

## LIST OF FIGURES

|            |  | <b>Page</b> |
|------------|--|-------------|
| Figure 1.1 | Schematic of Experimental Design for the Comparison of Esterases Between Life Stages and Sexes of Resistant And Susceptible Strains of Vector Mosquitoes   | 7           |
| Figure 2.1 | (a) The Life Cycle of <i>Aedes</i> mosquito and (b) the life cycle of <i>Culex</i> mosquito  | 12          |
| Figure 2.2 | Cross-resistance relationships of commonly used classes of insecticides  | 19          |
| Figure 3.1 | Comparison of LC <sub>50</sub> and resistance ratio to susceptible strain in 10 subsequent generations of malathion (F61-F70) and permethrin (F54-F63) selected <i>Culex quinquefasciatus</i>                    | 48          |
| Figure 3.2 | Comparison of LC <sub>50</sub> and resistance to susceptible strain in 10 subsequent generations of malathion (F43-F52) , temephos (F42-F51) and permethrin (F39-F48) selected <i>Aedes aegypti</i>              | 53          |
| Figure 3.3 | Comparison of LC <sub>50</sub> and resistance to field strain in 10 subsequent generations of malathion (F43-F52) , temephos (F42-F51) and permethrin (F39-F48) selected <i>Aedes aegypti</i>                    | 54          |
| Figure 3.4 | Comparison of LC <sub>50</sub> values of malathion selected <i>Culex quinquefasciatus</i> , <i>Aedes aegypti</i> and <i>Aedes albopictus</i> of early 4 <sup>th</sup> instar larvae in 10 subsequent generation  | 57          |
| Figure 3.5 | Comparison of LC <sub>50</sub> values of permethrin selected <i>Culex quinquefasciatus</i> , <i>Aedes aegypti</i> and <i>Aedes albopictus</i> of early 4 <sup>th</sup> instar larvae in 10 subsequent generation | 58          |
| Figure 3.6 | Comparison of LC <sub>50</sub> values of temephos selected <i>Aedes aegypti</i> and <i>Aedes albopictus</i> of early 4 <sup>th</sup> instar larvae in 10 subsequent generation                                   | 59          |
| Figure 4.1 | WHO adult bioassay Test Kit  | 65          |
| Figure 4.2 | Method for determining the susceptibility or resistance of adult mosquitoes to organophosphorus and carbamate insecticides   | 70          |

|             |   |     |
|-------------|---|-----|
| Figure 4.3  | Percent mortality and resistance threshold for <i>Cx quinquefasciatus</i> malathion selected strain exposed to diagnostic dosage of 5.0% malathion for 3 hours        | 80  |
| Figure 4.4  | Percent mortality and resistance threshold for <i>Cx quinquefasciatus</i> permethrin selected strain exposed to diagnostic dosage of 0.75% permethrin for 2 hours     | 83  |
| Figure 4.5  | Percent mortality and cross-resistance threshold for <i>Cx quinquefasciatus</i> malathion selected strain exposed to diagnostic dosage of 0.1 % propoxur for 2 hours  | 86  |
| Figure 4.6  | Percent mortality and cross-resistance threshold for <i>Cx quinquefasciatus</i> permethrin selected strain exposed to diagnostic dosage of 0.1 % propoxur for 2 hours | 89  |
| Figure 4.7  | Percent mortality and resistance threshold for <i>Ae. aegypti</i> malathion selected strain exposed to diagnostic dosage of 5.0 % malathion for 1 hour                | 97  |
| Figure 4.8  | Percent mortality and resistance threshold for <i>Ae. aegypti</i> permethrin selected strain exposed to diagnostic dosage of 0.75% permethrin for 1 hour              | 100 |
| Figure 4.9  | Percent mortality and cross-resistance threshold for <i>Ae. aegypti</i> malathion selected strain exposed to diagnostic dosage of 0.1% propoxur for 1 hour            | 103 |
| Figure 4.10 | Percent mortality and cross-resistance threshold for <i>Ae. aegypti</i> permethrin selected strain exposed to diagnostic dosage of 0.1% propoxur for 1 hour           | 106 |
| Figure 4.11 | Percent mortality and cross-resistance threshold for <i>Ae. aegypti</i> temephos selected strain exposed to diagnostic dosage of 0.1% propoxur for 1 hour             | 109 |
| Figure 4.12 | Percent mortality and resistance threshold for <i>Ae. albopictus</i> malathion selected strain exposed to diagnostic dosage of 5.0 % malathion for 1 hour             | 117 |
| Figure 4.13 | Percent mortality and resistance threshold for <i>Ae. albopictus</i> permethrin selected strain exposed to diagnostic dosage of 0.75 % permethrin for 1 hour          | 120 |

|             |   |     |
|-------------|---|-----|
| Figure 4.14 | Percent mortality and cross-resistance threshold for <i>Ae. albopictus</i> malathion selected strain exposed to diagnostic dosage of 0.1 % propoxur for 1 hour  | 123 |
| Figure 4.15 | Percent mortality and cross-resistance threshold for <i>Ae. albopictus</i> permethrin selected strain exposed to diagnostic dosage of 0.1 % propoxur for 1 hour | 126 |
| Figure 4.16 | Percent mortality and cross-resistance threshold for <i>Ae. albopictus</i> temephos selected strain exposed to diagnostic dosage of 0.1 % propoxur for 1 hour   | 129 |
| Figure 5.1  | Non-specific esterase O.D. value and resistance threshold in life stages of <i>Cx. quinquefasciatus</i> susceptible strain at absorbance 450 nm                 | 146 |
| Figure 5.2  | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Cx. quinquefasciatus</i> field strain at absorbance 450 nm                      | 146 |
| Figure 5.3  | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Cx. quinquefasciatus</i> malathion selected strain (F61) at absorbance 450 nm   | 147 |
| Figure 5.4  | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Cx. quinquefasciatus</i> malathion selected strain (F65) at absorbance 450 nm   | 147 |
| Figure 5.5  | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Cx. quinquefasciatus</i> malathion selected strain (F70) at absorbance 450 nm   | 147 |
| Figure 5.6  | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Cx. quinquefasciatus</i> permethrin selected strain (F54) at absorbance 450 nm  | 148 |
| Figure 5.7  | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Cx. quinquefasciatus</i> permethrin selected strain (F58) at absorbance 450 nm  | 148 |
| Figure 5.8  | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Cx. quinquefasciatus</i> permethrin selected strain (F63) at absorbance 450 nm  | 148 |

|             |  |     |
|-------------|--|-----|
| Figure 5.9  | Correlation between LC <sub>50</sub> value and mean esterase activity in <i>Culex quinquefasciatus</i> 3 <sup>rd</sup> instars larvae of malathion and permethrin (F54-F58) selected | 149 |
| Figure 5.10 | Correlation between LT <sub>50</sub> value and mean esterase activity in <i>Culex quinquefasciatus</i> adult female of malathion and permethrin selected strains                     | 149 |
| Figure 5.11 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> susceptible strain at absorbance 450 nm  | 154 |
| Figure 5.12 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> field strain at absorbance 450 nm  | 154 |
| Figure 5.13 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> malathion selected strain (F43) at absorbance 450 nm                                 | 155 |
| Figure 5.14 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> malathion selected strain (F47) at absorbance 450 nm                                 | 155 |
| Figure 5.15 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> malathion selected strain (F52) at absorbance 450 nm                                 | 155 |
| Figure 5.16 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> permethrin selected strain (F39) at absorbance 450 nm                                | 156 |
| Figure 5.17 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> permethrin selected strain (F43) at absorbance 450 nm                                | 156 |
| Figure 5.18 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> permethrin selected strain (F48) at absorbance 450 nm                                | 156 |
| Figure 5.19 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> temephos selected strain (F48) at absorbance 450 nm                                  | 157 |

|             |   |     |
|-------------|---|-----|
| Figure 5.20 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> temephos selected strain (F48) at absorbance 450 nm                     | 157 |
| Figure 5.21 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. aegypti</i> temephos selected strain (F48) at absorbance 450 nm                     | 157 |
| Figure 5.22 | Correlation between LC <sub>50</sub> value and mean esterase activity in <i>Ae. aegypti</i> 3 <sup>rd</sup> instars larvae of malathion and permethrin selected strains | 158 |
| Figure 5.23 | Correlation between LT <sub>50</sub> value and mean esterase activity in <i>Ae. aegypti</i> adult female of malathion and permethrin selected strains                   | 158 |
| Figure 5.24 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> susceptible strain at absorbance 450 nm                              | 162 |
| Figure 5.25 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> field strain at absorbance 450 nm                                    | 162 |
| Figure 5.26 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> malathion selected strain (F1) at absorbance 450 nm                  | 163 |
| Figure 5.27 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> malathion selected strain (F5) at absorbance 450 nm                  | 163 |
| Figure 5.28 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> malathion selected strain (F10) at absorbance 450 nm                 | 163 |
| Figure 5.29 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> permethrin selected strain (F1) at absorbance 450 nm                 | 164 |
| Figure 5.30 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> permethrin selected strain (F5) at absorbance 450 nm                 | 164 |

|             |   |     |
|-------------|---|-----|
| Figure 5.31 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> permethrin selected strain (F10) at absorbance 450 nm            | 164 |
| Figure 5.32 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> temephos selected strain (F1) at absorbance 450 nm               | 165 |
| Figure 5.33 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> temephos selected strain (F5) at absorbance 450 nm               | 165 |
| Figure 5.34 | Non-specific esterase O.D. value and resistance threshold in life stages for <i>Ae. albopictus</i> temephos selected strain (F10) at absorbance 450 nm              | 165 |
| Figure 5.35 | Correlation between $LC_{50}$ value and mean esterase activity in <i>Ae. albopictus</i> 3 <sup>rd</sup> instars larvae of malathion and permethrin selected strains | 166 |
| Figure 5.36 | Correlation between $LT_{50}$ value and mean esterase activity in <i>Ae. albopictus</i> adult female of malathion and permethrin selected strains                   | 166 |
| Figure 6.1  | Gel cassette preparation  | 180 |
| Figure 6.2  | Stacking gel preparation  | 184 |
| Figure 6.3  | Gel sandwich placed in the electrophoresis apparatus  | 188 |