UNIVERSITI PUTRA MALAYSIA

ECOLOGICAL CHARACTERISTICS OF APHIDOPHAGOUS *MENOCHILUS SEXMACULATUS* FABRICIUS AND ITS PERFORMANCE AGAINST *APHIS GOSSYPII* GLOVER

FRANSISCUS XAVERIUS WAGIMAN ADISUBROTO

FP 1996 16

ECOLOGICAL CHARACTERISTICS OF APHIDOPHAGOUS *MENOCHILUS SEXMACULATUS* FABRICIUS AND ITS PERFORMANCE AGAINST *APHIS GOSSYPII* GLOVER

By

FRANSISCUS XAVERIUS WAGIMAN ADISUBROTO

Dissertation Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in the Faculty of Agriculture,
Universiti Pertanian Malaysia

October, 1996

ACKNOWLEDGEMENTS

I wish to express my deep appreciation to members of my supervisory committee, Professor Dr. Mohd. Yusof Hussein (Chairman), Associate Professor Dr. Ahmad Said Sajap, Dr. Rita Muhamad and Dr. Azhar Ismail (MARDI), for their untiring and continued guidance, assistance, critical discussions and encouragement in the preparation of this dissertation.

I would like to thank Head of the Department of Plant Protection and Dean of the Faculty of Agriculture, Universiti Pertanian Malaysia (UPM), for granting permission to use facilities for carrying out laboratory and field experiments.

My special thank to members of the Entomological Laboratory, Department of Plant Protection, Faculty of Agriculture, UPM, particularly Mr. Hassanjaya Yahya, for his technical assistance during the conduct of the laboratory and field experiments.

I am indebted to the staff of the Experimental Field II Section, UPM, particularly Mr. Sahrir, for his technical assistance during the conduct of the field experiment.

The help and critical views of Associate Professor Dr. Yusof Ibrahim, Department of Plant Protection, UPM, is gratefully acknowledged.

Thanks are due to my friends and fellow graduate students, UPM, for their co-operation and discussion throughout my study period.

I am extremely grateful to the Dean of Faculty of Agriculture, Universitas Gadjah Mada (UGM), Yogyakarta, Indonesia, for his support and the Rector of UGM for granting the study leave.

I wish to thank the SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) for awarding the scholarship for my study.

To my wife, Lilis, and my children - Agung, Beni, Candra, I thank them for their love and encouragement throughout my stay in Malaysia.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure | Page

LIST OF PLATES

GLOSSARY AND ABBREVIATIONS

AG	: *Aphis gossypii* Glover
ANOVA	: Analysis of variance
aggregation	: coming together of coccinelid or aphid into a group in plants
CRD	: completely randomised design
cohort	: an initial number or unit of individual insects used in the study on life table in which its development is recorded from birth until the last member is dead.
distribution	: the position, arrangement, or frequency of occurrence (as of the members of a group) over an area or throughout a space or unit of time
DAT	: days after transplanting
DT	: doubling time
efficiency	: effectiveness of the predator in affecting coexistence of the prey.
fecundity	: a measure of the total egg production by a female (Southwood, 1978).
fertility	: the number of viable eggs laid by a female (Southwood, 1978).
functional response	: the form of an increasing number of prey eaten per predator as prey density increases, at least up to some limiting value representing maximum prey consumption within a prescribed time.
IPM	: Integrated Pest Management
L:D	: Light:Dark period
life cycle	: total number of days of immature stadia; egg, larva and pupa (for MS) or nymphal instars (for AG).
life table	: tabulation presenting complete data on the mortality and fecundity schedule of a cohort.
maximum prey requirement	: maximum prey eaten per day by the predator as indicator of voracity.

minimum prey requirement	: least number of prey required by the predator for life maintenance.
MS	: *Menochilus sexmaculatus* Fabricius
numerical response	: the increase in the numbers of predators as prey numbers increase.
optimum prey requirement	: least number of prey required by the predator to produce eggs.
performance	: attribute of the predator representing its ability to find and consume prey, suppress and keep prey density at levels that will not cause economic crop damage.
postreproduction period	: period of time (days) between the last time to produce eggs or new progenies and die.
preference	: choose the better prey than another represented by the deviation of the proportion of the prey attacked from the proportion available in the environment.
prereproduction period	: period of time (days) between emerging from pupa and the first time laying eggs.
prudent predator	: a character of predator to obtain its living needs accurately and judiciously
reproduction period	: period of time (days) to produce eggs or new progenies.
RH	: relative humidity
TIES	: third instar equivalents
T	: generation time
UPM	: Universiti Pertanian Malaysia

Abstract of dissertation submitted to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy.

ECOLOGICAL CHARACTERISTICS OF APHIDOPHAGOUS *MENOCHILUS SEXMACULATUS* FABRICIUS AND ITS PERFORMANCE AGAINST *APHIS GOSSYPII* GLOVER

By

FRANSISCUS XAVERIUS WAGIMAN ADISUBROTO

October, 1996

Chairman: Professor Mohd. Yusof Hussein, Ph.D.

Faculty : Agriculture

The chilli aphid, *Aphis gossypii* Glover (Homoptera: Aphididae) (here after abbreviated as AG), is vector of the chilli veinal mottle virus (CVMV) and is a main pest of chilli in Malaysia. The aphidophagous *Menochilus sexmaculatus* Fabricius (Coleoptera: Coccinellidae) (here after abbreviated as MS) is a well known predator of the aphid and hereby its ecological characteristics and predatory performance were assessed.

In nature, MS maintains its population on aphids of corn, beans, sambau weed and other plants. The predator searched its prey in random manner and tended to aggregate in high prey density. Both prey and predator were distributed

in a clumped pattern. Larval and adult MS showed no preference for any prey stages and prey species. However, there was a weak preference for AG over *Aphis craccivora* Koch.

MS was very voracious; the larva (1^{st}, 2^{nd}, 3^{rd} and 4^{th} instar) and adult consumed 8, 43, 46, 125 and 275 TIES of AG per day, respectively. The minimum prey requirement for oviposition was 50 TIES per day. The adult survived well when supplied with 10 TIES per day. The average fecundity was 378 to 745 eggs/♀, depending on aphid prey species (*A. craccivora* and *Hysteroneura setariae* (Thos.)). The predator numbers increased at the rate (r_m) of 0.1663 to 0.2116, while a higher r_m for the prey, AG, was calculated to be 0.4097 to 0.4645.

The predator exhibited a delayed density-dependent relationship with the prey as indicated by a strong functional response of Holling's Type II and a direct numerical response to AG. In the field cages, MS was able to eliminate its prey (AG) population within nine days given the initial ratio (mated female MS : AG) of 1:6,400. In the open field, AG population was suppressed completely within three weeks given the ratio (predator : prey) of 1:50. Results of the study may contribute in developing biological control programme of aphid vector in Malaysia and other countries where the MS is found.

Abstrak disertasi yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi keperluan untuk mendapatkan ijazah Doktor Falsafah.

CIRI-CIRI EKOLOGI *MENOCHILUS SEXMACULATUS* FABRICIUS AFIDOFAGUS DAN PRESTASINYA TERHADAP *APHIS GOSSYPII* GLOVER

Oleh

FRANSISCUS XAVERIUS WAGIMAN ADISUBROTO

Oktober, 1996

Pengerusi: Professor Mohd. Yusof Hussein, Ph.D.

Fakulti : Pertanian

Afid cili, *Aphis gossypii* Glover (Homoptera: Aphididae) (selanjutnya disingkat sebagai AG) adalah vektor kepada virus cili yang dinamakan dengan CVMV dan merupakan perosak utama tanaman cili di Malaysia. Serangga afidofagus, *Menochilus sexmaculatus* Fabricius (Coleoptera: Coccinellidae) (selanjutnya disingkat sebagai MS) amat terkenal sebagai pemangsa afid tersebut dan di sini ciri-ciri ekologi serta prestasi pemangsaanya telah dinilai.

Dalam alam semula jadi, populasi MS bergantung hidup pada afid jagung, kekacang, rumpai sambau dan tumbuh-tumbuhan lain. MS mencari mangsa secara rawak dan cenderung berkumpul pada populasi mangsa yang tinggi. Kedua-dua mangsa dan pemangsa tersebar secara berkelompok. Larva dan dewasa MS tidak memilih mana-mana peringkat mangsa dan species afid. Walau

bagaimanapun AG lebih digemari daripada *Rhopalosiphum maidis* (Fitch.) dan *Aphis craccivora* Koch.

MS didapati sangat rakus; larva (instar 1, 2, 3 dan 4) dan peringkat dewasa memakan AG sebanyak 8, 43, 46, 125 dan 275 TIES (setara instar 3) setiap hari. Untuk bertelur MS memerlukan jumlah minimum mangsa sebanyak 50 TIES setiap hari. MS dewasa hidup selesa dengan memakan 10 TIES per hari. Min kesuburan MS adalah antara 378 hingga 745 biji telur per betina, bergantung kepada species afid yang dimakan (*A. craccivora* dan *Hysteroneura setariae* (Thos.)). Bilangan pemangsa meningkat dengan kadar pertumbuhan (r_m) 0.1663 hingga 0.2116, manakala kadar pertumbuhan yang lebih tinggi untuk mangsa, AG, telah dianggarkan setinggi 0.4097 hingga 0.4645.

MS telah menunjukkan hubungan kepadatan tertakluk terlewat dengan mangsanya berdasarkan kepada respon fungsian Holling jenis II yang kuat dan respon numerik langsung terhadap AG. Di dalam sangkar, MS mampu mengawal populasi AG dalam masa sembilan hari pada nisbah awalan (MS betina yang sudah mengawan : AG) 1:6,400. Di lapangan, populasi AG dikawal sepenuhnya oleh MS dalam masa tiga minggu pada nisbah (pemangsa : mangsa) 1:50. Hasil penyelidikan ini boleh memberi sumbangan kepada perkembangan program kawalan biologi terhadap vektor afid di Malaysia dan di negara lain dimana MS didapati.

CHAPTER I

INTRODUCTION

Aphids are among the most damaging insect pests of vegetable crops. They cause economic crop loss by directly sucking sap from the plants and indirectly transmitting plant viruses. An aphid species, *Aphis gossypii* Glover (Homoptera: Aphididae) (hereafter referred to as AG; Plate 1), is a vector of more than 50 plant viruses (Blackman and Eastop, 1989). AG efficiently transmits non-persistent chilli veinal mottle virus (CVMV) (Ong et al., 1978; Lee et al., 1994) in the nursery and in the field. CVMV is among the most important constraints of chilli production in Malaysia (Syed and Loke, 1995) and was known to significantly reduce the chilli yield. The yield reduction may reach 60% if plants were infected at the early stage of growth (Ong et al., 1980).

The viral disease of crop plants may be controlled indirectly by controlling the vector. Under natural situation the vector populations are normally controlled by the natural enemies especially by polyphagous predators such as the ladybird beetle. The important role of the ladybird beetle as predators of aphids is well known since the mid-19th century (Whitcomb, 1981). Among the ladybird beetles *Menochilus sexmaculatus* Fabricius (Coleoptera: Coccinellidae) (hereafter