Module 14

Insecticides and Larvicides - Formulations and Dosages

At the end of the module, the participant will be able to understand:

- Chemical control
- Use of larvicides for vector control
- Use of insecticides for vector control
- Space spray
- Thermal fogging
- Safe handling of insecticides
- Storage
- Transportation

The following pesticides (chemicals) have been used to control vector-borne diseases by attacking both larvae and adults of vector species.

Use of Larvicides for Vector Control

Larviciding has to be done at weekly/ fortnightly intervals to avoid the emergence of adults. Its application is difficult and expensive on a long-term basis, therefore chemical larvicides are best used in situations where the disease and vector surveillance indicate the existence of certain periods of high risk and in localities where outbreaks might occur.

The following approved larvicides from the Dte. of NCVBDC can be used for the control of aquatic stages:

Table 1.Larvicides Formulations and Dosages

	Name of Larvicide	Comm-ercial Form-ulation	Prepa-ration of Ready-to-spray Form-ulation	1 square meter	50 Linear Meter	Per Hectare	Freq-uency of Appli-cation	Equip-ment Requ-ired	Remarks
1	MLO	100% petroleum project product	As it is	20 C.C.	1 Litre	200 Litres	Weekly	Knapsack/ hand compr-ession sprayer	To be applied along the shore of the water body

2	Temephos (Abate)	50% EC	2.5 c.c. in 10 litres of potable water	20 C.C.	1 Litre	200 Litres	-do-	Knapsack/ hand compr-ession sprayer	Can be applied in clean water
3	Bacillus thuring-iensisvar israelensis 164H Wettable Powder (WP)		5 kg in 200 litres of water	do	do	200 ltr.	Fort-nightly	Knapsack/ hand compr-ession sprayer	For both clean and non-potable polluted water
4	Bacillus thuring-iensisvar israelensis 12 Aqueous Suspe-nsion (AS)	Aqueous suspension 12 Aqueous Suspension	1 litre in 200 litres of water	do	do	200 Lit.	Weekly	Knapsack/ hand compr-ession sprayer	**Clean water**
			2 litres in 200 litres of water	do	Do	200 Lit.	Weekly	Knapsack/ hand compr-ession sprayer	**Polluted water**
5.	B.t.i. 5% WP Strain – ABIL, Serotype H-14, Accession No. NAIMC—B-01318	5% Aqueous suspension	5 lt.in 200 litres of water (250 cc in 10 litres)	-do-	-do-	200 Ltr	Fort-nightly	Knapsack/ hand compr-ession sprayer	**Clean water**
			7.5 lt. in 200 litres of water (375 cc in 10 litres)	-do-	-do-	200 ltr		Knapsack/ hand compr-ession sprayer	**Polluted water**
6.	Diflubenzuron 25%	25% wetable powder	100 gm (25 mg a.i.) in 100 litres of clean water (10 g in 10 litre)	-	-	100 ltr.	Weekly	Knapsack/ hand compression sprayer	**Clean water** **Polluted water**
			200 gm (50 mg a.i.) in 100 litres of clean water (20 g in 10 litre)	-	-	100 ltrs			

7.	Pyriproxifen (IGR)	0.5% granular	Ready to use	-	-	2 kg Clean water	Weekly	Granular applicator / Hand broadcast	**Clean water**
						4kg Polluted water			**Polluted water**

The rural areas with extensive breeding sites covered under the adulticiding programme are traditionally not covered under larviciding in India except in certain situations where dengue cases are reported or rural areas have been urbanised. Control personnel engaged in anti-larval programmes should always encourage house occupants to control larvae through environmental sanitation.

Figure 41.Larviciding Activities for LSM

Insect Growth Regulators

Insect growth regulators (IGRs) interfere with the development of the immature stages of the mosquito by interfering with chitin synthesis during the moulting process in larvae or disrupting pupal and adult transformation processes. Most IGRs have extremely low mammalian toxicity.

Two such compounds have been recommended in the programme i.e., pyriproxifen and diflubenzuron.

2 Use of Insecticides for Vector Control

Insecticidal Residual Spray (IRS): Insecticidal Residual Spray is one of the most cost-effective control measures for Malaria and Kala-azar in India. To maximise the impact of the IRS, it should be synchronised with case detection.

The objective of the IRS is to interrupt the transmission by reducing the number of infective vectors. This can be achieved by ensuring the safe and correct application of the insecticide to indoor surfaces of houses and animal shelters. For malaria only human dwelling and for Kala azar both human dwelling and animal shelters are covered. The success of IRS operations depends on the planning and implementation.

IRS plans should be developed before the end of the year so that there is no last-minute rush during implementation. IRS planning should be made, based on the capacity for achieving complete and uniform coverage. When there are resource constraints it is preferable to limit the size of the operation and achieve quality coverage.

Insecticide Formulations

Presently, different formulations of synthetic chemical insecticides are in use for vector control. Wettable powder (WP) formulations are used for indoor residual sprays while emulsion concentrate (EC) formulations are used for larval control.

For Indoor Residual spray (IRS) insecticides in use are DDT 50% WP, malathion 25% WP and synthetic Pyrethroid (WP). Synthetic pyrethroids include deltamethrin 2.5% WP, cyfluthrin 10% WP, lambda-cyhalothrin 10% WP, alphacypermethrin 5% WP, etofenprox 10% WP and bifenthrin 10% WP. Synthetic pyrethroid insecticides are also used for impregnation of bed nets.

Table 2.Insecticides Formulation and Its Dosages

S. No.	Name of Insecticide	Amount of Insecticide to Prepare 10 Litres of Suspension (kg)	Dosage per Sq. Metre of Active Ingredient	Residual Effect in Weeks	Area (in sq. m) to be Covered by 10 Litres of Suspension	Requirement of Insecticide Per Million Population (in MT)
1.	DDT 50% WP	1.000	1 gm	10–12	500	150.00
2.	Malathion 25% WP	2.000	2 gm	6–8	500	900.00
3.	Deltamethrin 2.5 WP	0.400	20 mg	10–12	500	60.00
4.	Cyfluthrin 10% WP	0.125	25 mg	10–12	500	18.75
5.	Lambdacyhalothrin 10% WP	0.125	25 mg	10–12	500	18.75
6.	Alphacypermethrin 5% WP	0.250	25 mg	10–12	500	37.50
7.	Bifenthrin 10% WP	0.125	25 mg	10–12	500	18.75

Indoor Residual Spray (IRS)

Most of the insecticides having residual effects are sprayed indoors, so that mosquitoes after having bitten an infective person will rest in the house and will pick up sufficient insecticide particles sprayed on the walls and other indoor surfaces of the house and its longevity will be reduced so much so that it does not survive to become infective. In areas where the vectors are strongly endophilic, i.e. they tend to rest indoors, indoor residual spraying of human dwellings can give very effective control. Vectors that are exophilic i.e. they tend to rest outdoors but tend to feed or rest indoors briefly, can be effectively controlled by indoor residual spraying with insecticides that have a good airborne effect. In areas where vectors are strongly exophilic and/ or exophagic, i.e. they rest and bite outdoors, other control methods, such as the use of insecticide-treated mosquito nets or exterior space spraying (for emergency control), should be considered.

Figure 42.Indoor Residual Spray

In practice, the effectiveness of house spraying for malaria control depends on adherence to the specified criteria of the insecticide and application procedure, public acceptance of spraying, the availability of well-maintained equipment, adequately trained spraying personnel, efficient supervision and strong financial support. The size of the area depends on local circumstances and is influenced by the distribution of malaria and malaria vectors; distance from important breeding sites, the flight range of the vectors and demographic features.

Target Area: Generally, all the interior walls and ceilings are treated. In addition to permanent human dwellings, field huts where people sleep during the planting or harvesting season should be sprayed depending on local vector behaviour. The underside of furniture, back of the doors, outside caves and porch may need to be treated. It should be noted that the residual effect of insecticides may be short on some surfaces, e.g. porous mud walls, oil-painted wood and alkaline whitewash.

Selection of Insecticides

Several factors need to be considered in the selection of an insecticide spraying, including availability, cost, residual effectiveness, safety, vector susceptibility and excito-repellency. There are a large number of insecticides, which are used as adulticides for indoor residual spray. These are DDT, Malathion and different formulations of synthetic pyrethroids. In India, insecticides are introduced into public health programmes based on entomological parameters and their impact on disease incidence/ prevalence.

Space Spray

Space spray is usually used to knock down the infected population of vector mosquitoes resting indoor situations. Pyrethrum extract 2% EC and Cyphenothrin 5% EC are being used for space spray. The pyrethrum 2% extract is used in a 1:19 ratio with kerosene oil or diesel.

Indoor Space Spray

S. No.	Name of Insecticide	Commercial Formulation	Preparation of Formulation	Equipment Required	Remarks
1.	Pyrethrum extract	2.0% extract	1:19 i.e. 1 part of 2% Pyrethrum extract in 19 part of Kerosine (50 ml in 1 litre K. oil)	Pressurised spray machine or fogging machine	Used for indoor spray
2.	Cyphenothrin	5% EC	0.5 gm a.i. Per sq metre (20 ml in 1 litre of K.oil)	- do	-do-

Thermal or ULV Fogging

During the outbreak situations, Thermal fogging or ULV is used in indoor and outdoor situations. Manually operated machines are used inside the premises, while the vehicle-mounted machines are used for outdoor situations. The following insecticides are used for thermal fogging/

These are additional interventions being implemented such as indoor space spraying, fogging or ultra-low volume (ULV) spray. However, the evidence base for aerial or truck-mounted ULV is limited since this intervention has no sustained impact on mosquito populations, and is not cost-effective for routine delivery. Vector control interventions are similar whether the disease is in urban or rural areas. In the case of JE-affected areas, coverage of the village reporting cases should be 100% with ULV. Malathion technical is recommended for outdoor fogging.

Safe Handling of Insecticides

Exposure to insecticides may occur when handling and spraying insecticides. Exposures to insecticides may occur in the following situations:

- When handling the insecticide product during the opening of the package, mixing and preparation of the spray.
- When spraying the insecticide.
- When disposing of the insecticide solution and containers

General Precautions

1. The operator should also wear a protective hat and face shield or goggles.
2. Do not eat, drink or smoke while working.
3. Wash hands and face with soap and water after spraying and before eating, smoking or drinking.
4. Shower or bath at the end of every day's work and wear new clean clothes.
5. Wash overalls and other protective clothing at the end of every working day in soap and water and keep them separate from the rest of the family's clothes.
6. If the insecticide touches the skin, wash it off immediately with soap and water.
7. Change clothes immediately if they become contaminated with insecticides.
8. Inform the supervisor immediately if one feels unwell.

Protective clothing and equipment absorption of insecticide occurs mainly through the skin, lungs and mouth. Specific protective clothing and equipment given below must be worn in accordance with the safety instructions on the product label.

- Broad-rimmed hat (protects head, face and neck from spray droplets).
- Face shield or goggles (protects face and eyes against spray fall-out).
- Face mask (protects nose and mouth from airborne particles).
- Long-sleeved overalls (worn outside of boots).
- Rubber gloves.
- Boots.

Storage

1. Insecticide storehouses must be located away from areas where people or animals are housed and away from water sources, wells, and canals.
2. They should be located on high ground and fenced, with access only for authorised persons. However, there should be easy access for insecticide delivery vehicles and, ideally access on at least three sides of the building for fire-fighting vehicles and equipment in case of emergency.
3. Insecticides must NOT be kept where they would be exposed to sunlight, water, or moisture which could affect their stability.
4. Storehouses should be secure and well-ventilated.
5. Containers, bags or boxes should be well stacked to avoid the possibility of spillage. The principle of the first expiry first out should be followed.
6. Stock and issue registers should be kept up to date. Access to the insecticides should be limited to authorised personnel only.
7. The store room should have a prominently displayed mark of caution used for Stock and issue registers should be kept up to date. Access to the insecticides should be limited to authorised personnel only. The store room should have a prominently displayed mark of caution used for poisonous or hazardous substances. It should be kept locked.
8. Containers should be arranged to minimise handling and thus avoid mechanical damage which could give rise to leaks. Containers and cartons should be stacked safely, with the height of stacks limited to ensure stability.

Transportation

1. Insecticides should be transported in well-sealed and labelled containers, boxes or bags.
2. Insecticides should be transported separately. It should NOT be transported in the same vehicle as items such as agricultural produce, food, clothing, drugs, toys, and cosmetics that could become hazardous if contaminated.
3. Pesticide containers should be loaded in such a way that they will not be damaged during transport, their labels will not be rubbed off and they will not shift and fall off the transport vehicle onto rough road surfaces.

1. Vehicles transporting pesticides should carry prominently displayed warning notices.
2. The pesticide load should be checked at intervals during transportation, and any leaks, spills, or other contamination should be cleaned up immediately using accepted standard procedures. In the event of leakage, while the transport vehicle is moving, the vehicle should be brought to a halt immediately so that the leak can be stopped and the leaked product cleaned up. Containers should be inspected upon arrival at the receiving station.

There should be official reports at the national level and follow-up enquiries in the event of fires, spills, poisonings, and other hazardous events. Disposal of remains of insecticides and empty packaging

1. At the end of the day after work during IRS activities, the inside of the spray pump should be washed and any residual insecticide should be flushed from the lance and nozzle.
2. The rinsing water should be collected and carefully contained in clearly marked drums with tightly fitted lids. This should be used to dilute the next day during tank loads or disposed of properly by the supervisor at disposal sites like pits or digs.
3. Never pour the remaining insecticide into rivers, pools or drinking water sources.
4. Decontaminate containers where possible. For glass, plastic or metal containers this can be achieved by triple rinsing, i.e. part-filling the empty container with water three times and emptying it into a bucket or sprayer for the next application.
5. All empty packaging should be returned to the supervisor for safe disposal according to national guidelines.
6. Never reuse empty insecticide containers.
7. It shall be the duty of manufacturers, formulators of insecticides and operators to dispose of packages or surplus materials and wash them in a safe manner so as to prevent environmental or water pollution.
8. The used packages shall not be left outside to prevent their re-use.
9. The packages shall be broken and buried away from habitation.

Disposal of Expired Insecticides

1. Adequate measures should be undertaken to avoid the expiry of stocks in storehouses.
2. The First Expiry First Out principle should be strictly followed during stock movements.
3. Information about near-expiry stock, should be provided well in time so that the stock can be re-allocated to other locations.
4. The expired stock should be returned to the manufacturer for disposal as per guidelines preferably through an incineration process.
5. The chemical efficacy should be tested before disposal of expired insecticide to find out the possibility of usage. The efficacy and active ingredient percentage of insecticide are tested and certified by the authorised testing laboratory.

Health Monitoring

1. 1. In case of accidental exposures or appearances of symptoms of poisoning, medical advice must be sought immediately.
2. 2. In the case of organophosphorus (Malathion), regular monitoring of cholinesterase (CHE) level should be carried out and sprayed showing a decline in CHE to 50% should be withdrawn and given rest and if needed medical aid.