UNIVERSITI PUTRA MALAYSIA

THE TOXICITY AND SUBLETHAL EFFECT OF BOTANICAL INSECTICIDES AGAINST THE LARVAE OF GREEN LACEWINGS, Chrysoperla nipponensis (NEUROPTERA : CHRYSOPIDAE)

SITI KHADIJAH BINTI MD HUSIN

FP 2017 64

THE TOXICITY AND SUBLETHAL EFFECT OF BOTANICAL INSECTICIDES AGAINST THE LARVAE OF GREEN LACEWINGS, *Chrysoperla nipponensis* (NEUROPTERA : CHRYSOPIDAE)

SITI KHADIJAH BINTI MD HUSIN

FACULTY OF AGRICULTURE

UNIVERSITI PUTRA MALAYSIA

SERDANG, SELANGOR DARUL EHSAN

2016/2017

THE TOXICITY AND SUBLETHAL EFFECT OF BOTANICAL INSECTICIDES AGAINST THE LARVAE OF GREEN LACEWINGS, *Chrysoperla nipponensis* (NEUROPTERA : CHRYSOPIDAE)

BY

SITI KHADIJAH BINTI MD HUSIN

A project report submitted to Faculty of Agriculture, Universiti Putra Malaysia,in fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of Bachelor of Agricultural Science

Faculty of Agriculture

Universiti Putra Malaysia

2016/2017

CERTIFICATION

This project report entitled **The Toxicity and Sublethal Effect of Botanical Insecticides against the Larvae of Green Lacewings, *Chrysoperla nipponensis* (Neuroptera : Chrysopidae)** and submitted to the Faculty of Agriculture in fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of Bachelor of Agriculture Science.

Student's name : Student's signature :

SITI KHADIJAH BINTI MD HUSIN ……

Certified by :

……

(PROF. DR. DZOLKHIFLI OMAR)

DEPARTMENT OF PLANT PROTECTION

Date : ……..

ACKNOWLEDGEMENT

First of all, I would like to thanks Allah the Almighty for His blessings and strengths He give to me on the completion of my final year project. I would like to express my sincerest gratitude and appreciation to my supervisor, Prof. Dr. Dzolkhifli Omar who had given guidance, support, constructed the idea and comments, and also invaluable advice throughout finishing this final year project. Special thanks also I gave to Dr. Norhayu Asib for her guidance and helps during the completion of this project.

I would also like to thanks Mr. Syafique Ahmad who had helped in the mass rearing of the green lacewing. Besides, my thanks also to Mr. Jarkasi and Mr. Zaki, the lab assistance of Department of Plant Protection, Faculty of Agriculture for their assistance and guidance in laboratory and for the preparation of the materials that needed in my experiment. My thankful also I gave to my friends Nadiah Jaliludin, Nur Ashikin Khairudin, Nabilah Hakim and Nurul Fatini Shahidan for their support, cooperation and help in completing my project. Not to forget, I would like to thanks my fellow friends for their assistance and support throughout finishing my project.

Not to forgotten, my special thanks to my parents, Md Husin Hosnan, Haliah Salleh and my siblings and Taufiq Saiwon for their moral support, encouragement and financial support during completing my final year project.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATE

ABSTRACT

Green lacewing, *Chrysoperla nipponensis* is a common predator of insect pests particularly the leaf sucking insects and is commonly found in vegetable crops. Green lacewing is an important predator of arthropod pests such as aphids, psyllids, thrips and whiteflies. Green lacewing belongs to the family of Chrysopidae. Synthetic insecticides are commonly used to control insect pests and could be harmful to the *C. nipponensis*. The alternative is to use plant based insecticides. These insecticides are less toxic than synthetic insecticides to the predators and not very harmful to the humans and environments. However, the toxicity of botanical insecticides against *C. nipponensis* is not well known. A laboratory study was conducted to determine the toxicity and sub lethal effect of four different types of botanical insecticides against larvae of green lacewing. The insecticides were neem, rotenone, garlic oil and entomic. The bioassay was conducted by dipping the leaves into the solution and allowed them to dry at room temperature. The third instar larvae of the green lacewing were exposed to the treated leaf. The mortality of the larvae and sub lethal effect were recorded after 24, 48, 72, 96 and 120 hours. One larva was used per treatment with a minimum of 10 replicates per treatment. Data were subjected to Analysis of Variance (ANOVA) and means separation by Tukey test. The order of the toxicity was rotenone > neem > bralic > entomic. The LC_{50} of rotenone was 68.19µg/ml while entomic was 949.14µg/ml.

ABSTRAK

Green lacewing, *Chrysoperla nipponensis* adalah pemangsa biasa bagi serangga perosak terutamanya serangga penghisap daun dan lazimnya dijumpai dalam tanaman sayur-sayuran. *Green lacewing* merupakan pemangsa penting untuk perosak dari keluarga Artropod seperti aphids*, psyllids, thrips* dan *whiteflies*. Ia adalah serangga terbanyak di dalam keluarga Chrysopidae. Pada masa ini, racun serangga konvensional biasanya digunakan untuk mengawal serangga perosak dan boleh mendatangkan bahaya kepada *C. nipponensis* itu. Alternatif kepada permasalahan tersebut adalah dengan menggunakan racun serangga yang berasaskan tumbuhan. Racun tersebut dipilih kerana ianya kurang toksik berbanding dengan racun serangga konvensional untuk pemangsa dan tidak begitu berbahaya kepada manusia dan kawasan persekitaran. Walau bagaimanapun, ketoksikan racun serangga botani terhadap *Chrysoperla nipponensis* tidak diketahui. Oleh itu, satu kajian telah dijalankan untuk menentukan ketoksikan dan kesan lain empat jenis racun serangga botani terhadap larva *green lacewing*. Racun serangga tersebut adalah *neem, rotenone*, minyak bawang putih dan *entomic*. Kaedah yang digunakan adalah dengan mencelup daun ke dalam larutan racun dan daun tersebut dibiarkan kering pada suhu bilik. Larva pada tahap ketiga didedahkan dengan daun yang telah dicelup ke dalam larutan racun. Setelah itu, kadar kematian larva direkod selepas 24, 48, 72, 96 dan 120 jam. Setiap rawatan mempunyai satu larva dengan sekurang-kurangnya 10 ulangan bagi setiap rawatan. Data tersebut dianalisis menggunakan Analisis Varians (ANOVA) dan purata telah ditentukan oleh *Tukey test*. Turutan ketoksikan racun adalah daripada racun *rotenone* > *neem* > minyak bawang putih > *entomic*. Nilai LC_{50} racun *rotenone* adalah 68.19µg/ml, manakala bagi racun *entomic* adalah 949.14µg/ml.

CHAPTER 1

INTRODUCTION

Biological control of pests and diseases is a method of management of pests and diseases in agriculture that relies on their natural enemies rather than the chemicals. Biological control agent can include predators, parasitoids and pathogens. Among the different organisms that can be used in the biological control of agricultural pests, arthropod predators play a central role in controlling pests and diseases. The important predators of arthropod pests include lacewings, true bugs, beetles and predatory mites. Nowadays, the green lacewings are popular as they are quite resistance to the chemicals applied in the field.

Green lacewings (Neuroptera : Chrysopidae) is one of the biological control agents for controlling insect pests population such as aphids in vegetables and fruits. *Chrysoperla nipponensis* is one of the genus from Chrysopidae family. It is a common predator of insect pests particularly the leaf sucking insects. The adults of *C. nipponensis* feed on pollen, sweet nectar and honey and they do not kill the insect pest or can be called as non-predacious. However, the larvae of *C. nipponensis* kill the insect pest and the important predator of the Homopteran. They feed on insect pests such as aphids, mealybugs and whiteflies. Even though the green lacewings, *C. nipponensis* can act as biological control agent in the field, the application of chemicals such as botanical insecticides are still being used to entire insect pests.

Botanical insecticides are referred to the naturally occurring chemicals that are extracted or derived from the plant. They also known as natural insecticides. They undergo certain processes and being used in the field to control and manage the insect pest population. In general, botanical insecticides are less toxic to human and the surrounding environment compared to the conventional insecticides. Besides, botanical insecticides degrade rapidly. Botanical insecticides have been chosen by the farmers to be used as one of the alternatives to control the pest population in agriculture field.

At present there are four major types of botanical insecticide used for insect control namely pyrethrum, rotenone, neem and also essential oils. There are other botanical insecticides that can also be used but in limited use namely ryania, nicotine, and sabadilla. The use of botanical insecticides was replaced following the introduction of synthetic insecticides after the Second World War. Synthetic insecticides are the popular chemical control and widely used by the farmers. It has become the farmer's choice because of its rapid acting, readily available in the market and also highly reliable in controlling the pest population.

However, the use of conventional insecticides has been discovered to give a threat to human health and the environment such as undesirable side effect, pollution, development of resistance and negative effects to the non – target organisms as well as more toxic to the human and environment. Other than that, synthetic insecticides are costly and leave residues on the crops that could affect the consumer. In order to solve this problem, botanical insecticides have been chosen as the driving forces for changes of insecticide usage in insect pest management (IPM).

The main reason of using insecticides in the field is to control the pest population that attacks the crop especially in the vegetables and fruits. However, the use of insecticides in the field may also affect non – target organisms such as beneficial insects. The beneficial insect existence in the agriculture field can also help to suppress insect pest population. Conventional insecticides are widely used among the farmers in controlling the insect pest but they may give many harmful effects to the environment and the non-target organism which is beneficial insect due to high and residual toxicity. Therefore, botanical insecticides are chosen as an alternative to control the insect pest population in the field since they have little effect to non – target organisms, environmental pollution and health hazards. However, there is not much research conducted on the toxicity and sub lethal effect of botanical insecticides against the larvae of green lacewings, *C. nipponensis*.

Therefore, this experiment was conducted based on the following objectives: 1) to study the toxicity of different botanical insecticides against larvae of green lacewings, *C. nipponensis* and 2) to study the sub lethal effects of the botanical insecticides on the larvae of green lacewings namely the duration to pupation, the percentages of pupation, the duration to adult emergence and the percentages of adult emergence. The outcome from this experiment would enable us to plan the best solution in controlling the insect pest population and at the same time the beneficial insect population in the field will not be disturbed.

REFERENCES

AGROW Synergy, 2012. Entomic: Best alternative for pest management. Retrieved 10th September 2016 from http://entomic.agrowsynergy.com/.

Amarasekare, K.G. and Shearer, P.W. 2013. Comparing effects of insecticides on two green lacewings species, *Chrysoperla johnsoni* and *Chrysoperla carnea* (Neuroptera: Chrysopidae). Journal of Economic Entomology. 106(3):1126-1133.

Bharadwaj, A., Hayes, L. E. and Stafford, K.C. 2015. Effectiveness of garlic for the control of *Ixodes scapularis* (Acari:Ixodidae) on residential properties in Western Connecticut. Journal of Medical Entomology. 52(4):722-725.

Canard, M. 2001. Natural sood and feeding habits of lacewings. *In*: Lacewings in the crop environment (ed. by McEvew, P., New, T. and Whittington, A.), pp. 116-129. New York : Cambridge University Press.

Canard, M. and Pricinpi, M.M. 1984. Development of Chrysopidae. *In*: Biology of Chrysopidae (ed. by Canard, M., Séméria, Y. and New, T.R.), pp. 57-75. The Hague.

Chandler, D., Bailey, A.S., Tatchell, G.M., Davidson, G., Greaves, J., Grant, W.P., 2011. The development, regulation and use of biopesticides for integrated pest management. Philos. Trans. R. Soc. B (366).

Charles, J.G., Bell, V.A., Lo, P.L., Cole, L.M., Chhagan, A., 2010. Mealybugs (Hemiptera: Pseudococcidae) and their natural enemies in New Zealand vineyards from 1993–2009. N. Z. Entomology. 33:84–91.

Chaubeya, M.K. 2013. Insecticidal effect of *Allium sativum* (Alliaceae) essential oil. Journal of Biologically Active Products from Nature. 3(4):248-258.

Daane, K.M., Almeida, R.P.P., Bell, V.A., Walker, J.T.S., Botton, M., Fallahzadeh, M., Mani, M., Miano, J.L., Sforza, R., Walton, V.M., Zaviezo, T., 2012. Biology and management of mealybugs in vineyards. *In*: Arthropod management in vineyards: Pests, approaches, and future directions (ed. by Bostanian, N.J., Vincent, C., Isaacs, R..), pp. 271-307. Springer, The Netherlands.

Dadang, Fitriasari, E.D., and Prijono, D. 2009. Effectiveness of two botanical insecticide formulations to two major cabbage insect pests on field application. J. ISSAAS. 15(1): 42-51.

Dauda, Z., Maina, Y.T. and Richard 2012. Insecticidal activity of garlic (*Alium sativum* (L.)) oil on *Callosobruchus maculatus* (F.) in post-harvest cowpea (*Vigna unguiculata* (L.) WALP.). Journal of Biology, Agriculture and Healthcare. 2(3):28-35.

DeBach, P. 1964. The scope of biological control. *In*: Biological control of insect pests and weeds (ed. by DeBach, P.), pp. 3-20. Chapman and Hall Ltd., London.

El-Wakiel, N.E. 2013. Botanical pesticides and their mode of action. Gesunde Pflanzen. 65(4):125–149.

Franco, J.C., Zada, A., Mendel, Z., 2009. Novel approaches for the management of mealybug pests. *In*: Biorational control of arthropod pests: Application and resistance management programs (ed. by Ishaaya, I., Horowitz, A.R.), pp. 233-278. Springer, New York.

Franco, J.C., Suma, P., Silva, E.B., Blumberg, D., Mendel, Z., 2004. Management strategies of mealybug pests of citrus in Mediterranean countries. Phytoparasitica 32, 507–522.

Gebreyohannes, G., Gebreyohannes, M. 2013. Medicinal values of garlic: A review. International Journal of Medicine and Medical Sciences. 5(9):401-408.

Giger, M. 2012. The neem tree. Retrieved 7th October 2016 from http://www.gigers.com/matthias/engmala/neemtree.htm.

Hanem, F.K. 2012. Ecosmart biorational insecticides: alternative insect control strategies insecticides - Advances in integrated pest management. Retrieved 7th October 2016 from http://www.intechopen.com/books/insecticides-advances-in-integrated-pest-management/ecosmart-biorational-insecticides-alternative-insect-control-strategies.

Hodgson, E.W., Trina, J. 2008. Beneficial insects: Lacewings and Antilions. Utah State University Extension and Utah Plant Pest Diagnostic Laboratory. ENT.124(08).

Isman, M. 2008. Perspective botanical insecticides: For richer, for poorer. Pest Management Science. 64:8–11.

Isman, M. 2006. Botanical insecticides, deterrents and repellents in modern agriculture and an increasingly regulated world. Annual Rev. Entomol. 51:45–66.

Kegley, S.E., Hill, B.R., Orme S., Choi A.H., PAN Pesticide Database, Pesticide Action Network, North America (Oakland, CA, 2016), http://www.pesticideinfo.org.

Kuhne, S. 2008. Prospects and limits of botanical insecticides in organic farming. Agronomski Glasnik. 377-382.

McEwen, P.K., New, T.R. and Whittington, A.E. 2007. Lacewings in the crop environment. Science, Cambridge University Press.

Medina, P., Budia, F., Del, E.P., and Vinuela, E. 2004. Influence of azadirachtin, a botanical insecticide, on *Chrysoperla carnea* (Stephens) reproduction: toxicity and ultrastructural approach. J Econ Entomol. 97:43-50.

Memim.com 2016. Azadirachtin. Retrieved 8th October 2016 from http://memim.com/azadirachtin.html.

Mpumi, N., Mtei, K., Machunda, R. and Ndakidemi, P.A. 2016. The toxicity, persistence and mode of actions of selected botanical pesticides in Africa against insect pests in common beans, *P. vulgaris*. American Journal of Plant Sciences. 7:138-151.

Mustafizur, R.G.K.M., and Motoyama, N. 2009. Repellent effect of garlic against stored product pest. Nippon Noyaku Gakkaishi. 25:247-252.

Pappas, M.L., Broufas, G.D. and Koveos, D.S., 2011. Chrysopid predators and their role in biological control. Journal of Entomology. 8:301–326.

Pavela, R. 2009. Effectiveness of some botanical insecticides against *Spodoptera littoralis* Boisduvala (Lepidoptera: Noctudiae), *Myzus persicae* Sulzer (Hemiptera: Aphididae) and *Tetranychus urticae* Koch (Acari: Tetranychidae). Plant Protection Sci., 45(4):161–167.

Prasad, R. 2016. Biopesticides. Advances and applications through fungal nanobiotechnology. Springer.

Ranger, C.M., Reding, M.E., Oliver, J.B., Moyseenko, J.J., and Youssef, N.N. 2009. Toxicity of botanical formulations to nursery-infesting white grubs (Coleoptera: Scarabaeidae). Journal of Economic Entomology. 102(1):304-308.

Ridgway, R.L.and Murphy, W.L. 1984. Biological control in the field. *In*: Biology of Chrysopidae (eds. by Canard M., Semeria, Y. and New, T.R.), pp. 220-228. Junk, Boston.

Ridgway, R. L., and Kinzer R.E. 1974. Chrysopids as predators of crop pests. Entomophaga. Mem. H. S. 7:45–51.

Roberta, 2015. Bug of the week: Green lacewing life cycle. Retrieved 7th October 2016 from http://blog.growingwithscience.com/2015/01/bug-of-the-week-green-lacewing-life-cycle/.

Saeed, R.. M. A., Zayed, A.A. , El Namaky A.H., Ismail H.M. and Mady, H.Y. 2010. Biochemicals studies on *Culex pipiens* (L.) (Diptera : Culicidae) exposed to *Allilum sativum*, Citrus lemon and *Bacillus thuringiensis israelensis* with reference to assessment of the biosafety on albino mice. Global Vet. 4:22-23.

Tassan, H., 2014. Indentification: Natural enemies gallery (green lacewings). Retrieved 10th October 2016 from http://www.ipm.ucdavis.edu/PMG/NE/green_lacewing.html.

Tauber, M.J., Tauber, C.A., Daane, K.M. and Hagen K.S. 2000. Commercialization of predators: recent lessons from green lacewings (Neuroptera: Chrysopidae). American Entomologist. 46:26–37.

Viswanathan, V., Phadatare, A.G. and Mukne A., 2014. Antimycobacterial and antibacterial activity of *Allium sativum* bulbs. Indian Journal of Pharmacy. 76(3): 256-261

Waard, M., Georgopoulos, S., Hollomon, D., Ishii, H., Leroux, P., Ragsdale, N., Schwinn, F. 1993. Chemical control of plant diseases: problems and prospects. Annu. Rev. Phytopathol. 31:403–421.

World Health Organisation (WHO). Recommended classification of pesticide by hazard. WHO/PCS/01.4 (2000-01).

Woolfolk, S.W., Smith, D.B., Martin, R.A., Sumrall, B.H., Nordlund, D.A. and Smith, R.A. 2005. Multiple orifice distribution system for placing green lacewing eggs into verticel larval rearing units. J. Econ. Entomol. 100(2): 283-290.

Zehnder, G., Gurr, G.M., Kuhne, S., Wade, M.R. and Wratten, S.D. 2007. Arthropod pest management in organic crops. Annual Review of Entomology. 52:57-80.

Zhao, N.N., Zhang, H., Zhang, X.C, Luan, X.B., Zhou, C., Liu, Q.Z., Shi, W.P. and Liu, Z.L. 2013. Evaluation of acute toxicity of essential oil of garlic (*Allium sativum*) and its selected major constituent compounds against overwintering *Cacopsylla chinensis* (Hemiptera: Psyllidae). Journal of Economic Entomology. 106(3):1349-1354.

Zubairi, S.I., Sarmidi, M.R. and Aziz, R.A. 2012. A thermal degradation (Thermolysis) study of rotenone extracted from *Derris elliptica* Roots using reverse-phase high performance liquid chromatography (RP-HPLC). Sains Malaysiana. 44(1): 121–126.