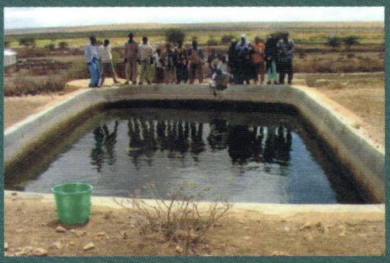
WHO-EM/MAL/282/E/G
Distribution: General

Integrated vector management in the Eastern Mediterranean Region

A training manual



World Health Organization
Regional Office for the Eastern Mediterranean

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Integrated vector management in the Eastern Mediterranean Region

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World Health Organization
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Preface

In countries of the WHO Eastern Mediterranean Region, vector-borne diseases contribute to about 2.2% of the total burden of disease and approximately 7% of all communicable diseases. The burden of vector-borne diseases may seem low; however, it is disproportionately distributed to a few countries which suffer a high burden.

Vector-borne diseases include malaria, leishmaniasis, schistosomiasis, lymphatic filariasis, African trypanasomiasis, onchocerciasis, dracunculiasis and arboviral infections (yellow fever, Rift Valley fever, dengue and Crimean–Congo haemorrhagic fever), as well as other diseases that can be carried by pests, such as diarrhoeal disease, trachoma and asthma. The distribution of these diseases varies greatly among and within the countries of the Region.

Well-planned and coordinated vector control interventions can contribute significantly to the reduction of disease incidence and thus to reduction in vector-borne disease burden. Effective vector control methods exist, but their implementation as part of integrated disease management packages has been limited. Moreover, the lack of a training manual for the implementation of integrated vector management by field teams at the grass-roots level has limited the success of such interventions.

The Division of Communicable Diseases at the WHO Regional Office for the Eastern Mediterranean is actively promoting integrated disease management as a cornerstone of regional and national strategies to control communicable diseases. This manual was developed to help address the need for training on

integrated vector management at field level. It is intended for use in training field staff in the following areas:

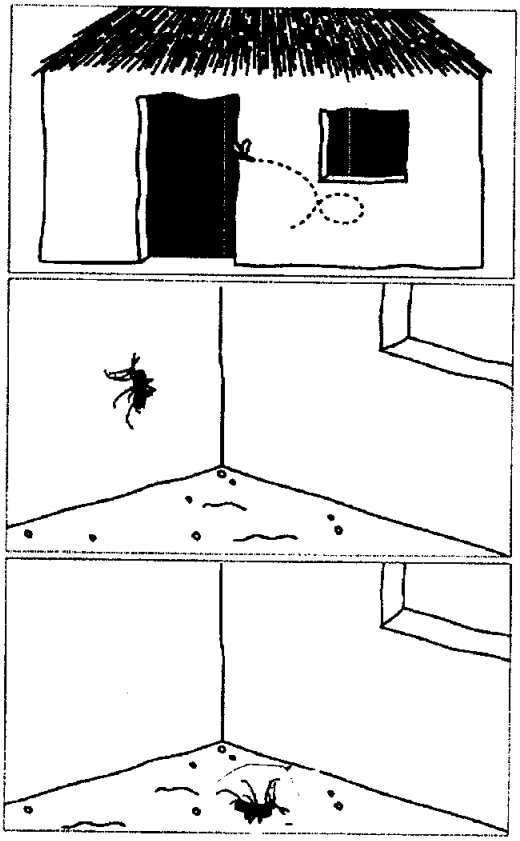
- Understanding the concept of integrated vector management
- Applying insecticides to wall surfaces, netting materials and breeding sites
- Maintaining vector control equipment
- Monitoring and evaluating vector control activities.

It is also intended as a reference for managers of control programmes, particularly in the selection of appropriate control measures at country level, including types and formulations of insecticide. This will help in reducing hazards to human health and to the environment, as well as avoiding financial losses.

This manual has been adapted from the *Manual for indoor residual spraying* (WHO/CDS/WHOPES/GCDPP/2000.3/Rev.1). Some material was also taken from *Vector control – methods for use by individuals and communities* and *Malaria vector control: decision making criteria and procedures for judicious use of insecticides.* The Regional Office would like to acknowledge the work of all who contributed to these documents.

1. Objectives

The main objective of this manual is to provide a resource for training on integrated vector management in countries of the WHO Eastern Mediterranean Region. This will help to ensure the safe and correct application of a residual insecticide to indoor surfaces and to nets on which malaria and other disease vectors may rest. This training manual was developed specifically to be handy, simple but detailed, and appropriate to local situations.

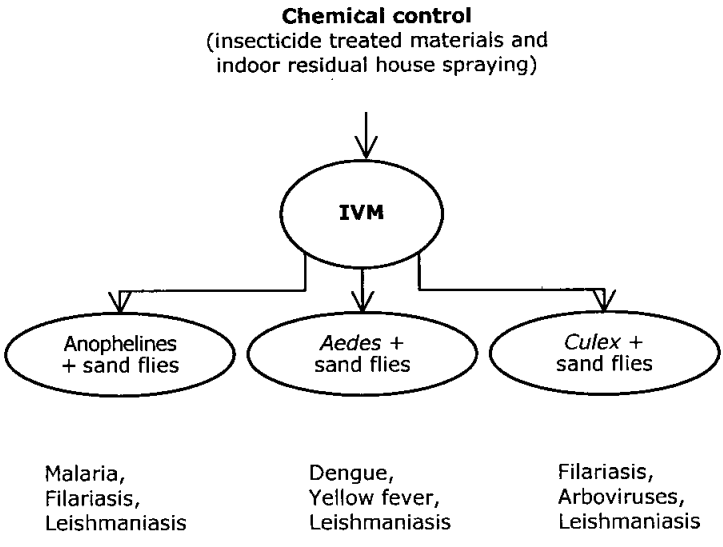


2. Integrated vector management

2.1 Principles

- Integrated vector management (IVM) is the selective and sustainable use of available methods for combined and cost-effective control of vector-borne disease, as shown below.

- This includes the judicious use of chemicals for control of vector-borne disease.



In the majority of countries of the Eastern Mediterranean Region, more than one vector-borne disease can occur in the same place. Some vectors share breeding or resting sites, such as those causing malaria, arboviral infections and filariasis. Use of one method of control can have an impact on more than one vector-borne disease.

2.2 Methods

2.2.1 Larvae/pupae control

- Environmental management can reduce the number of sites where vector larvae grow (source reduction).

- Biological methods, including larvivorous fish, insect growth regulators, entomo-pathogenic bacteria and other parasites, prevent insects from reaching adult stage.

- Chemicals, including temephos and used engine oil, kill larvae before they reach adult stage.

2.2.2 Adult control

- Indoor residual house spraying (IRHS) uses insecticides with a residual efficacy, which kill insects as they rest on indoor surfaces.

- Insecticide-treated materials (ITMs), such as bednets, curtains and chadors, kill insects as they alight on treated surfaces, repel them or inhibit them from feeding/biting.

- House improvements, such as screens, can reduce opportunities for insects to enter the house.

- Space spraying in certain situations, e.g. during epidemics or in urban areas, reduces the population of adult insects.

- Repellents, such as creams and coils, repel insects before they bite.

2.3 Selection of methods

Selection of methods must be based on epidemiology of the disease; cost-effectiveness of the methods (i.e. cost and impact); acceptance of intervention by communities; and simplicity of intervention.

Using the example of malaria, the rate of transmission of the parasites from one person to another (vectorial capacity) depends on:

- Vector densities (absolute numbers)
- Age of the vectors (longevity)
- Duration of the sporogenic cycle (number of days taken for development of gametocytes through to sporozoites within the vectors)
- Proportion of vectors that feed on humans.

Vectorial capacity is therefore an expression of:

- density of vectors in relation to humans
- number of blood meals taken on humans per vector per day
- proportion of vectors surviving per day
- incubation period in the vector (days).

2.4 Summary

- Both larval and adult control methods have an impact on vector density.

- Effectiveness of larval control methods depends on types of breeding site; where vectors breed profusely, impact is limited.

- Indoor residual house spraying and treated materials affect vector longevity.
- Nets (treated or untreated) reduce the contact between people and vectors.

- In selecting any of the above methods, cost must be assessed in relation to community acceptance.

3. Selection of insecticides

The selection of insecticide for use in integrated vector control is important. Selection must be based on safety, cost and duration of effectiveness. The duration of effectiveness is dependent on target dosage, formulation and application.

Lists of insecticides recommended for indoor residual house spraying, larval control and treatment of nets are included as Tables 1, 2 and 3, respectively.

Table 1. Insecticides recommended for indoor residual house spraying (IRHS)

Insecticides	Dosage (g/m^2)	Formulation	Duration of effectiveness	Insecticidal action	Safety class of ingredient
Organochlorines					
DDT	1–2	WP	6 months or more	Contact	MH
Organophosphates					
Malathion	2	WP	2–3 months	Contact	SH
Fenitrothion	2	WP	3–6 months	Contact, airborne	MH
Pirimiphos-methyl	1–2	WP	2–3 months or more	Contact, airborne	SH
Carbamates					
Bendiocarb	0.1–0.4	WP	2–6 months	Contact, airborne	MH
Propoxur	1–2	WP	3–6 months	Contact, airborne	MH
Pyrethroids					
Alpha-cypermethrin	0.02–0.03	WP	4–6 months	Contact	MH
Cyfluthrin	0.02–0.05	WP	3–6 months	Contact	MH
Deltamethrin	0.01–0.025	WP	3–6 months	Contact	MH
Lambda-cyhalothrin	0.02–0.03	WP	3–6 months	Contact	MH
Etofenprox	0.1–0.3	WP	3–6 months	Contact, airborne	MH

Note. MH = moderately hazardous; SH = slightly hazardous; WP = wettable powder

Table 2. Insecticides suitable for mosquito larval control

Insecticide	Type[a]	Dosage (a.i.)[b]	Oral toxicity for rats (LD_{50} mg/kg body weight)
Temephos	OP	56–112 g/ha	8600
Temephos	OP	1–2 mg/l drinking water	8600
Chlorpyrifos	OP	11–25 g/ha	135
Diflubenzuron	GR	25–100 g/ha	>4640
Diflubenzuron	GR	1–2 mg/l drinking water	>4640
Pirimiphos-methyl	OP	50–500 g/ha	2018
B. thuringiensis	MI	*	Absent
B. sphaericus	MI	*	Absent

[a] OP = organophosphate; GR = growth regulator; MI = microbial insecticide
[b] a.i. = active ingredient
[c] LD = lethal dose
* according to formulation

Table 3. Recommended insecticides for treatment of mosquito nets

Insecticide	Formulation[a]	Dosage[b]
Alpha-cypermethrin	SC 10%	20–40
Cyfluthrin	EW 5%	50
Deltamethrin	SC 1% and WT 25%	15–25
Etofenprox	EW 10%	200
Lambda-cyhalothrin	CS 2.5%[c]	10–15
Permethrin	EC 10%	200–500

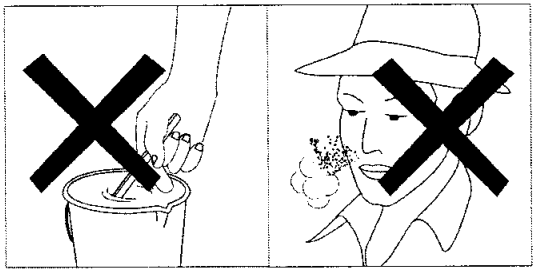
[a] EC = emulsifiable concentrate; EW = emulsion, oil in water; CS = capsule suspension; SC= suspension concentrate; WT = water dispersible tablet
[b] Milligrams of active ingredient per square metre of netting
[c] WHO specifications under development

4. Safety

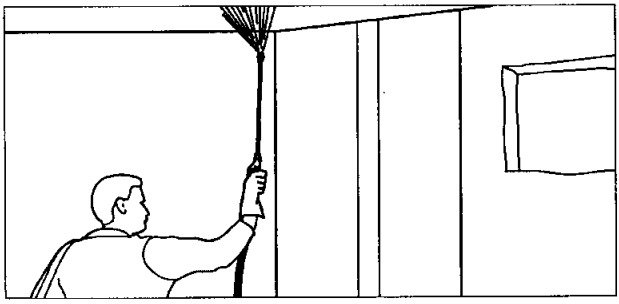
4.1 Exposure

Exposure to insecticides may occur when handling and spraying insecticides as follows.

– When handling the insecticide product during opening of the package, mixing and preparation of the spray.

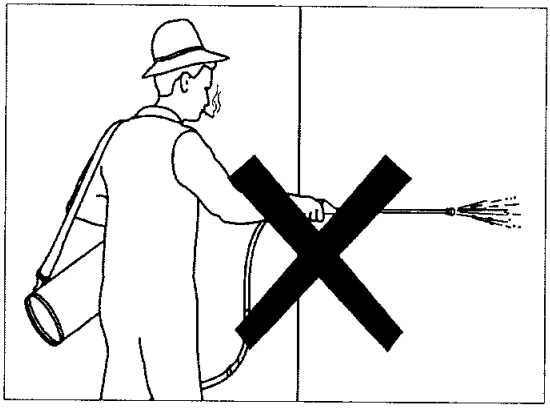


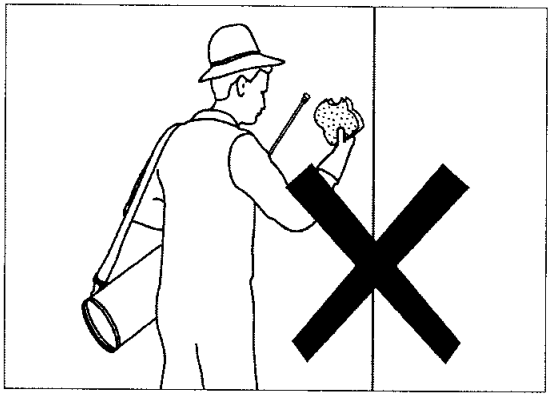
– When spraying the insecticide, especially in high places.



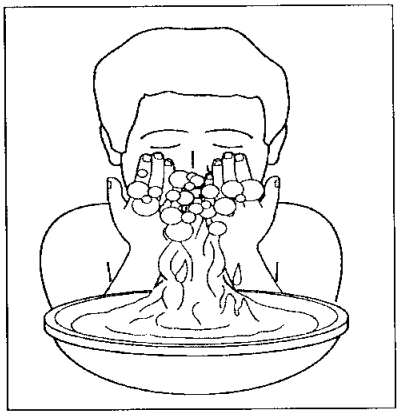
4.2 Safety precautions

– Do not eat, drink or smoke while working.

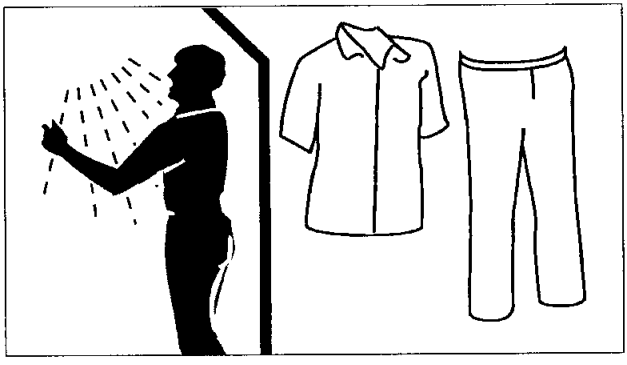




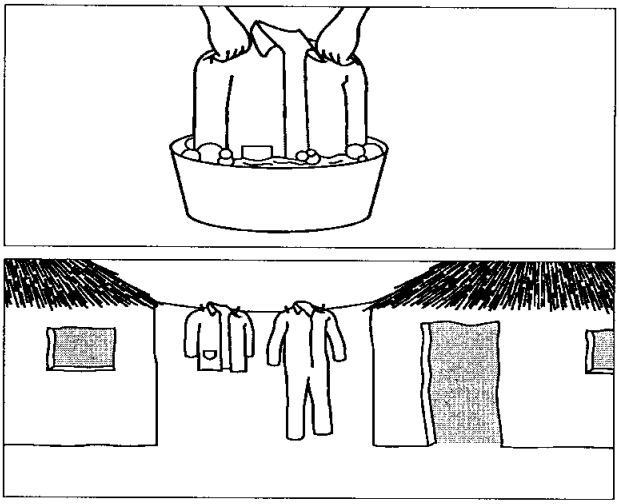
– Wash your hands and face with soap and water after spraying and before eating, smoking or drinking.



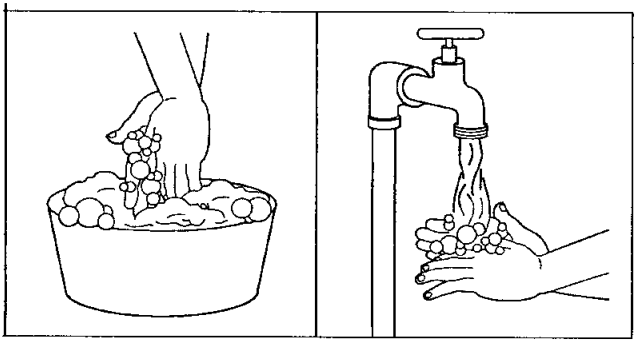
– Shower or bathe at the end of every day's work and change into clean clothes.



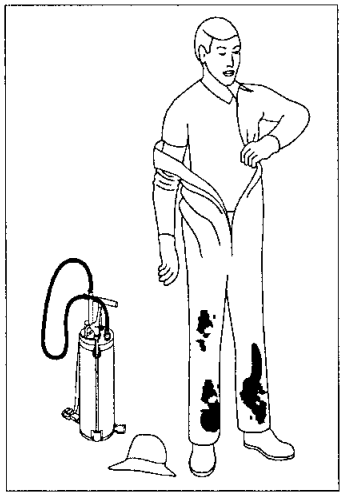
- Wash your overalls and other protective clothing at the end of each working day in soap and water and keep them separate from the rest of the family's clothes.



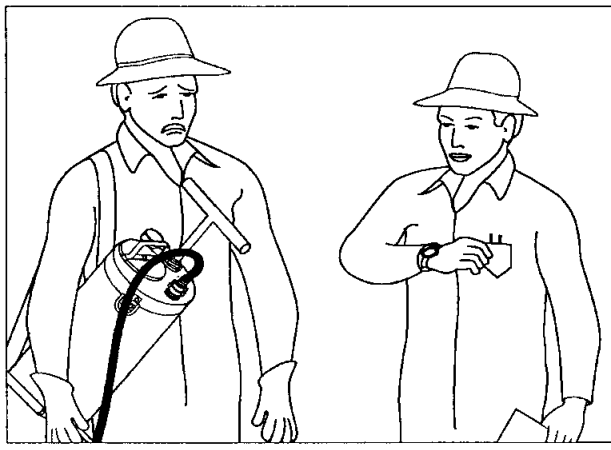
- If the insecticide gets on your skin, wash off immediately with soap and water.



– Change your clothes immediately if they become contaminated with insecticides.



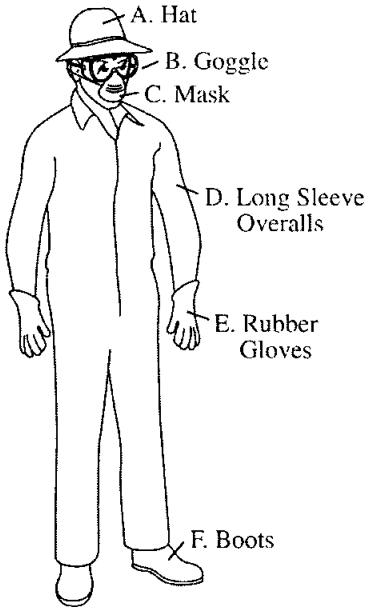
– Inform your supervisor immediately if you do not feel well.



4.3 Protective clothing

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

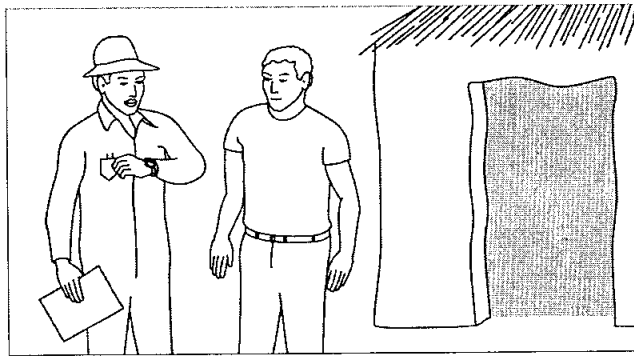
A. Broad rim hat (protects head, face and neck from spray droplets)
B. Goggles or face shield (protects face and eyes against spray fallout)
C. Face mask (protects nose and mouth from airborne particles of the spray fallout)
D. Long sleeved overalls (Keep overalls outside of boots)
E. Rubber gloves
F. Boots



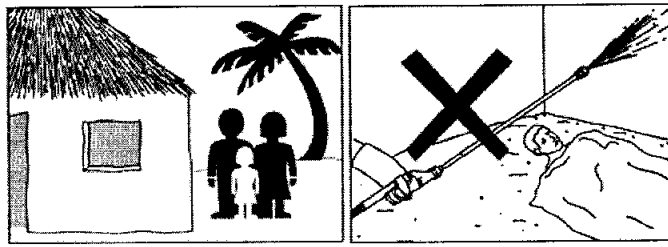
5. Insecticide house spraying

5.1 Preparations – *The household*

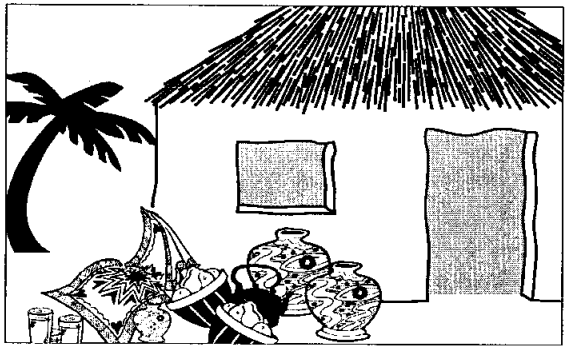
– Inform the head of the household of the spraying schedule and the purpose of spraying, giving the occupants time to prepare and vacate the house.



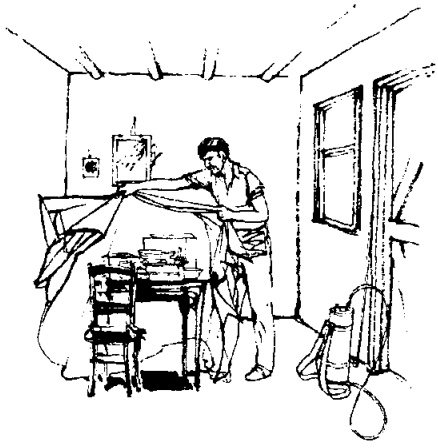
– Occupants MUST leave houses before spraying. Rooms occupied by sick people who cannot be moved must NOT be sprayed.



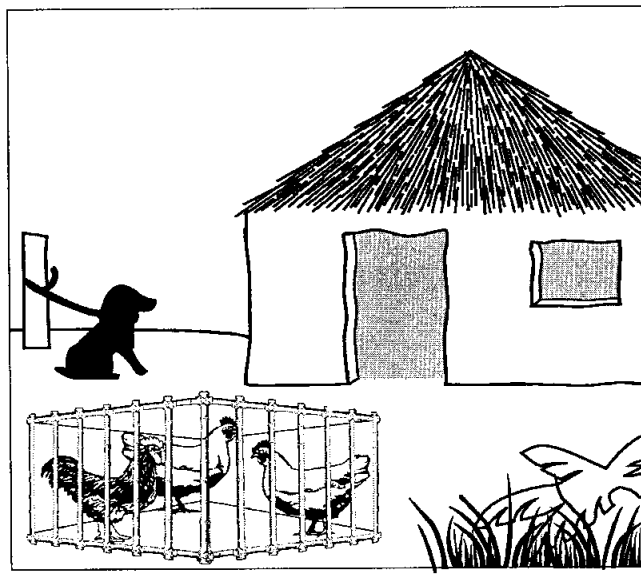
- Remove all household items, including water, food, cooking utensils and toys from the house.



- Move and cover, or take out the furniture to allow easy access for spraying walls. Items that cannot be removed should be well covered.



– Cage or tether pets and domestic animals away from the house.

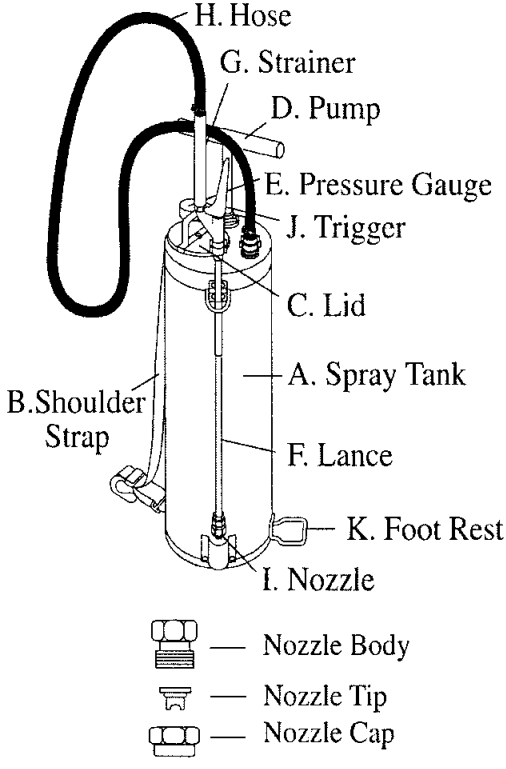


5.2 Preparations - *Equipment*

Indoor residual spraying of insecticides is normally done using hand-operated compression sprayers. Before starting a spray operation, the equipment must be checked. Faulty sprayers may result in poor control or over-treatment.

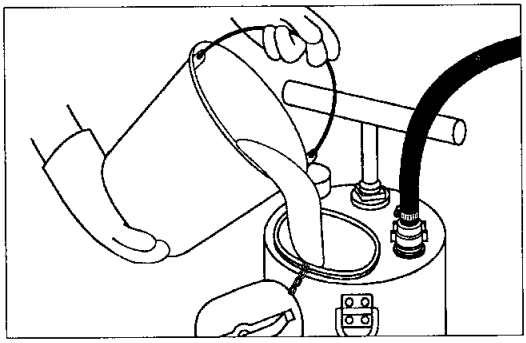
Examine the sprayer visually to ensure that all parts are present, assembled correctly and are in good condition.

A. Sprayer tank
B. Shoulder strap
C. Lid
D. Pump (handle)
E. Pressure gauge
F. Lance
G. Strainer
H. Hose
I. Nozzle - check correct type of nozzle is fitted and is not damaged or worn (flat fan nozzle with 80° swath and 0.76 l/min flow rate at 40 psi)
J. Trigger on/off valve. Is the strainer inside valve handle clean?
K. Footrest

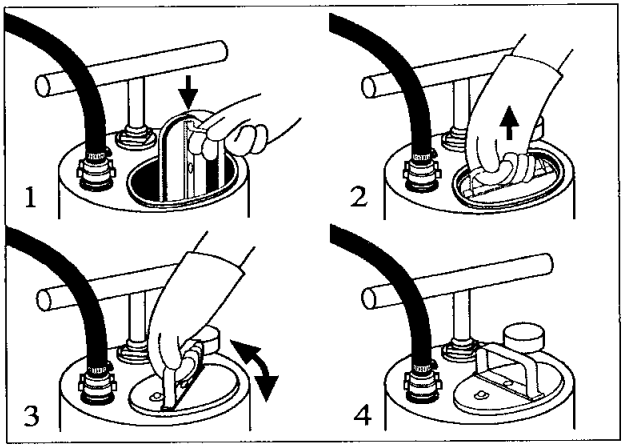


Before using an insecticide use clean water to ensure that the equipment operates properly and does not leak. Wear protective clothing. To check, follow the steps below.

– Pour clean water into the tank (never fill tank more than 3/4 full).

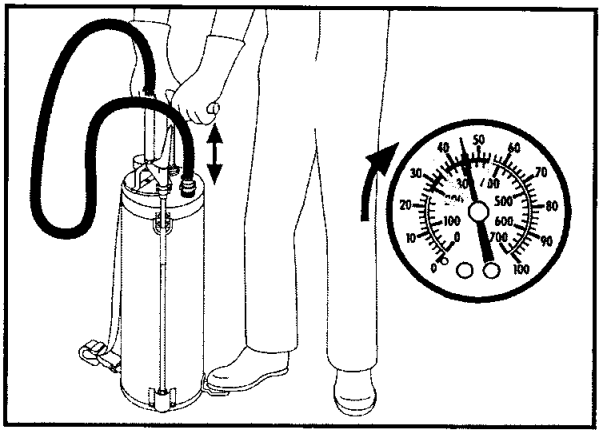


– Fit the lid. Turn the handle to lock the lid in position.

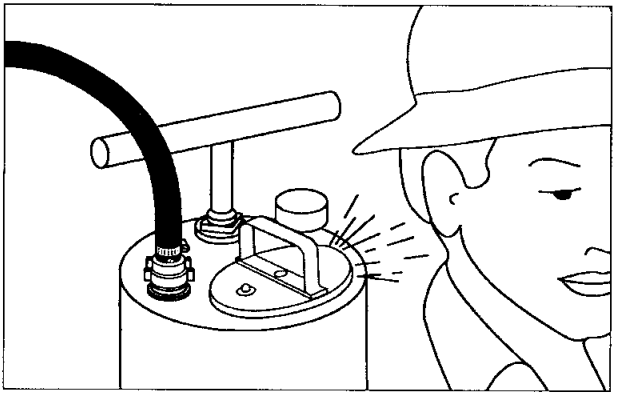


- Operate the pump using both hands and with foot on the footrest. Pump to the working pressure 55 psi (3.8 bar). Every full stroke gives about 1 psi.

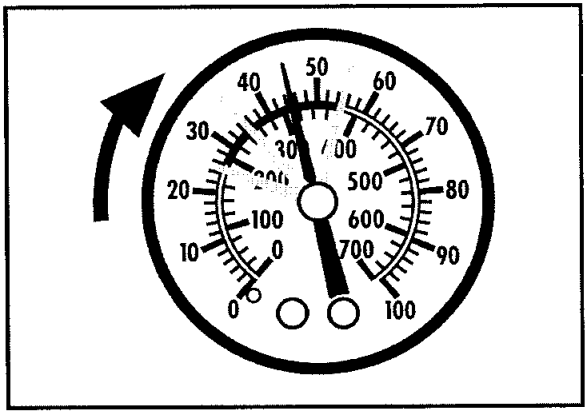
Note. (1 bar = 100 millibar = 14.5 psi = 100 kpa)



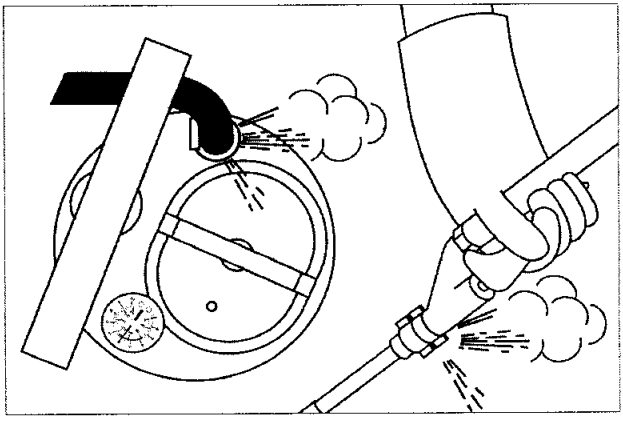
- Check tank is holding pressure. Listen for hissing sound of escaping air.



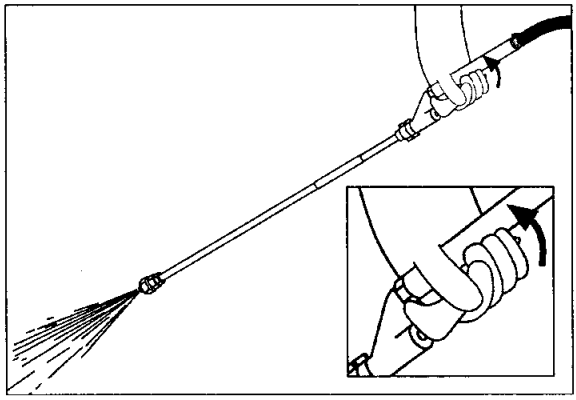
Does the pressure gauge show an increase in pressure as you pump?



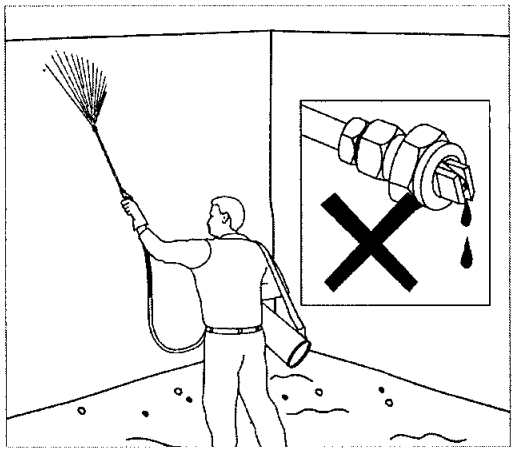
– Check to make sure there are no leaks along lance and hose, especially where hose joins tank and trigger on/off valve.



– Operate trigger on/off valve to make sure that spray is emitted from the nozzle.

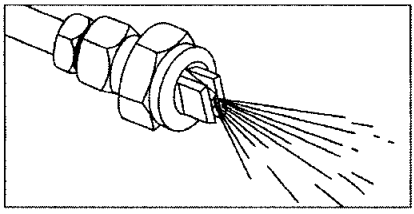


– Check the spray pattern from the nozzle by spraying a dry wall surface. Look to see that the pattern is even and without streaks. Ensure nozzle does not drip when trigger on-off valve is released.



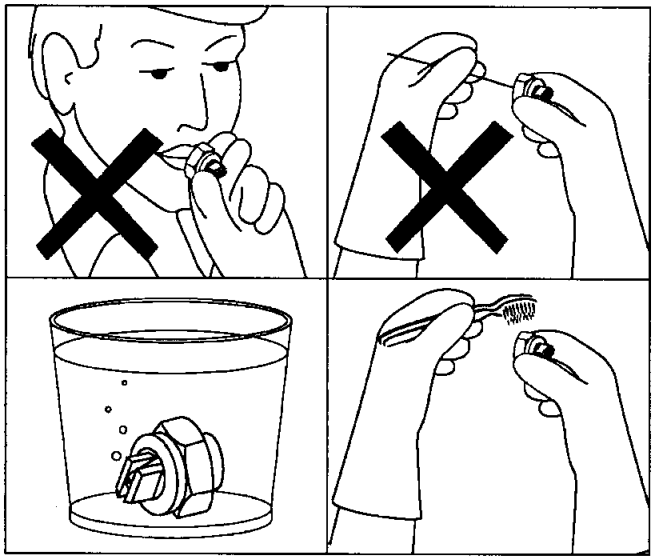
- Calibrate the nozzle with water in the tank. Pump to 55 psi (3.8 bar). Open the trigger on–off valve for one minute, collect the discharge and measure the amount in a measuring jug. Empty the jug. Discharge for a further one minute and measure the amount. Repeat for a third discharge. Calculate the average of the three, one-minute measurements.

- With the above procedure, the average discharge of a 8002 nozzle is about 760 ml per minute. If the discharge is incorrect (760 ± 15 ml/minute), check the nozzle and the screen filters to ensure they are not clogged. If necessary replace nozzle. Repeat the calibration. The addition of a constant flow valve set on the lance will ensure the flow rate does not decrease as pressure in the tank falls.

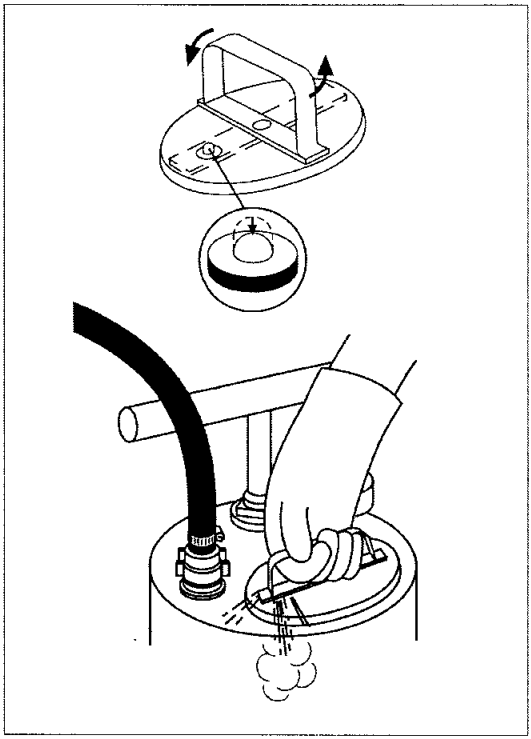


If the nozzle is clogged:

– The opening in a nozzle is very small and must not be damaged. Clogged nozzles should be put in a container with water for several hours before the blockage is removed by a very soft toothbrush. **NEVER** clean nozzle with a hard pin or piece of wire and **NEVER** put a nozzle to your mouth to blow through it.

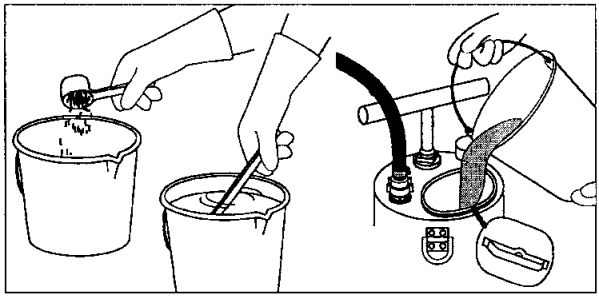


– Having checked the sprayer, de-pressurize by rotating the lid handle so that it stops on top of the pressure release button valve on top of the lid. During this process, hold the handle to prevent the lid from falling into the tank. Empty out the clean water you have used for testing the sprayer.

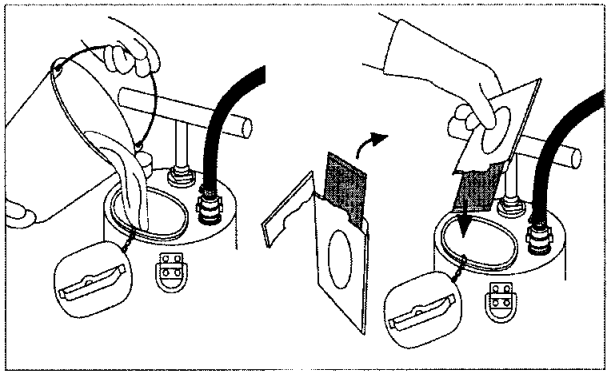


5.3 Mixing, handling and spray techniques

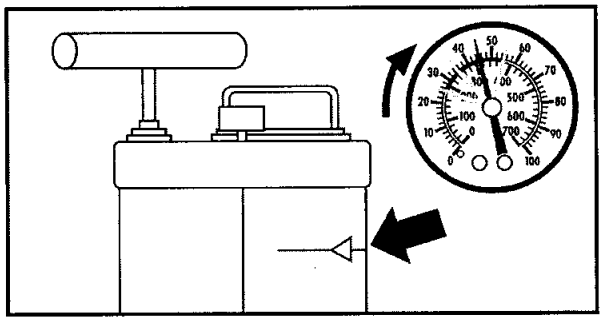
– Prepare the insecticide spray according to the manufacturer's instructions. The insecticide may be mixed separately in a bucket and poured into the sprayer.



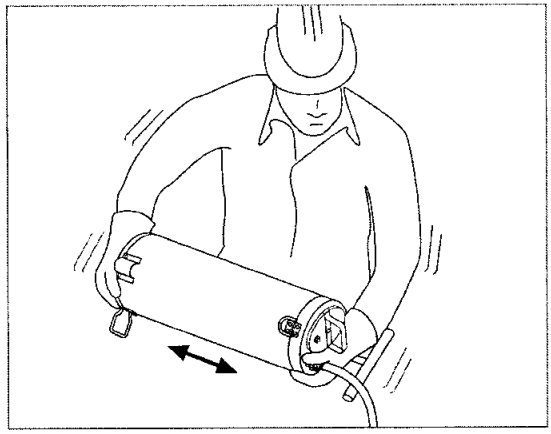
– Water soluble sachets, tablets and insecticides granules are added directly to the water filled tank. These formulations mix readily with water and reduce the hazards associated with handling and mixing in a separate container.



– When the sprayer has been filled with water to the maximum level indicated on the tank, the lid of the tank is fitted and the sprayer pumped until the pressure gauge shows 55 psi (3.8 bar). Every full stroke gives about 1 psi. About 55 full strokes are required to reach the working pressure.



– The contents of the tank should be thoroughly mixed by shaking the tank before starting to spray.



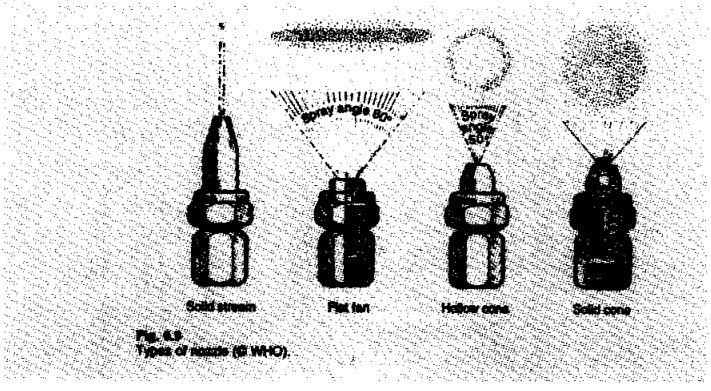
Types of nozzle

- Solid or jetstream nozzle is used in cracks and crevices for control of bedbugs, soft ticks, cockroaches and ants.

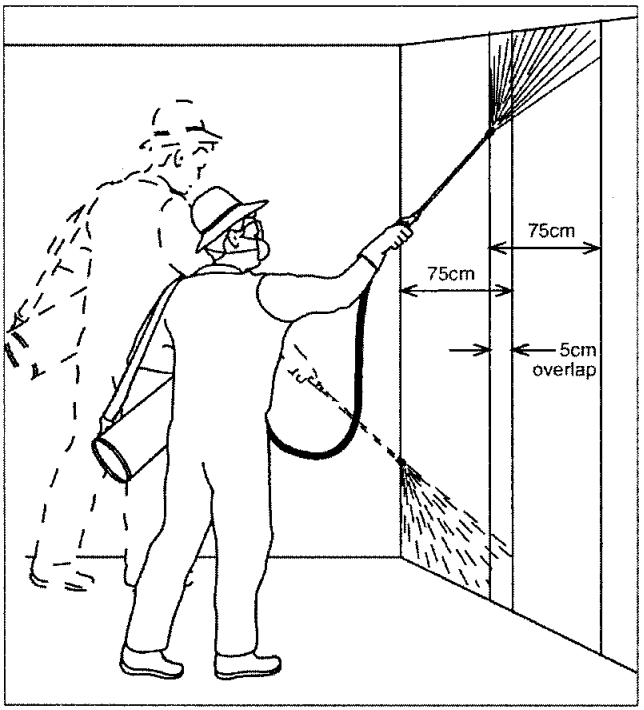
- Flat-spray nozzle delivers a fan-shaped spray ideal for residual house spraying.

- Hollow-cone nozzle is used to spray breeding sites in vegetation.

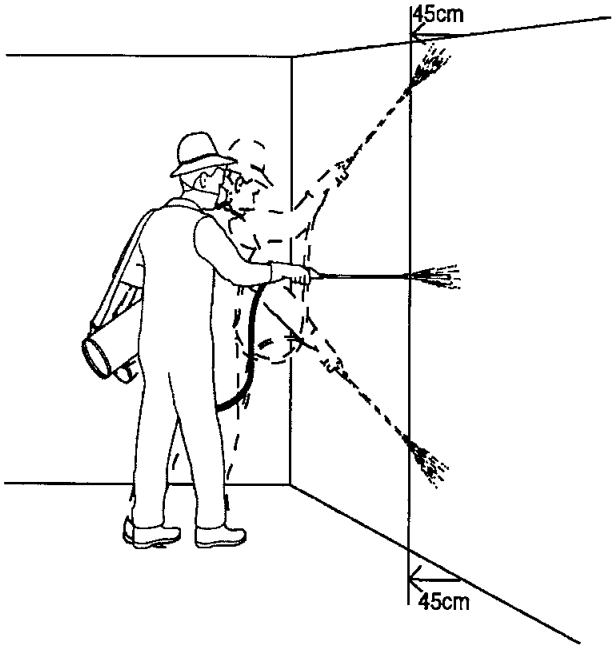
- Solid-cone nozzle is used to spray mosquito breeding sites.



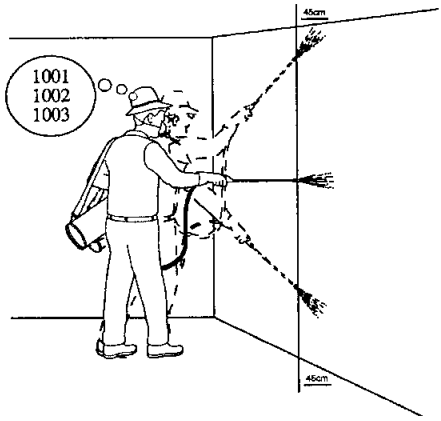
– Spray is applied in vertical swaths 75 cm wide. Swaths should overlap by 5 cm. Spray from roof to floor, using a downward motion, to complete one swath. Step sideways and spray upwards from floor to roof.



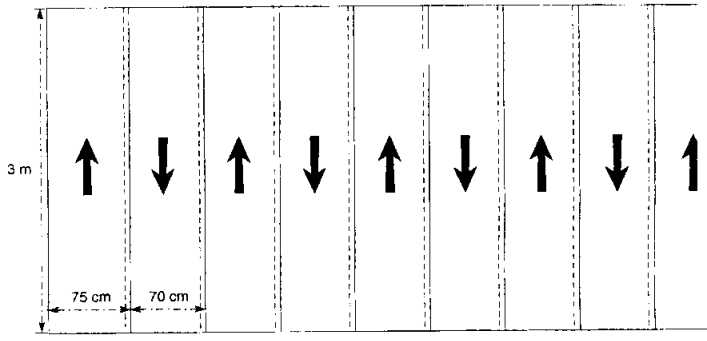
– To ensure the correct swath width, keep the spray tip about 45 cm from the wall. Lean forwards as you spray from top of the wall and move back as you bring the nozzle downwards. Continue the procedure, moving in a clockwise direction until the room is completed.



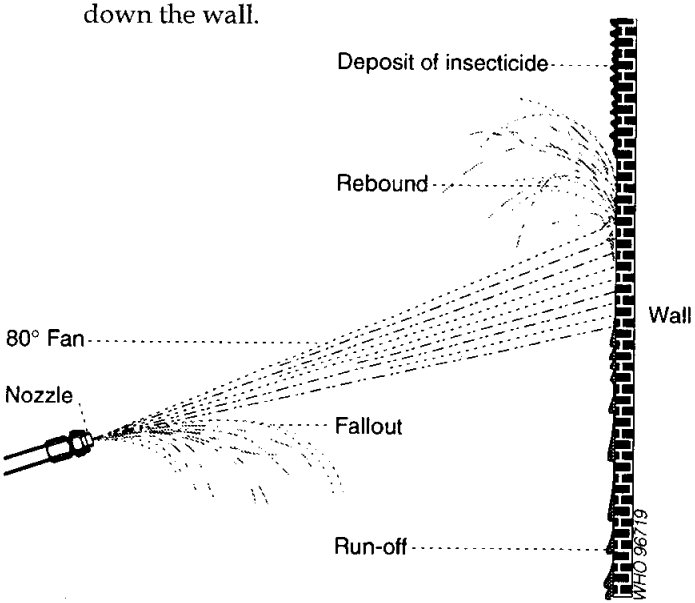
– Time your spray speed to cover one metre every 2.2 seconds, i.e. 4.5 seconds for a 2 m high wall. Timing may be aided by mentally counting "one thousand and one, one thousand and two, one thousand and three...". Adjust the mental counting procedure according to the local language.



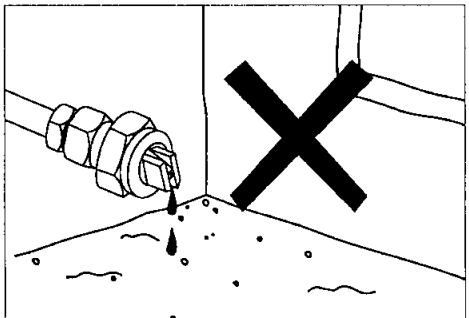
– A training board for residual spraying can be marked with chalk on the wall of a large building.



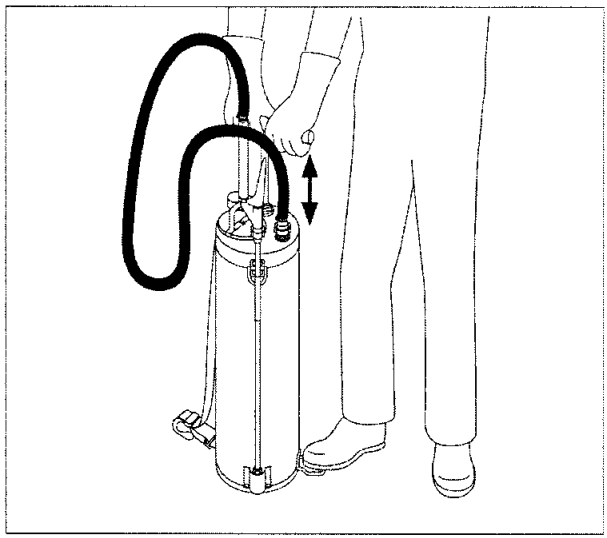
– When a vertical surface is sprayed, some of the insecticide particles bounce off into the air. A heavy application results in insecticide run-off down the wall.



– If spray stops due to a blockage in nozzle, unscrew the nozzle cap, remove blocked nozzle and replace with a new one. The blocked nozzle should be cleaned as explained above. Do not let spray drip on the floor.



– Re-pressurize the tank when the pressure gauge falls below 25 psi.

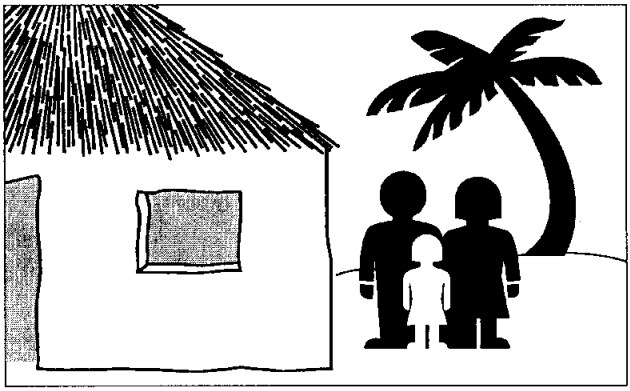


The use of "control flow valve (CFV)" is recommended as it will reduce the need for re-pumping and will produce a uniform discharge rate ensuring that a uniform amount of insecticide is placed on wall. The valve is fitted by first removing the nozzle body. Fit a washer into the end of the CFV that is then screwed to the nozzle body. The nozzle tip and cap are then screwed back on the open end of the CFV.

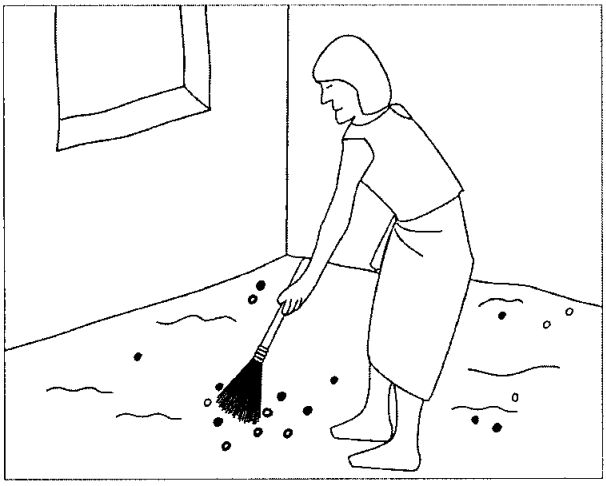
With a "red CFV" that operates at 1.5 bar (21 psi) the output will be 580 ml/minute and 30 ml/m^2 at the same spraying speed (see page 30).

5.4 Procedures after spraying

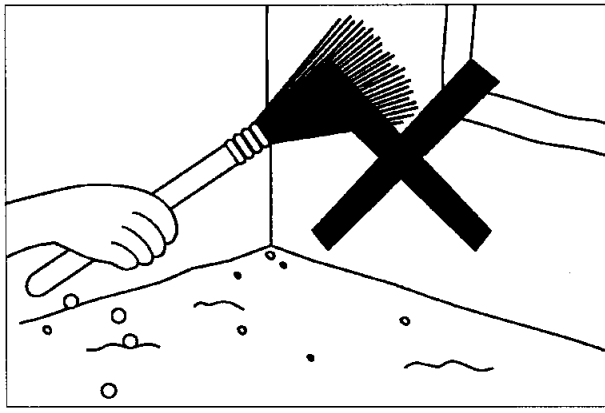
– Advise the occupants to stay outside until the spray is dry.



– Instruct the head of the household to sweep or mop the floor before children or pets are allowed to re-enter.

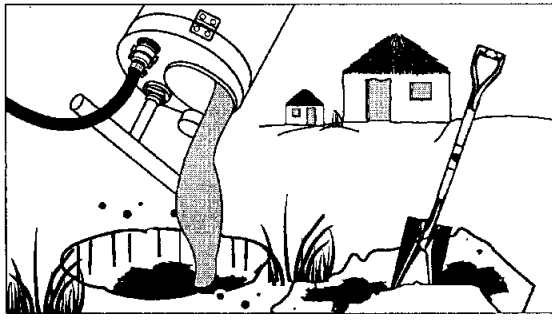


– Instruct the head of the household not to clean the sprayed surfaces.

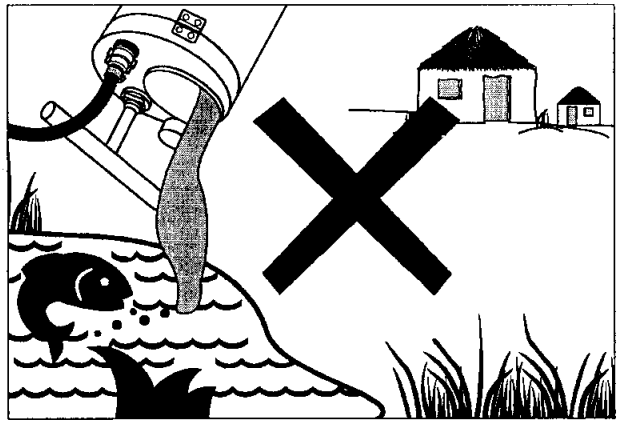


5.5 Disposal of remains of insecticides and empty packaging

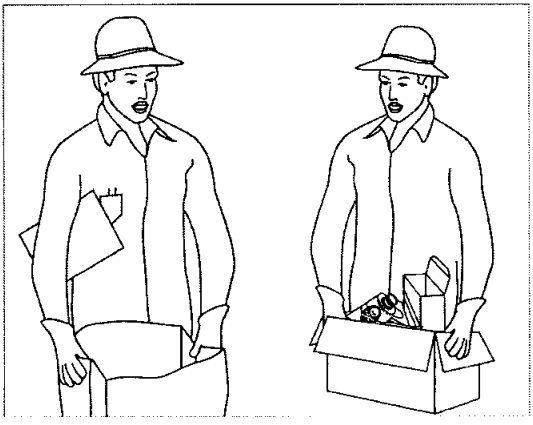
– At the end of the day's work, put the washings from the sprayer into pit latrines, if available, or into pits dug especially for this purpose and away from sources of drinking-water. Dilute any insecticide with water before putting into pits.
Note. It is advisable to prepare only the amount of insecticide needed.



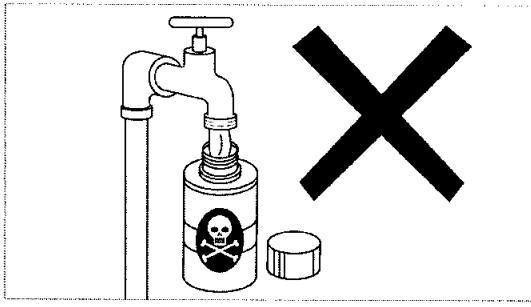
– Never pour the remaining insecticide into rivers, pools or drinking-water sources.



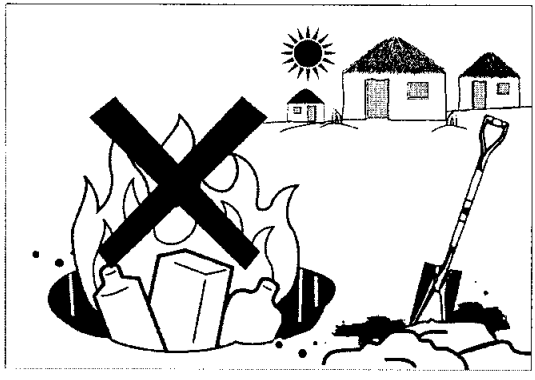
– All empty packaging should be returned to the supervisor for SAFE disposal.



– Never re-use empty insecticide containers.



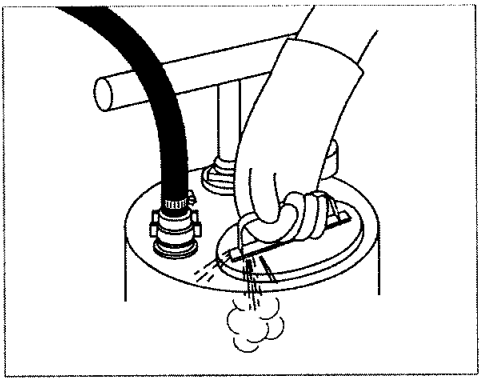
– Empty insecticide containers should NOT be burned or buried.



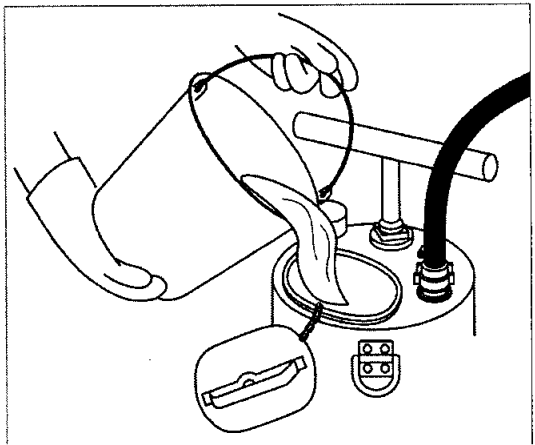
5.6 Maintenance of equipment

After completing the day's work, de-pressurize the tank and empty any remaining insecticide, following the instructions given in the previous section. Clean the tank as explained below.

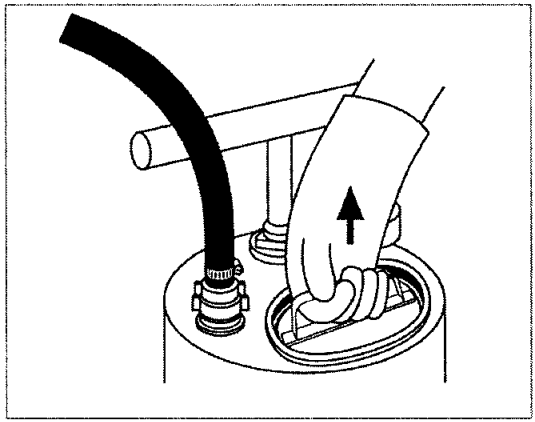
1. De-pressurize the tank.



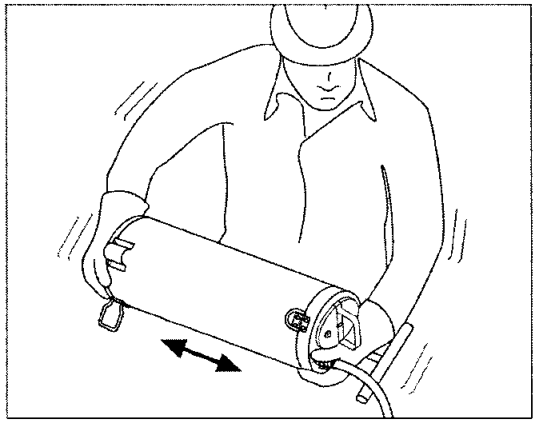
2. Fill the tank half-full with clean water.



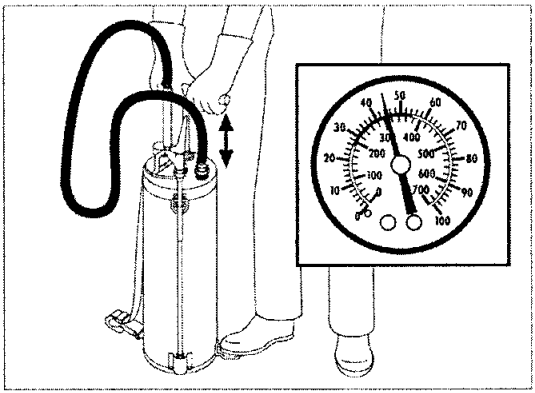
3. Replace the lid.



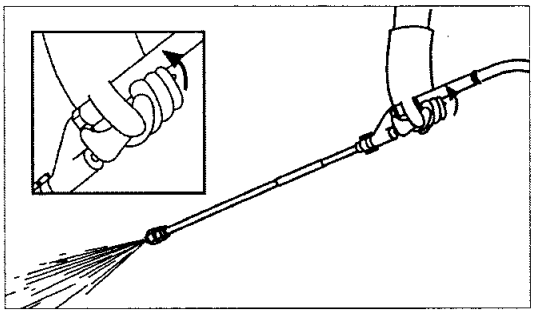
4. Shake the tank so that all inside surfaces are washed.



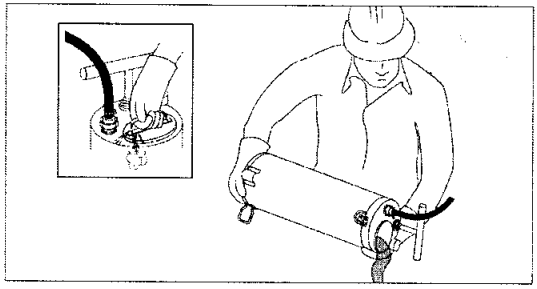
5. Pump up to 3 bar (=43.5 psi) pressure.



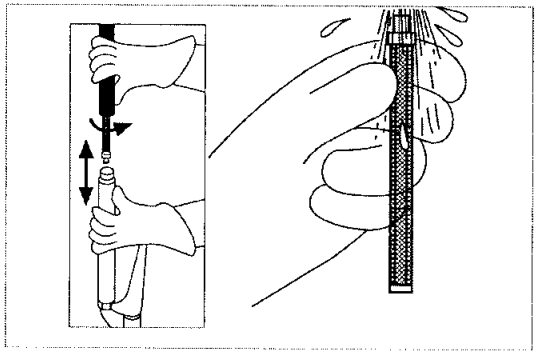
6. Spray water through nozzle.



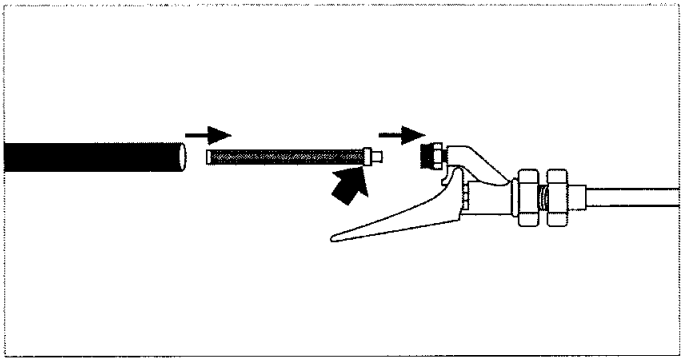
7. De-pressurize the tank and pour out any remaining water into pit latrines or into a pit away from sources of water.



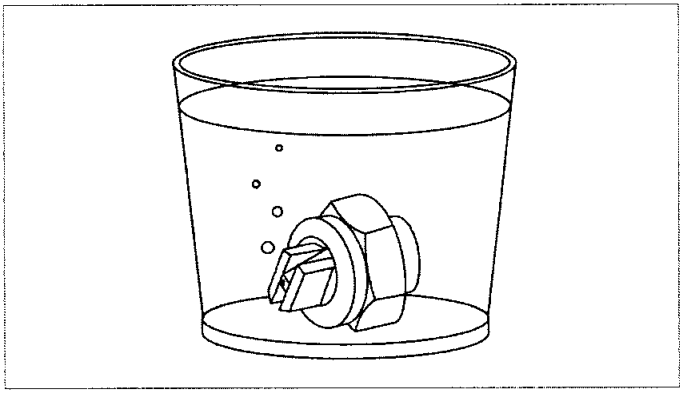
8. Unscrew trigger on/off valve handle and check and clean the strainer.



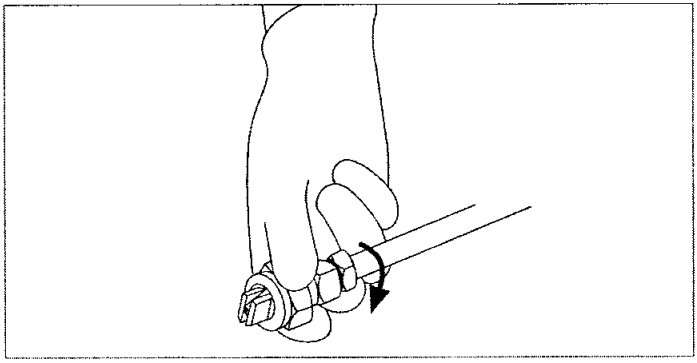
9. Reassemble the trigger on/off valve.



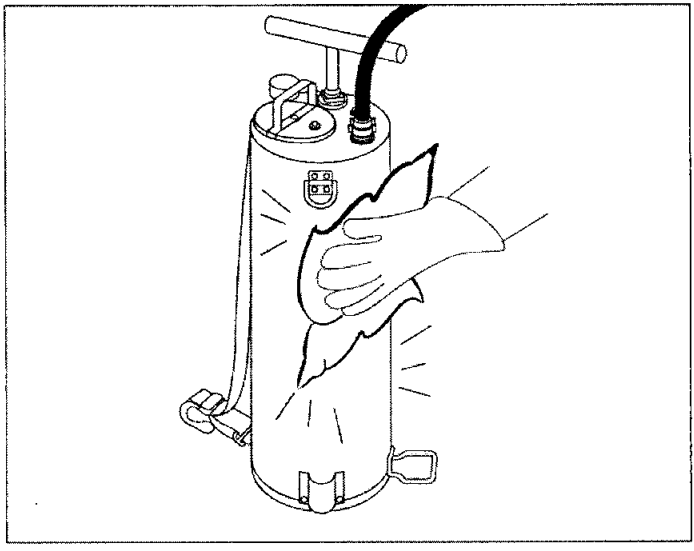
10. Remove the nozzle tip and wash.



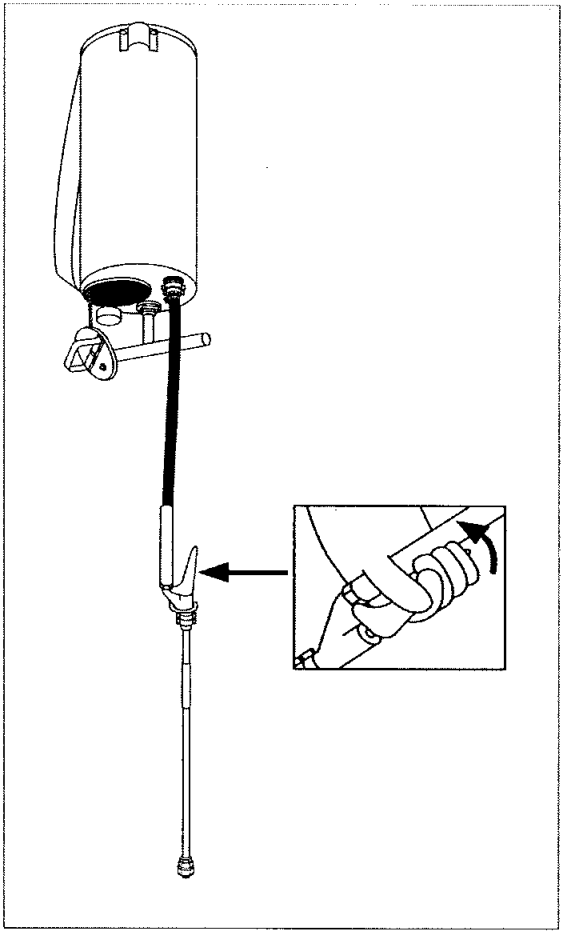
11. Refit the nozzle.



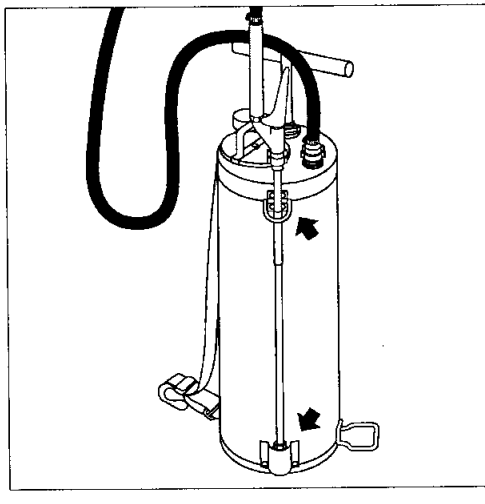
12. Clean outside of tank.



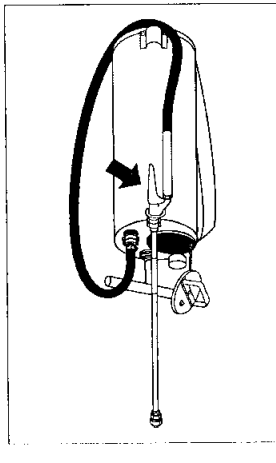
13. With lid open, turn tank upside down, open the on/off valve and let all the water drain out of the hose and lance.



– Ensure that the lance is parked to protect nozzle when not in use.



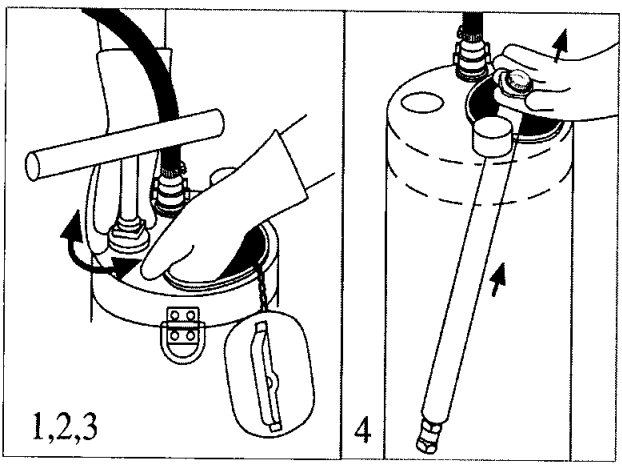
– When storing the sprayer for a long period, hang it upside down with lid open to allow air circulation. Allow lance to hang from D-ring on the tank with the trigger valve kept open.



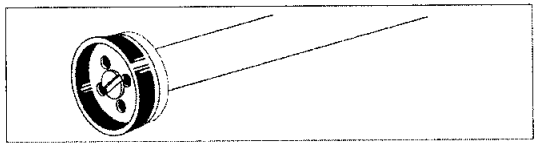
5.7 Troubleshooting

If the pump fails to pressurize the tank:

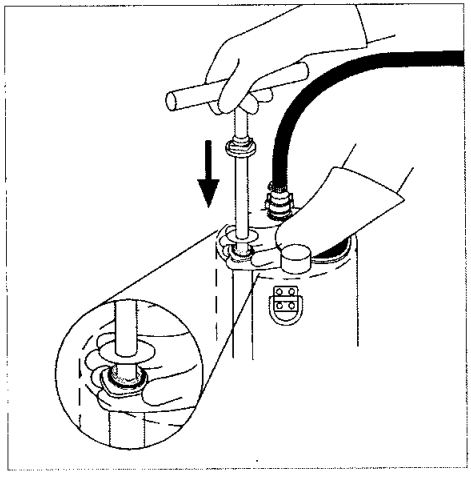
1. Remove the pump plunger from the sprayer by loosening the nut holding the pump on the top of the tank
2. Insert a gloved hand into the tank and hold the pump cylinder.
3. Unscrew cap holding the pump and pull the plunger from the tank.
4. Remove the pump cylinder from inside the tank.



5. If leather pump plunger cup is dry, soften it by rubbing in some clean engine oil. If it is damaged and needs replacing, unscrew the disc holding the plunger cup and replace.

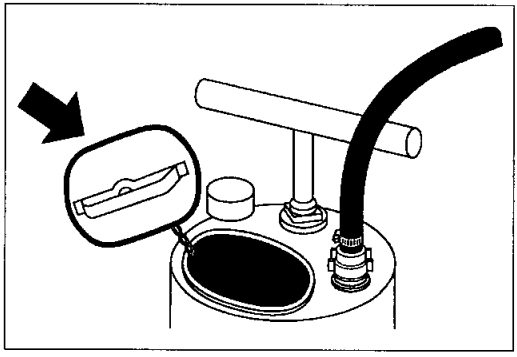


6. Reassemble the pump; check the gasket is in place on the pump cylinder, then hold the pump cylinder inside the tank, with threaded part through opening in the top of the tank; insert the pump plunger into the cylinder, turn the plunger cap counter-clockwise on the cylinder to ensure the threads match, then screw the cap on and tighten.

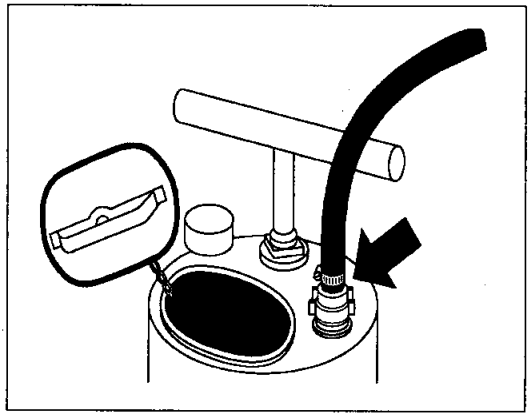


If the tank fails to hold pressure:

- Check the rubber seal on the lid and replace if necessary.



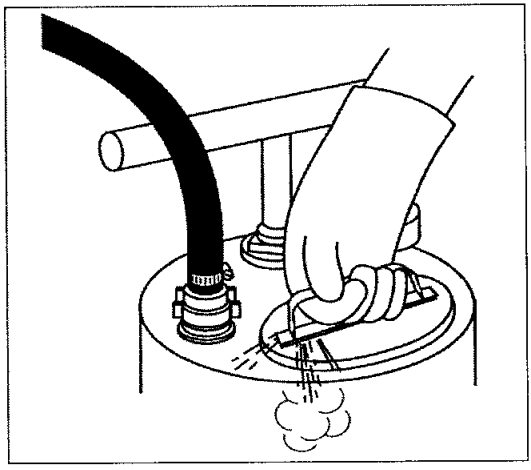
- Check that the hose connections to the tank are tight.



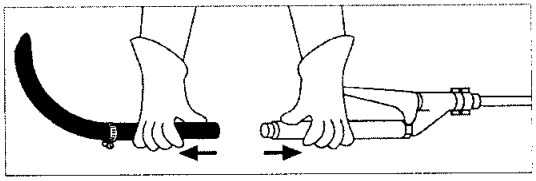
If the sprayer does not shut off:

Check the trigger on/off valve.

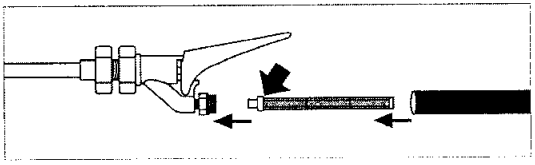
1. De-pressurize the tank.



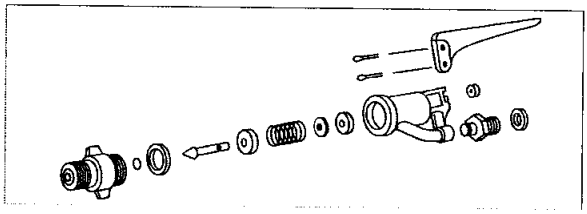
2. Disconnect the trigger valve from the hose.



3. Take the filter out of the handle.



4. Unscrew the remaining assembly to see if spring and washers need to be cleaned or replaced.



5.8 Preparation of insecticide spray

The amount of formulated insecticide required for the preparation of an insecticide spray is based on the average discharge rate of the sprayer and speed of application. At a working pressure of between 25 and 55 psi and the standard speed of application (see page 30), the application rate will be 40 ml/m^2. This means that 8 litres (8000 ml) of spray suspension can be sprayed to 200 m^2 (*calculation: 8000 ml / 40 ml/m^2 = 200 m^2*).

Example 1. A target application of 2 g of active ingredient/m^2 requires 400 g of active ingredient in the tank (*calculation: 2 g/m^2 × 200 m^2= 400 g*). Therefore for a formulated insecticide of 50% wettable powder, 800 g of the formulated product should be mixed with water to give 8 litres of suspension (*calculation: 400 g / 0.50 = 800 g*).

Example 2. A target application of 0.050 g of active ingredient/m^2 requires 10 g of active ingredient in the tank (*calculation: 0.050 g/m^2 × 200 m^2 = 10 g*). Therefore for a formulated insecticide of 2.5% wettable powder, 400 g of the formulated product should be mixed with

water to give 8 litres of suspension (*calculation: 10 g / 0.025 = 400*).

Note 1. The amount of active ingredient (a.i.) in liquid formulations (e.g. EC, SC) may be expressed as weight/weight (w/w) or weight/volume (w/v). In the latter case, the calculations proceed as in the previous examples. However, in the case of w/w, consult the label carefully, it will also give the amount of active ingredient per litre. Convert this to percent before proceeding with the calculations, as stated above. For example, if the label indicates that the formulation is 8% w/w, but also indicates that it contains 100 g a.i./L, convert 100 g/L to percent (*Calculation: 100 g / 1000 ml = 10%*).

Note 2. In some countries spray pumps of 10 L capacity are used. With such tank capacity the spray suspension covers 250 m^2 when applied at 40 ml/m^2.

Note 3. With the "red CFV" (see page 32) the application rate will be 30 ml/m^2 and, therefore, 8 litres of spray suspension can be sprayed to 266 m^2, at the same spraying speed (*calculation 8000 ml / 30 ml/m^2 = 266 m^2*). A target application of 2 g of active ingredient/m^2 requires 532 g of active ingredient in the tank (*calculation: 2 g × 266 m^2 = 532 g*). For a formulated insecticide of 50% wettable powder, therefore, 1064 g of the formulated product should be mixed with water to give 8 litres of suspension (*calculation: 532 g / 0.50 = 1064 g*).

6. Application of insecticides for larval control

- Larvicides are available in two forms, emulsifiable concentrate (EC) and granular (see Table 2).

- EC formulations are applied using pressure pumps, or motorized pumps where access is difficult (see types of nozzles).

- Granular formulations are applied by hand or with power-operated granule applicators.

- Granules do not require mixing, are safer to handle, easier to apply and able to penetrate aquatic vegetation.

7. Implementation of bednets

7.1 Specifications for nets

7.1.1 Shape

- Conical: easy to hang and fold up, especially in small rooms.
- Rectangular: needs six strings to hang but more spacious, reducing the chance of contact with the net.
- *Dumuria*: traditional non-transparent rectangular net with advantages of increased privacy and security.
- Net may come with a border at the bottom, to reduce tear and wear, or at the top, to prevent dust, snakes etc.
- A large border of different fabric (e.g. cotton) requires large quantities of insecticides.

7.1.2 Netting materials

- Polyester material is recommended as it binds well with insecticide.
- Cotton material absorbs a lot of insecticide.
- Mesh refers to number of holes per square inch; 156 mesh is recommended.
- Denier refers to fibre strength; nets range from 40 (flimsy) to 100 denier (strong and durable but more costly)

7.1.3 Colour

Nets come in different colours (white, green, beige, blue, pink etc). Coloured nets reduce the frequency of washing, as they do not show dirt easily, but may interfere with insecticide binding. They are also slightly more expensive than white nets.

To decide on the shape, colour and sizes of nets, a survey should be conducted to determine people's knowledge, attitudes, practices and sleeping patterns.

7.2 Net re-treatment

7.2.1 Strategies

- Various strategies are available, each with its own advantages and disadvantages.
- Individual net treatment at home is less costly to organize, but quality of treatment cannot be ensured.
- Family net treatment in accessible centres, with supervision from health workers (volunteers or community health workers), is recommended.
- Communal net treatment should be discouraged, unless within the same family.

- Long lasting insecticidal mosquito nets (LLINs) that are WHO-approved, which require no re-treatment during their expected life span, will help solve the problem of low re-treatment rates. However, provision must still be made for re-treatment of traditional nets.

7.2.2 Procedures

Step 1: Take precautions
- Dipping should be done in open air to allow ventilation.
- Long rubber gloves should be used if possible.
- Care should be taken to avoid touching the face, and hands should be washed immediately after finishing net dipping.

Step 2: Assemble materials
- Washed nets
- Small (100 ml) and large (1 litre) graduated measuring cylinders
- Mixing containers (buckets, bowls, plastic bags)
- Insecticide and water

Step 3: Measure water
- Measure the water absorbed by a single net.
- Multiply this amount by the number of nets to be dipped and put this amount of water in the mixing container.

Step 4: Measure insecticide
- Measure the area of one net in m^2.
- Multiply the area by the target dosage in mg/m^2 - (e.g. 12 m^2 × 200 mg/m^2 (target dosage for Permethrin) = 2400 mg).
- Divide the result by the concentration of insecticide in mg/ml. For example, permethrin

EC 25% concentration has 250 mg/ml, therefore 2400 mg divided by 250 mg/ml = 9.6 ml.
- Multiply this result by the number of nets to be dipped.
- Measure that much concentrate, add it to the water in the mixing container and mix.

Note. It is preferable to calculate the dosage per net as listed above. However, in situations where accurate measurements and calculations are difficult, simplified dosages may be used as indicated in Table 4.

Step 5: Dip nets
- Ensure nets are clean and dry before dipping.
- Soak each net completely.
- Wring the net thoroughly so that excess fluid drips into the dipping container.

Step 6: Dry nets
- Preferably, lay nets flat on beds or on plastic sheeting under shade.
- Turn them occasionally as they dry.

Table 4. Amount of insecticides recommended for net treatment

Insecticide product[a]	Dosage per net
Alpha-cypermethrin 10% SC	6 ml
Cyfluthrin 5% EW	15 ml
Deltamethrin 1% SC	40 ml
Deltamethrin WT	One tablet
Etofenprox 10% EW	30 ml
Lambda-cyhalothrin 2.5% CS	10 ml
Permethrin 10% EC	75 ml

[a] SC = aqueous suspension concentrate; EW = emulsion, oil in water; WT = water dispersible tablet; CS = capsule suspension (encapsulated); EC = emulsifiable concentrate

8. Monitoring and evaluation of vector control activities

8.1 Operational indicators

- Proportion of people in sprayed areas
- Proportion of people in sprayed houses
- Proportion of households with at least one treated net
- Proportion of people using nets
- Proportion of people living in areas under larviciding operations
- Proportion of breeding sites with no larvae

8.2 Entomological indicators

8.2.1 Routine

- Adult mosquito densities
- Presence and density of mosquito larvae
- Insecticide susceptibility status

8.2.2 Trend assessment

- Human-biting rates
- Human blood index (proportion of human blood-fed mosquitoes)
- Adult mosquito density
- Adult mosquito parity

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