Section 6: Human Health

Learning Objectives

When you have completed this section, you should be able to:

- select pesticides for mosquito and black fly control on the basis of their oral and dermal LD_{50} values
- describe how blood cholinesterase tests work
- list the pesticides for which blood cholinesterase tests could be used to establish if poisoning has occurred

Reduce Risk with Least Toxic Pesticides

The General Pesticide Safety Manual emphasized that when you have a choice of pesticides to use it is preferable to select the product that is least toxic. To help you in this selection the acute oral LD_{50} values for the active ingredients used in biting fly control are shown in Table 1. **To reduce risk choose the product with the highest LD_{50} values.**

Table 1. LD_{50} Values, Formulation Types and Chemical Group of Insecticides Used for Mosquito or Black fly Control.

LARVICIDES

COMMON NAME	FORMULATION*	ORAL LD_{50}	DERMAL LD_{50}	CHEMICAL GROUP**
chlorpyrifos	G/EC	135-163	202	OP
malathion	G/EC	1,375	>4,400	OP
diflubenzuron	G/WP	4,600	4,000	P
BT H-14	G/L	>30,000	>30,000	Bacteria
methoprene	B/L	>34,600	>30,000	FA

* G=granular; L=liquid; EC=Emulsifiable concentrate; WP=Wettable Powder; B=Briquette; T=Tossits

** OP=organophosphate; CH=chlorinated hydrocarbon; B=botanical; P=phenyl-urea(insect growth regulator); FA=fatty acid(insect growth regulator)

ADULTICIDES

COMMON NAME	USE*	ORAL LD_{50}	DERMAL LD_{50}	CHEMICAL GROUP**
dichlorvos	TF/ULV	80	107	OP
propoxur	R/TF/ULV	90-128	1,000	C
chlorpyrifos	R/TF	135-163	202	OP
naled	R/TF/ULV	430	800	OP
resmethrin	TF	750	3,040	SB
malathion	TF/ULV	1,37	>4,400	OP
pyrethrin	TF/ULV	>1,800	1,800	B
methoxychlor	R/TF	6,000	>6,000	CH

* R=residual spray; TF=thermal fog; ULV=ultra low volume

** OP=organophosphate; CH=chlorinated hydrocarbon; C=carbamate; B=botanical; SB=synthetic botanical

Organophosphate and Carbamate

The most acutely toxic insecticides used for mosquito and black fly control are in the organophosphate and carbamate groups. These products inhibit the activity of an enzyme known as **acetyl cholinesterase** or simply **cholinesterase**. Overexposure to these pesticides may lead to a significant decline in the activity of this enzyme and acute poisoning. It is important to understand the role cholinesterase in the normal function of nerve cells.

When a nerve impulse travels from the brain to initiate the movement of a muscle, it must pass through a number of nerve junctions. At each junction, a chemical called acetyl choline is released to carry the nerve impulse across the gap between nerve cells. When acetyl choline reaches the next nerve cell the impulse continues down the next nerve. The acetylcholine is then quickly destroyed by the enzyme cholinesterase. If it were not destroyed repeated nerve impulses would be sent down the nerve. If cholinesterase is not working, the acetylcholine is not broken down and nerve impulses are repeatedly sent down the nerve. This results in a variety of poisoning symptoms ranging from headache, fatigue, and dizziness in mild poisoning through nausea, trembling, convulsions, respiratory failure and death in severe poisoning.

A blood test is available to help medical personnel establish whether the symptoms are the result of poisoning by organophosphate or carbamate insecticides. When overexposure occurs, the cholinesterase level in the blood as well as that at nerve junctions is reduced in activity. Therefore, if a reduced level of cholinesterase in the blood is detected, it indicates poisoning from these insecticides.

However, there is no standard level of cholinesterase activity in human blood and the person to person variation in activity is very large. Therefore individuals working with organophosphate or carbamate insecticides should have their normal cholinesterase activity in their blood measured before working with these pesticides. This normal level is used for comparison to subsequent tests when poisoning is suspected.

In the absence of additional exposure, blood cholinesterase enzymes will regenerate in about 120 days from very low to normal values in the case of organophosphate poisoning, and more rapidly for carbamate insecticides. Cholinesterase testing must be done immediately following exposure to be of much value. The test is ineffective for the carbamate fungicides.

It is recommended that applicators working frequently with organophosphate pesticides or carbamate insecticides monitor the severity of their exposure to these compounds through a cholinesterase test program.

Contact your family physician and plan the time of your pre-season baseline test and one or more tests during the spray season.

Botanical and Synthetic Botanical

As their name implies, botanical insecticides are derived from plants. The only botanical used in mosquito and black fly control is **pyrethrin**. Pyrethrin is extracted from the flower heads of the chrysanthemum plant. It is a mixture of four compounds with similar chemical structure. **Resmethrin** is a synthetic pyrethroid with very similar characteristics to natural pyrethrum.

These compounds disrupt the electrical transmission of the nerve impulse. By disrupting the transmission of the nerve impulse, the muscle system is rapidly paralysed.

Poisoning by this group is rare because of the low percentage of active ingredient in the products available and their relatively high LD_{50} values. Symptoms of poisoning range from lack of coordination, tremors, salivation, and irritability to sound and touch, to the severe poisoning symptoms of nausea, vomiting, diarrhea.

Chlorinated Hydrocarbon

Methoxychlor is the only chlorinated hydrocarbon insecticide used for the control of mosquitoes and black flies. Chlorinated hydrocarbon insecticides disrupt the electrical transmission of nerve impulses. Methoxychlor does not show the characteristics of many other chlorinated hydrocarbons. It is not persistent, does not bioaccumulate or biomagnify. It has a relatively high LD_{50} and poisoning is rare. Symptoms of mild poisoning include: dizziness, excessive sweating, headache, muscular twitching, fatigue, nervousness, nausea, convulsions, and vomiting.

Other Products

Methoprene and **diflubenzuron** are relatively new products that do not affect the nervous system. Methoprene mimics the action of juvenile hormone in insects. Methoprene results in the death of the insect when it attempts to moult from the pupal stage to the adult.

Diflubenzuron acts by disrupting the formation of **chitin** in the insect exoskeleton. Diflubenzuron and methoprene are virtually nontoxic mammals.

Bacillus thuringiensis israelensis (H14) is a bacteria that controls the larvae of both mosquitoes and black flies. When ingested by the larvae it produces a toxin in the stomach of insects that results in their death. It is virtually nontoxic to mammals.

Review Questions

1. Based on the oral LD_{50} what is the most toxic larvicide?

2. Based on the oral LD_{50} what is the most toxic adulticide?

3. In general the oral LD_{50} values are _____ than the dermal values.

4. Which group of insecticides have the lowest LD_{50} values?

5. What is cholinesterase?

6. When should cholinesterase tests be done?

7. Cholinesterase tests will help establish if poisoning has occurred from which group(s) of insecticides?

8. List the symptoms of poisoning associated with an organophosphate or carbamate insecticide.

9. List the symptoms of poisoning associated with botanical or synthetic botanical insecticides.

10. List the symptoms of poisoning associated with chlorinated hydrocarbon insecticides.