DELAWARE MOSQUITO CONTROL SECTION

FAQ #3. What kinds of insecticides are used, and when do you use them?

A variety of insecticides are needed for performance of modern-day mosquito control, and are used only when and where other types of control are not practicable to do (see FAQ #4 for a discussion of alternative control methods to insecticide use). The Mosquito Control Section utilizes insecticides as an important component of its **Integrated Pest Management (IPM)** program. Please note that IPM does not mean that no insecticides can be used (as sometimes popularly misunderstood), nor that insecticides must be only a minor part of an IPM control strategy. Rather IPM refers to making the best use of **a combination of the most practicable control methods at our disposal** to deal with real world situations in treating pest problems only when and where they occur, doing such in the most efficacious, environmentally-compatible, cost-effective manner possible.

There are two basic types of mosquito control insecticides – **larvicides** for control of larval or immature mosquitoes, selectively applied to wetland areas and other aquatic larval habitats; and **adulticides** for control of flying or resting adults, selectively used primarily in upland areas where adults on-wing are causing problems. All insecticides that we use are registered by the U.S. Environmental Protection Agency (EPA) for the types of applications we perform. Insecticide applications are done only when and where we have indications of unacceptable or intolerable numbers of mosquitoes undergoing larval development or already on-wing, and these mosquitoes must also be of the dozen or so species that are particularly problematic biters of humans or other mammals. Indications of when and where spraying is necessary are derived through **an extensive and intensive field surveillance/monitoring effort**, involving a variety of detection efforts – e.g. larval sampling in wetlands and other mosquito-production areas ("dipper counts"); landing rate counts (i.e. numbers of adult female mosquitoes that land on a field inspector per minute); nightly adult light trap collections; detection or occurrence of disease viruses or other pathogens within mosquitoes themselves or in sentinel organisms; the numbers and patterns of public complaints received; etc. No spraying is done unless threshold criteria (involving subjective or objective measures) are exceeded for these various indicators, and quite often a combination of indicators is used.

Spray applications might be aerially done using fixed-wing aircraft or helicopters for larvicides or adulticides, or might involve truck-mounted applications of larvicides (via "pump truck") or adulticides (via "foggers"). Larviciding to treat small areas or container habitats is often done on-foot, using backpack sprayers or hand-tossed formulations. The choice of what type of insecticide to use and its mode of delivery is dependent upon the type of species to be controlled, the life stage(s) targeted for control during any particular brood, and the type of habitat or location where spraying will occur. Since in almost all cases larviciding involves less direct exposure of people to insecticides than adulticiding, whenever we have to spray we usually **always prefer to try to larvicide first**, and turn to **adulticiding only as a last resort**.

The timing for when we apply our insecticides, and for how the applications are done, is also determined (and quite often complicated) by weather conditions (e.g. air temperature, wind speed and direction, humidity, rainfall), all which must be considered in our performing appropriate and allowable treatments. All of our public spray announcements have the condition of "weather permitting." When dealing with saltmarsh mosquito larval control, we must also take into consideration daily tide stages and the monthly lunar tide cycle too. In doing our spring woodland-pool species control, we are often racing against the calendar to complete our aerial larviciding before forest canopy leaf-out prevents effective spraying of our products. And you can probably readily envision the many problems we face when trying to treat urban or congested areas – think about all the things you might have to deal with when trying to operate a truck-mounted adulticide sprayer as one encounters crowds of people along the streets, traffic jams, or detours, during an effort to prescriptively apply uniform amounts or concentrations of an insecticide – this is one reason why you might see inner-city ground adulticiding being performed 3:00 am in the early morning rather than 5:00 pm in afternoon.

Our frontline <u>larvicides</u> are ***Bti*** (e.g. VectoBac, VectoLex, Teknar or Aquabac, which are all bacterially-produced insecticides) and ***methoprene*** (e.g. Altosid, a juvenile growth hormone mimic), both which can be applied in liquid or granular formulations. *Bti* is primarily effective against earlier immature stages, and seems to work better (or at least more consistently) for control of freshwater species (e.g. spring woodland-pool breeding species) than for saltmarsh mosquitoes of the open marsh. *Methoprene* is best used against later immature stages, and is effective against both freshwater and saltmarsh species, but still has to be applied before the larvae pupate. Both *Bti* and *methoprene* are state-of-art, third-generation pesticides that are classified as "biorational" products. Another type of larvicide available to us is ***temephos*** (e.g. Abate, an organophosphate second-generation insecticide), which we use in liquid formulation for control of freshwater mosquitoes in roadside ditches, or in granular form for saltmarsh mosquito control in areas of heavy wetlands vegetation – *temephos* is effective against all larval stages. A final type of larvicide that we occasionally use are ***monomolecular surface films*** (e.g. Agnique or Arosurf) to treat larvae or pupae, usually hand-applied to container-breeding or other types of confined freshwater habitats.

Our frontline aerially-applied <u>adulticide</u> to treat problem mosquitoes on-wing is ***naled*** (Trumpet or Dibrom, an organophosphate), which is equally effective against freshwater or saltmarsh mosquitoes. [*Naled* is used by many mosquito control programs around the country; as is another organophosphate adulticide, *malathion* (e.g. Fyfanon or Atrapa) which the Section currently does not use.] Another category of adulticides that we use is synthetic pyrethroids, which seem to be more efficacious when applied by truck-mounted sprayers ("foggers") than by aircraft. The primary synthetic pyrethroid that we use for ground "fogging" is ***permethrin*** (e.g. Permanone, Biomist, Aqua-Reslin), although alternatives such as ***resmethrin*** (e.g. Scourge) or ***sumithrin*** (e.g. Anvil) are also available and used around the country. Natural pyrethroid derivatives such as ***pyrethrin*** (e.g. Pyrenone) can also be used. Unfortunately, in comparison to *naled*, synthetic pyrethroids

don’t seem to be as efficacious against saltmarsh mosquitoes, nor seemingly as good for aerial applications.

It is important that we have this diversity of mosquito control insecticide products to call upon, since we need such versatility in dealing with different target species, different brood or life stages, different types of habitats to treat, varying weather conditions to work under, special concerns for avoiding certain types of potential non-target impacts, etc. We must also take steps not to overuse any one of these products against our local mosquito populations, in order to avoid or at least postpone the possible appearance of **insecticide resistance** (which undercuts effective control) among our target species. Insecticide resistance can arise through overly-aggressively targeting certain species or life stages with but a single product, such that the small percentage of any species population that might be naturally resistant to whatever insecticide is being used then greatly multiplies because of its essentially insecticide “resistant” or immune nature, to then dominate future generations of the target species (for which we would then have one less control tool that will work). As such, for avoidance of resistance problems alone, it’s important to be able to use and rotate a variety of insecticides in our control work, and to also adopt new insecticides whenever possible and appropriate.