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Nationwide Insecticide Susceptibility Screening Against Six Active Ingredients

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Introduction

Mosquitoes may develop resistance to insecticide active ingredients after repeated exposures. Thus, it is crucial that mosquito populations be tested for resistance to confirm efficacy of control, inform management decisions, and protect public and environmental health.

Objectives

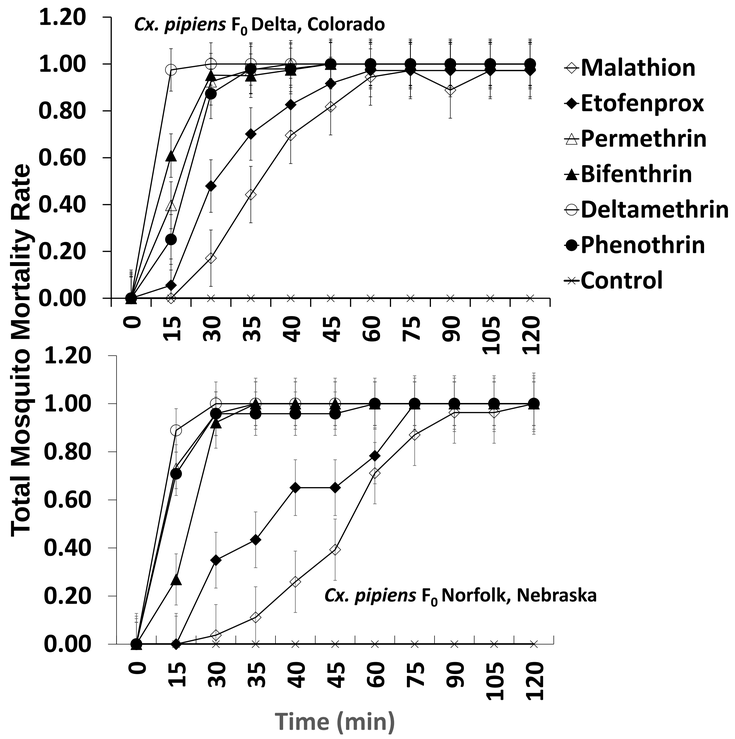
1) Determine a baseline of resistance for six active ingredients commonly used in mosquito control in the United States.
2) Assess the extent to which resistance differs between active ingredients and mosquito genera.

Methods

- Field-collected eggs from 26 mosquito populations of 5 species or hybrid species were obtained from mosquito abatement programs and universities in 5 geographic regions of the United States (Figure 1).
- Centers for Disease Control and Prevention bottle bioassays were used to determine resistance ratios to six active ingredients (bifenthrin, deltamethrin, etofenprox, malathion, permethrin, phenothrin).
- World Health Organization guidelines were used to classify mosquitoes as susceptible (98-100% mortality at diagnostic time), possibly resistant (80-97% mortality at diagnostic time), or resistant (< 80% mortality at diagnostic time).

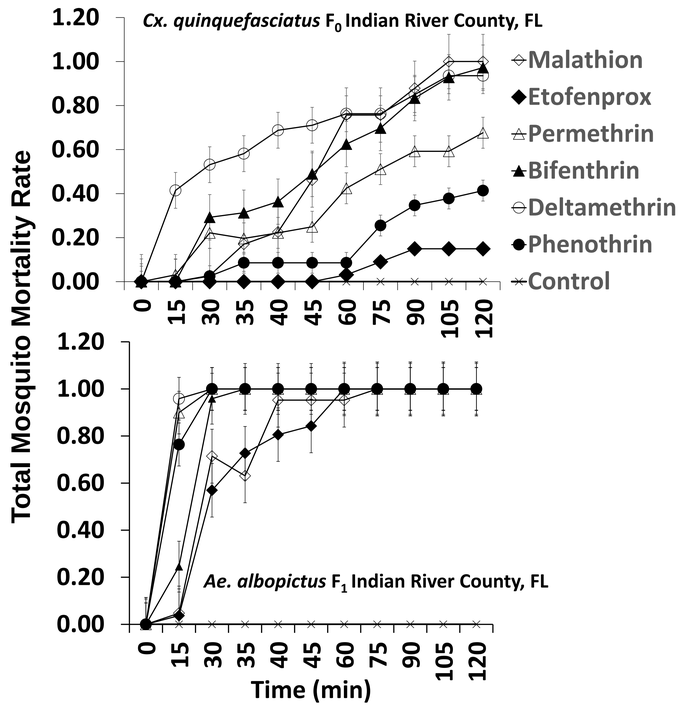
Figure 1. Mosquito Collections

Examples of Results



- **High (9 to 26 fold greater) degree of resistance to malathion and etofenprox compared to other active ingredients.**

Examples of Results



- **Differences observed in resistance profiles between genera.**
- ***Aedes* spp. generally more susceptible than *Culex*.**

Highest to lowest (%) mortality at diagnostic time

Ae. albopictus (N = 12 populations)

Phenothrin > Permethrin ≈ Deltamethrin ≈ Bifenthrin > Malathion > Etofenprox
(99.8) (97.7) (97.3) (97.2) (43.9) (26.8)

Ae. triseriatus (N = 1)

Bifenthrin = Deltamethrin = Malathion = Permethrin = Phenothrin > Etofenprox
(100) (100) (100) (100) (100) (32.0)

Cx. pipiens (N = 4)

Deltamethrin > Permethrin > Bifenthrin > Phenothrin > Malathion > Etofenprox
(100) (89.8) (84.3) (80.3) (29.0) (3.8)

Cx. pipiens/quinquefasciatus (N = 1)

Deltamethrin > Bifenthrin > Phenothrin > Permethrin > Malathion > Etofenprox
(96.0) (22.0) (15.0) (12.0) (9.0) (0)

Cx. quinquefasciatus (N = 8)

Deltamethrin > Permethrin > Bifenthrin > Malathion ≈ Phenothrin > Etofenprox
(87.9) (43.0) (39.0) (21.8) (21.5) (0)

General Observations

- *Aedes* spp. and *Culex* spp. exhibited variation in resistance ratios.
- Susceptibility to active ingredients was higher in *Aedes* compared to *Culex* spp.

- Survival analyses indicated significant differences in survival of mosquitoes between active ingredients, genera, and regions.

Conclusions

- Resistance ratios for mosquitoes may help us understand resistance trends and highlights the importance of surveying efficacy of control measures.
- Some *Culex* populations were highly resistant (never achieved 80% mortality during experiment).
- Trend most prevalent when exposed to phenothrin and etofenprox.
- High degree (9 - 26 fold greater) of resistance to etofenprox and malathion compared to other active ingredients tested.

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