The Use of Pesticides in Mosquito Control

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More people are becoming increasingly aware of mosquito control programs using insecticides to prevent outbreaks of diseases to humans, and they may be wondering about these chemicals and how they are engineered to target specific organisms. This article will provide information about several of the pesticides currently being used, and their toxicity to humans. The Environmental Protection Agency (EPA), which enforces the stringent standards mandated by the *Federal Insecticide, Fungicide, and Rodenticide Act*, is charged with regulating all chemicals being used to control pests and disease carrying organisms. As a condition of their registration, these products are extensively tested up to12 years to ensure that risks to humans and the environment are minimal when the chemicals are used as directed.

Pest management control programs involve ongoing research, field surveillance and control operations, and public education. Control operations are based upon a thorough knowledge of the target. Only when surveys indicate a specific need, are public health insecticides considered for use.

Control of mosquito larvae is accomplished through proper water and land use management, in conjunction with the EPA-approved larvicide program, when required. Larvicides come in four basic types, each possessing a different mode of action. Stomach poisons must be ingested; *Bacillius thuringiensis israelensis* (or B.t.i.) is a live bacterial spore that produces a toxin when it comes in contact with the chemicals in the mosquitoes' gut. Growth regulators include methoprene, which is a hormone that prevents the larvae from eventually molting to an adult. Surface films inhibitors include ®Agnique MMF, which reduces the surface tension of the water, making it impossible for the larvae to attach their breathing tubes at the surface, thus drowning them. Others may physically obstruct the breathing apparatus of the larvae, in effect suffocating them. Contact poisons such as temephos, is a nerve poison that is rarely used, however, it is labeled for use in potable water.

Because these larvicides are to be used in sensitive aquatic environments, they are specifically designed to minimize their impact on non-target organisms. They must be applied, by law, only to a predefined target site following guidelines that are specified on the label. To ensure its effectiveness, the application rate for each larvicide is calculated on the basis of its toxicity profile and degradation characteristics. For example, the application rate for methoprene is calculated to achieve a final concentration in water of between 0.22 to 1.1 parts of product per billion (ppb). This would be equivalent to an initial dose of roughly one drop of the chemical in an Olympic sized swimming pool.

Modern pest management strategies endorsed by the EPA and the Centers for Disease Control and Prevention recommends application of adulticides when surveillance indicates that larval control measures have proven inadequate to prevent imminent disease outbreaks. Certified operators trained in the special handling requirements for

adulticides, apply them after dusk when mosquitoes are most active and non-target species are generally at lower risk. Larvicides, such as B.t.i, are applied in tablet form (or briquettes). Adulticides are usually applied in aerosol form comprised of extremely small droplets (74 million droplets could fit inside a "BB") so that they remain airborne to impinge upon mosquitoes in flight at the time of application. The minute droplet size also ensures that products dissipate and degrade quickly, to minimize any deposition of active ingredient on the ground or other surfaces. The low application rates of these aerosols — generally less then a half an ounce of insecticide per acre treated, further minimizes environmental risk.

Adulticides used in the United States fall into two general chemical categories, organophosphates and pyrethroids. Only two organophosphates, malathion (®Fyfanon) and naled (®Dibrom, ®Trumpet), are in general use for adult mosquito control. Malathion is a popular choice because of its low price, proven efficacy and relatively low level of toxicity. Pyrethroids constitute the other class of adulticides. Three products currently on the market, resmethrin (®Scourge), sumethrin (®Anvil) and permethrin (®Aqua-Reslin) are produced from a highly potent chrysanthemum extract. These synthetic derivatives have a longer shelf life and are as much as 50 times less toxic than the natural insecticide, whilst performing the same function. The pyrethroids and organophosphates are rotated at specified intervals in mosquito management programs to prevent the mosquitoes from becoming resistant after long-term exposure to a single group of pesticide.

Toxicity profiles of adulticides are well known and form the basis for the label recommendations mandated by EPA. Table 1 lists toxicity categories applicable to insecticide labels defined by EPA. Malathion and all pyrethroids are designated Category III (Slightly Toxic), and all larvicides that are applied fall under Category IV. A comparison of mosquito larvicide oral toxicities along with common household products is provided in [Table 2]. However, ingestion by the public of adulticides during their normal usage is unlikely, and lethal amounts for an average adult are more likely to result from inhalation and skin absorption [Table 3]. Note that lethal toxicities to humans in this context range from 250 to 10,000,000 times the standard label rate.

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Table 1. Human Toxicity Rating and Labeling Requirements for Pesticides

Category (Human Toxicity)	Signal word required on label	Probable oral lethal dose (Human)
I highly toxic	DANGER-POISON (skull and crossbones)	a few drops to a teaspoon
II moderately toxic	WARNING	over 1 teaspoon to 1 ounce
III slightly toxic	CAUTION	over 1 ounce
IV practically non-toxic	none required	

Table 2. Comparative Toxicity of Larvicides Used in Mosquito Control to Common Household products

Common Name	Trade Name ®	Oral LD50 (Rat)***
Aspirin	Various	1900
Table Salt	Various	4500
Monomolecular Film	Agnique MMF Golden Bear	>20,000
Table Sugar	Various	27,000
Methoprene	Altosid	>34,600
Bti	Various	Non-toxic

*****LD50 is the dose, expressed in milligrams of active ingredient per kilogram of body weight needed to kill 50 % of the subject (rat) population. Higher numbers indicate lower toxicity.**

Table 3. Comparison of lethal levels* of insecticide for 165 lb human to actual exposure during adulticide application

Insecticide	Dermal (lethal amount)	Actual Dermal Exposure	Inhalation (lethal amount)	Actual Inhalation Exposure
Naled	29.25	0.0084	0.193	0.0007
Phenothrin	>150	0.00156	2.1	0.00013
Malathion	>150	0.0504	4.0	0.0042
Resmethrin	187.5	0.00312	>9.5	0.00026
Permethrin	300	0.00312	2,350.0	0.00026

***grams of insecticide/cubic meter of air**