchez, E.G., Sigit, D.W., Nurhasyim, Heong, K. L., Zalucki, M. P. and Norton, G. A. (1998). Some factors affecting white stem borer *Scirpophaga innotata* (Walker) (Lepidoptera: Pyralidae) injury to rice. *Crop Protection*, 17(6): 529-534.

Rygg, T.D. (1996). Flight of *Oscinella frit* L. (Diptera: Chloropidae) females in relation to age and ovary development. *Entomologia Experimentalis et Applicata*, 9: 74–84.

Sallam, M.N.S. (2006). A review of sugarcane stem borers and their natural enemies in Asia and Indian Ocean Islands: an Australian perspective. *Annales-Societe Entomologique de France*, 42(3-4): 263-283.

Santos, A.M.C., Besnard, G. and Quicke, D.L.J. (2011). Applying DNA barcoding for the study of geographical variation in host-parasitoid interactions. *Molecular Ecology Resources*, 11: 46-59.

Sarwar, M. (2012). Management of rice stem borers (Lepidoptera: Pyralidae) through host plant resistance in early, medium and late plantings of rice (*Oryza sativa* L.). *Journal of Cereals and Oil seeds*, 3(1): 10-14.

Satish, D., Chander, S. and Reji, G. (2007). Simulation of economic injury levels for leaf folder *Cnaphalocrocis medinalis* (Guenee) on rice (*Oryza sativa* L.). *Journal of Scientific and Industrial Research*, 66: 905-911.

Sato, Y., Tagawa, J. and Hidaka, T. (1986). Effects of the gregarious parasitoids, *Apanteles ruficrus* and *A. Kariyai* on host growth and development. *Journal of Insect Physiology*, 32(4): 281-286.

Saxena, R.C. and Khan, Z.R. (1991). Electronic recording of feeding behavior of *Cnaphalocrocis medinalis* (Lepidoptera: Pyralidae) on resistant and susceptible rice cultivars. *Annals of the Entomological Society of America*, 84(3): 316-318.

Schowalter, T.D. (2006). *Insect ecology: An ecosystem approach*. Tokyo: Tokyo Academic Press.

Schwartz, M.D. (2003). *Phenology: an integrative environmental science*. Dordrecht, the Netherlands: Kluwer Academic.

Selvaraj, K., Chander, S. and Sujithra, M. (2012). Determination of multiple-species economic injury levels for rice insect pests. *Crop Protection*, 32: 150-160.

Shanmungam, T.R., Sendhil, R. and Thirumalvalavan, V.V. (2006). Quantification and prioritization of constrainst causing yield loss in rice (*Oryza sativa*) in India. *Agricultura Tropica et Subtropica*, 39: 194-201.

Shepard, B.M., Barrion, A.T. and Litsinger, J.A. (1987). Parasite of leaffolder larvae-wasp. In *Friends of the farmers: Helpful insects, spiders and pathogens* (pp. 80). Los Baños: International Rice Research Institute.

Shikano, I., Akhtar, Y. and Isman, M.B. (2010). Relationship between adult and larval host plant selection and larval performance in the generalist moth, *Trichoplusia ni*. *Arthropod Plant Interaction*, 4: 197–205.

Shimohigashi, M. and Tominaga, Y. (1986). The compound eye of *Parnara guttata* (Insecta, Lepidoptera, Hesperiidae): Fine structure of the ommatidium. *Zoomorphology*, 106:131-136.

Shirai, Y. (2006). Flight activity, reproduction, and adult nutrition of the beet webworm, *Spoladea recurvalis* Fabricius (Lepidoptera: Pyralidae). *Applied Entomology and Zoology*, 41: 405–414.

Singh, S.P. and Singh, D. (1982). Influence of cruciferous host plants on the survival and development of *Plutella xylostella*. *Journal of Research Punjab Agricultural University*, 19: 100–104.

Siswanto, M.R., Dzolkhifli, O. and Elna, K. (2008). Population fluctuation of *Helopeltis antoni* Signoret on cashew *Anacarcium occidentalle* L., in Java Indonesia. *Pertanika Journal of Tropical Agricultural Science,* 31: 191–196.

Smilanich, A.M. and Dyer, L.A. (2012). Effects of banana plantation pesticides on the immune response of lepidopteran larvae and their parasitoid natural enemies. *Insects*, 3: 616-628.

Smith, M.A., Fisher, B.L. and Hebert, P.D.N. (2005). DNA barcoding for effective biodiversity assessment on a hyperdiverse arthropod group: the ants of Madagascar. *Philosophical Transactions of the Royal Society B*, 360: 1825-1834.

Southwood, T.R.E. (1978). *Ecological methods with particular reference to the study of insect populations* (2nd Edition). London: Chapman and Hall.

Southwood, T.R.E. and Henderson, P.A. (2000). *Ecological Methods* (3rd Edition). Oxford: Blackwell Science.

Srinivasa Rao, M., Manimanjari, D., Rama Rao, A.C., Swathi, P. and Maheswari, M. (2014). Effect of climate change on Spodoptera litura Fab. on peanut: A life table approach. *Crop Protection*, 66: 98-106.

Stehr, F.W. (2009). Larva. In V.H. Resh and R.T. Carde (Second Ed.), *Encyclopedia of Insects* (pp. 551-552). Michigan State: Academic Press.

Stillwell, R.C. and Davidowitz, G. (2010). A developmental perspective on the evolution of sexual size dimorphism of a moth. *Proceedings of the Royal Society B Biological Sciences*, 277: 2069-2074.

Stillwell, R.C., Blanckenhorn, W.U., Teder, T., Davidowitz, G. and Fox, C.W. (2010). Sex differences in phenotypic plasticity affect variation in sexual size dimorphism in insects: From physiology to evolution. *Annual Review of Entomology*, 55: 227-245.

Stillwell, R.C., Daws, A. and Davidowitz, G. (2014). The ontogeny of sexual size dimorphism of a moth: When do males and females grow apart? *PLoS ONE*, 9(9): 1-7.

Sulagitti, A., Raghuraman, M., Sai Reddy, M.S. and Sathua, S.K. (2017). Seasonal variation in major insect pests incidence on rice and impact of various abiotic factors on their incidence under Varanasi conditions. *Journal of Entomology and Zoology Studies*, 5(3): 1060-1063.

Sule, H., Muhamad, R., Omar, D. and Hee, A. (2012). Life Table and Demographic Parameters of Asian Citrus Psyllid *Diaphorina citri* on Limau Madu *Citrus suhuiensis*. *Journal of Entomology*, 9(3): 146-154.

Sun, B.B., Jiang, X.F., Zhang, L., Stanley, D.W., Luo, L.Z. and Long, W. (2013). Methoprene influences reproduction and flight capacity in adults of the rice leaf roller, *Cnaphalocrocis medinalis* (Guenee) (Lepidoptera: Pyralidae). *Archieves of Insect Biochemistry and Physiology*, 82: 1–13.

Supawan, J. and Chongrattanameteekul, W. (2017). Influence of humidity, rainfall, and fipronil toxicity on rice leaffolder (*Cnaphalocrocis medinalis*). *ScienceAsia*, 43: 82–87.

Sutrisno, H. (2012). Molecular phylogeny of indonesian armyworm *Mythimna* Guenée (Lepidoptera: Noctuidae: Hadeninae) based on CO I gene sequences. *Hayati Journal of Biosciences*, 19 (2): 65-72.

Tanwar, R.K., Anand Prakash, Panda, S.K., Swain, N.C., Garg, D.K., Singh, S.P., Sathya Kumar, S. and Bambawale, O.M. (2010). Rice swarming caterpillar (*Spodoptera mauritia*) and its management strategies. *Technical Bulletin,* 24.

Tena, A., Wackers, F.L., Heimpel, G.E., Urbaneja, A. and Pekas, A. (2016). Parasitoid nutritional ecology in a community context: the importance of honeydew and implications for biological control. *Current Opinion in Insect Science*, 14: 100-104.

Teng, Z.W., Xu, G., Gan, S.Y., Chen, X., Fang, Q. and Ye, G.Y. (2016). Effects of the endoparasitoid *Cotesia chilonis* (Hymenoptera: Braconidae) parasitism, venom, and calyx fluid on cellular and humoral immunity of its host *Chilo suppressalis* (Lepidoptera: Crambidae) larvae. *Journal of Insect Physiology*, 85: 46-56.

Udayagiri, S., and Mason, C.E. (1995). Host plant constituents as oviposition stimulants for a generalist herbivore: European corn borer. *Entomologia Experimentalis et Applicata*, 76: 59–65.

Vastrad, A.S. (2011). Evaluation of insecticides and bio-rationals against yellow stem borer and leaf folder on rice crop. *Karnataka Journal of Agricultural Science*,24 (2): (244-246).

van Vreden, G. and Ahmadzabidi, A.L. (1986). *Pests of rice and their natural enemies in Peninsular Malaysia*. The Netherlands: Centre for Agricultural Publishing and Documentation.

Vromant, N., Rothuis, A.J., Cuc, N.T.T. and Ollevier, F. (1998). The effect of fish on the abundance of rice caseworm *Nymphula depunctalis* (Guenee) (Lepidoptera: Pyralidae) in direct-seeded, concurrent rice-fish fields. *Biocontrol Science and Technology*,8: 539-546.

Wackers, F.L., Romeis, J., van Rijn, P.C.J. (2007). Nectar and pollen feeding by insect herbivores and implications for multitrophic interactions. *Annual Review of Entomology*, 52: 301-323.

Wada, T., Kobayashi, M., (1980). Effects of temperature on development of the rice leaf roller, *Cnaphalocrocis medinalis* Guenee (Lepidoptera: Pyralidae). *Applied Entomological Zoology*, 15: 207–214.

Wan, X., Li, J., Kim, M.J., Kang, T.H., Jin, B.R. and Kim, I. (2011). Population genetic structure of the migratory rice leaf roller, *Cnaphalocrocis medinalis* (Lepidoptera: Pyralidae), inferred from the mitochondrial A + T-rich region and nuclear ITS2 sequences. *Genetics and Molecular Research*, 10: 273–294.

Wan, N.F., Ji, X.Y., Cao, L.M and Jiang, J.X. (2015). The occurrence of rice leaf roller, *Cnaphalocrocis medinalis* Guenée in the large-scale agricultural production on Chongming Eco-island in China. *Ecological Engineering*, 77: 37–39.

Wang, Z. (2000). *Plant physiology*. Beijing: Chinese Agricultural Press.

Wang, X.Q., Zhang, H.C., Huang, Y.Z., Dai, Q.G., Huo, Z.Y., Xu, K., Shao, S.Z. and Xu, X.J. (2003). Effects of N-application rate on the characters of uptake nitrogen and nitrogen recovery of different rice varieties. *Journal of Shanghai Jiaotong University: Agricultural Sciences*, 21(4): 325-330.

Winqvist, C., Bengtsson, J., Aavik, T., Berendse, F., Clement, L.W., Eggers, S., Fischer, C., Flohre, A., Geiger, F., Liira, J., Pärt, T., Thies, C., Tscharntke, T., Weisser, W.W. and Bommarco, R. (2011). Mixed effects of organic farming and landscape complexity on farmland biodiversity and biological control potential across. *European Journal of Applied Ecology*, 48: 570–579.

Wu, K.M. and Guo, Y.Y. (2005). The evolution of cotton pest management practices in China. *Annual Review of Entomology*, 50:31-52.

Xu, J., Jiang, L.B., and Wu, J.C. (2011). Changes in the survival rate and fecundity of the rice leaffolder, *Cnaphalocrocis medinalis* Guenée (Lepidoptera: Pyralidae), at different magnesium concentrations in hydroponic culture. *Crop Protection*, 30: 765-769.

Xu, J., Li, C.M., Yang, Y.J., Qi, J.H., Zheng, X.S., Hu, R.L., Lu, Z.X., Liu, Q. (2012). Growth and Reproduction of Artificially Fed *Cnaphalocrocis medinalis*. *Rice Science*, 19(3): 247−251.

Xu, L., Wang, F., Wu, J.C. and Wang, Q.X. (2007). Life table parameters of a semi-natural population of Cnaphalocrocis medinalis (Guenée) on different rice varieties and changes in sugar content in rice plants after insect infestation. *Acta Ecologica Sinica*, 27(11): 4547-4554.

Yadav, R. and Chang, N.T. (2013). Effects of temperature on the development and population of the melon thrips, *Thrips palmi*, on eggplant, *Solanum melongena*. *Journal of Insect Science*, 14(78): 1-9.

Yasar, B. and Gungor, M.A. (2005). Determination of life table and biology of Colorado potato beetle, *Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae), feeding on five different potato varieties in Turkey. *Applied Entomology and Zoology*, 40: 589–596.

Yu, Q.G., Ye, J., Yang, S.N., Fu, J.R., Ma, J.W., Sun, W.C., Jiang, L.N., Wang, Q. and Wang, J.M. (2013). Effects of nitrogen application level on rice nutrient uptake and ammonia volatilization. *Rice Science*, 20(2): 139-147.

Zainab, S. Ram, B. and Singh, R.N. (2017). Environmental effect on yellow stem borer, *Scirpophaga incertulas* (Walker) and rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) on rice crop. *Journal of Environmental Biology*, 38: 291-295.

Zalucki, M.P., Clarke, A.R. and Malcolm, S.B. (2002). Ecology and behaviour of first instar larval Lepidoptera. *Annual Review of Entomology*, 47: 361-393.

Zhang, G.F., Lu, C.T., Shen, X.C. and Wang, W.X. (1995). The synthesized ecological effect of rice density and nitrogen fertilizer on the occurrence of main rice pests. *Acta Phytophyla Sinica*, 22: 38-44.

Zhang, Y., Wu, K.M., Kris, A.G.W. and George, E.H. (2009). Trade-off between flight and fecundity in the soybean aphid (Hemiptera: Aphididae). *Journal of Economic Entomology*, 102: 133–138.

Zhang, L., Pan, P., Sappington, T.W., Lu, W., Luo, L. and Jiang, X. (2015). Accelerated and synchronized oviposition induced by flight of young females may intensify larval outbreaks of the rice leaf roller. *PLoS ONE*, 10(3): 1-13.

Zhang, F.X., Zhang, Z.F., Zhang, Y. and Wu, W.J. (2019). Adult oviposition preferences and larval performance of rice leaf folder, *Cnaphalocrocis medinalis* on rice and non-rice graminaceous plants. *Arthropod-Plant Interactions*, 13(1): 31-40.

Zheng, X., Ren, X. and Su, J. (2011). Insecticide Susceptibility of *Cnaphalocrocis medinalis* (Lepidoptera: Pyralidae) in China. *Journal of Economic Entomology*, 104(2): 653-658.

Zheng, H., Cheng, T., Yao, X., Deng, X., Tian, Y., Cao, W. and Zhu, Y. (2016). Detection of rice phenology through time series analysis of ground-based spectral index data. *Field Crops Research*, 198: 131–139.

Zheng, X., Lu, Y., Zhu, P., Zhang, F., Tian, J., Xu, H., Chen, G., Nansen, C. and Lu, Z. (2017). Use of banker plant system for sustainable management of the most important insect pest in rice fields in China. *Scientific Report,* **7**: 45581.

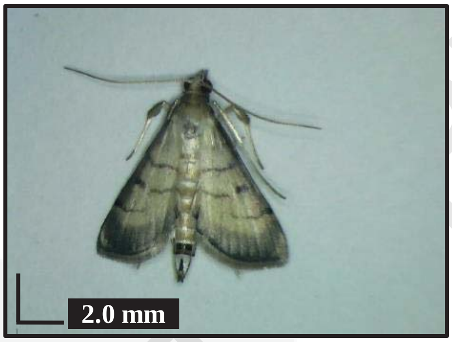
Zhou, H., Wu, W.J., Zhang, Z.F. and Zhang, Y. (2011). Antennal sensilla of Apanteles cypris Nixon (Hymenoptera: Braconidae), a larval endoparasitoid of *Cnaphalocrocis medinalis* Guenee (Lepidoptera: Pyralidae). *Microscopy Research and Technique*, 74(12): 1199-1208.

Zhu, P., Wang, G., Zheng, X., Tian, J., Lu, Z., Heong, K.L., Xu, H., Chen, G., Yang, Y. and Gurr, G.M. (2015). Selective enhancement of parasitoids of rice Lepidoptera pests by sesame (*Sesamum indicum*) flowers. *BioControl*, 60: 157-167.

APPENDICES

Appendix A.1: Pictures of lepidopteran rice pest species

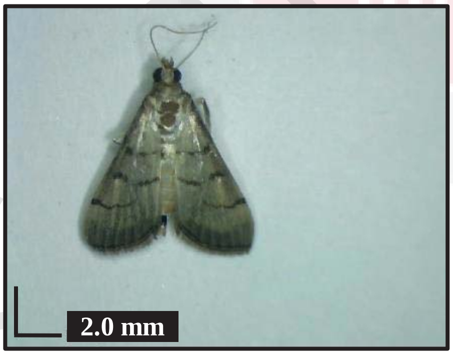
Chilo polychrysus
(Source: http://www.padil.gov.au/pests-and-disease/pest/main/142274/42994)



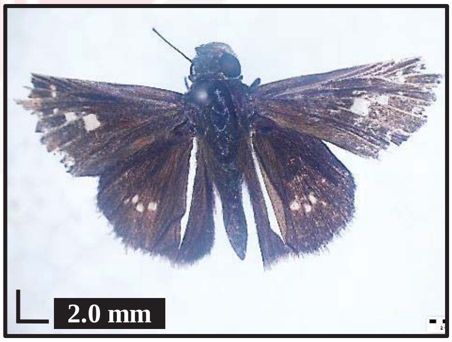
Marasmia exigua

Cnaphalocrocis medinalis

Melanitis leda

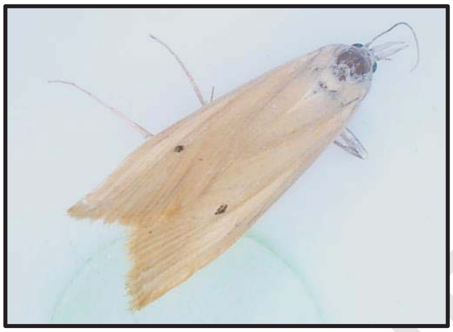


Marasmia patnalis



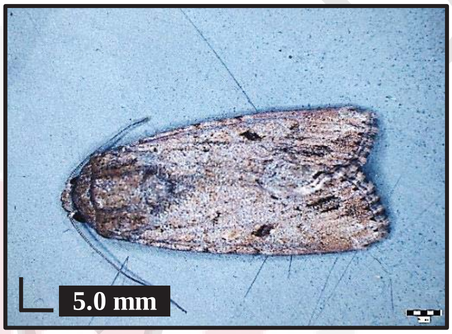
Parnara guttata

Mythimna venalba



Scirpophaga incertulas

Nymphula depunctalis
(Source: http://www.nppc.gov.bt/insects-mites)



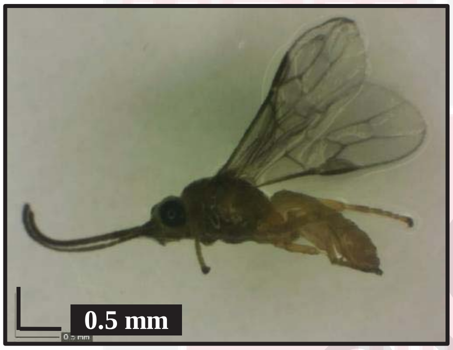
Spodoptera mauritia

Pelopidas mathias

Appendix A.2 : Pictures of parasitoid species

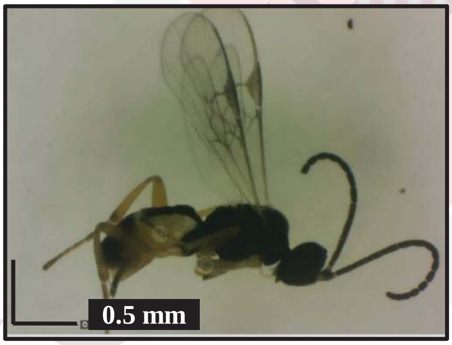
Apanteles cypris

Apanteles sp.



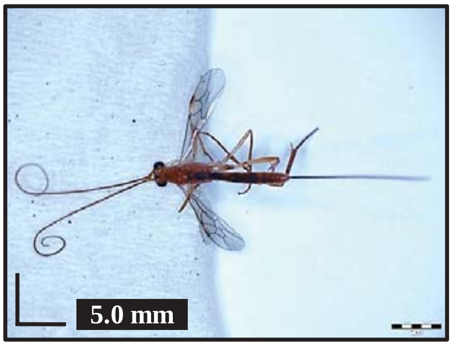
Bracon sp.

Cotesia chilonis

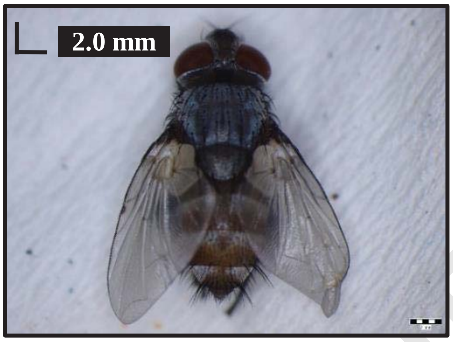


Cotesia ruficrus

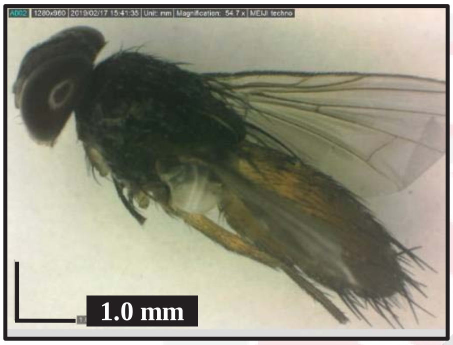
Euplectrus sp.



Macrocentrus philippinensis



Argyrophylax cinerella



Halidaya sp.

Appendix A.3: Average weekly temperature, relative humidity and rainfall in main season

Week of sampling	Month	Mean temperature (°C)	Mean relative humidity (%)	Mean rainfall (mm)
1	October 2015	26.0	83.9	14.2
2	October 2015	26.1	89.6	9.0
3	November 2015	26.6	85.3	0.0
4	November 2015	28.0	84.2	7.5
5	November 2015	26.2	86.3	5.4
6	November 2015	27.1	88.7	7.7
7	December 2015	27.3	89.1	13.1
8	December 2015	27.2	87.3	2.5
9	December 2015	26.7	85.7	10.9
10	December 2015	27.1	81.7	3.3

Appendix A.4: Average weekly temperature, relative humidity and rainfall in off season

Week of sampling	Month	Mean temperature (°C)	Mean relative humidity (%)	Mean rainfall (mm)
1	April 2015	27.7	77.6	2.7
2	April 2015	27.2	82.9	9.9
3	April 2015	27.7	76.1	0.7
4	April 2015	28.0	76.9	0.7
5	May 2015	28.5	76.4	2.7
6	May 2015	27.3	83.0	4.4
7	May 2015	27.9	82.9	4.4
8	May 2015	27.5	84.7	4.4
9	May 2015	27.1	77.1	2.3
10	June 2015	27.0	77.6	0.7

Appendix A.5: Analysis of variance for population of *C. medinalis* at different weeks in main season

Source	Degree of freedom	Sum of squares	Mean square	F-value	P-value
Weeks	9	0.101191	0.011243	15.93	0.000
Error	20	0.014114	0.000706		
Total	29	0.115305			

Appendix A.6: Analysis of variance for population of *C. medinalis* at different weeks in off season

Source	Degree of freedom	Sum of squares	Mean square	F-value	P-value
Weeks	9	0.08432	0.00937	7.08	0.000
Error	20	0.02645	0.00132		
Total	29	0.11077			

Appendix A.7: Stepwise regression analysis for *C. medinalis* population and abiotic factors in main season

Forward selection. Alpha-to-Enter: 0.25
Response is Population Main on 3 predictors, with N = 10

Step	1	2
Constant	-3.576	-7.440
RH-main	0.044	0.048
T-Value	2.36	3.05
P-Value	0.046	0.019
Temp-main		0.130
T-Value		2.06
P-Value		0.079
S	0.141	0.119
R-Sq	41.03	63.23
R-Sq(adj)	33.66	52.73
Mallows Cp	3.7	2.0

Appendix A.8: Stepwise regression analysis for *C. medinalis* population and abiotic factors in off season

Forward selection. Alpha-to-Enter: 0.25
Response is Population Off on 3 predictors, with N = 10

Step	1	2	3
Constant	-2.478	-7.981	-9.055
RH-off	0.0328	0.0393	0.0565
T-Value	2.80	4.40	5.85
P-Value	0.023	0.003	0.001
Temp-off		0.181	0.174
T-Value		2.78	3.52
P-Value		0.027	0.012
Rainfall-off			-0.029
T-Value			-2.49
P-Value			0.047
S	0.119	0.0876	0.0664
R-Sq	49.57	76.06	88.22
R-Sq(adj)	43.27	69.22	82.34
Mallows Cp	19.7	8.2	4.0

Appendix A.9: Analysis of variance for width of head capsule of *C. medinalis* larvae in different instars

Source	Degree of freedom	Sum of squares	Mean square	F-value	P-value
Instars	4	9.04506	2.26127	1757.64	0.000
Error	85	0.10936	0.00129		
Total	89	9.15442			

Appendix A.10: Analysis of variance for body length of *C. medinalis* larvae in different instars

Source	Degree of freedom	Sum of squares	Mean square	F-value	P-value
Instars	4	2117.91	529.48	237.34	0.000
Error	85	189.62	2.23		
Total	89	2307.53			

Appendix A.11: Age-specific life table of *C. medinalis* (Cohort 1)

x	l_x	d_x	L_x	$100q_x$	S_x	T_x	e_x
1	1.00	0	102.00	0.00	100.00	1654.00	16.22
2	1.00	0	102.00	0.00	100.00	1552.00	15.22
3	1.00	0	102.00	0.00	100.00	1450.00	14.22
4	1.00	8	98.00	7.84	92.16	1348.00	13.76
5	0.92	17	85.50	18.09	81.91	1250.00	14.62
6	0.75	7	73.50	9.09	90.91	1164.50	15.84
7	0.69	5	67.50	7.14	92.86	1091.00	16.16
8	0.64	8	61.00	12.31	87.69	1023.50	16.78
9	0.56	6	54.00	10.53	89.47	962.50	17.82
10	0.50	2	50.00	3.92	96.08	908.50	18.17
11	0.48	3	47.50	6.12	93.88	858.50	18.07
12	0.45	0	46.00	0.00	100.00	811.00	17.63
13	0.45	1	45.50	2.17	97.83	765.00	16.81
14	0.44	1	44.50	2.22	97.78	719.50	16.17
15	0.43	1	43.50	2.27	97.73	675.00	15.52
16	0.42	3	41.50	6.98	93.02	631.50	15.22
17	0.39	0	40.00	0.00	100.00	590.00	14.75
18	0.39	1	39.50	2.50	97.50	550.00	13.92
19	0.38	2	38.00	5.13	94.87	510.50	13.43
20	0.36	1	36.50	2.70	97.30	472.50	12.95
21	0.35	0	36.00	0.00	100.00	436.00	12.11
22	0.35	0	36.00	0.00	100.00	400.00	11.11
23	0.35	0	36.00	0.00	100.00	364.00	10.11
24	0.35	0	36.00	0.00	100.00	328.00	9.11
25	0.35	0	36.00	0.00	100.00	292.00	8.11
26	0.35	2	35.00	5.56	94.44	256.00	7.31
27	0.33	0	34.00	0.00	100.00	221.00	6.50
28	0.33	2	33.00	5.88	94.12	187.00	5.67
29	0.31	2	31.00	6.25	93.75	154.00	4.97
30	0.29	2	29.00	6.67	93.33	123.00	4.24
31	0.27	6	25.00	21.43	78.57	94.00	3.76
32	0.22	4	20.00	18.18	81.82	69.00	3.45
33	0.18	3	16.50	16.67	83.33	49.00	2.97
34	0.15	3	13.50	20.00	80.00	32.50	2.41
35	0.12	2	11.00	16.67	83.33	19.00	1.73
36	0.10	4	8.00	40.00	60.00	12.50	1.56

37	0.06	3	4.50	50.00	50.00	6.50	1.44
38	0.03	2	2.00	66.67	33.33	3.00	1.50
39	0.01	0	1.00	0.00	100.00	1.50	1.50
40	0.01	1	0.50	100.00	0.00	0.50	1.00

x=developmental stage in days, l_x=proportion of number entering stage, d_x=number of dying in stage x, L_x=number alive between age x and x+1, 100_{qx}=percent apparent mortality, S_x=survival rate within stage, T_x=total number of age x beyond the age, e_x=life expectancy

Appendix A.12: Age-specific life table of *C. medinalis* (Cohort 2)

x	l_x	d_x	L_x	$100q_x$	S_x	T_x	e_x
1	1.00	0	103.00	0.00	100.00	1744.00	16.93
2	1.00	0	103.00	0.00	100.00	1641.00	15.93
3	1.00	0	103.00	0.00	100.00	1538.00	14.93
4	1.00	5	100.50	4.85	95.15	1435.00	14.28
5	0.95	13	91.50	13.27	86.73	1334.50	14.58
6	0.83	3	83.50	3.53	96.47	1243.00	14.89
7	0.80	11	76.50	13.41	86.59	1159.50	15.16
8	0.69	7	67.50	9.86	90.14	1083.00	16.04
9	0.62	0	64.00	0.00	100.00	1015.50	15.87
10	0.62	3	62.50	4.69	95.31	951.50	15.22
11	0.59	4	59.00	6.56	93.44	889.00	15.07
12	0.55	3	55.50	5.26	94.74	830.00	14.95
13	0.52	2	53.00	3.70	96.30	774.50	14.61
14	0.50	2	51.00	3.85	96.15	721.50	14.15
15	0.49	3	48.50	6.00	94.00	670.50	13.82
16	0.46	4	45.00	8.51	91.49	622.00	13.82
17	0.42	1	42.50	2.33	97.67	577.00	13.58
18	0.41	1	41.50	2.38	97.62	534.50	12.88
19	0.40	3	39.50	7.32	92.68	493.00	12.48
20	0.37	1	37.50	2.63	97.37	453.50	12.09
21	0.36	0	37.00	0.00	100.00	416.00	11.24
22	0.36	1	36.50	2.70	97.30	379.00	10.38
23	0.35	0	36.00	0.00	100.00	342.50	9.51
24	0.35	0	36.00	0.00	100.00	306.50	8.51
25	0.35	1	35.50	2.78	97.22	270.50	7.62
26	0.34	3	33.50	8.57	91.43	235.00	7.01
27	0.31	0	32.00	0.00	100.00	201.50	6.30
28	0.31	3	30.50	9.38	90.63	169.50	5.56
29	0.28	1	28.50	3.45	96.55	139.00	4.88
30	0.27	1	27.50	3.57	96.43	110.50	4.02
31	0.26	7	23.50	25.93	74.07	83.00	3.53
32	0.19	6	17.00	30.00	70.00	59.50	3.50
33	0.14	2	13.00	14.29	85.71	42.50	3.27
34	0.12	1	11.50	8.33	91.67	29.50	2.57
35	0.11	2	10.00	18.18	81.82	18.00	1.80
36	0.09	2	8.00	22.22	77.78	14.00	1.75

37	0.07	2	6.00	28.57	71.43	10.00	1.67
38	0.05	2	4.00	40.00	60.00	6.50	1.63
39	0.03	1	2.50	33.33	66.67	4.00	1.60
40	0.02	1	1.50	50.00	50.00	2.50	1.67
41	0.01	0	1.00	0.00	100.00	1.50	1.50
42	0.01	1	0.50	100.00	0.00	0.50	1.00

x=developmental stage in days, l_x=proportion of number entering stage, d_x=number of dying in stage x, L_x=number alive between age x and x+1, 100_{qx}=percent apparent mortality, S_x=survival rate within stage, T_x=total number of age x beyond the age, e_x=life expectancy

Appendix A.13: Age-specific life table of *C. medinalis* (Cohort 3)

x	l_x	d_x	L_x	$100q_x$	S_x	T_x	e_x
1	1.00	0	105.00	0.00	100.00	1794.50	17.09
2	1.00	0	105.00	0.00	100.00	1689.50	16.09
3	1.00	0	105.00	0.00	100.00	1584.50	15.09
4	1.00	6	102.00	5.71	94.29	1479.50	14.50
5	0.94	15	91.50	15.15	84.85	1377.50	15.05
6	0.80	3	82.50	3.57	96.43	1286.00	15.59
7	0.77	11	75.50	13.58	86.42	1203.50	15.94
8	0.67	7	66.50	10.00	90.00	1128.00	16.96
9	0.60	1	62.50	1.59	98.41	1061.50	16.98
10	0.59	3	60.50	4.84	95.16	999.00	16.51
11	0.56	3	57.50	5.08	94.92	938.50	16.32
12	0.53	1	55.50	1.79	98.21	881.00	15.87
13	0.52	1	54.50	1.82	98.18	825.50	15.15
14	0.51	3	52.50	5.56	94.44	771.00	14.69
15	0.49	1	50.50	1.96	98.04	718.50	14.23
16	0.48	4	48.00	8.00	92.00	668.00	13.92
17	0.44	4	44.00	8.70	91.30	620.00	14.09
18	0.40	1	41.50	2.38	97.62	576.00	13.88
19	0.39	1	40.50	2.44	97.56	534.50	13.20
20	0.38	0	40.00	0.00	100.00	494.00	12.35
21	0.38	0	40.00	0.00	100.00	454.00	11.35
22	0.38	0	40.00	0.00	100.00	414.00	10.35
23	0.38	1	39.50	2.50	97.50	374.00	9.47
24	0.37	0	39.00	0.00	100.00	334.50	8.58
25	0.37	0	39.00	0.00	100.00	295.50	7.58
26	0.37	2	38.00	5.13	94.87	256.50	6.75
27	0.35	0	37.00	0.00	100.00	218.50	5.91
28	0.35	2	36.00	5.41	94.59	181.50	5.04
29	0.33	4	33.00	11.43	88.57	145.50	4.41
30	0.30	3	29.50	9.68	90.32	112.50	3.81
31	0.27	9	23.50	32.14	67.86	83.00	3.53
32	0.18	4	17.00	21.05	78.95	59.50	3.50
33	0.14	3	13.50	20.00	80.00	42.50	3.15
34	0.11	1	11.50	8.33	91.67	29.00	2.52
35	0.10	2	10.00	18.18	81.82	22.50	2.25
36	0.09	3	7.50	33.33	66.67	15.00	2.00

37	0.06	2	5.00	33.33	66.67	8.00	1.60
38	0.04	3	2.50	75.00	25.00	3.00	1.20
39	0.01	1	0.50	100.00	0.00	0.50	1.00

x=developmental stage in days, l_x=proportion of number entering stage, d_x=number of dying in stage x, L_x=number alive between age x and x+1, 100_{qx}=percent apparent mortality, S_x=survival rate within stage, T_x=total number of age x beyond the age, e_x=life expectancy

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Marina binti Roseli, the author of this thesis was born on January 24, 1988 in Beseri, Perlis, Malaysia. She attended school at Sekolah Kebangsaan Beseri, Perlis (primary school) from year 1995 until 2000 and Sekolah Menengah Kebangsaan Tengku Suleiman, Perlis (secondary school) from year 2001 until 2005. Then in mid of 2006, she went to Perlis Matriculation College for one year and later pursued her first degree study, Bachelor's degree of Science (Honors) in Biology (majoring in Zoology) at Faculty of Science and Technology, UKM, Bangi, Selangor for three years. In 2010, she pursued her master's degree at the same faculty and university and was awarded the degree of Master of Science in Entomology in year 2011. After finished her master study, she pursued her doctoral degree in year 2012 in the field of Entomology at Faculty of Agriculture, Universiti Putra Malaysia under supervision of Associate Professor Dr. Nur Azura binti Adam (Department of Plant Protection).

LIST OF PUBLICATIONS

Journals

Marina, R., Nur Azura, A., Lau, W.H. and Yaakop, S. (2020). Population fluctuation of rice leaffolder, *Cnaphalocrocis medinalis* Guenee (Lepidoptera: Pyralidae) in two consecutive rice seasons. *Journal of Agrobiotechnology* (accepted on September 2, 2020).

Marina, R., Nur Azura, A., Lau, W.H. and Yaakop, S. (2019). Life table and demographic parameters of rice leaffolder, *Cnaphalocrocis medinalis* Guenee (Lepidoptera: Pyralidae). *Serangga*, 24(2): 49-60.

Abstracts/Proceedings

Marina, R., Nur Azura, A., Lau, W.H. and Yaakop, S. (2018). Determination of larval instars of rice leaffolder, *Cnaphalocrocis medinalis* (Lepidoptera: Pyralidae). In *3rd International Symposium on Insects 2018 (ISoI 2018)*, (p. 76), Bayview Hotel Langkawi, Malaysia, March 19 – 21, 2018.

Marina, R., Nur Azura, A., Lau, W.H. and Yaakop, S. (2014). Lepidopteran rice pests and associated parasitoids in Malaysia. In *2nd International Symposium on Insects 2014 (ISoI 2014)*, (p. 70), Bayview Hotel Melaka, Malaysia, December 1 – 3, 2014.

Marina, R., Nur Azura, A., Lau, W.H. and Yaakop, S. (2014). Molecular identification of lepidopteran rice pests and associated parasitoids. In *2014 ISSAAS International Congress and General Meeting*, (p. 43), Tokyo University of Agriculture, Tokyo, Japan, November 8 – 10, 2014.

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