UNIVERSITI PUTRA MALAYSIA

NUCLEOPOLYHEDROSIS VIRUS OF SPODOPTERA UTURA: INFLUENCE OF ENVIRONMENTAL FACTORS ON EFFICACY AND IMPROVEMENT FOR FIELD APPLICATION

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NUCLEOPOLYHEDROSIS VIRUS OF *SPODOPTERA LITURA*: INFLUENCE OF ENVIRONMENTAL FACTORS ON EFFICACY AND IMPROVEMENT FOR FIELD APPLICATION

By

MOHAMMAD ABDUL BAKIR

Thesis Submitted in Fulfilment of the Requirement for the Degree of Doctor of Philosophy in the Faculty of Forestry Universiti Putra Malaysia

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To

My daughter Aniqa Tahsin Liya and father Abdul Baten

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

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Chemical pesticides significantly reduce agricultural losses but pose environmental hazards. Their effectiveness are threatened by increasing insect resistance and unwanted destruction of non-target organisms. Nucleopolyhedroviruses (NPVs) are getting wide attention as an alternative and biorational method to control insect pests. In this study, infectivity of a locally isolated NPV to control the polyphagous pest *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) was examined. The effects of different environmental factors such as pH, temperature, sunlight and ultraviolet lights (UV-A, UV-B and UV-C) on the infectivity of the virus were studied. Capabilities of different materials to protect the virus from deleterious effects of UV and sunlight were evaluated. The virus was formulated with different protectant materials and the effectiveness of different virus formulations at practical field level with single and multiple applications to control *S. litura* were investigated.

S. litura larvae were observed to be susceptible to infection by the studied NPV. Larval mortalities were 10% to 100%, when first to fourth instar larvae were infected with the virus concentrations of 1×10^2 to 1×10^{10} polyhedral inclusion bodies (PIBs)/mL. The median lethal concentration (LC_{50}) values for the 1st to 4th instar larvae were 3.2×10^6, 1.1×10^7, 1.3×10^7 and 4.7×10^7 PIBs/mL, respectively. The median lethal time (LT_{50}) values were 2.0, 5.4, 9.2 and 16.6 days for the 1st to 4th instar larvae, respectively. Optimum infective virus persistency was observed at neutral pH. NPV infectivity decreased whilst LT_{50} values increased, when exposed to high alkaline pH suspension (pH 11.0) compared with that of neutral pH. However, virus exposures to pH 3.0, 5.0 and 9.0 did not significantly reduce the infectivity. Larval mortality increased with increasing larval rearing temperature and LT_{50} value decreased by 4 fold when infected larvae were reared at 30°C compared with that of 20°C. Optimum infection was observed when the infected larvae reared at 30°C. The virus lost all infectivity after 12 hours of exposure to direct sunlight. All types of UV (UV-A, UV-B and UB-C) demonstrated deleterious effect on NPV infectivity. UV-B and UV-C were more deleterious compared with that of UV-A. NPV infectivity was completely destroyed when continuously exposed to UV-B and UV-C for 360 hours (15 days). However, UV protectant materials tinopal and riboflavin provided 100% protection of NPV against UV-B inactivation at 1% concentration and also enhanced infectivity by reducing larval killing time. Only tinopal at 1% concentration provided 100%

protection of the virus against sunlight inactivation and also enhanced the infectivity. Field studies conducted with single and multiple spray applications of NPV on sawi (*Brassica rapa* Linnaeus) demonstrated that NPV is effective for controlling *S. litura*. As a result, *B. rapa* yield increased and damage was less in the NPV treated plots compared with those of control plots. Yield and damage in NPV treated plots were similar to chemical pesticide treated plots. Results of this study may contribute in developing biological control program using NPV in Malaysia and other countries where *S. litura* is predominantly found.

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

SPODOPTERA LITURA NUKLEOPOLIHEDROSIS VIRUS: PENGARUH FAKTOR ALAM SEKITAR KE ATAS BERKESANAN DAN PEMBAIKAN APLIKASI DI LAPANGAN

Oleh

MOHAMMAD ABDUL BAKIR

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Racun seranga kimia dapat mengurangkan kerugian dalam hasil pertanian yang desebabkan oleh serangga perosak, walau bagaimanapun ia boleh membahayakan alam sekitar, memusnahkan serangga-serangga lain yang tidak berkaitan dan mengurangkan keberkesanannya terhadap serangga perosak pada masa akan datang akibat peningkatannya ketahanan serangga perosak tersebut terhadap racun kimia. Sebagai alternatif, satu kaedah biorasional untuk mengawal serangga perosak ulat ratus polifagus (*Spodoptera litura*, Fab.) dijalankan. Keberkesanan nukleopolihedrovirus (NPV) untuk mengawal larva *S. litura*, kesan factor-faktor persekitaran seperti pH, suhu, UV dan sinaran matahari, kesan perlindungan dari UV dan sinaran matahari, formulasi dan keberkesanan formulasi-formulasi virus di peringkat lapangan untuk mengawal perosak ini turut dikaji dalam penyelidikan ini.

Nilai LC_{50} untuk larva di instar pertama hingga keempat adalah $3.2x10^6$, $1.1x10^7$, $1.3x10^7$ dan $4.7x10^7$, manakala nilai LT_{50} adalah 2.0, 5.4, 9.2 dan 16.6 hari. Kematian tertinggi yang disebabkan oleh SlNPV adalah pada pH neutral (pH 7.0) dan mengurang secara tidak signifikan pada pH 3.0 dan 9.0 tetapi mengurang secara signifikan pada pH alkali (pH 11.0). Nilai LT_{50} yang terendah adalah pada pH 7 dan yang tertinggi adalah pada pH 11.0. kematian tertinggi (100%) berlaku pada suhu 30°C dan yang terendah pada suhu 20°C. Nilai LT_{50} ialah 24 hari pada 20°C dan 5.5 hari pada 30°C. UV-B dan UV-C di dapati lebih merosakkan daripada UV-A. Jangkitan virus akan musnah apabila didedah kepada UV-B dan UV-C selama 360 jam (15 hari). Selepas terdedah secara langsung kepada sinaran matahari selama 12 jam ke semua aktiviti virus akan hilang. Nukleopolyhedrovirus (NPV) dengan 1% tinopal dan riboflavin menyebabkan 100% kematian larva selepas pendedahan kepada UV-B manakala NPV tanpa pelindung akan menyebabkan kematian larva sebanyak 41%. Tinopal (1%) memberikan 100% perlindungan kepada SlNPV dari sinaran terus matahari dan mengurangkan 1.2 kali nilai LT_{50} berbanding virus yang tidak didedahkan. Dalam kajian di lapangan, formulasi virus dan tinopal dengan satu semburan memberikan pengeluaran hasil yang tinggi berbanding virus sahaja dan tiada perbezaan signifikan dengan racun kimia bagi pengeluaran hasil sawi (*Brsssica rapa*) dan kerosakan daun. Antara formulasi-formulasi virus, virus yang menggunakan kaedah penyemburan berlipat ganda (multiple) dan diformulasi dengan 0.5%

tinopal dapat menggurangkan kerosakan berbanding plot yang dirawat dengan racun kimia. Daripada penyelidikan yang dijalankan NPV dapat digunakan sebagai racun biologi untuk mengawal serangga perosak ini dan pengawalan yang lebih baik boleh diperolehi dengan menggunakan kaedah penyemburan berganda dan penyemburan pada peringkat awal larva.

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