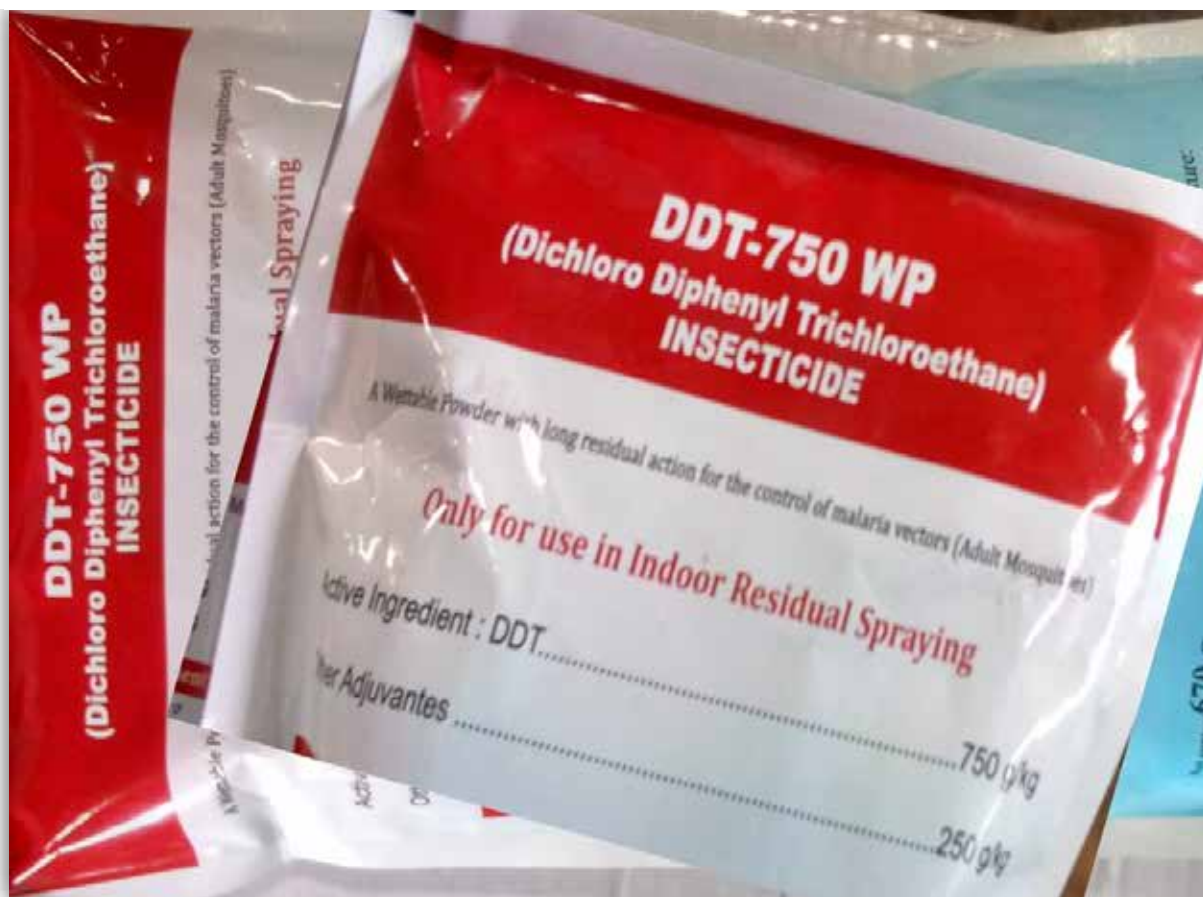


REPUBLIC OF ZAMBIA



MINISTRY OF HEALTH



DDT GUIDELINES FOR INDOOR RESIDUAL SPRAYING IN ZAMBIA

2019





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2019

NATIONAL MALARIA ELIMINATION PROGRAMME WWW.NMEC.ORG.ZM

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Abbreviations

DDT	Dichloro-diphenyl-trichloroethane
IRS	Indoor residual spraying
LD	Lethal dosage
MOH	Ministry of Health
NMEP	National Malaria Elimination Programme
PPM	Parts-per-million
WHO	World Health Organization
ZEMA	Zambia Environmental Management Agency

1. Introduction

Dichloro-Diphenyl-Trichloroethane (DDT) has shown to be an effective, affordable residual insecticide for malaria vector control. It is considered relatively safe to use in public health vector control activities. However, its long persistence in the environment and its high bioaccumulation in fatty tissues have led to a great reduction in its use in recent years. This is further compounded by the fact that the mosquito vector has developed a resistance to DDT.

Generally, all insecticides are poisons and can be harmful if improperly used. Users should be fully aware of the hazards they pose. They can enter the body by three different routes: the skin (dermal absorption), the mouth (ingestion), and the lungs (inhalation). Poisoning may occur while preparing, spraying, storing, or transporting insecticides.

Taking special safety precautions and using common sense minimizes the risk of poisoning that insecticides not only pose to users, but to other people, non-target organisms, and the environment (including drinking water, food, and soil).

Precaution must be central to a proper insecticide management and monitoring system. People who work with insecticides should receive quality training in procedures for handling insecticides safely.



Offloading insecticides for storage in full personal protective equipment

Zambia is currently exempted by the Stockholm Convention to use DDT for malaria vector control. The exemption was granted on the condition that the Zambian authorities ensure that DDT is used solely for malaria control and in accordance with all the regulations and requirements of the Stockholm and Basel conventions and the World Health Organization (WHO). The use of DDT for any other purpose, including agriculture, is strictly banned in Zambia. In Zambia, DDT importation and use is regulated by the Zambia Environmental Management Agency (ZEMA). The implementation of the Indoor Residual Spraying (IRS) Programme is conducted by National Malaria Elimination Programme (NMEP).

These guidelines provide basic information and direction to health workers working with DDT in Zambia. It also includes fundamental information on IRS that should help them use it effectively. It is hoped that workers' adherence to these guidelines will facilitate the judicious use of insecticides in malaria control and reduce disease burden in Zambia.

2. General description

DDT is a white, crystalline, tasteless, almost odourless, solid substance. It does not occur naturally in the environment and is a man-made synthetic. Thus, the presence of DDT in the environment is generally a result of human dispersal of DDT residuals through land, water, and air.

DDT is insoluble in water, but very soluble in ethyl ether, acetone, benzene, and other organic solvents. It is stable in strong acids and can withstand acid permanganate oxidation.

3. DDT formulation

In its raw form, DDT cannot be easily applied. It must be prepared or formulated before it can be easily sprayed or applied onto a target and have a lasting effect. The formulation is usually made up of several components:

- Active ingredient (the chemical component that kills or controls the insect).
- Carrier (an inert component of solid formulations [e.g., powders, granules]).
- Solvent (used in liquid formulations).
- Surface active agents (used in liquid or solid formulations to enable the product to mix with water; also used to allow the product to spread or stick to the target better).

For example, the formulation DDT 75% WP is a 75% formulation. It contains 750 grams of DDT in every 1000 grams of formulated product. It is a wettable powder and 25% of it is carrier.

DDT is a mixture of finely ground inert materials with highly concentrated active chemical. DDT is water dispersible; the insecticide remains suspended in water with occasional stirring. Water-dispersible DDT powder is most suited for porous surfaces such as walls made of brick and mud (informal structures). Its insecticide particles are large so absorption is low, thereby allowing the active ingredient to remain on the surface for the target vector to pick up.

Water-dispersible particles are also lighter. Prior to application, the powder is mixed with a large volume of water, resulting in an insecticide suspended in water. However, no suspension is stable. Therefore, with time, solid particles will separate from liquid and settle. It is important that the spray liquid should be prepared just before application and agitated every 30 minutes.

4. DDT production and supply

The production of DDT is restricted to malaria vector control in accordance with WHO recommendations, which promote safety and cost-effectiveness. At the time of writing these guidelines, there is only one WHO Prequalified manufacturer for DDT. An identified local supplier should be responsible for importing, transporting DDT into Zambia and to its points of use. When ordering DDT, one should take into account the lag time between order and arrival at its point of use. Suppliers should provide a safety data sheet on DDT that must include information on transportation and safe use and disposal of the insecticide.

5. Factors guiding the choice of DDT

The following should be considered when deciding whether to use DDT for IRS in a certain locale.

5.1 Target mosquito vector

Vector characteristics are a critical consideration. It is important that the target vector is highly endophilic (indoor resting) and susceptible to the DDT. Target mosquitoes should die within 30 minutes after contact with DDT, otherwise resistance should be suspected.

5.2 Public compliance

DDT should never be used without express consent of target house owners. Since it is a restricted substance and leaves a white residue on walls, health education is important: reasons for spraying should be explained to house owners and fellow health workers. Local customs and beliefs should also be respected.

5.3 Insecticide characteristics

DDT should:

- Be highly toxic to target mosquitoes. Insecticides lose their effectiveness when insects develop resistance. Resistance should be tested for from time to time.
- Have long-lasting effect on target surfaces.
- Not repel nor irritate target insects. This is important in ensuring that target insects will pick up lethal doses of DDT.
- Be safe to humans and domestic animals (domestic animals should be kept away from spray sites).
- Not be a danger to spray operators.
- Be acceptable to house owners (some insecticides are less acceptable because they smell or leave unattractive residue on sprayed walls).

5.4 Construction material of houses

The presence of large numbers of informal structures (structures with mud or unplastered walls and thatched roofs) in malarial peri-urban areas in Zambia call for the use of DDT. DDT has proven to be more effective than other insecticides when sprayed on informal structures with absorbent surfaces. DDT had been successfully used in Zambia up until 2010, when insecticide resistance was recorded. However, these new guidelines will allow DDT to be sprayed on all structures (both porous and non-porous).

6. DDT regulations



Insecticides should be stored properly on a raised pallet.

6.1 Importation

DDT importers should obtain a licence to import DDT from ZEMA and provide them with information on their supplier and the quantity they intend to import. ZEMA should ensure that DDT importers take the responsibility of ensuring proper DDT disposal.

6.2 Use of DDT

Following correct procedures for storage, application, and waste management that ensure safety for people and the environment, users should only use DDT for purposes of public health vector control. Users should send information to ZEMA on how they monitor the use of DDT. A user who has either been authorized or licenced to buy DDT for public health use should never transport the product across district boundaries except with express permission from the Ministry of Health (MOH) and ZEMA. The DDT should be well-labelled.

7. DDT storage

It is important that DDT is correctly stored to maintain its quality. The following should be strongly considered:

- The store should be lockable, sufficiently far from people's homes, and not susceptible to floods and fires.
- Unauthorised personnel should not have access to the store.
- Warning signs should be placed at each entrance of the store.
- DDT should be stored in its original containers with labels intact.
- Food should neither be stored nor eaten in the store.
- The store should be kept dry at all times.
- DDT should be stored away from fires and direct sunlight.
- DDT containers should be stacked well to prevent breaks and spills.
- The store should be constructed of fire-resistant materials, have a concrete floor (for easy cleaning of spills), and be well-ventilated.
- The store should be guarded 24 hours by dedicated store attendants.
- A checklist card for stored insecticides must be available in the store.

8. DDT packaging and labelling

DDT should be packaged and labelled according to the labelling requirements by ZEMA in line with GHS Standard (ZS 708) and WHO specifications (refer to the latest "Specifications for Pesticides in Public Health: Insecticides, Molluscides, Repellents, Methods" of the World Health Organization). Packaging it in water-soluble sachets ensures that it can be added easily and directly into water-filled spray pumps thereby reducing the hazard associated with handling and mixing them in separate containers.

Labels should be in English and indicate the following:

- Date of manufacture
- Date of expiry
- Trade or brand name
- Generic name
- Contents
- Ingredients
- Net volume or weight
- Registration or licence number
- Type of formulation
- Name and address of manufacturer, distributor, and/or formulator
- Batch number
- Precautionary statements
- Signal word such as DANGER, WARNING or CAUTION
- Hazard statement
- GHS pictogrammes
- Directions for use

The labeling should also provide safety instructions, warnings (symbolic or textual), and measures to take in case of accident (e.g., ingestion, contamination). Instructions for physicians on what antidote to use in case of poisoning should also be provided.

9. Safe application of DDT

9.1 Principles

Though considered a relatively safe insecticide, DDT, like any other insecticide, is a toxic chemical that can harm and even kill people, animals, and plants if improperly used. However, DDT can be used with minimal or no risk to either people or the environment if the principles below are observed. Note that the use of DDT for any purpose other than malaria vector control (e.g. as an agricultural pesticide) has been banned in Zambia.

- Follow guidelines that ensure safety to the environment and spray operators.
- Apply insecticides carefully, correctly, and only onto target surfaces.
- Before any application, evaluate the likelihood of effectiveness to justify the application and have adequate knowledge of the method of application, equipment, and protective clothing.
- Observe all directions, restrictions, and precautions as stated on insecticide labels.
- Store DDT in a locked room in its original containers with labels intact away from food, feed, and clothing, and out of the reach of animals and unauthorized people.
- Experience in dealing with DDT or insecticides in general is useful to ensure safety. Engage services of experienced persons as often as possible.
- Use DDT at correct dosages with correct nozzle sizes to avoid excessive residue and injury to non-target people, plants, and animals.

9.2 Precautions to take before and during spraying

- Remove all jewellery (e.g., watches, bangles, etc.), foodstuffs, drinking water, and utensils used in the preparation of foods from the vicinity of spray activities.
- Remove all bedding.
- Wear protective clothing and use equipment as specified on labels.
- Clear the area around houses being sprayed of people, pets, and livestock.
- Move the elderly and the sick from rooms that are being sprayed. If this is not possible, those rooms should not be sprayed.
- Check your application equipment for leaks and faulty nozzles.
- Be sure that your equipment is putting out the proper amount of water. Calibrate spray equipment before adding DDT.
- Use the correct spraying pressure and nozzle orifices.
- Check the label to determine the precautions that must be taken after DDT application.
- Reserve a pair of spare gloves and ensure they are in good condition before using them.
- Do not eat or smoke after handling or spraying DDT until hands are washed.
- Take sufficient breaks during spraying (20 minutes for every hour of spraying).
- Never employ spray operators for more than six hours a day and check them for toxicity every 60 days.

“Note that the use of DDT for any purpose other than malaria vector control (e.g., as an agricultural pesticide) has been banned in Zambia”

9.3 Mixing and loading DDT into tanks

Read the directions on DDT labels carefully before opening the containers or sachets. The general steps for mixing DDT in readiness for spraying are as follows:

- Place the pump on the plastic sheet
- Pour 2 litres of water in the spray tank
- Add DDT in the spray pump; cover the orifice and pressurize to mix the content
- Add more water to the required mark of either 10 or 7.5 litres
- Close the pump and pressurise to 15 PSI
- Shake the spray pump vigorously

- Pressurise to 55 PSI and shake the spray pump vigorously again
- Spray the house.
- Continue agitating the pump while spraying (Chinese greeting)

9.4 Basic principles when handling and mixing DDT

- Keep people, pets, and livestock away from the area where DDT mixing and loading is taking place.
- Handle and mix in a well-lit and ventilated area, preferably outdoors. Do not handle and mix alone.
- Wear tightly woven pants and shirts with long legs and sleeves that extend over liquid-proof boots and gloves.
- Wear a liquid-proof apron or raincoat, a wide-brimmed liquid-proof hat, goggles, and any other protective clothing or equipment that is specified on the label.
- Consider the toxicity of the pesticide and the working conditions when deciding on the protection needed.
- Measure carefully and mix only the amount of DDT you intend to use. Keep containers below eye level to avoid splashes and spills entering your eyes. Close the container immediately after mixing.
- Stand with your back to the wind when loading or mixing DDT so that it does not blow onto you. If you spill any DDT on yourself, immediately remove the contaminated clothing, wash the affected area with detergent and water, and clean up the spill.

9.5 Procedures to follow at the end of each spraying day

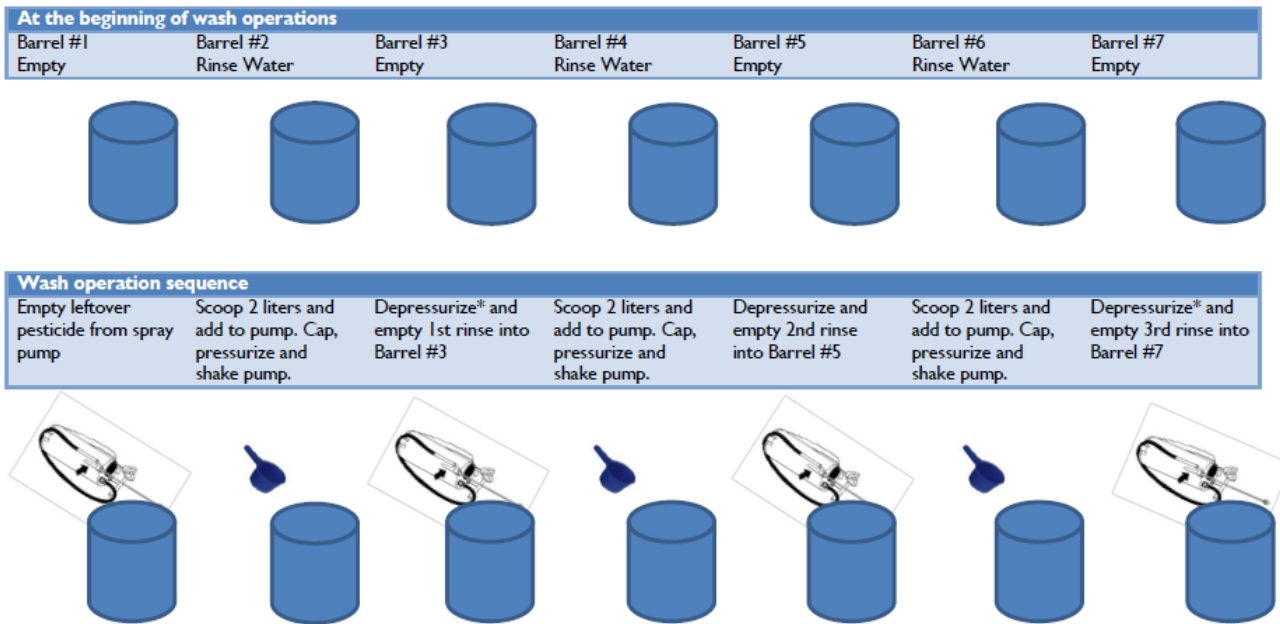
1. Hand over the empty sachets and remaining DDT to the supervisor.
2. Pour remaining DDT into a drum (1) to save for re-use the following day.
3. Never pour remaining DDT into rivers, pools, or sources of drinking water
4. Perform triple rinsing and cleaning of the spray pumps to prevent daily accumulation of chemicals.
5. Wash the personal protective equipment before wearing it again with hot water and a strong detergent
6. Leave all personal protective equipment in the storeroom before going home.
7. Take a complete shower, shampoo your hair, and clean your fingernails.
8. Choose your cleaning area with great care.

9.6 Cleanup of equipment

At the end of each spraying season, clean the sprayer thoroughly, both inside and out, by following the steps below:

1. Fill sprayers half way with clean water and flush it out through the nozzles by operating them. Do this three times (triple rinsing as shown in Figure 1).
2. Remove nozzle tips and strainers and check for wear and tear.
3. Clean the tips and strainers with clean water in a bucket using a toothbrush.
4. Do not use knives, wire, or any other hard material to clean nozzle tips (the fine surface of sprayer tips can be easily damaged, causing spray pattern distortion and an increase in the rate of application).
5. Store the nozzle tips and strainers safely.
6. Store the sprayers in a clean, dry shed.
7. Order replacement parts if necessary to prepare for the next season.

Figure 1: Schematic diagram on triple rinsing spray pumps.



*Spray hose, wand, and nozzles must be purged with rinse water from the 1st and 3rd rinses. After pressurizing and agitating, discharge rinse water into the collection barrel.

NOTES: After this operation is complete, the outside of the pump is washed, along with the spray operators' helmet, face shield, gloves, boots, and neck protection, in the central wash area, with the washwater directed to the soak pit.

When using a mobile soak pit (MSP) a four-barrel rinse system may be employed in order to minimize the number of barrels that the spray team must carry, and the necessary size of the wash area constructed. See the section on mobile soak pits for a full description.



Sprayer pumps stored upside down to drain water.

10. Safe disposal of DDT

- Never reuse empty DDT containers.
- All empty DDT containers should be returned to the supervisor for safe disposal.
- The recommended method of safe disposal of DDT waste is by a high temperature incineration at 1000 degrees by an authorized person.
- Liquid waste should be contained in evaporation tanks (See Annex 3 for design of evaporation tanks).
- Ordering DDT in carton boxes instead of drums makes disposal easier.
- To avoid wasteful disposal, estimate the amounts needed for spraying accurately and apply according to specified directions with common sense and economy.



DDT evaporation tank under construction



DDT evaporation tank completed and roofed



DDT waste packed in sacks in readiness for final disposal

11. Preventing the development of mosquito resistance to DDT

- Never apply DDT below the recommended dosage.
- Apply insecticides intelligently. Where possible, use different insecticides in rotation if applying and reapplying over a long period.
- Mix the insecticide properly when diluting.
- Monitor the susceptibility of vectors to DDT by bioassays.
- Study the indoor resting habits of the vectors (the killing action of DDT is through contact). Vectors should be highly endophilic.

12. Partnerships in spraying campaigns with DDT

A good spraying operation requires an inter-sectoral approach with participation from district health offices, local authorities, private entities, NGOs, and any other interested parties. Information on spraying operations should be well-communicated and public acceptance and cooperation with spraying operations should be obtained in advance.

13. Training spray operators on using DDT

The success of a spraying programme depends largely on properly training spray operators and supervisors. Training for supervisors should be five days long—two days for theory and three days for practicals. Supervisors should receive extra in-depth training on environmental hazards, protection, toxicity, first aid, safe handling, and safe disposal of DDT and other alternative insecticides.

When the supervisors have been trained, they then train the spray operators in their districts in line with the spray operator training outlined in the Indoor Residual Spraying Guidelines.

Annexes

Annex 1. An explanation of selected terms

Insecticide

An insecticide is a toxic chemical that is used to kill insects, but can also injure and even kill people, animals, and plants if improperly used. Properly used, lethal doses of insecticide can be given to insects without doing collateral harm.

Formulation

Insecticides are seldom used at full strength but, rather, formulated with other substances. Thus, an insecticide as it appears on the market is composed not only of a toxic part (either called the toxicant or the active ingredient), but of a toxic part and one or more non-toxic parts (often referred to as inert materials). The typical ingredients of a formulation include an active ingredient, solvents, carriers, surface-active agents, and special additives. The inert materials may serve to dissolve the active ingredient, act as carriers, disperse the active ingredient, improve effectiveness, reduce toxicity, or break the active ingredient down into smaller parts making the resulting formulation diluted, extended, and easier to apply. Formulation has great influence on the effectiveness of an insecticide.

Common formulations include dusts, granules, and wettable powders. Dusts are used dry. Wettable powders have the appearance of dusts but are meant to be diluted or suspended in water and used as sprays. To make a dust act as wettable powder, a dispersing and wetting agent can be added (as is done with DDT). Wettable powders are more concentrated than dusts and are composed of as much as 75 percent toxicant. In general for all formulations, as the size of an insecticide particle decreases, so does its toxicity.

Active ingredient

The active ingredient is the toxic or poisonous part of the insecticide. It is the most important part of a formulation as it determines the other ingredients. Relevant properties of active ingredients include its melting or boiling point, water solubility, and stability.

Toxicity

Toxicity measures the degree to which a substance may cause harm to humans, animals, or insects. It is usually expressed in terms of lethal dosage (LD). To compare the toxicity of various insecticides, the value of Lethal Dose 50 (LD50—see below) is used. Acute oral and acute dermal toxicity is measured by observing test animals' responses to single doses of a toxin.

Toxin doses are measured in milligrams of active ingredient per kilogram weight of test animal (e.g., a rat or rabbit). A milligram is one millionth of a kilogram so these units are called parts-per-million (PPM).

LD50

LD50 refers to the dose, measured in PPM, of a chemical that kills 50 percent of a population of test animals. Insecticides are divided into various hazard classes according to their LD50 values. The toxicity of an insecticide is determined by the concentration of its active ingredient and its formulation. For any insecticide, a granule formulation is safer to use than a spray, and a coarse spray is safer to use than an aerosol.

The most highly toxic chemicals are applied as granules since fine powders are too easily inhaled.

A chemical's LD50 value is not absolute: it varies between different species of animals and even different individuals within a single species of animal. Each species, and each individual (to a lesser extent), reacts differently to different chemicals. This often causes toxicity to be misinterpreted but also allows for species targeting. Toxicity also varies depending on the route of absorption into the body. An LD50 value of a chemical may vary depending on whether it enters the body through the mouth (ingestion), the skin (dermal absorption), or the lungs (inhalation).

Modes of action

Insecticides generally kill insects by interfering with their normal life processes. Different insecticides have different modes of action in killing insects. For example, some insecticides kill insects on contact by interfering with their nervous systems. Insecticides that kill on contact are called knockdown insecticides, while others, which kill in time, are called systemic insecticides.

Annex 2. First aid procedures

The following precautions and procedures should be followed to ensure maximum safety and minimum harm:

- If an insecticide accidentally comes in contact with skin or clothing, remove the clothing and wash the skin with plenty of water.
- Keep extra sets of personal protective equipment.
- Maintain effective communication with supervisors (with mobile phones, etc.).
- If insecticide is accidentally inhaled, immediately get to a location where there is fresh air.
- If insecticide is accidentally ingested, rinse the mouth with plenty of water and see a healthcare provider at once (do not induce vomiting unless specifically instructed to do so on the insecticide label).
- When consulting a healthcare provider in case of accident, bring the insecticide label with you.
- Ensure familiarity with first aid procedures on insecticide labels.

Symptoms of poisoning

In order to protect one another, workers must know the signs and symptoms of insecticide poisoning. If someone has been poisoned, co-workers should get that person medical help immediately. They should not leave the person alone. When taking the poisoned person to a healthcare provider, they should take with them the insecticide label or, if necessary, the entire insecticide container. If they take the entire container, they should not carry it in the passenger space of the vehicle. Symptoms for different insecticides are detailed below:

Chlorinated hydrocarbons (e.g., DDT, Chlordane, Lindane)

Not many insecticide users have been poisoned by chlorinated hydrocarbons. Early indications of poisoning include headache, nausea, vomiting, general discomfort, and dizziness. The victim may also be unusually excited or irritable. With severe poisoning, convulsions occur with or without earlier symptoms. Coma may follow the convulsions (refer to hospital).

Synthetic pyrethroids (e.g., Deltamethrin, Icon)

Toxicity to warm-blooded animals is generally low, but pyrethrins, the active ingredient in pyrethroids, may elicit inhalant allergic responses: stuffy or runny nose, scratchy throat, asthma and, rarely, anaphylactic shock in extremely sensitive persons. Symptoms can be managed with antihistamines for less severe reactions and adrenalin or hydrocortisone for severe asthma or anaphylaxis.

Organophosphates (e.g., Actellic 300CS, Parathion, Malathion)

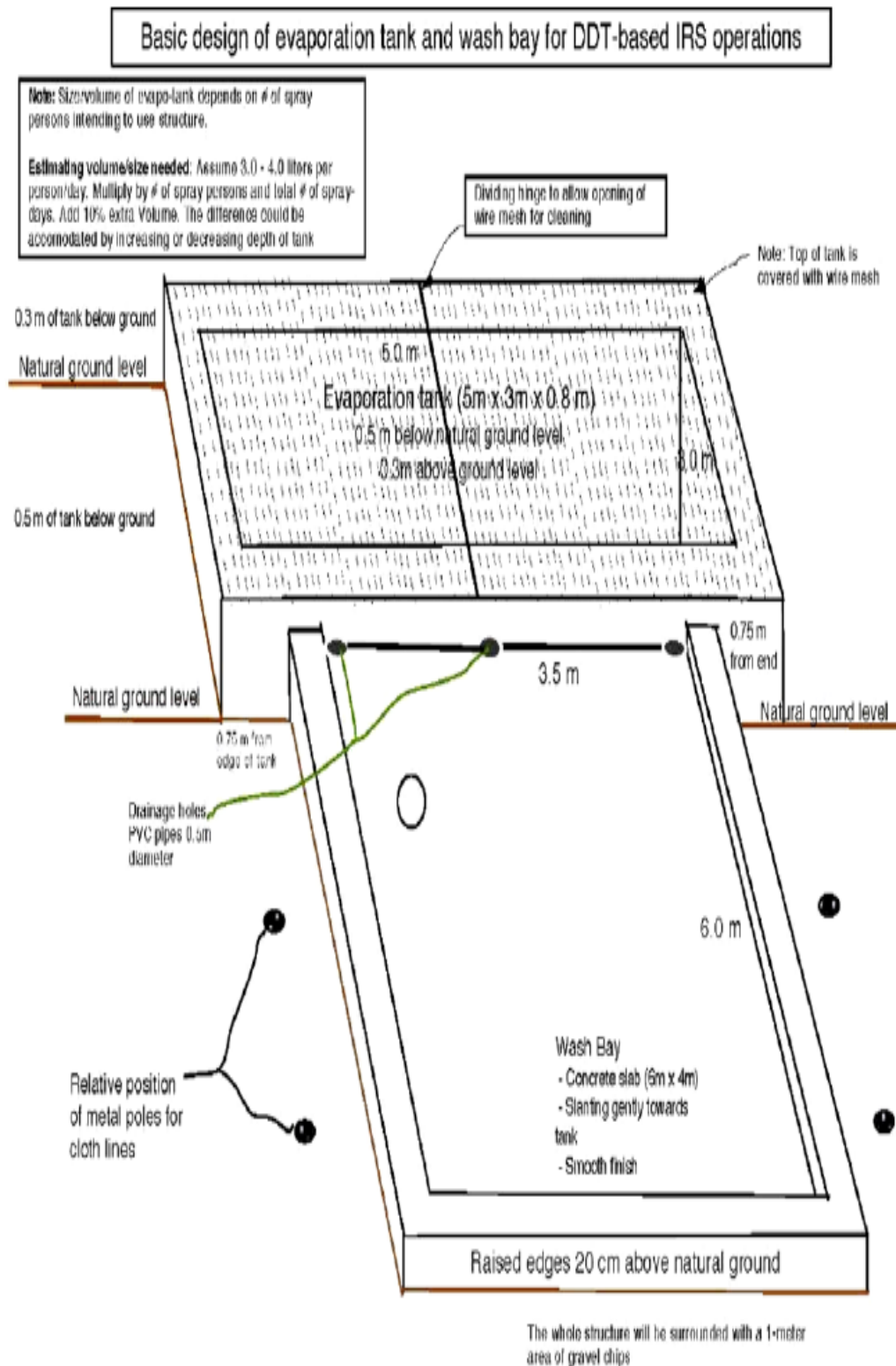
Symptoms usually begin within 12 hours after exposure. They usually occur in approximately the order listed below:

1. Mild poisoning causes fatigue, headache, dizziness, blurred or dark vision, excess sweat and saliva, nausea and vomiting, stomach cramps and diarrhea.
2. Moderate poisoning causes difficulty in walking, weakness, chest discomfort, muscle twitches, pinpoint pupils, and increased severity of earlier symptoms.
3. Severe poisoning causes unconsciousness, severely pinpointed pupils, muscle twitches, secretions from mouth and nose, breathing difficulty, and death if not treated,

Carbamates (e.g., Propoxur)

Carbamates cause about the same symptoms as organophosphates, but a physician can treat the poisoning more easily.

Annex 3. Design of evaporation tank



Annex 4. Mobile DDT Filtration System for Indoor Residual Spraying

The use of DDT comes with a lot of restriction due to its nature to persist in the environment in case of any contamination. As such environmental compliance must be adhered to at all times (transportation, storage, mixing, spraying, management of waste both solid and liquid etc).

In view of this, each district that will use DDT must have an evaporation tank for managing the liquid waste of DDT. However, we are aware that most of the districts do a lot of camping during the IRS campaign and management of liquid waste is a critical issue.

It is against this that a mobile DDT filtration system comes into play to help with management of DDT liquid waste during camping or while implementing IRS in areas without a static evaporation tank. The DDT filtration system is similar to the mobile soak pit with a few differences.

Requirements

- 20 litre bucket/container
- 2 X 40 litre bucket/container
- 7 cm thick of foam or saw dust
- Granulated charcoal or activated charcoal
- Tarpaulin tent or high density plastic sheet (1mm thick)
- Hoe/pick
- Shovel
- A stand

Steps in construction of the filtration system

Step 1:

Make a stand similar to that for the hand washing bucket and stand. It should be 90 cm high and wide enough to support the bucket.

Step 2: Construct the filtration system as follows:

- Get the 60 litre bucket/container and drill one 1.5 cm hole in the center of the bottom of the bucket before adding any materials.
- Then place a **7cm** thick of foam or wood shavings at the base of the bucket; Followed by **20cm** of granulated charcoal or activated carbon and finally **11cm** of gravel or foam. This will provide a deep bed of granulated charcoal, and greater capacity for pesticide adsorption.
- Place a fine nylon or netting material at the bottom of the bucket, in between the wood shavings/foam and granulated charcoal layers, as well as between granulated charcoal layers and gravel or foam.

Step 3:

Mount the filtration system on stand and place the 20 litre under the stand to be receiving the filtrate as illustrated in the picture below.



Figure 1: DDT Filtration system mounted on the stand

In the field

While in the field, the team will need to set up the filtration system as follows:

1. Dig a hole the size and depth of the bucket to be used for receiving any droplets or liquids from the tarpaulin or polythene sheet.
2. Level the ground with a gradient of 1:15 towards the hole for the bucket.



Figure 2: Installation of the receiving bucket in the ground

3. Install the bucket in the hole as shown above
4. Lay the tarpaulin or 1mm thick polythene sheet or plastic and place the drum and the DDT filtration system on top as shown below. The polythene sheet should be folded in the bucket to ensure any liquid flows into the bucket and not the ground.



5. After the cleaning of the equipment, whatever liquid flows into the receiving budget should be poured into the filtration bucket.
6. The filtrate should be collected and used as water for mixing the insecticides the following day.
7. Number 5 and 6 are repeated daily

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