



Combatting Resistance

It can be as easy as switching trucks mid-season!

Resistance monitoring assays conducted on New Jersey mosquito populations reveal that resistance has been detected to both pyrethroid and organophosphate active ingredients. The attached report shows results of CDC bottle bioassays conducted with New Jersey *Ae. albopictus* and *Cx. restuans* since 2017.

The good news is it is not too late to act. Populations classified as 'susceptible' and 'developing resistance' are present in New Jersey and **now** is the time to develop and implement resistance management strategies. Thanks to Jack Peterson and his collaborators for conducting this valuable research and allowing us to disseminate it.

Facts

1. A review of the scientific literature reveals that resistance is a widespread problem that needs to be addressed.
2. Rotation of chemical classes (i.e. between a pyrethroid and organophosphate) is the recommended rotational strategy from the Insecticide Resistance Action Committee (IRAC).
3. The rotation interval will depend on your local mosquito populations, and their response to various adulticides. However rotating chemical classes on a bi-annual basis is recommended.
4. True rotation is switching between products with different modes of action. Therefore, switching between various pyrethroid active ingredients (etofenprox, sumithrin, deltamethrin, resmethrin, prallethrin, permethrin) or combinations of these products is **NOT** a true rotational strategy. These active ingredients, although different, act on the same target site in the mosquito and should be rotated with active ingredients that act on a different target site.
5. Malathion is one of the only organophosphates that can be applied by ground and should be used in rotation with pyrethroids. Fyfanon EW is the new low odor formulation of Malathion, now available.

Operational Recommendations

1. From your fleet of ground-adulticiding vehicles, set up 1/2 with your preferred synthetic pyrethroid product and the other 1/2 with Fyfanon (EW is low odor formulation; ULV is more cost effective, but has an odor).
2. Mid-season (approximately July 15th) switch the routes that spray trucks are applying. Routes that were being treated with the synthetic pyrethroid product will now be treated with Fyfanon for the remainder of the season and vice versa.

Benefits

- Rotating insecticides will delay the onset of insecticide resistance and preserve the effectiveness of your adulticides.
- This strategy does not require recalibration.
- Applicators can keep their original routes when the products are rotated mid-season.

Results and Key Findings from Peterson et al. 2019

Peterson et al. 2019 reports the results of CDC bottle bioassays performed by New Jersey mosquito control programs from 2017 to 2019. The pyrethroid active ingredients permethrin, etofenprox, sumithrin, and the organophosphate active ingredient, malathion, were evaluated against several *Aedes albopictus* and *Culex restuans* populations.

The CDC bottle bioassay characterizes mosquitoes as susceptible, developing resistance, or resistant, based on their mortality at a diagnostic time. The results from Peterson et al. 2019 are summarized below.

Susceptible > 97% Mortality	Developing Resistance 90 – 96% Mortality	Resistant < 90% Mortality
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County	Species	Active Ingredient	% Mortality at Diagnostic Time		
			2017	2018	2019
Cumberland	<i>Aedes albopictus</i>	Etofenprox		100	86.67
Monmouth	<i>Aedes albopictus</i>	Etofenprox		97.53	38.1
Morris	<i>Aedes albopictus</i>	Etofenprox			93.88
Salem	<i>Aedes albopictus</i>	Etofenprox		93	100
Mercer	<i>Aedes albopictus</i>	Malathion	95	100	
Middlesex	<i>Aedes albopictus</i>	Malathion	90.2		92.59
Salem	<i>Aedes albopictus</i>	Malathion			81.38
Cumberland	<i>Aedes albopictus</i>	Permethrin			55.17
Hudson	<i>Aedes albopictus</i>	Sumithrin	100	100	
Hunterdon	<i>Culex restuans</i>	Malathion			100
Hunterdon	<i>Culex restuans</i>	Permethrin			95.45
Warren	<i>Culex restuans</i>	Sumithrin			93.62

Key Findings:

- Susceptibility and resistance were detected to both pyrethroids and organophosphates.
- Some populations transitioned from being susceptible to resistant over time while others regained susceptibility. This is evidence that it is possible to regain susceptibility, which is enhanced by a rotational strategy.
- Resistance to commonly used active ingredients has been detected in New Jersey. Resistance monitoring should continue over time so action can be taken, and integrated strategies can be implemented.
- Rotating between pyrethroids and organophosphates actively fights against resistance and can delay or prevent it.

Reference: Peterson J, Rainey T, Cervantes K, and Crans S. 2019. Insecticide Resistance Monitoring in New Jersey. Proceedings of the New Jersey Mosquito Control Association. *In Press*.