



UNIVERSITI PUTRA MALAYSIA

**BEHAVIOURAL RESPONSES OF TRICHOGRAMMA PAPILIONIS
NAGARKATTI, EGG PARASITOID OF MAIZE BORER, OSTRINIA
FURNACALIS (GUEN.) TO SEMIOCHEMICALS FROM MAIZE PLANT
AND SELECTED WEEDS**

SARIPAH ULPAH.

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MAIZE PLANT AND SELECTED WEEDS**

**By
SARIPAH ULPAH**

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

February 2006



I dedicate this work to all of my big family

ESPECIALLY

my beloved husband and my kids

for your prayers, love and understanding



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

**BEHAVIOURAL RESPONSES OF *TRICHOGRAMMA PAPILIONIS*
NAGARKATTI, EGG PARASITOID OF MAIZE BORER, *OSTRINIA*
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February 2006

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Faculty : Agriculture

Manipulation of parasitoid behaviour for the purposes of habitat location and host finding could optimise the utilisation of biological control agents in pest management. In order to be able to do so, factors that elicit such behavioural responses of the parasitoid need to be elucidated. As such, members of the first trophic level, i.e maize and associated weeds, were investigated for possible semiochemicals by determining their attractancy, arrestant and activation effects of the plant chemicals to the third trophic level, i.e. *Trichogramma papilionis* Nagarkatti, the egg parasitoid of the Asiatic maize-borer, *Ostrinia furnacalis* (Guen.).



Attractancy effects of volatile plant chemicals of selected weeds and extracts of maize leaf of various growth stages were studied using a modified linear olfactometer. Contact effects of plant chemicals on the retention time of *T. papilionis* were investigated in a glass cylinder arena, and by tracing the locomotion of female parasitoid upon encountering plant chemical patch. Effects of plants chemicals on parasitization rate by *T. papilionis* were evaluated in Petri-dish and in cage experiment. Effects of stimulation from plant chemicals prior to parasitoid release was studied in the laboratory. A Field trial was conducted to probe the response of naturally occurring *Trichogramma* to the extracts of *Amaranthus hybridus*, a weed species found to elicit positive response in *T. papilionis*.

The weeds studied were *Ageratum conyzoides*, *Amaranthus hybridus*, *Asystasia gangetica*, *Borreria latifolia*, *Cleome rutidosperma*, *Cyperus rotundus* and *Eleusine indica*.

Results of experiments using linear olfactometer revealed that volatiles from fresh plant material of *A. gangetica*, *C. rutidosperma* and *A. hybridus* showed attractancy effects, on the contrary, that of *A. conyzoides* showed repellent effect, while those of *B. latifolia*, *C. rotundus* and *E. indica* did not elicit significant response to the parasitoid compared to control. Extracts of maize leaf at early-whorl stage did not cause significant difference in *T.*



papilionis rate of displacement at concentrations 0.005 g/ml and 0.05 g/ml; extract of maize leaf from tasseling/silking stages, however, elicited significant responses at both concentrations tested.

Through contact effect studies, extracts of early-whorl stage at all concentration tested (0.001, 0.01, and 0.03 g/ml), did not result in the increase of retention time by the female parasitoid. However, increasing the extract concentration of other maize stages generally increased the retention time of the parasitoid. Silking stage at 0.03 g/ml revealed highly significant difference. Surface extract of *A. hybridus* resulted in significantly higher retention time at all concentration tested (1, 2 and 3 g/ml). The extract from *C. rutidosperma* did not cause any significant difference at all concentration tested, while that of *A. gangetica* gave significant difference only at the highest concentration. Extract of *Ageratum*, however, caused significantly reduced retention time.

Female parasitoids that were allowed to oviposit prior to being used in the experiment showed extended retention time in Petri dish testing. Parasitization experiments revealed that the extracts of maize leaves and of two weeds, *A. gangetica*, and *A. hybridus*, significantly increased the parasitization of *Corcyra cephalonica* eggs by the *T. papilionis*. Pre-release

stimulation using the extracts of maize and *A. hybridus* increased parasitization rates. In field trials inconclusive results were obtained due to the unusually low parasitoid number during the experiment. However, the performance of *Trichogramma* in the field seemed to be enhanced with the application of *A. hybridus* extract.

It is concluded that *T. papilionis* seemed to be adaptive to chemicals from maize, the host plant of its natural host, *O. furnacalis*. The response, however, varied depending on plant stage of plant growth. *Trichogramma papilionis* showed positive responses to chemicals from *A. hybridus* which were comparable to those caused by maize leaves extracts. Since response of the parasitoid varied among weeds present in maize field ecosystem, selective weeding would be able to enhance the parasitoid performance. *Amaranthus hybridus* showed the prospect to be utilised for manipulation of the parasitoid foraging behaviour, for the purpose of the maize borer control, and the possibility of bridging the *T. papilionis* to other lepidopteran pest in other crop system. The methods, however, need further refinement.



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

**TANGGAP PERILAKU *TRICHOGRAMMA PAPILIONIS* NAGARKATTI,
PARASITOID TELUR DARI PENGOREK BATANG JAGUNG,
OSTRINIA FURNACALIS (GUEN.), TERHADAP SEMIOKIMIA DARI
TANAMAN JAGUNG DAN BEBERAPA RUMPAI TERPILIH**

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Februari 2006

Pengerusi : **Profesor Yusof Ibrahim, PhD**

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Manipulasi perilaku parasitoid untuk tujuan penetapan habitat dan penemuan perumah dapat mengoptimumkan kepenggunaan agen kawalan biologi di dalam pengurusan perosak. Agar dapat melakukan hal itu, faktor-faktor yang menyebabkan penghasilan perilaku dari parasitoid perlu diperjelaskan. Oleh itu, semiokimia tumbuhan dari trofik aras pertama, seperti tanaman jagung dan rumpai yang bersekutu telah dikaji dengan cara menentukan pengaruh ketertarikan, penahanan dan keaktifan semiokimia tersebut terhadap ahli trofik aras ketiga seperti *Trichogramma papilionis* Nagarkatti, parasitoid telur dari pengorek batang jagung Asia, *Ostrinia furnacalis* (Guen.).



Pengaruh ketertarikan kimia tumbuhan yang bersifat meruap dari beberapa rumputai dan ekstrak daun jagung dari berbagai peringkat tumbesaran dikaji dengan menggunakan olfaktometer lurus yang telah diubah suai. Kesan kontak kimia tumbuhan terhadap masa pengekalan penahanan of *T. papilionis* dikaji di dalam arena silinder kaca, dan dengan menjejaki pergerakan parasitoid betina ketika menemui tompok kimia tumbuhan. Pengaruh kimia tumbuhan terhadap daya pemparasitan *T. papilionis* dikaji di dalam piring dan di dalam kurungan. Kajian pengaruh rangsangan sebelum penglepasan parasitoid telah dilakukan di dalam makmal. Kajian lapangan telah dilakukan untuk mengetahui respon *Trichogramma* yang terdapat secara asli terhadap ekstrak *Amaranthus hybridus*, satu spesies rumputai yang telah didapati menghasilkan respon positif daripada *T. papilionis*

Jenis-jenis rumputai yang dikaji meliputi *Ageratum conyzoides*, *Amaranthus hybridus*, *Asystasia gangetica*, *Borreria latifolia*, *Cleome rutidosperma*, *Cyperus rotundus* dan *Eleusine indica*.

Kajian menggunakan olfaktometer lurus mendedahkan bahawa kandungan meruap dari bahan tanaman *A. gangetica*, *C. rutidosperma* dan *A. hybridus* menunjukkan pengaruh ketertarikan, akan tetapi kandungan meruap dari tanaman *A. conyzoides* menunjukkan pengaruh penolakan, sementara dari *B.*

latifolia, *C. rotundus* dan *E. indica* tidak menghasilkan respon yang berarti kepada parasitoid berbanding kawalan. Ekstrak daun jagung dari peringkat puser awal tidak menyebabkan perbezaan berarti dalam kepantasan pergerakan *T. papilionis* untuk kepekatan 0.005 g/ml dan 0.05 g/ml; pun begitu ekstrak dari peringkat berbunga jantan/berjambul menyebabkan perbezaan respon yang berarti untuk kedua-dua kepekatan yang diuji

Dari segi kesan kontak, ekstrak daun jagung peringkat puser awal tidak menyebabkan peningkatan pengekaln penahanan daripada parasitoid betina. Akan tetapi peningkatan kepekatan ekstrak dari peringkat lainnya, secara umum meningkatkan pengekaln penahanan parasitoid; peringkat berjambul pada kepekatan 0.03 g/ml menunjukkan perbezaan yang amat berarti. Ekstrak permukaan dari *A. hybridus* menunjukkan peningkatan pengekaln penahanan yang berarti. Ekstrak dari *C. rutidosperma* tidak menyebabkan sebarang perbezaan yang berarti manakala dari *A. gangetica* menyebabkan perbezaan yang berarti hanya pada kepekatan tertinggi yang diujikan. Sebaliknya, ekstrak *Ageratum* meningkatkan pengekaln penahanan oleh parasitoid betina dengan berarti.

Parasitoid betina yang diberi kesempatan untuk bertelur sebelum digunakan dalam kajian menunjukkan pengekaln penahanan yang lebih dalam kajian

piring Petri. Kajian pamparasitan menunjukkan bahawa ekstrak dari daun jagung dan rumpai *A. gangetica*, dan *A. hybridus* meningkatkan pamparasitan telur *Corcyra cephalonica* oleh *T. papilionis*. Rangsangan prapelepasan parasitoid dengan mengguna ekstrak daun jagung dan *A. hybridus* menyebabkan peningkatan kadar pamparasitan. Kajian di lapangan mendapat hasil yang tidak dapat disimpulkan kerana bilangan parasitoid yang rendah yang luar biasa pada saat kajian dilakukan. Akan tetapi, prestasi *Trichogramma* di lapangan nampaknya dipertingkatkan dengan aplikasi ekstrak *A. hybridus*.

Disimpulkan bahawa *T. papilionis* nampaknya telah dapat menyesuaikan diri terhadap bahan kimia dari tanaman jagung, tanaman perumah semula jadi *O. furnacalis*. Responnya, akan tetapi berbeza mengikut peringkat tumbesaran tanaman. Respon *T. papilionis* terhadap ekstrak dari *A. hybridus* adalah positif dan sebanding dengan yang disebabkan oleh ekstrak daun jagung. Oleh kerana respon *T. papilionis* berbeza-beza terhadap jenis-jenis rumpai yang terdapat dalam ekosistem tanaman jagung, penyiangan rumpai secara berpilih akan meningkatkan prestasi parasitoid tersebut. *Amaranthus hybridus* memiliki prospek untuk dimanfaatkan dalam manipulasi perilaku pencarian *T. papilionis* bagi tujuan pengawalan pengorek batang jagung dan berkemungkinan menjadi jambatan penghubung *T. papilionis* dengan Lepidoptera perosak dalam sistem

tanaman lainnya. Akan tetapi, kajian lebih lanjut diperlukan dari segi kaedah yang digunakan.

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I certify that an Examination Committee has met on February 14, 2006 to conduct the final examination of Saripah Ulpah on her Doctor of Philosophy thesis entitled "Behavioral Responses of *Trichogramma papilionis* Nagarkatti, Egg Parasitoid of Maize Borer, *Ostrinia furnacalis* (Guen.), to Semiochemicals from Maize Plant and Selected Weeds" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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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.



SARIPAH ULPAH

Date: 9 March, 2006

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