UNIVERSITI PUTRA MALAYSIA

EFFECTS OF SECONDARY POISONING FROM ANTICOAGULANT AND BIOLOGICAL RODENTICIDES ON BARN OWL, *Tyto alba javanica,* IN AN IMMATURE OIL PALM PLANTATION

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By

MOHD. NA'IM

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

April 2011

Bismillahirrahmannirrahim

To my late father H. Trubus bin Karsomedjo
And my mother Hj. Wagiyem Binti Ahmad Karto
Who brought me up and cares me with patience

To my wife Eliza Afni
My children Hatta, Afief and Zahra
For your love which nourishes my inspiration

I dedicated this work

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

EFFECTS OF SECONDARY POISONING FROM ANTICOAGULANT AND BIOLOGICAL RODENTICIDES ON BARN OWL, *Tyto alba javanica,* IN AN IMMATURE OIL PALM PLANTATION

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Chairman: Assoc. Prof. Hafidzi Mohd. Noor, Ph.D.

Faculty: Agriculture

The barn owl, *Tyto alba javanica* has been used as a biological control agent to deal with rat infestation in oil palm plantation for several decades now. However, the employment of chemical rodenticides to suppress rat population when damage increases have detrimental effects on the bird. This research was conducted with the objectives of evaluating the evidence and effects of warfarin, brodifacoum, and a biological based rodenticide, *Sarcocystis singaporensis* on breeding performance, ranging behavior, nestling growth and health status of barn owl. The field study was conducted in immature oil palm area in the FELCRA Seberang Perak, Malaysia from July 2008 to January 2010.

From three breeding seasons of barn owls assessed, there was no significant difference in mean clutch size for untreated control plot, warfarin

treated plot, brodifacoum treated plot and biorodenticide treated plot. However, the mean hatching success and the mean fledging success of barn owls in the control plot was significantly higher compared to the rodenticide treated plots. Both the hatching and fledging success in the biorodenticide treated plot was significantly higher compared to the chemical rodenticides treated plots. Also the warfarin treated plot showed a significantly higher mean hatching and fledging success compared to brodifacoum treated plot.

Rat damage analysis indicated that in the control plot, rat was solely controlled by predation of barn owls contributing moderate control 24 months after the nest boxes were installed. Damage fluctuated from 4.81% to 9.78% throughout that period. Nonetheless, rat damage recorded at the end of the study was lower compared to the damage incurred at the start of the census. Baiting with *S. singaporensis* and warfarin were found to be effective to control rat when applied in two rounds. In contrast baiting with brodifacoum can achieve satisfactory control with a single round of baiting. On the other hand it poses secondary poisoning risks to non target animals including barn owls as evidenced from the addled eggs, abandoned nest boxes and the teratogenic signs in nestlings showed in this study.

Nestling growth analysis showed that nestlings in control plot were consistently heavier in body mass and longer in culmen, tarsus, wing and tail length compared to rodenticide treated plots. The culmen and tarsus length of nestlings reached that of the adult size towards the end of the growth

period monitored. On the contrary, the wings and tail feathers still grew until day 49 i.e., several days to fledging and continued to grow after fledging. The mean wing and tail length in the control plot was longer by 15.26% and 18.24% respectively compared to the brodifacoum treated plot.

Home range size in the control plot was smaller compared to rodenticide treated plots for both males and females during the mating and brooding periods. The home range size of females and males at the mating stage was inversely correlated to the levels of rat damage i.e., rat abundance, but only females showed a significant correlation to rat abundance (Pearson Correlation, $r = -0.9844; p < 0.05$), while males did not ($r = -07148; p > 0.05$). Home range size changed dramatically during the brooding period. At this time home range of females was not significantly correlated to rat abundance (*Pearson Correlation, $r = -0.8286; p > 0.05$)*. In contrast, the home range size for males was significantly correlation to rat abundance ($r = -0.9760; \quad p < 0.05$). The study also indicates that home range size of females during mating was significantly larger compared to during brooding (*t-test; $p<0.05$*). The males exhibited a significantly larger home range size during brooding compared to the period of the onset of mating (*t-test; $p<0.01$*).

Warfarin and brodifacoum residues were found in the food of barn owls only during and one month after baiting campaign. Out of the 91 pellets recovered from the warfarin treated plot, 25.27% (n= 23) contained warfarin residue ranging from 0.034 to 2.826 µg/g wet weight. Of the 99 pellets

collected from the brodifacoum plot, 24.24% (n=24) contained brodifacoum residue ranging from 0.011 to 1.156 μg/g wet weight. Of 18 eggs collected in warfarin treated plot 61.11% (n=11), contained warfarin residue ranging from 0.007 to 0.332 ug/g wet weight. Of the 18 eggs collected in brodifacoum treated plot, 66.67% (n=12) contained brodifacoum residue ranging from 0.04 to 0.0615 ug/g wet weight. No pellets and eggs recovered from the control and biorodenticide treated plot detected to contain warfarin and brodifacoum residue. The study showed that rodenticide residues can be transferred to egg and decrease eggshell mass and lead to thinning of eggshell of barn owls.

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

KESAN KERACUNAN SEKUNDER DARIPADA ANTIKOAGULAN DAN RODENTISID BERASASKAN EJEN BIOLOGI KEATAS BURUNG PUNGGUK, *Tyto alba javanica,* DI KAWASAN LADANG KELAPA SAWIT MUDA

Oleh

MOHD. NA'IM

April, 2011

Pengerusi: Prof. Madya Hafidzi Mohd. Noor, Ph.D.

Fakulti: Pertanian

Burung pungguk jelapang, *Tyto alba javanica* telahpun digunapakai sebagai ejen kawalan biologi bagi mengawal serangan tikus di ladang kelapa sawit selama beberapa dekad. Walaubagaimanapun, racun rodentisid kimia bagi mengawal bilangan tikus ketika meningkatnya serangan mempunyai kesan buruk kepada burung pungguk. Kajian ini dilakukan dengan objektif untuk menilai bukti dan kesan warfarin, brodifacoum, dan rodentisid berasaskan biologi, *Sarcocystis singaporensis* terhadap burung pungguk dari aspek lakuan, banjaran kediaman, tumbesaran anak dan status kesihatannya. Kajian lapangan dilakukan di ladang kelapa sawit belum matang di FELCRA Seberang Perak, Malaysia dari bulan Julai 2008 hingga Januari 2010.

Daripada tiga musim pembiakan burung pungguk, tidak didapati perbezaan yang bererti dalam saiz kluc untuk semua rawatan. Namun, kadar penetasan dan kadar kejayaan juvena menjadi dewasa di plot kawalan lebih tinggi

secara bererti berbanding dengan plot rawatan rodentisid. Plot biorodentisid juga menunjukkan kadar penetasan dan kadar kejayaan anak menjadi dewasa lebih tinggi secara bererti berbanding dengan plot rodentisid kimia. Plot warfarin berbeza secara bererti untuk kejayaan menetas dan kejayaan menjadi dewasa berbanding dengan plot brodifacoum.

Analisis kerosakan tikus menunjukkan bahawa dalam plot kawalan, tikus dikawal oleh pemangsaan burung pungguk menyumbang kepada kawalan secara moderat 24 bulan selepas kotak sarang disediakan dengan kerosakan yang berfluktuasi di antara 4.81% sehingga 9.78%. Walaubagaimanapun, kerosakan pada akhir kajian lebih rendah berbanding dengan kerosakan yang dicerap pada awal bancian. *Sarcocystis singaporensis* dan warfarin dijumpai berkesan untuk mengawal serangan tikus apabila pengumpanan dibuat dalam dua pusingan. Berbeza dengan warfarin dan *S. singaporensis*, brodifacoum boleh mencapai kawalan yang memuaskan hanya dengan satu pusingan umpan, tetapi menimbulkan risiko keracunan sekunder untuk haiwan bukan sasaran termasuk terhadap burung pungguk, sebagaimana yang dibuktikan dari telur yang rosak, kotak sarang yang ditinggalkan dan juga kesan teratogenik yang dicerap pada anak burung seperti yang dipamerkan dalam kajian ini.

Analisa pertumbuhan juvena pula menunjukkan bahawa juvena di plot kawalan secara konsisten lebih berat dan menunjukkan ukuran kulmen, tarsus, sayap dan ekor yang lebih panjang berbanding dengan plot plot rodentisid. Ukuran kulmen dan tarsus dari juvena di plot kawalan mencapai

saiz dewasa selama tempoh pertumbuhan. Berbeza dengan kulmen dan tarsus, sayap dan ekor masih tumbuh hingga hari ke 49 iaitu, beberapa hari menjelang anak meninggalkan sarang dan tumbuh terus setelah meninggalkan sarang. Panjang sayap dan ekor pada plot kawalan adalah 15,26% dan 18,24% masing-masing lebih panjang berbanding dengan anak pada plot brodifacoum.

Banjaran kediaman burung jantan dan betina pada plot kawalan lebih kecil berbanding plot-plot rodentisid selama tempoh mengawan dan membela anak. Purata banjaran kediaman betina pada tempoh mengawan adalah berkadar songsang berbanding dengan kadar kerosakan dari serangan tikus (Korelasi Pearson, $r = -0,9844$; $p < 0.05$), manakala jantan pula tidak dipengaruhi oleh kelimpahan tikus ($r = -0.7148$; $p > 0.05$). Banjaran kediaman burung berubah secara drastik selama tempoh membela anak, banjaran kediaman betina selama masa membela anak tidak dipengaruhi oleh kadar kerosakan dari serangan tikus (Korelasi Pearson , $r = -0,8286$; $p > 0.05$). Sebaliknya banjaran kediaman burung jantan berkadar songsang dengan kadar kerosakan dari serangan tikus ($r = -0,9760$; $p < 0.05$). Kajian juga menunjukkan bahawa banjaran kediaman betina pada tempoh mengawan adalah lebih luas secara bererti berbanding dengan tempoh membela anak (t-test, $p < 0.05$). Burung jantan pula menunjukkan banjaran kediaman lebih luas secara bererti selama tempoh membela anak berbanding dengan tempoh mengawan (t-test, $p < 0.01$).

Residu warfarin dan brodifacoum didapati pada makanan burung pungguk only pada saat pengumpanan racun tikus dan satu bulan selepasnya. Daripada 91 pelet yang dikutip dari plot warfarin, 25.27% (n = 23) mengandungi residu warfarin antara 0.034 – 2.826 ug /g berat basah. Daripada 99 pelet yang dikutip dari plot brodifacoum, 24.24% (n = 24) mengandungi 0.011 – 1.156 μg/g berat basah. Daripada 18 telur yang diperolehi dari plot warfarin, 61.11% (n = 11) mengandungi residue warfarin dengan julat di antara 0.007 – 0.332 ug/g berat basah. Daripada 18 telur yang diperolehi dalam plot brodifacoum 66.67% (n = 12) mengandungi residu brodifacoum dengan julat di antara 0.04 – 0.0615 ug/g berat basah. Tiada pelet dan telur yang diambil daripada plot kontrol dan plot biorodentisid dikesan mengandungi residu warfarin dan brodifacoum. Kajian ini mendapati bahawa residu rodentisid boleh ditransfer keatas telur dan akan mengurangi massa kulit telur dan akan menyebabkan penipisan pada kulit telur burung pungguk.

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I certify that a Thesis Examination Committee has met on 15th April 2011 to conduct the final examination of Mohd. Na'im on his Doctor of Philosophy thesis entitled "Effects of Secondary Poisoning from Anticoagulant and Biological Rodenticides on Barn Owl, *Tyto alba javanica,* in an Immature Oil Palm Plantation" in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Pertanian Malaysia (P.U.(A) 106) 15 March 1998.. The Committee recommends that the student be awarded the degree of Doctor of Philosophy.

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

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Date: 25 July 2011

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

MOHD. NA'IM

Date: 15 April 2011

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