UNIVERSITI PUTRA MALAYSIA

POPULATION ECOLOGY, REPRODUCTIVE BEHAVIOUR AND FEEDING HABIT OF *Helopeltis antonii* Signoret ON CASHEW (*Anacardium occidentale* L.) PLANTS

SISWANTO

FP 2007 28

POPULATION ECOLOGY, REPRODUCTIVE BEHAVIOUR AND FEEDING HABIT OF *Helopeltis antonii* Signoret ON CASHEW (*Anacardium occidentale* L.) PLANTS

By

SISWANTO

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

November 2007

DEDICATION

I dedicate this thesis to my wife Yuyun Nurohmah and children Arina Yusianti, Naufal Yuwanto and Hanifa Triyuwanti for their patient and support during my study in Malaysia.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

POPULATION ECOLOGY, REPRODUCTIVE BEHAVIOUR AND FEEDING HABIT OF *Helopeltis antonii* Signoret ON CASHEW (*Anacardium occidentale* L.) PLANTS

By

SISWANTO

November 2007

Chairman : Associate Professor Rita Muhamad, PhD

Faculty : Agriculture

Helopeltis antonii Signoret (Hemiptera: Miridae) is well known as one of the important pest of the cashew plant, *Anacardium occidentale* L. Both the nymph and adult stages feed on young and succulent parts of the plant such as the young leaves, shoots, inflorescences and fruits causing death of those parts. This research was conducted with the objectives to establish age-specific life table, to investigate some biological aspects of *H. antonii*, to study the effect of damage caused by *H. antonii* on shoot, inflorescence and fruit, and also to study some ecological aspects related to *H. antonii* population in the field. The studies were conducted in pesticide-free cashew plantation belonging to smallholders and also in the laboratory of Estate Service of Wonogiri Regency in Ngadirojo district, Wonogiri, Central Java, Indonesia from March 2004 to May 2006. The life table of *H. antonii* revealed a high hatchability but a bulk mortality occurred at early nymphal stages and relatively fewer death during the adult stage. The contribution of the female towards female births (m_x) was at its maximum on the 16th day of oviposition.

The population parameters of *H. antonii* fed cashew showed that the intrinsic rate of natural increase (r_m) was 0.092/female/day, the net reproductive rate (R_o) was 12.84, the capacity for increase (r_c) was 0.090, the finate rate for increase (λ) was 1.097 female/day, and mean generation time (T) was 27.70 days with the population doubling (DT) every 7.52 days. Biological studies revealed that *H. antonii* feeding lesions developed faster on inflorescence and shoot compared to fruits. The lesions on shoot and inflorescence produced depressed and wrinkled surface which then dried up within four days. Meanwhile it caused depression on apple and flattened the surface on nut. Feeding preference with no choice experiment suggested that *H. antonii* preferred to feed on shoot and young fruits rather than the inflorescence and older fruits. Results in the choice experiment suggested that *H. antonii* preferred to feed on shoot compared to inflorescence and fruits. The female preferred to oviposit on inflorescence compared to shoot and fruit. The premating period for both male and female *H. antonii* was one day. Sex ratio of females to males did not influence the number of eggs laid. However, overcrowded males seemed to influence female longevity. The frequency of matings did not influence the number of eggs laid and the hatchability, eventhough, females which mated more than once tended to lay more eggs. Damage assessment study revealed that the percentage of shoot, inflorescence and fruit death increased with the number of lesions. Apart from the number of lesions, position of lesions and stage (age of part attacked) also affected damage intensity, particularly on inflorescence and fruits. Small or young fruits were not able to tolerate heavy damage by *H. antonii*, whereas older fruits were relatively not affected by the damage. Field

experiments indicated that cashew fruit particularly small and medium sized were more susceptible to *H. antonii* feeding lesions compared to inflorescences. The infestation of *H. antonii* was linked to the phenology of the cashew plants. Higher percentage of inflorescence death occurred in the second phase of flowering season, meanwhile higher percentage of fruit death occurred in the third flowering season. Studies on the population fluctuation and dispersion of *H. antonii* in cashew plantation indicated that the fluctuation in the population of *H. antonii* was cyclical with the population peaking around July when cashew shoots and inflorescences were abundant. The population began to increase just after the rainfall season stopped and reached the peak three months later when rainfall was intermittent low. Number of shoots and inflorescences of cashew plants had significant influence on the number of *H. antonii*. The trend of population abundance was not directly associated with the rainfall, but rainfall influenced the physiology of the cashew plant to produced flushes/shoots and inflorescences. Distribution analysis using various indices of dispersion and regression models indicated an aggregated distribution when the population was high during flushing-flowering season of cashew plants and a regular or random distribution when the population was low during post-flowering season.

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

EKOLOGI POPULASI, PERLAKUAN PEMBIAKAN DAN TABIAT PEMAKANAN *Helopeltis antonii* Signoret KE ATAS POKOK GAJUS (*Anacardium occidentale* L.)

Oleh

SISWANTO

2007

Pengerusi : Profesor Madya Rita Muhamad, PhD

Fakulti : Pertanian

Helopeltis antonii Signoret di kenali sebagai salah satu serangga perosak pada pokok gajus, *Anacardium occidentale* L. Kedua-dua nimfa dan dewasa memakan pada bahagian muda dan bahagian sukulen seperti daun muda, pucuk, infloresens dan buah yang menyebabkan kematian pada bahagian ini. Penyelidikan ini dijalankan dengan beberapa objektif iaitu membina jadual hidup umur-spesifik, untuk mengkaji aspek ekologi *H. antonii*, untuk mengkaji kesan kerosakan yang disebabkan oleh *H. antonii* ke atas pucuk, infloresens dan buah, dan juga mengkaji aspek ekologi berhubung dengan populasi *H. antonii* di lapangan. Kajian ini dijalankan di kawasan pemilik kecil ladang pokok gajus yang bebas dari pestisid dan di makmal Dinas Perkebunan Wonogiri di daerah Ngadirojo, Wonogiri, Jawa Tengah, Indonesia dari Mac 2004 sehingga Mei 2006. Jadual hidup *H. antonii* menunjukkan kebolehan menetas yang tinggi tetapi kebanyakan mati pada tahap awal peringkat nimfa dan relatif rendah pada peringkat dewasa. Sumbangan betina terhadap kelahiran betina (m_x) adalah pada kadar

maksimum pada hari ke 16 peneluran. Parameter populasi *H. antonii* yang memakan pokok gajus menunjukkan pertambahan semulajadi kadar intrisik (r_m) adalah 0.092/betina/hari, kadar penghasilan bersih (Ro) 12.84, kapasiti pertambahan adalah 0.090 dan pertambahan kadar finate (λ) adalah 1.097 betina/hari, dan min tempoh generasi (T) adalah 27.70 hari, dan populasi akan berganda setiap 7.52 hari. Kajian biologi menunjukkan pemakanan kecederaan berkembang dengan cepat pada infloresens dan pucuk berbanding buah. Kecederaan pada pucuk dan infloresens menyebabkan tekanan dan permukaan berkedut dan kering dalam masa 4 hari, manakala ianya menyebabkan tekanan pada epal dan permukaan rata pada kacang. Pemilihan pemakanan dengan eksperimen tiada pilihan menunjukkan yang *H. antonii* lebih memilih memakan bahagian pucuk dan buah muda berbanding infloresens dan buah lebih tua. Daripada kajian eksperimen dengan pilihan menunjukkan *H. antonii* lebih memilih memakan bahagian pucuk berbanding inflorescences dan buah. Betina juga lebih memilih untuk bertelur pada infloresens berbanding pada pucuk dan buah. Tempoh pramatang bagi betina dan jantan *H. antonii* adalah 1 hari. Nisbah jantina betina kepada jantan tidak dipengaruhi bilangan telur yang dikeluarkan. Walaubagaimanapun, kelimpahan jantan mungkin mempengaruhi jangkahidup betina. Kekerapan persenyawaan tidak mempengaruhi bilangan telur yang dihasilkan dan yang menetas, walaubagaimanapun betina yang disenyawakan lebih cenderung menghasilkan telur. Kajian penilaian kerosakan menunjukkan peratus kematian pada pucuk, infloresens dan buah bertambah dengan bilangan kecederaan. Selain daripada bilangan kecederaan, kedudukan kecederaan dan peringkat (umur bahagian yang

diserang) juga mempengaruhi intensiti kerosakan terutama pada bahagian infloresens dan buah. Buah kecil dan muda tidak dapat bertoleransi dengan kerosakan yang banyak oleh *H. antonii*, manakala buah tua tidak dipengaruhi oleh kerosakan tersebut. Kajian lapangan menunjukkan buah gajus terutama size kecil dan ménengah adalah lebih terdedah kepada kecederaan pemakanan *H. antonii* berbanding dengan infloresens. Serangan *H. antonii* adalah berkait rapat dengan fenologi pokok gajus. Peratus kematian infloresens tinggi pada musim kedua berbunga, manakala peratus kematian buah tinggi pada musim ketiga berbunga. Kajian fluktuasi dan taburan populasi *H. antonii* berkitar dengan kemuncak populasi pada sekitar Julai apabila bilangan infloresens dan buah gajus melimpah. Populasi mulai bertambah selepas musim hujan berhenti dan mencapai kemuncak tiga bulan kemudian apabila sela hujan rendah. Bilangan pucuk dan infloresens pokok gajus sangat signifikan mempengaruhi ke atas bilangan *H. antonii*. Corak kelimpahan populasi tidak berhubung langsung dengan jumlah hujan, tetapi jumlah hujan mempengaruhi fisiologi pokok gajus untuk menghasilkan pucuk dan infloresen. Analisis taburan menggunakan indeks taburan model regressi menunjukkan taburan aggregasi apabila populasi tinggi pada musim berbunga lebat pokok gajus dan biasa atau random apabila populasi rendah pada akhir musim berbunga.

ACKNOWLEDGEMENTS

All praises and thanks are to Allah SWT., the Almighty, for giving me guidance, strength and patience in finishing my study. The author invokes Allah's blessings of peace for the Holy Prophet Mohammad, the messenger of Allah.

First of all I would like to express my sincerest thanks and appreciation to Associate Professor Dr. Rita Muhamad, Chairman of my supervisory committee for her encouragement, familiar support, invaluable advice and intellectual guidance during my study, preparation of the research proposal, in the conduct of the research and in the writing up this thesis. Grateful thanks are also due to my supervisory committee member, Professor Dr. Dzolkifli Omar and Dr. Elna Karmawati for their constructive comments, advice and help throughout my study and encouragement during the completion of this thesis.

My sincere thanks to the Director General of the Indonesian Agency for Agricultural Research and Development (IAARD), Dr. Ir. Ahmad Suryana, MS; The Chair of the Committee of Human Resources Development, Dr. Haryono; Director of Indonesian Center for Estate Crops Research and Development, Dr. Bambang Prastowo and the former chair, Dr. Hasnam; Director of Indonesian Medicinal and Aromatic Crops Research Institute, Bogor, Dr. Muhamad Syakir and the former Director of Indonesian Spices

and Medicinal Crops Research Institute, Bogor, Dr. Molide Rizal for giving me the opportunity to take up PhD program.

My gratitude also to Dr. Darmono Taniwiryono, Manager of Integrated Pest Management for Smallholder Estate Crops Project (IPM-SECP), for the opportunity and financial support to pursue a PhD study in Univeriti Putra Malaysia. I would also to thank to all IPM Project staff, especially Mrs. Ina Purwantini, the financial officer, for their help with financial arrangements.

I would like to thank the Director of Wonogiri Estate Service and Staff for providing laboratory for my research; cashew farmers in Ngadirojo district, Wonogiri for permission to use their cashew plots for my experiments, especially to Mr. Supardi in Pondok village, Ngadirojo district . Thanks are also extended to Mr. Ahyar, Mr. Cucu Sukmana, Mr. Endang Sugandi and Mr. Eko Tri Wahyono for their assistance in collecting data for the experiments. Without their assistance I would have difficulties conducting the experiments.

I also would like to thank to my housemates especially to Antario Dikin and Taufik Ratule for sharing the daily joy together during my stay in Malaysia.

Finally, my special thanks to my wife, Yuyun Nurohmah and my children, Arina Yusianti, Naufal Yuwanto and Hanifa Triyuwanti for their patience, understanding, support and inspiration given to me during the period of my study in Malaysia.

I certify that an Examination Committee met on 16th November 2007 to conduct the final examination of Siswanto on his degree in Doctor of Philosophy thesis entitled "Population ecology, reproductive behaviour and feeding habit of *Helopeltis antonii* Signoret on cashew (*Anacardium occidentale* L.) plants" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the degree of Doctor of Philosophy.

Members of the Examination Committee are as follows:

Kamaruzaman Sijam, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Yusof Ibrahim, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Rohani Ibrahim, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Idris Abd. Ghani, PhD
Professor
Faculty of Science and Technology
Universiti Kebangsaan Malaysia
(External Examiner)

HASANAH MOHD. GHAZALI, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirements for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follow:

Rita Muhamad, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Dzolkifli Omar, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Elna Karmawati, PhD
Senior Research Officer
Indonesian Center for Estate Crops Research and Development, Bogor, Indonesia
(Member)

_____
AINI IDERIS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 21 February 2008

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

Siswanto

Date: 17 - 12 - 2007

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDIX TABLES