UNIVERSITI PUTRA MALAYSIA

BIOECOLOGY OF ORIENTAL FRUIT FLY (BACTROCERA DORSALIS HENDEL) ON MANGO (MANGIFERA INDICA L.) IN ORCHARDS UNDER FOUR DIFFERENT MANAGEMENT PRACTICES

SALMAH MOHAMED

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By

SALMAH BINTI MOHAMED

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 husband, Mohd Azli Bin Sutaman, my two lovely daughters (Afni Saffiya and Amni Safwa) and three wonderful sons (Adam Syahmi, Aidil Syamil and Aqil Syamim), my parents (Mohamed Bin Muda and Maznah Binti Embong), my mother in-law (Fouziah Binti Kassim), brothers and sister in-law, siblings 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 Adam, PhD
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An Oriental fruit fly, *Bactrocera dorsalis* Hendel, is one of the most problematic tephritid fruit flies due to the severe damages caused to commercial fruits such as mango (*Mangifera indica* L.). However, the information on biology and ecology of this tephritid species particularly on mango variety is still lacking. Thus, this study aimed to investigate its infestation level through damaged mango fruits collection during mango fruiting season from four Chokanan mango orchards with different management practices in Jitra, Kedah (organic orchard), Bumbong Lima, Penang (unmanaged orchard), Bukit Changgang, Selangor (Good Agricultural Practices orchard) and Pulau Gadong, Malacca (conventional orchard). In addition, population fluctuation of *B. dorsalis* in the same mango orchards was conducted using methyl eugenol traps from mango flowering stage until harvesting stage. Moreover, the life table and demographic parameters from three cohorts of *B. dorsalis* eggs as well as the oviposition behaviour and offspring of *B. dorsalis* females on three different Chokanan mango ripening stages (i.e. unripe, ripe and fully-ripe) at five replication were determined in the laboratory. Results show the highest fruit infestation rate was recorded in Bumbong Lima (93.09±9.00 pupae/kg) due to no proper integrated control of fruit flies was conducted whilst Jitra showed the lowest infestation rate (10.74±1.25 pupae/kg) due to better control of fruit fly populations. Among the total of 5,229 *Bactrocera* pupae collected from infested fruits and 33,467 male flies collected from methyl eugenol traps, *B. dorsalis* showed significantly the highest numbers ($P<0.05$) compared to *B. carambolae* in all locations indicating that it is a dominant species and a major fruit fly pest of mango in Malaysia. *Bactrocera dorsalis* populations show similar fluctuation trends in most locations which the flies number start to increase in week 8 to 10 and peak numbers were recorded in week 14 to 16 because at this point the fruits reached the matured and ripe stages, which the most favourable stage for *B. dorsalis* females to lay eggs. Monthly relative humidity contributed significantly towards the population fluctuation of *B. dorsalis* in Pulau Gadong, Bumbong Lima and Jitra. However, only rainfall contributed significantly towards the population fluctuation of *B. dorsalis* in Bukit Changgang. Both abiotic factors are closely related to the *B. dorsalis* pupae development and adult

emergence which they depend on the moist condition in soil and air. Age-specific survival (l_x) indicated that 22.33% *B. dorsalis* eggs successfully reached to adults. The highest mortality recorded was in the 1st instar larvae (48.59%) with K-value of 0.289 and the pattern of survivorship curves falls in type III. This high mortalities may be regarded as the key factor regulating the population size of *B. dorsalis*. Age specific fecundity (m_x) showed the earliest egg laying on day 35 and the last female died on day 69. The female laid on average 410.0±61.22 eggs. The intrinsic rate of natural increase (r_m) was 0.06 per female per day with mean generation time (T_c) of 46.39 days. The net reproductive rate (R_o) was 13.68 female offspring per female. Doubling time occurred in 12.38 days. This showed that the population of *B. dorsalis* has rapid buildup in short period of time. Fully-ripe mango was relatively preferred by *B. dorsalis* females to visit and oviposit eggs followed by the ripe mango in no-choice and choice experiment. In contrast, unripe mango was the least preferred for eggs oviposition by *B. dorsalis* in both experiments. This indicated that the fully-ripe stage is more susceptibility in terms of fruit characteristics and nutrient contents.

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

BIOEKOLOGI LALAT BUAH ORIENTAL (*Bactrocera dorsalis* HENDEL) KE ATAS MANGGA (*Mangifera indica* L.) DALAM KEBUN BAWAH EMPAT AMALAN PENGURUSAN BERBEZA

Oleh

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Pengerusi : Profesor Madya Nur Azura Adam, PhD
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Lalat buah Oriental, *Bactrocera dorsalis* Hendel, adalah salah satu lalat buah tephritid yang paling bermasalah kerana menyebabkan kerosakan teruk terhadap buah-buahan komersial seperti mangga (*Mangifera indica* L.). Walau bagaimanapun, maklumat biologi dan ekologi spesis tephritid ini terutama terhadap varieti mangga masih berkurangan. Oleh itu, kajian ini bertujuan untuk menyiasat tahap serangan yang berkaitan melalui pengumpulan buah mangga rosak semasa musim buah dari empat kebun mangga Chokanan yang berbeza amalan pengurusan di Jitra, Kedah (kebun organik), Bumbong Lima, Pulau Pinang (kebun tidak terjaga), Bukit Changgang, Selangor (kebun Amalan Pertanian Baik) dan Pulau Gadong, Melaka (kebun konvensional). Di samping itu, turun naik populasi *B. dorsalis* menggunakan perangkap methyl eugenol di kebun mangga yang sama juga telah dijalankan dari peringkat manga berbunga sehingga peringkat menuai. Tambahan pula, jadual hidup dan parameter demografi daripada tiga kohort telur *B. dorsalis* serta keutamaan kelakuan mencucuk telur dan hasil anak daripada *B. dorsalis* betina pada tiga peringkat masak mangga Chokanan yang berbeza (iaitu belum masak, masak dan masak sepenuhnya) pada lima replikasi telah ditentukan di makmal. Hasil menunjukkan kadar serangan buah tertinggi telah direkodkan di Bumbong Lima (93.09±9.00 pupa/kg) kerana tiada kawalan bersepadu lalat buah yang sepatutnya dijalankan manakala Jitra menunjukkan kadar serangan terendah (10.74±1.25 pupa/kg) kerana terdapat kawalan populasi lalat buah yang lebih baik. Daripada jumlah 5229 pupa *Bactrocera* dikumpul daripada buah yang diserang dan 33467 lalat jantan dikumpul daripada perangkap metil eugenol, *B. dorsalis* telah menunjukkan bilangan yang paling tinggi secara signifikan ($P<0.05$) berbanding *B. carambolae* di semua lokasi menandakan ia adalah spesis dominan dan perosak lalat buah utama mangga di Malaysia. Populasi *Bactrocera dorsalis* menunjukkan gaya turun naik yang hampir sama di kebanyakan lokasi di mana bilangan lalat mula meningkat pada minggu 8 hingga 10 dan bilangan tertinggi telah direkodkan pada minggu 14 hingga 16 kerana pada ketika ini buah telah mencapai peringkat matang dan masak, di mana ia merupakan peringkat paling digemari oleh *B. dorsalis* betina untuk bertelur. Kelembapan relatif bulanan menyumbang secara signifikan ke atas populasi turun naik *B. dorsalis* di

Pulau Gadong, Bumbong Lima dan Jitra. Walau bagaimanapun, hanya hujan menyumbang secara signifikan ke atas populasi turun naik *B. dorsalis* di Bukit Changgang. Kedua-dua faktor abiotik ini adalah berkait rapat dengan pembentukan pupa dan penjelmaan dewasa *B. dorsalis* di mana ia bergantung ke atas keadaan lembab di dalam tanah dan udara. Kemandirian spesifik umur (l_x) menunjukkan bahawa 22.33% telur *B. dorsalis* berjaya mencapai ke tahap dewasa. Kematian tertinggi direkodkan pada instar larval yang pertama (48.59%) dengan nilai K 0.289 dan corak lengkung kemandirian tergolong di dalam jenis III. Kematian tertinggi ini berkemungkinan boleh menjadi faktor kunci penentuan saiz populasi *B. dorsalis*. Fekunditi umur spesifik (m_x) menunjukkan telur terawal dihasilkan pada hari ke-35 dan individu betina terakhir mati pada hari ke-69. Betina menghasilkan telur secara puratanya sebanyak 410.0±61.22 biji. Kadar pertambahan semulajadi intrinsic (r_m) adalah sebanyak 0.06 bagi setiap betina setiap hari dengan generasi purata (T_c) ialah 46.39 hari. Kadar pembiakan bersih (R_o) adalah 13.68 anak betina kepada setiap betina dewasa. Masa gandaan dua berlaku selama 12.38 hari. Ini menunjukkan populasi *B. dorsalis* meningkat secara pantas dalam tempoh yang singkat. Peringkat mangga yang masak sepenuhnya secara dasarnya lebih disukai untuk dilawati dan bertelur oleh betina *B. dorsalis* diikuti oleh mangga masak dalam kedua-dua eskperimen tanpa pilihan dan dengan pilihan. Sebaliknya, mangga belum masak paling kurang disukai oleh *B. dorsalis* untuk mengoviposit telur dalam kedua-dua eksperimen. Hasil menunjukkan bahawa peringkat masak sepenuhnya adalah lebih bersesuaian dari segi ciri-ciri buah dan kandungan nutrien berbanding peringkat masak dan belum masak.

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I certify that a Thesis Examination Committee has met on 27 November 2017 to conduct the final examination of Salmah binti Mohamed on her thesis entitled "Bioecology of Oriental Fruit Fly (*Bactrocera dorsalis* Hendel) on Mango (*Mangifera indica* L.) in Orchards under Four Different Management Practices" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
cm	centimeter
cv.	cultivar
CRD	Completely Randomized Design
DAFB	Days after full bloom
DOA	Department of Agriculture of Malaysia
EPPs	Entry Point Projects
ETP	Economic Transformation Programme
FAMA	Federal Agricultural Marketing Authority of Malaysia
FR	Fully-ripe
g	gram
GNI	Gross National Income
hrs.	hours
HSD	Honest significant difference
IPM	Integrated Pest Management
kg	kilogram
L.	Linnaeus
l	liter
L:D	Light: Dark
m	meter
ml	milliliter
ME	methyl-eugenol
MOA	Ministry of Agriculture and Agro-Based Industry Malaysia
N	Newton
NKEA	The Agriculture National Key Economic Area
ºC	Degrees Celsius
PP	Percentage of parasitism
R	Ripe
RH	Relative humidity
T.A	Total acidity
TSS	Total soluble solids
UK	United Kingdom
UPM	Universiti Putra Malaysia
UR	Unripe

CHAPTER 1

INTRODUCTION

The Agriculture National Key Economic Area (NKEA) of Malaysia aims to double the agriculture sector's Gross National Income (GNI) contribution to RM28.9 billion by 2020, through 16 Entry Point Projects (EPPs) (ETP Annual Report, 2011). One of the EPPs aims is upgrading capabilities to produce fruits and vegetables for premium markets up to RM1.571 million with 68% of total production by 2020 and this includes mango (*Mangifera indica* L.).

Mango is one of the prominent fruits which has a huge market locally and internationally. It is one of the world major tropical fruits which are fast gaining popularity, especially among the European consumers. In Malaysia, mango fruits are one of the most popular nutritive and attractive tropical fruits to eat. For instance, about 131,279 metric tons of mangoes were consumed by Malaysians in 2012 (FAMA, 2014). Thus, mango consumption in Malaysia has increased significantly from 2000 to 2013 among consumers which included the households, factories, and institutions (FAMA, 2014). Although Malaysia is not one of the major producers of mangoes in the Asian countries, the mango industry in Malaysia is growing bigger from time to time. For instance, in 2010, almost 10,000 ha of mangoes have been planted in Malaysia with the production of around 25,000 metric tons (MOA, 2010).

However, Malaysia is still way behind of producing mango at a maximum level compared to its neighbouring country although this fruit has already been commercially produced over the years. For example, in 2012, the production of mangoes was declined to 22,823 metric tons whilst in 2013 the export value was decreased to 5.44% (FAMA, 2014). In order to fulfil the demand of the Malaysian consumers, Malaysia has to import about 35,000 metric tons of mangoes from other countries such as Thailand, India, Philippines and Australia and the import value was increasing to 15.43% in 2013 (FAMA, 2014). One of the major factor contributing to the stated matter is pest infestation particularly fruit flies (Diptera: Tephritidae) that reduced the quality and quantity of the commodity as they prefer to attack the matured and ripe fruits (Badri et al., 2008).

Fruit flies (Diptera: Tephritidae) are great economic and agricultural important pests due to damage caused to commercial fruits and vegetable crops throughout Asia, Australia and the South Pacific (White and Elson-Harris, 1992). It was recorded that economic losses due to infestation by fruit flies can cause more than two billion dollars worldwide (Garcia and Ricalde, 2013). Fruit flies are capable of damaging fruit crops at the severe stage. The severity of the damage is not only because of aggressiveness and high abundance of a species but also due to the competency of a single species to attack many hosts and one individual female fruit fly is capable of laying eggs on many fruits at one

time in her entire life span (Singh, 1988). Therefore, without proper control, the direct damage to fruits can lead to yield loss up to 90% or even worst at 100% depending on the fruit fly population, season, variety and area (Kumar et al., 2011). Fruit flies from the genus *Bactrocera* is the most serious and problematic tephritid fruit flies reported in Southeast Asia and Pacific regions including Malaysia (Allwood et al, 1999; Tan, 2000). It has been reported that from 1.14 million metric tonnes of fruit which were produced in Malaysia in 2009, the cost of managing the fruit fly infestation was estimated at 29 million ringgit (Norain, 2010). According to Tan (2004), one of the main factors contributing to this matter is the warm climate in Malaysia which allows continuous cultivation of fruit fly host fruits such as mangoes and this is an ideal condition for fruit flies to multiply rapidly.

An Oriental fruit fly *Bactrocera dorsalis* Hendel (formerly known as *Bactrocera papayae*) which one of the related species of *B. dorsalis* complex and native species of Malaysia (Tan, 2004) is considered the most virulent and serious fruit fly species because it can attack about 209 plant species from 51 different families (Chua, 1991; Drew and Romig, 1997; White and Elson-Harris, 1992). In Peninsular Malaysia, commercial crops such as mango (*Mangifera indica* L.), star fruit (*Averrhoa carambola* L.), guava (*Psidium guajava* L), and papaya (*Carica papaya* L.) have been seriously attacked by *B. dorsalis* (Allwood et al., 1999; Wee and Tan, 2005).

Due to their economic importance, various research on biology, morphology, physiology, and ecology of *Bactrocera* fruit flies had been done around the world (Hardy, 1988; Rwomushana et al., 2008). In Malaysia, the first intensive and systematic study of the various species of *Bactrocera* fruit flies, their host range and distribution was initiated in the year of 1986 (Vijaysegaran and Mohd, 1991) and followed by Allwood et al. (1999) and Chinajariyawong et al. (2000). Tan (2004) studied on *B. dorsalis* genetic and molecular taxonomic variation while Wee and Tan (2000 and 2005) focused on sexual mating behaviour of *B. dorsalis*. Moreover, intensive studies have been conducted on growth and development of *B. dorsalis* on guavas (Mohd Noor et al., 2011) and species composition and infestation on starfruits (Juma et al. 2014). However, information on the bioecology of *B. dorsalis* mainly on mango variety in terms of infestation level, associated parasitoid, population fluctuation in field, life table study, and ovipositional behaviour preference on different mango ripening stages are still lacking. It is hoped that this study will contribute to the knowledge development on the biology, ecology and mass-rearing of *B. dorsalis* for the success of fruit fly control programs in the future.

Therefore, the main objectives of this study are:

1. To determine the species of *Bactrocera* infesting mango, infestation rate and its associated parasitoids in mango orchards with different agronomic practices
2. To determine population fluctuation of *B. dorsalis* in mango orchards with different agronomic practices and relationship with abiotic factors
3. To construct life table and demographic parameters of *B. dorsalis*, and
4. To determine ovipositional preference of *B. dorsalis* on different mango ripening stages.

REFERENCES

Abdullah, F. and Shamsulaman, K. 2008. Insect pests of *Mangifera indica* plantation in Chuping, Perlis, Malaysia. *Journal of Entomology*, 5(4): 239-251.

Adandonon, A., Vayssières J.F., Sinzogan, A. and Van Mele, P. 2009. Density of pheromone sources of the weaver ant *Oecophylla longinoda* affects oviposition behaviour and damage by mango fruit flies (Diptera: Tephritidae). *International Journal of Pest Management*, 55: 285–292.

Ahmad Tarmizi, S., Lam, P.F. and Mohamed, M.S. 1996. Pemetikan hasil dan pengendalian lepas tuai. In T.M. Tengku Ab. Malik, S. Ahmad Tarmizi, M. Zainal Abidin, and C.S. Teng (Ed.), *Panduan Penanaman Mangga* (pp. 56 – 63). Serdang: MARDI.

Ali, S. A. I., Mohamed, S. A., Mahmoud, M. E. E., Sabiel, S. A. I., Ali, S. and Ali, A. 2014. Monitoring of tephritidae of fruit trees and their level of infestation in South Kordofan State, Sudan. *International Journal of Agriculture Innovations and Research*, 2(5): 2319–1473.

Allwood, A.J., Chinajariyawong, A., Drew, R.A.I., Hamacek, E.L., Hancock, D.L., Hengsawad, C., Jinapin, J.C., Jirasurat, M., Krong, C., Kritsaneepaiboon, S., Leong C.T.S. and Vijaysegaran, S. 1999. Host plant records for fruit flies (Diptera: Tephritidae) in South-East Asia. *The Raffles Bulletin of Zoology* Supplement 7:1-92.

Aluja, M. and Liedo, P. 1993. *Fruit Flies: Biology and Development*. New York: Springer-Verlag.

Aluja, M. and Mangan, R.L. 2008. Fruit fly (Diptera: Tephritidae) host status determination: critical conceptual, methodological, and regulatory considerations. *Annual Review of Entomology*, 53(1): 473–502.

Aluja, M. and Rull, J. 2009. Managing pestiferous fruit flies (Diptera: Tephritidae) through environmental manipulation. In M. Aluja, T.C. Leskey and C. Vincent (Ed.), *Biorational Tree-Fruit Pest Management* (pp. 171-213). Wallingford, UK: CABI.

Aluja, M., Celedonio-Hurtado, H., Liedo, P., Cabrera, M., Castillo, F., Guillen, J., and Rios, E. 1996. Seasonal population fluctuations and ecological implications for management of Anastrepha fruit flies (Diptera: Tephritidae) in commercial mango orchards in Southern Mexico. *Journal of Economic Entomology*, 89(3): 654–667.

Aluja, M., Ordano, M., Guillen, L. and Rull, J. 2012. Understanding long-term fruit fly (Diptera: Tephritidae) population dynamics: implications for area wide management. *Journal of Economic Entomology*, 105:823-836.

Alyokhun A.V., Messing R.H. and Duan J.J. 2000. Visual and olfactory stimuli affect trap captures of oriental fruit flies (Diptera: Tephritidae). *Journal of Economic Entomology*, 93: 644-649.

Am, M., Sridharan, C.S. and Awasthi, N.S. 2017. Varying infestation of fruit fly, *Bactrocera cucurbitae* (Coquillett) in different cucurbit crops. *Journal of Entomology and Zoology Studies*, 5(53): 1419–1421.

Ambele, F.C., Billah, M.K., Afreh-Nuamah, K. and Obeng-Ofori, D. 2012. Susceptibility of four mango varieties to the Africa invader fly, *Bactrocera invadens* Drew, Tsuruta and White (Diptera: Tephritidae) in Ghana. *Journal of Applied Biosciences*, 49: 3425– 3434.

Ansari, M.S., Hasan, F. and Ahmad, N. 2012. Threats to fruit and vegetable crops: Fruit flies (Tephritidae) - Ecology, behaviour, and management. *Journal of Crop Science and Biotechnology*, 15(3), 169–188.

Badri, I., Osman, M.S. and Salleh, M.M. 2008. *Serangga Perosak Buahan-buahan Tropika Malaysia.* Kuala Lumpur: Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI).

Balasubramaniam, S., Lee, H.C., Lazan, H., Othman R. and Ali Z.M. 2005. Purification and properties of a beta-galactosidase from carambola fruit with significant activity towards cell wall polysaccharides. *Phytochemistry*, 66(2): 153-163.

Bally, I.S.E. *Mangifera indica* (mango), ver. 3.1. In C.R. Elevitch (Ed.), *Species Profiles for Pacific Island Agroforestry*. Permanent Agriculture Resources (PAR), Hōlualoa, Hawai‘i.

Barbehenn, R.V., Reese, J.C. and Hagen, K.S. 1999. The food of insects. In C.B. Huffaker and A.P. Gutierrez (Ed.), *Ecological Entomology 2nd Ed.* (pp. 83-121). New York: John Wiley & Sons.

Barbosa-Cánovas, G.V., Fernández-Molina, J.J., Alzamora, S.M., Tapia, M.S., López-Malo, A. and Chanes, J.W. 2003. Chapter 2. Basic harvest and post-harvest handling considerations for fresh fruits and vegetables. In *Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas* (pp. 19). Rome: Food and Agriculture of Organization of the United Nations.

Bashir, H.A. and Abu-Goukh, A.A. 2003. Compositional changes during guava fruit ripening. *Food Chemistry*, 80(4): 557-563.

Basri, M.W., Siburat, S., Ravigadevi, S. and Othman, A. 1999. Beneficial plants for the natural enemies of the bagworm in oil palm plantations. In: Ariffin Darus, Chan Kook Weng & Sharifah Shahrul Rabiah Syed Alwee. (eds). *Proceedings of the 1999 PORIM International Palm Oil Congress (Agriculture)*. Bangi: Palm Oil Research Institute of Malaysia. pp. 441-455.

Bateman, M.A. 1972. The ecology of fruit flies. *Annual Review of Entomology*, 17:493-518.

Begon, M. and Mortimer, M. 1981. *Population ecology: A unified study of animals and plants*. Massachusetts, USA: Sunderland Sinauer Associated Inc.

Balagawi, S., Vijaysegaran, S., Drew R.A.I. and Raghu, S. 2005. Influence of fruit traits on oviposition preference and offspring performance of *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae) on three tomato (*Lycopersicon lycopersicum*) cultivars. *Australian Journal of Entomology,* 44(2): 97-103.

Biale, J.B. 1960. The post-harvest biochemistry of tropical and subtropical fruits. *Advances in Food Research,* 10: 293 − 354

Bidwell, R.G.S. 1979. *Plant Physiology 2nd Edition.* New York: Macmillan Publishing Co. Inc.

Braga Sobrinho, R., Caceres, C., Islam, A., Wornoayporn, V. and Enkerlin, W. 2006. Improving mass rearing technology for South American fruit fly (Diptera:Tephritidae). *Revista Caatinga*, 19(3):310-316.

Brecht, J.K. and Yahia, E.M. 2009. Postharvest physiology. In R.E. Litz (Ed.), *The Mango, Botany, Production and Uses, 2nd Edition* (pp. 484 – 528). Wallingford, UK: CABI.

Carey, J.R. 1982. Demography and population dynamics of the Mediterranean fruit fly. *Ecological Modelling,* 16: 125-150.

Carey, J.R. 1989. Demographic analysis of fruit flies, In A. S. Robinson and G. Hooper (Ed.), *World Crop Pests. Fruit Flies: Their Biology, Natural Enemies and Control* (pp. 252-265). Amsterdam: Elsevier Science Publishers.

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

Carey, J. R., 2001. Insect biodemography. *Annual Review of Entomology*, 46: 79-110.

Carey, J.R. and Vargas, R.I. 1985. Demographic analysis of insect mass rearing: a case study of three tephritids. *Journal of Economic Entomology*, 78: 523-527.

Chang, C.L., Caceres, C. and Ekesi, S. 2007. Life history parameters of *Ceratitis capitata* (Diptera: Tephritidae) reared on liquid diets. *Annals of the Entomological Society of America,* 100(6): 900-906.

Chen, P., Ye, H., and Liu, J. 2006. Population dynamics of *Bactrocera dorsalis* (Diptera: Tephritidae) and analysis of the factors influencing the population in Ruili, Yunnan Province, China. *Acta Ecologica Sinica*, 26(9): 2801–2808.

Chi H. 1988. Life-table analysis incorporating both sexes and variable development rate among individuals. *Environmental Entomology,* 17(1): 26–34.

Chinajariyawong, A., Clark, A. R., Jirasurat, M., Kritsaneepiboon, S., Labey, H.A., Vijaysegaran, S. and Walter, G.H. 2000. Survey of Opiine parasitoids of fruit flies (Diptera: Tephritidae) in Thailand and Malaysia. *The Raffles Bulletin of Zoology*, 48(1):71-101.

Choo, A., Crisp, P., Baxter, S., O'Keefe, L. and Saint, R. 2016. Generating a male-selecting strain of *Bactrocera tryoni* by CRISPR/CAS genome editing for sterile insect Technique applications. In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016* (p. 50), Putrajaya, Malaysia, August 15-18, 2016.

Christenson, I.D. and Foote, R.H. 1960. Biology of fruit flies. *Annual Review of Entomology*, 5: 171-192.

Chua, T.H. 1991. Comparison of demographic parameters in wild *Bactrocera* sp. (Malaysian A) (Diptera: Tephritidae) from different hosts. *Journal of Plant Protection in the Tropic*, 8(3): 161-166.

Chua, T. H. 1993. Pattern of parasitism in the carambola fruit fly, *Bactrocera* sp. (Malaysian A) (Dipt., Tephritidae) by *Biosteres vandenboschi* (Fullaway) (Hym., Braconidae) *Journal of Applied Entomology* 115:287-291.

Clarke, A.R., Allwood, A., Chinajariyawong, A., Drew, R.A.I. Hengsawad, C., Jirasurat, M., Kong Krong, C., Kritsaneepaiboon, S. and Vijaysegaran, S. 2001. Seasonal abundance and host use patterns of seven *Bactrocera* Macquart species (Diptera: Tephritidae) in Thailand and Peninsular Malaysia. *The Raffles Bulletin of Zoology*, 49: 207–220.

Clarke, A.R., Armstrong, K.F., Carmichael, A.E., Milne, J.R., Raghu, S., Roderick, G.K. and Yeates, D.K. 2005. Invasive phytophagous pests arising through a recent tropical evolutionary radiation: the *Bactrocera dorsalis* complex of fruit flies. *Annual Review of Entomology*, 50: 293–319.

Dalby-Ball, G. and A. Meats. 2000. Influence of the odour of fruit, yeast and cue-lure on the flight activity of the Queensland fruit fly, *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae). *Australian Journal of Entomology*, 39(3): 195-200.

Danjuma, S., Boonrotpong, S., Thaochan, N., Permkam, S. and Satasook, C. 2014. Seasonality of the Asian papaya fruit fly *Bactrocera papayae* Drew and Hancock (Diptera: Tephritidae) on guava *Psidium guajava* in peninsular Thailand. *Journal of Entomology and Zoology Studies*, 2(5): 276-284.

Deevey, E. S., 1947. Life tables for natural populations of animals. *Quarterly Review of Biology*, 22: 283-314.

Diamé, L., Grechi, I., Rey, J.Y., Sané, C.A. B., Diatta, P., Vayssières, J.F. and Diarra, K. 2015. Influence of *Oecophylla longinoda* Latreille, 1802 (Hymenoptera: Formicidae) on mango infestation by *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) in relation to Senegalese orchard design and management practices. *African Entomology*, 23(2): 294–305.

Diatta, P., Rey J.Y., Vayssieres, J.F., Diarra, K., Coly, E.V., Lechaudel, M., Grechi, I., Ndiaye, S. and Ndiaye, O. 2013. Fruit phenology of citruses, mangoes and papayas influences egg-laying preferences of *Bactrocera invadens* (Diptera: Tephritidae). *Fruits*, 68: 507-516.

DOA. 2009. *Pakej Teknologi Mangga*. Kuala Lumpur: Jabatan Pertanian Malaysia, Kementerian Pertanian dan Industri Asas Tani

Drew, R.A.I. 1989. The tropical fruit flies (Diptera: Tephritidae: Dacinae) of the Australasian and Oceanian regions. *Memoirs of the Queensland Museum*, 26: 1-521.

Drew, R. A. I. and Hancock, D. L. 1994. The *Bactrocera dorsalis* complex of fruit flies (Diptera: Tehphritidae: Dacinae) in Asia. *Bulletin of Entomolical Research*, Supplement No. 2: 1-68.

Drew, R.A.I. and Hardy, D.E. 1981. *Dacus* (*Bactrocera*) *opiliae*, a new sibling species of the *dorsalis* complex of fruit flies from Northern Australia (Diptera: Tephritidae). *Journal of the Australian Entomological Society*, 20(2): 131-137.

Drew, R.A.I. and Romig, M.C. 1997. Overview: Tephritidae in the Pacific and Southeast Asia. In A.J. Allwood and R.A.I. Drew (eds.), *Management of Fruit Flies in the Pacific*, (p. 267). A regional symposium, ACIAR Proceedings No. 76. Canberra: Australian Centre for International Agricultural Research.

Drew, R.A.I. and Romig, M.C. 2013. *Tropical Fruit Flies of South-East Asia*. Wallingford UK: CAB International.

Drew, R.A.I., Rodgers, D.J. Vijaysegaran S. and Moore, C.J. 2008. Mating activity of *Bactrocera cacuminata* (Hering) (Diptera: Tephritidae) on its larval host plants *Solanum muaritianum* Scopoli in southeast Queensland. *Bulletin of Entomological Research*, 98(1): 77-81.

Economic Transformation Programme (ETP) Annual Report 2011. 2011. Jabatan Perdana Menteri: Putrajaya, Malaysia.

Eitam, A. and Vargas, R.I. 2007. Host habitat preference of *Fopius arisanus* (Hymenoptera: Braconidae), a parasitoid of tephritid fruit flies. *Annals of the Entomological Society of America*, 100(4):603-608.

Ekesi, S. and Mohamed, S.A. 2011. Mass rearing and quality control parameters for tephritid fruit flies of economic importance in Africa. In Akyar, I. (Ed). *Wide Spectra of Quality Control*. Croatia: InTech Europe.

Ekesi, S., P.W. Nderitu, and L.C. Chiou. 2007. Adaptation to and small-scale rearing of invasive fruit fly *Bactrocera invadens* (Diptera: Tephritidae) on artificial diet. *Annals of Entomology Society of America*, 100(4): 562-567.

Ekesi, S., Billah, M.K., Nderitu, P.W., Lux, S. and Rwomushana, I. 2009. Evidence for competitive displacement of *Ceratitis cosyra* by the invasive fruit fly *Bactrocera invadens* (Diptera: Tephritidae) on mango and mechanisms contributing to the displacement. *Journal of Economic Entomology*, 102(3):981-991.

Elson-Harris, M.M. 1988. Studies in larval taxonomy of tropical fruit flies (Tephritidae),. In S. Vijaysegaran and A.G. Ibrahim (Eds.), *Proceedings First International Symposium on Fruit Flies in the Tropics*, (pp. 67-70). Kuala Lumpur, Malaysia.

Evans, E.A. 2008. *Recent Trends in World and U.S. Mango Production, Trade, and Consumption*. Florida: University of Florida, IFAS Extension.

FAMA. 2014. Statistik Utama Pemasaran FAMA 2014. Kuala Lumpur: Lembaga Pemasaran Pertanian Persekutuan.

Ganie, S.A., Khan, Z.H., Ahangar, R.A., Bhat, H.A. and Hussain, B. 2012. Population dynamics, distribution, and species diversity of fruit flies on curcubits in Kahsmir Valley, India. *Journal of Insect Science*, 13(65):1-7.

Garcia, F.R.M. 2009. Fruit fly: Biological and ecological aspects. In R.R. Bandeira (Ed.), *Current Trends in Fruit Flies Control on Perennial Crops and Research Prospects*, (pp. 1-35), Transworld Research Network, Kerala, India.

Garcia, F.R.M. and Ricalde, M.P. 2013. Augmentative biological control using parasitoids for fruit fly management in Brazil. *Insects*, 4:55-70.

Gomina, G.M., Mondedji, A.D., Nyamador, W., Vayssieres, J.F., Amevoin, K. and Glitho A.I. 2014. Development and demographic parameters of *Bactrocera invadens* (Diptera: Tephritidae) in guinean climatic zone of Togo. *International Journal of Natural Sciences Research*, 2(11): 263-277.

Goergen, G, Vayssières J.F., Gnanvossou, D. and Tindo, M. 2011. *Bactrocera invadens* (Diptera: Tephritidae), a new invasive fruit fly pest for the Afrotropical Region: host plant range and distribution in West and Central Africa. *Environmental Entomology*, 40: 844-854.

Gullan, P.J. and Cranston, P.S. 2008. *The Insects: An Outline of Entomology* (3rd Ed). USA: Blackwell Publishing Ltd.

Hardy, D.E. 1955. A reclassification of the Dacini (Tephritidae-Diptera). *Annual Review of Entomology*, 48: 425-437.

Hardy, D.E. 1969. Taxonomy and distribution of the Oriental fruit fly and related species (Tephritidae-Diptera). *Proceedings of the Hawaiian Entomological Society*, 20(2): 395-428.

Hardy, D.E., 1988. The Tephritinae of Indonesia, New Guinea, the Bismarck and Solomon islands (Diptera: Tephritidae). Bishop Mus. Bull. Ento., I. Bishop Museum Press, Honololu.

Hee, A.K.W. and Toh, P.H. 2016. Attraction of female oriental fruit fly to carambola. In First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016, (p. 60), Putrajaya, Malaysia. August 15-18, 2016.

Hee, A.K.W., Ooi, Y.S., Wee, S.L., and Tan, K.H. 2015. Comparative sensitivity to methyl eugenol of four putative *Bactrocera dorsalis* complex sibling species - further evidence that they belong to one and the same species *B. dorsalis*. *ZooKeys*, (540): 313–21.

Hennessey, M.K. and Schnell, R.J. 2001. Resistance of immature mango fruits to Caribbean fruit fly (Diptera: Tephritidae). *Florida Entomologist*, 84: 318-319.

Hernandez, M.M., Sanz, I., Adelantado, M., Ballach, S. and Primo, E. 1996. Electroantennogram activity from antennae of *Ceratitis capitata* (Wied.) to fresh orange airborne volatiles. *Journal of Chemical Ecology*, 22(9): 1607-1619.

Hernandèz-Ortiz, V., Delfin-Gonzales, H., Escalante, A. and Manrique-Saide, P. 2006. Hymenopteran parasitoids of *Anastrepha* fruit flies (Diptera: Tephritidae) reared from different hosts in Yucatan, Mexico. *Florida Entomologist*, 89:508-515.

Honma, A., Haraguchi, D. and Matsuyama, T. 2016. A new monitoring system for checking and controlling adequate sterilized insect release. In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 46), Putrajaya, Malaysia. August 15-18, 2016.

Huang, K.Y.B. and Chi, H. 2012. Age-stage, two-sex life tables of *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) with a discussion on the problem of applying female age-spesific life tables to insect populations. *Insect Science*, 19: 263-273.

Huang, K.Y.B. and Chi, H. 2014. Fitness of *Bactrocera dorsalis* (Hendel) on seven host plants and an artificial diet.

Huang, K.Y.B. and Chi, H. 2016. Effect of feeding methyl eugenol on the population traits of *Bactrocera dorsalis* (Hendel). In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 65), Putrajaya, Malaysia. August 15-18, 2016.

Ibrahim, A.G., Palacio, I.P. and Rohani, I. 1994. Biology of *Diachasmimorpha longicaudata* (Ashmead) (Hymenoptera: Braconidae), a parasitoid of carambola fruit fly (Diptera: Tephritidae). *Pertanika Journal of Tropical Agriculture Science*, 17: 139-143.

Ibrahim, A.G. and Rahman, M.D.A. 1982. Laboratory studies of the effects of selected tropical fruits on the larva of *Dacus dorsalis* Hendel. *Pertanika*, 5: 90-94.

Iwahashi, O. 1999a. Distinguishing between two sympatric species, *Bactrocera occipitalis* and *B. philippinensis* (Diptera: Tephritidae), based on aedeagal length. *Annals of the Entomological Society of America*, 92: 182–187.

Iwahashi, O. 1999b. Distinguishing between the two sympatric species *Bactrocera carambolae* and *B. papayae* (Diptera: Tephritidae) based on aedeagal length. *Annals of the Entomological Society of America*, 92: 639–643.

Iwaizumi, R., Kaneda, M. and Iwahashi, O. 1997. Correlation of length of terminalia of males and females among nine species of *Bactrocera* (Diptera: Tephritidae) and differences among sympatric species of *B. dorsalis* complex. *Annals of the Entomological Society of America*, 90: 664–666.

José, L., Cugala, D. and Santos, L. 2013. Assessment of invasive fruit fly fruit infestation and damage in Cabo Delgado Province, Northern Mozambique. *African Crop Science Journal*, 21(1): 21–28.

Juma, S.A., Muhamad, R., Adam, N.A., Hee, A.K.W. and Gnanasegaram, M. 2014. Occurrence of tephritid fruit flies with intermediate morphologies of *Bactrocera carambolae* and *B. papayae* (Diptera: Tephritidae) in Selangor, Peninsular Malaysia. *Australian Journal of Basic and Applied Sciences*, 8(17): 609-616.

Kader, A. A. 2008. Perspective flavor quality of fruits and vegetables. *Journal of the Science of Food and Agriculture*, 88:1863–1868.

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.

Kamala Jayanthi, P.D., Ravindra, M.A., Vivek, K., Tapas, K.R., Kodthalu, S.S. and Verghese, A. 2015. Salicylic acid induces changes in mango fruit that affect oviposition behavior and development of the Oriental fruit fly, *Bactrocera dorsalis*. *PLoS ONE*, 10(9):1-18.

Kamala Jayanthi, P.D., Vivek, K., Ravindra, M.A., Ravindra, K.V., Bakthavatsalam, N. Verghese, A. and Bruce, T.J. 2014. Specific volatile compounds from mango elicit oviposition in gravid *Bactrocera dorsalis* females. *Journal of Chemical Ecology*, 40: 259–266.

Kapoor, V.C. 1993. Indian Fruit Flies. Oxford & IBH Publishing Co. Ltd. New

Kartika, A.P. and Tati, S.S. 2016. Fruit fly infestation on wax apple (*Syzygium samarangense*) at North Sumatera, Indonesia. In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 93), Putrajaya, Malaysia. August 15-18, 2016.

Kienzle, S., Sruamsiri, P., Carle, R., Sirisakulwata, S., Spreer, W. and Neidhart, S. 2011. Harvest maturity specification for mango fruit (*Mangifera indica* L. 'Chokanan') in regard to long supply chains. *Postharvest Biology and Technology*, 61(1): 41–55.

Kumar, P., Abubakar, AlmaLinda, Ketelaar, J.W., Vijaysegaran, S. 2011. Field exercise guides on fruit flies integrated pest management for farmer's field schools and training of trainers. In *Area-wide Integrated Pest Management of Fruit Flies in South and Southeast Asia*. Bangkok: Asian Fruit Fly IPM Project.

Landis, D.A., Wratten, S.D. and Gurr, G.M. 2000. Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology*, 45: 175-201.

Lawson, A.E., McGuire, D.J., Yeates, D.K., Drew, R.A.I. and Clarke, A.R. 2003. *Dorsalis*: An interactive identification tool for fruit flies of the *Bactrocera dorsalis* complex. Griffith University, Brisbane, Australia (Multimedia CD-Rom).

Li, Z. 2016. On the way: A review on the prevention and control of fruit flies of economic importance in China. In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 31), Putrajaya, Malaysia. August 15-18, 2016.

Lieth, H. 1974. *Phenology and Seasonality Modeling*. New York: Springer Verlag.

Liu, Y.C and Huang, L.H. 1990. The oviposition preference of the oriental fruit fly, *Dacus dorsalis. Chinese Journal of Entomology*, 10(2): 159-168.

Liquido, N.J. 1993. Reduction of Oriental fruit fly (Diptera: Tephritidae) populations in papaya orchards by field sanitation. *Journal of Agriculture Entomology*, 10: 163–170.

Lux, S. A., Overholt, W. A. and Kimani, S. 1998. Economic role and distribution of fruit flies. In *ICIPE Annual Scientific Report (1995-1998)*, (pp. 29-30). ICIPE Press, Nairobi, Kenya.

Maia, H.N.M., Luiz, A.J.B. and Campanhola, C. 2000. Statistical inference on associated fertility life table parameters using jackknife technique: computational aspects. *Journal of Economic Entomology*, 93: 511-518.

Marwat N. K. and Baloch U. K. 1984. Methyl eugenol, a male fruit fly sex- attractant. *Pakistan Journal of Agricultural Research*, 7: 234.

Messina, F.J. and V.P. Jones. 1990. Relationship between fruit phenology and infestation by the apple maggot (Diptera: Tephritidae) in Utah. *Annals of the Entomological Society of America*, 83(4): 742-752.

Messina, F.J., Alston D.G. and Jones, V.P. 1991. Oviposition by the western cherry fruit fly (Diptera: Tephritidae) in relation to host development. *Journal of the Kansas Entomological Society*, 64(2): 197-208.

Metcalf, R.L. 1990. Chemical ecology of Dacinae fruit flies (Diptera: Tephritidae). *Entomological Society of America*, 83: 1017–1030.

Migani, V., Ekesi, S., Merkel, K. and Hoffmeister, T. 2017. At lunch with a killer: The effect of weaver ants on host-parasitoid interactions on mango. PLoS ONE 12(2): e0170101. https://doi.org/10.1371/journal.pone.0170101.

MINITAB®17 Statistical Software. 2017. Minitab Pty Ltd. Sydney NSW.

MOA. 2010. FAMA Anjur Fiesta Mangga. Retrieved 13 April 2014 from http://www.moa.gov.my/web/guest/fama_fiestamangga.

Mohamed, A. S. 2003. *Biology, Host and Host Plant Relationship of Two* Psyttalia *Species (Hymenoptera: Braconidae): Parasitoids for Fruit Flies (Diptera: Tephritidae) in Kenya*, PhD Thesis, University of Gezira.

Mohd Noor, M.A.Z., Nur Azura, A. and Muhamad, R. 2011. Growth and development of *Bactrocera papayae* (Drew & Hancock) feeding on guava fruits. *Australian Journal of Basic and Applied Sciences*, 5(8):111-117.

Nagle, M., Spreer, W., Neidhart, S., Sruamsiri, P., Carle, R. and Müller, J., 2005. Documentation of cavity closure by the seed in mango fruit (*Mangifera indica* L.). In: *Deutscher Tropentag*, Stuttgart-Hohenheim, Germany, October 11–13, 2005.

Nicácio, J.N., Uchôa, M.A., Faccenda, O., Guimarães, J.A. and Marinho, C.F. 2011. Native larval parasitoids (Hymenoptera) of frugivorous Tephritoidea (Diptera) in South Pantanal region, Brazil. *Florida Entomologist*, 94: 407–419.

Norain, N.F.A. 2010. Malaysian Researcher Advances Identification of Fruit flies. Retrieved 13 April 2014 from The Brunei Times: http://www.bt.com.bn/science-technology/2010/05/18/malaysian-researcher-advances-identification-fruit-flies.

Nurul Nisa, A.A. 2015. Perilaku oviposisi lalat buah *Bactrocera papayae* Drew & Hancock dan *B. carambolae* Drew & Hancock pada tingkat kematangan buah jambu biji (*Psidium guajava* L.), Master Thesis, Fakultas Pertanian, Institut Pertanian Bogor, Bogor, Indonesia.

Ooi, P.A.C. and Oon, W.S.H. 2016. Fruit fly complex of *Bactrocera dorsalis* (Hendel) from host plant, *Citrofortunella microcarpa* (Limau Kasturi). In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 69), Putrajaya, Malaysia. August 15-18, 2016.

Ovruski, S., Aluja, M., Sivinski, J. and Wharton, R. 2000. Hymenopteran parasitoids on fruit-infesting Tephritidae (Diptera) in Latin America and the southern United States: Diversity, distribution, taxonomic status and their use in fruit fly biological control. *Integrated Pest Management Review*, 5: 81-107.

Pankaj Sood, P., Yadav, D.S., Prabhakar, C.S. and Mehta, P.K. 2016. Fruit fly (Diptera: Tephritidae) Diversity and Management in North-Western Himalaya States of India. In In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 66), Putrajaya, Malaysia. August 15-18, 2016.

Papadopoulos, N.T., Katsoyannos, B.I. and Carey, J.R. 2002. Demographic parameters of the Mediterranean fruit fly (Diptera: Tephritidae) reared in apples. *Annals of the Entomological Society of America*, 95: 564–569.

Papaj D.R. and Messing R.H. 1996. Functional shifts in the use of parasitized hosts by a tephritid fly: The role of host quality. *Behaviour Ecology*, 7: 235–242.

Pauziah, M. and Wan Mohd Reza Ikhwan, W.H. 2014. Effects of 1-methylcyclopropene on quality of Chokanan mangoes stored at ambient. *Journal of Tropical Agriculture and Food Science*, 42: 37-49.

Pena, J.E., Mohyddin A.I. and Wysoki, M. 1998. A review of the pest management situation in mango agroecosystem. *Phytoparasitica*, 26(2): 129-148.

Pereira, R., Enkerlin, W., Vreysen, M.J.B. and Hendrichs, J. 2016. *Area-wide management of fruit flies.* In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 30), Putrajaya, Malaysia. August 15-18, 2016.

Piñero J.C., Mau, R. F. L. And Vargas, R. I. 2009. Managing Oriental fruit fly (Diptera: Tephritidae), with spinosad-based protein bait sprays and sanitation in papaya orchards in Hawaii. *Journal of Economic Entomology*, 102(3): 1123-1132.

Piñero, J.C., I. Jacome, R.I. Vargas and R.J. Prokopy. 2006. Response of female melon fly, Bactrocera cucurbitae, to host-associated visual and olfactory stimuli. Entomologia Experimentalis et Applicata, 121(3): 261-269.

Price, P.W., 1997. Insect Ecology. London: John Wiley and Sons Ltd.

Prokopy, R.J., Romig, M.C. and Drew, R.A.I. 1999. Facilitation in ovipositional behaviour of *Bactrocera tryoni* flies. *Journal of Insect Behaviour*, 12(6): 815-832.

Rajitha, A.R. and Viraktamath, S. 2005. Species diversity and relative abundance of fruit flies (Diptera: Tephritidae) in guava and mango orchards at Dharwad. In National Conference on Animal Taxonomy – Emerging Trends, Kochi.

Ratna, E.S., Nurul Nisa, A.A. and Riski, S. 2016. Oviposition behaviour of *Bactrocera carambolae* and *B. papayae* on guava fruit and hydrolyzate protein influenced their fitness. In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 75), Putrajaya, Malaysia. August 15-18, 2016.

Rattanapun, W. 2009. *Mango Varietal Preference and The Effect of Physiological Changes During Mango Ripening on Host Utilisation by* Bactrocera dorsalis *(Hendel) (Diptera: Tephritidae)*, PhD Thesis, Kasetsart University, Thailand.

Rattanapun, W., Amornsak, W. and Clarke, A. 2009. *Bactrocera dorsalis* preference for and performance on two mango varieties at three stages of ripeness. *Entomologia Experimentalis et Applicata*, 131: 243-253.

Rohani, I. 1986. Opiinae parasites associated with fruit flies in Malaysia. In M.Y. Hussein and A.G. Ibrahim (Ed.), *Proceedings of Biological Control in Tropics*, (Pp. 303-313), Universiti Pertanian Library Publication, Serdang, Selangor, Malaysia.

Romoser, W.S. and Stoffolano, J.G. 1998. *The Science of Entomology. Fourth Edition*. Boston, M.A.: Mc Graw-Hill.

Rousse, P., Harris, E.J. and Quilici, S. 2005. *Fopius arisanus*, an egg–pupal parasitoid of Tephritidae. Overview. *Biocontrol News and Information*, 26(2):59N-69N.

Royer, J. 2015. *Fruit Flies of Economic Importance Diagnostic Workshop – Identification of Key* Bactrocera *Pests*. State of Queensland: Department of Agriculture and Fisheries.

Rugman-Jones, P.F., J.G. Morse, and R. Stouthamer. 2009. Rapid molecular identification of armored scale insects (Hemiptera: Diaspididae) on Mexican 'Hass' avocado. *Journal of Economic Entomology*, 102:1948-1953.

Rwonushana, I., Ekesi, S., Gordon, I. and Ogol, C.K.P.O. 2008. Host plants and host plant preference studies for *Bactrocera invadens* (Diptera: Tephritidae) in Kenya, a new invasive fruit fly species in Africa. *Annual Entomology Society of America*, 101(2): 331-340.

Sane, V.A., A. Chourasia and P. Nath. 2005. Softening in mango (*Mangifera indica* cv. Dashehari) is correlated with the expression of an early ethylene responsive, ripening related expansin gene, *MiExpA1*. *Postharvest Biology and Technology*, 38(3): 223-230.

Sarker, D., Rahman, M.M. and Barman J.C. 2009. Efficacy of different bagging materials for the control of mango fruit fly. *Bangladesh Journal of Agricultural Research*, 34(1): 165-168.

Sarris A, 2003. Medium-term prospects for agricultural commodities: projections to the year 2010. In *Tropical Fruits,* (pp. 181).

Sarwar, M., Hamed, M., Yousaf, M. and Hussain, M. 2014. Monitoring of population dynamics and fruits infestation of tephritid fruit flies (Diptera: Tephritidae) in guava (*Psidium guajava* L.) orchard. *Research and Reviews: Journal of Agriculture and Allied Sciences,* 3(2): 36-40.

Satyanjai.Yadav, S. 2013. *Post-Harvest Profile of Mango*. Nagpur, India: Directorate of Marketing & Inspection, Branch Head Office.

Schowalter, T.D. 2016. *Insect Ecology: An Ecosystem Approach (Fourth Edition)*. UK: Elsevier.

Schutze, M.K., Aketarawong, N., Namornsak, W. et al. 2015. Synonymization of key pest species within the *Bactrocera dorsalis* species complex (Diptera: Tephritidae): taxonomic changes based on a review of 20 years of integrative morphological, molecular, cytogenetic, behavioural and chemoecological data. *Systematic Entomology*, 40: 456–471.

Serit, M. and Tan, K.H. 1990. Immature life table of natural population of *Dacus dorsalis* in a village ecosystem. *Crop Pest Mangement,* 36:305-309.

Singh, B.R. 1988. Significance of fruit flies in fruit and vegetable production in the Asia-Pasific region. In S. Vijayasegaran and A.G. Ibrahim (Eds.), *Proceedings of the First International Symposium on Fruit Flies in the Tropics,* Kuala Lumpur, Malaysia.

Southwood T.R.E. 1978: *Ecological Methods with Particular Reference to the Study of Insect Populations. 2nd Ed.* London: Chapman and Hall.

Speight, M. R., Hunter, M. D., and Watt, A. D. 2008. *Ecology of Insects: Concepts and Applications. (Second Edition)*. New York: Wiley-Blackwell.

Spreer, W. and Müller, J. 2011. Estimating the mass of mango fruit (*Mangifera indica*, cv. Chokanan) from its geometric dimensions by optical measurement. *Computers and Electronics in Agriculture,* 75: 125-131.

Stark, J.D., Vargas, R.I. and Miller, N.W. 2004. Toxicity of spinosad in protein bait to three economically important tephritid fruit fly species (Diptera: Tephritidae) and their parasitoids Hymenoptera: Braconidae). *Journal of Economic Entomology*, 97: 911–915.

Steck, G.J., F.E. Gilstrap, R.A. Wharton, and W.G. Hart. 1986. Braconid parasitoids of Tephritidae (Diptera) infesting coffee and other fruits in West-Central Africa. *Entomophaga*, 31: 59–67.

Stefan, J., Hau, A.M. and von Oppen, M. 2003. An analysis of the world market for mangoes and its importance for developing countries. In *Conference on International Agricultural Research for Development*. Deutscher Tropentag Göttingen, Germany.

Stibick, J.N.L. 2004. *Natural Enemies of True Fruit Flies (Tephritidae).* United States: Department of Agriculture.

Tan, K.H. 2000. Fruit flies (*Bactrocera* spp.) as pests and pollinators. *Sabah Society Journal*., 17:37-56.

Tan, Y.L. 2004. *Identification of* Bactrocera *Genus (Diptera: Tephritidae) via Molecular Marker*, Master of Science Thesis, Malaysia University of Science and Technology.

Tan, K.H. and Serit, M. 1994. Adult population dynamics of *Bactrocera dorsalis* (Diptera: Tephritidae) in relation to host phenology and weather in two village of Penang Island Malaysia. *Environmental Entomology*, 23: 267-275.

Tang, L.D., Ji, X.C., Han, Y., Fu, B.L. and Liu, K. 2015. Parasitism, emergence, and development of *Spalangia endius* (Hymenoptera: Pteromalidae) in pupae of different ages of *Bactrocera cucurbitae* (Diptera: Tephritidae). *Journal of Insect Science*, 15(1): 1-5.

Tanga, C.M., Ekesi, S., Govender, P., Nderitu, P.W. and Mohamed, S.A. 2016. Antagonistic interactions between the African weaver ant *Oecophylla longinoda* and the parasitoid *Anagyrus pseudococci* potentially limits suppression of the invasive mealybug *Rastrococcus iceryoides*. *Insects*, 7(1): doi:10.3390/insects7010001.

Tello, V., Díaz, L. and Sánchez, M. 2013. Side effects of the natural pesticide Spinosad (GF-120 Formulation) on *Eretmocerus paulistus* (Hymenoptera: Aphelinidae), a parasitoid of the whitefly *Aleurothrixus floccosus (Hemiptera: Aleyrodidae)*, under laboratory conditions. Cien. Inv. Agr., 40: 407-417.

Van Mele, P., Vayssières, J.F., Van Tellingen, E. and Vrolijks, J. 2007. Effects of an African weaver ant, *Oecophylla longinoda*, in controlling mango fruit flies (Diptera: Tephritidae) in Benin. *Journal of Economic Entomology*, 100(3):695-701.

Vargas, R.I. and Carey, J.R. 1990. Comparative survival and demographic statistics for wild oriental fruit fly, Mediterranean fruit fly, and melon fly (Diptera: Tephritidae) on papaya. *Journal of Economic Entomology*, 83: 1344-1349.

Vargas, R.I. and Nishida, T. 1985. Life history and demographic parameters of *Dacuslatifrons* (Diptera:Tephritidae). *Journal of Economic Entomology*, 78: l242-l244.

Vargas, R.I., Leblanc, L., Harris, E.J. and Manoukis, N.C. 2012. Regional suppression of *Bactrocera* fruit flies (Diptera: Tephritidae) in the pacific through biological control and prospects for future introductions into other areas of the world. *Insects,* 3: 727-742.

Vargas, R.I., Leblanc, L., Putoa, R. and Eitam, A. 2007. Impact of introduction of *Bactrocera dorsalis* (Diptera: Tephritidae) and classical biological control releases of *Fopius arisanus* (Hymenoptera: Braconidae) on economically important fruit flies in French Polynesia. *Journal of Economic Entomology*, 100(3): 670-679.

Vargas, R.I., Miyashita, D.H. and Nishida, T. 1984. Life history and demographic parameters of three laboratory reared tephritids (Diptera: Tephritidae). *Annals of the Entomological Society of America,* 77: 651-656.

Vargas, R.I., Piñero, J.C. and Leblanc, L. 2015. An overview of pest species of *Bactrocera* fruit flies (Diptera: Tephritidae) and the integration of biopesticides with other biological approaches for their management with a focus on the Pacific region. *Insects*, 6(2):297-318.

Vargas, R.I., Piñero, J.C., Mau, R.F.L., Stark, J.D., Hertlein, M., Mafra-Neto, A., Coler, R. and Getchell, A. 2009. Attraction and mortality of oriental fruit flies to SPLAT-MAT-methyl eugenol with spinosad. *Entomologia experimentalis et applicata,* 131(3): 286-293.

Vargas, R.I., Ramadan, M., Hussain, T. and Mochizuki, N. 2002. Comparative demography of six fruit fly (Diptera: Tephritidae) parasitoids (Hymenoptera: Braconidae). *Biological Control*, 25: 30-40.

Vargas, R.I., Stark, J.D., Kido, M.H., Ketter, H.M. and Whitehand, L.C. 2000a. Methyl eugenol and cue-lure traps for supresion of male oriental fruit flies and melon flies (Diptera) in Hawaii: effects of lure mixtures and weathering. *Journal of Economic Entomology*, 93(1): 81-87.

Vargas, R.I., Stark, J.D., Uchida, G. and Purcell, M. 1993. Opiine parasitoids (Hymenoptera, Braconidae) of Oriental fruit fly (Diptera, Tephritidae) on Kauai Island, Hawaii- Island wide relative abundance and parasitism rates in wild and orchard guava habitats. *Environmental Entomology,* 22: 246-253.

Vargas, R.I., Walsh, W.A. and Nishida, T. 1995. Colonization of newly planted coffee fields: dominance of Mediterranean fruit fly over Oriental fruit fly (Diptera: Tephritidae**).** *Journal of Economic Entomology*, 88(3): 620-627.

Vargas, R.I., Walsh, W.A., Kanehisa, D. Stark, J.D. and Nishida, T. 2000b. Ecology and population biology comparative demography of three Hawaiian fruit flies (Diptera: Tephritidae) at alternating temperatures. *Annals of the Entomological Society of America,* 93: 75-81.

Vásquez-Caicedo, A.L., Neidhart, S., Pathomrungsiyounggul, P., Wiriyacharee, P., Chattrakul, A., Sruamsiri, P., Manochai, P., Bangerth, F. and Carle, R. 2002. Physical, chemical and sensory properties of nine Thai mango cultivars and evaluation of their technological and nutritional potential. In *International Symposium Sustaining Food Security and Managing Natural Resources in Southeast Asia - Challenges for the 21st century*, Chiang Mai, Thailand, Jan 8 – 11, 2002.

Vayssières, J.F., Korie, S. and Ayegnon, D. 2009. Correlation of fruit fly (Diptera Tephritidae) infestation of major mango cultivars in Borgou (Benin) with abiotic and biotic factors and assessment of damage. *Crop Protection*, 28: 477–488.

Vayssières, J.F., Adandonon, A., N'Diaye, O., Sinzogan, A., Kooymann, C., Badji, K., Rey, J.Y. and Wharton, R.A. 2012. Native parasitoids associated with fruit flies (Diptera: Tephritidae) in cultivated and wild fruit crops in Casamance, Senegal. *African Entomology*, 20: 308-315.

Vijaysegaran, S. 1984. The occurrence of Oriental fruit fly on starfruit in Serdang and the status of its parasitoids. *Journal of Plant Protection in the Tropics*, 1(2): 93-98.

Vijaysegaran, S. and Mohd, S.O. 1991. Fruit flies in Peninsular Malaysia: Their economic importance and control strategies. In K. Kawasaki, O. Iwahashi and K.Y. Kaneshiro (Ed.), *Proceeding of The International Symposium on The Biology and Control of Fruit Flies*, Okinawa, Japan, Sept. 2-4, 1991.

Okinawa, Japan, 1991.Walker, G.P., Tora Vueti, E., Hamacek, E.L., and A.J. Allwood. 1997. Laboratory-rearing techniques for Tephritid fruit flies in the South Pacific. In: Allwood, A.J., Drew, R.A.I. *Fruit fly Management in the Pacific*, (pp. 145-152), ACIAR Proceedings No. 76.

Wang, X.G. and Keller, M.A. 2002. A comparison of host searching efficiency of the two larva parasitoids of *Plutella xylostella*. *Ecological Entomology*, 27: 105-114.

Wang, X.G., Johnson, M.W., Daane, K.M. and Opp, S. 2009. Combined effects of heat stress and food supply on flight performance of olive fruit fly (Diptera: Tephritidae). *Annals of the Entomological Society of America*, 102(4):727-734.

Wee, S.L. and Tan, K.H. 2000. Sexual maturity and intraspecific mating success of the two siblings of *Bactrocera dorsalis* complex. *Entomologia Experimentalis et Applicata*, 94: 133-139.

Wee, S.L. and Tan, K.H. 2005. Female sexual response to male rectal volatile constituents in the fruit fly, *Bactrocera carambolae* (Diptera: Tephritidae). *Applied Entomology and Zoology*, 40: 365–372.

Wee, S.L., Hee, A.K.W., Nishida, R. and Tan, K.H. 2016. Synonymization of four invasive species of *Bactrocera dorsalis* complex: An insight from fruit fly innate behaviour of attraction and ingestion on male lure. In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 56), Putrajaya, Malaysia. August 15-18, 2016.

Wei, D., Feng, Y.C, Wei, D.D., Yuan, G.R., Dou, W and Wang, J.J. 2015. Female remating inhibition and fitness of *Bactrocera dorsalis* (Diptera: Tephritidae) associated with male accessory glands. *Florida Entomologist*, 98:52-58.

Wharton, R. A. 1987. Changes in nomenclature and classification of some opiine Braconidae (Hymenoptera). *Proceedings of the Entomological Society of Washington*, 89:61-73

Wharton, R. A. and Gilstrap, F. E. 1983. Key to and status of opiine braconid (Hymenoptera) parasitoids used in biological control of *Ceratitis* and *Dacus* s. l. (Diptera: Tephritidae). *Annals of the Entomological Society of America*, 76:721-742.

Wharton, R.A. and Yoder, M.J. 2014. Parasitoids of Fruit-infesting Tephritidae. Retrieved 13 April 2014 from http://www.paroffit.org.

White, I.M. 2000. Morphological features of the Tribe Dacini (Dacinae): Their significance to behaviour and classification. In M. Aluja and A.L. Norrbom (Eds.), *Fruit Flies (Tephritidae): Phylogeny and Evolution of Behaviour*, (pp. 505-841), CRC Press, Canberra.

White, I.M. and Elson-Harris, M. 1992. *Fruit Flies of Economic Significance: Their Identification and Bionomics*. CABI, Wallingford, UK.

Win, S.S., Muhamad, R., Ahmad, Z.A.M. and Adam N.A. 2009. Life table and population parameter of *Sogatella furcifera* (Horvath) (Homoptera: Delphacidae) on rice. *Journal of Biological Sciences*, 9: 904–908.

Yashoda, H.M., Prabha, T.N. and Tharanathan, R.N. 2007. Mango ripening – Role of carbohydrases in tissue softening. *Food Chemistry*, 102(3): 691-698.

Yin, N.Y., Theint, Y.Y., Myaing, K.M., Oo, S.S., Khin, O., Yin, M., Aye, M.T., Hlaing, H.H. and Swe, K. 2016. Population dynamics of Oriental fruit fly *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) in Yezin, Myanmar. In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 64), Putrajaya, Malaysia, August 15-18, 2016.

Yong H.S. and Khoo, S.G. 1994. Current research on tropical fruit flies and their management. In *Proceedings of the Symposium on Tropical Fruit Flies. Kuala Lumpur, Malaysia*. May 18-20, 1992.

Yu, W.H. 2013. Host Selection and Olfactory Learning Behaviour of *Bactrocera dorsalis* to Several Host Fruit, MSc, Thesis, Southwest University.

Zainal Abidin, M. and Tengku Ab Malik, T.M. 1996. Pemetikan hasil dan pengendalian lepas tuai. In T.M. Tengku Ab. Malik, S. Ahmad Tarmizi, M. Zainal Abidin, and C.S. Teng, (Eds.), *Panduan Penanaman Mangga* (pp. 11 – 16), Serdang: MARDI.

Zamek, A.L., Spinner, J.E., Micallef, J.L., Gurr, G.M. and Reynolds, O.L. 2012. Parasitoids of Queensland fruit fly *Bactrocera tryoni* in Australia and prospects for improved biological control. *Insects*, 3:1056-1083.

Zulida, S. and Tati, S.S. 2016. Fruit fly diversity and its parasitoid in coffee orchard at Takengon-Central Aceh, Indonesia. In *First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 2016*, (p. 87), Putrajaya, Malaysia, August 15-18, 2016.

LIST OF PUBLICATIONS

Journals

Salmah Mohamed, Nur Azura Adam, Rita Muhamad, Lau Wei Hong and Hamdan Ahmad. 2017. Ovipositional preference of Oriental fruit fly *Bactrocera dorsalis* Hendel (Diptera: Tephritidae) on mango (*Mangifera indica* L. cv. Chokanan). *Australian Journal of Basic and Applied Sciences*, 11(13): 14-19.

Salmah, M., Adam, N.A., Muhamad, R., Lau, W.H. and Ahmad, H. 2017. Infestation of fruit fly, *Bactrocera* (Diptera: Tephritidae) on mango (*Mangifera indica* L.) in Peninsular Malaysia. *Journal of Fundamental and Applied Sciences*, 9(2S): 799-812.

Abstracts/Proceedings

Salmah, M, Nur Azura, A., Rita, M., Lau, W.H., Marina, R. and Ahmad, H. 2017. Effect of different mango ripening stages on oviposition behaviour of the Oriental fruit fly, *Bactrocera dorsalis* Hendel (Diptera: Tephritidae). In *ISSAAS 2017 International Congress and General Meeting, Green Agriculture in Southeast Asia: Theories and Practices*, Vietnam National University of Agriculture, Hanoi, Vietnam, October 14 – 17, 2017.

Salmah, M, Nur Azura, A., Rita, M., Lau, W.H., Marina, R. and Ahmad, H. 2016. Oviposition Preference of Asian Papaya Fruit Fly *Bactrocera papayae* Drew & Hancock (Diptera: Tephritidae) on Different Ripening Stages of Mango, *Mangifera indica* L. In *Proceedings of 9th International Conference on Plant Protection in the Tropics*, (p.58), Hilton Hotel Kuching, Sarawak, Malaysia, August 3-5, 2016.

Salmah Mohamed, Nur Azura Adam, Rita Muhamad, Lau Wei Hong, Marina Roseli and Hamdan Ahmad. 2015. Population fluctuation and abundance of fruit flies, *Bactrocera* (Diptera: Tephritidae) in mango orchards. In Lakatos, A. and B. Topcuoglu (Eds.), *2nd International Conference on Agriculture, Environment and Biological Sciences (ICAEBS'15)*, (p. 73), IBIS Hotel Kuta, Bali, Indonesia, August 16-17, 2015.

Salmah, M, Nur Azura, A., Rita, M., Lau, W.H., Marina, R. and Ahmad, H. 2014. Fruit flies infestation on mango (*Mangifera indica* L.) and the associated parasitoids in Peninsular Malaysia. In *2014 ISSAAS International Congress and General Meeting*, (p. 45), Tokyo University of Agriculture, Tokyo, Japan, November 8-10, 2014.

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