Standard operating procedures for operating, maintenance and storage of desert locust sprayers

Ultra-low volume vehicle mounted sprayer
ULVAMAST - manual version (V4M)
Purpose

The Desert Locust *Schistocerca gregaria* (Forskal) is one of the most serious insect pests that causes heavy losses in agricultural crops and natural pastures, consequently causing economic and social crises for many countries.

Control operations relies on spraying conventional chemical pesticides by air or ground as the main effective means to contain the threat of the desert locust.

It is essential that locust field officers should be familiar with the aspects that relating to the sprayers that are used against the desert locust, e.g. operation, maintenance and common troubleshooting to resolve problems that might otherwise hamper the control operations.

This field guide describes a sprayer used in the desert locust control. The sprayer was selected based on technical reports and related references that indicate the importance, effectiveness and efficiency of this sprayer against the desert locust.

This guide presents only the features and characteristics of the sprayer that are suitable for the use of desert locust in accordance with FAO's vision and therefore there may be some dissimilarity between this manual and the manufacturer's manual.

Hopefully this field guide will contribute to the efficiency and efficacy of desert locust control operations.
Specifications

**Weight (empty):** 65 kg.

**Operating Voltage:** 12 V DC (Vehicle’s Battery).

**Frame:** Strong 30 mm and 40 mm box section mild steel, folding mast and support arm.

**Pesticide Tank:** 100 litre capacity. 5-litre graduations.

**Flushing Tank:** 10 litre tank.

**Pump:** Magnetically coupled centrifugal pump.

**Flow rate:** 0.2 - 2.0 l/min (V4M), 0.2 – 1.5 l/min (V4E).

**Flow rate control:** In line orifice restrictor plates/hand operated needle valve (V4M), or electronically (V4E).

**Hose material:** Flexible stainless steel braided PTFE lined hose.

**Fittings:** Metal/brass fittings with union nut connections.

**Electrical cable:** Protected by black nylon conduit.

**Atomiser speed adjustment:** single high speed (7 200 rpm).

**Control box:**
- For (V4M): Standard ON/OFF pump and atomiser control and fused with LED indicator lights.
- For (V4E): Electronic control, Master ON/OFF, three atomiser settings, ten flow control settings and fused with LED indicator lights.

Note: Specifications may varied according to the used version, this machine is available in both the ULVAMAST M (V4M-manual flow control) and ULVAMAST E (V4E- electronic flow control) versions.
1. ULVAMAST components

- Atomiser
- Mast
- Locking Mechanism
- Mast Extension Arm
- Main Tank (100 litre)
- Drain Tube
- Pump
- Filter
- Flushing tank 10 litre
- ATOMISER ON / OFF
- PUMP ON / OFF
Ultra-low volume vehicle mounted sprayer ULVAMAST

2. Pump

3. Valves

- Tank Selector Valve
- Isolation Valve
- Drain Valve
Loading and installation instructions

1. The ULVAMAST can be mounted on any suitable open backed vehicle with an enclosed cab to protect the driver from the spray;

2. the sprayer should be positioned as far to the rear of the vehicle as possible so that, when the mast is extended, the atomiser projects behind the rear of the vehicle;

3. the ULVAMAST should be secured rigidly to the vehicle by means of bolts in four holes drilled in the vehicle floor (in appropriate positions);

Take care to avoid the vehicle fuel tank or other vulnerable parts when drilling holes.

4. the electrical supply to the ULVAMAST is normally provided by the vehicle battery. The conduit containing the electrical cable should be run to the vehicle cab allowing the cable (with the control box detached) to enter the cab either through a small hole in the cab or through a window. The control box can then be located in the cab of the vehicle and connected to the battery terminals as follows:
   - Red/brown wire to the positive terminal +;
   - black/blue wire to the negative terminal –.

Be sure that the accessories of maintenance and calibration are supplied with the machine.
Preparation instructions

• Never, run the pump without the spray liquid (Dry);
• Always use the personal protective equipment (PPE).

1. Unscrew the wing nut from the mast retaining bracket and disengage the retaining clamp and raise the mast to the operating position so that the atomiser is pointing outwards beyond the rear of the vehicle. Secure the mast with the extension arm, Lock in place by turning the locking mechanism;
2. remove the protective atomiser cover and ensure that the stack of atomiser discs rotates freely;
3. check that the pump and atomiser are working by:
   • Rotate the two-way valve to open the 10 litre tank;
   • make sure the isolation valve near the filter is open;
   • open restrictor valve;
   • close drain valve;
   • placing a small amount (5-10 litres) of kerosene or diesel oil in the 10 litre tank;
   • switch on the pump at the control box. After a short period, liquid should start flowing from the atomiser;
   • switch off the pump and then switch on the atomiser at the control box and check that it is running smoothly. Rotational speed of the atomiser can be checked with the Vibratak tachometer.
4. Fill the main tank with pesticide (in the case of control operation).
## Valve positions

<table>
<thead>
<tr>
<th>Valve</th>
<th>Calibration</th>
<th>Control</th>
<th>Drain</th>
<th>Flushing</th>
<th>Stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation V.</td>
<td>open</td>
<td>open</td>
<td>open</td>
<td>open</td>
<td>close</td>
</tr>
<tr>
<td>Tank selector valve</td>
<td>open-main tank</td>
<td>open-main tank</td>
<td>open-main tank</td>
<td>open-flushing tank</td>
<td>open-flushing tank</td>
</tr>
<tr>
<td>Drain V.</td>
<td>close</td>
<td>close</td>
<td>open</td>
<td>close</td>
<td>close</td>
</tr>
</tbody>
</table>

## Operating modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Pump</th>
<th>Atomiser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration</td>
<td>working</td>
<td>not working</td>
</tr>
<tr>
<td>Control</td>
<td>working</td>
<td>working</td>
</tr>
<tr>
<td>Flushing</td>
<td>working</td>
<td>working</td>
</tr>
</tbody>
</table>
Safety instructions (operator)

1. Always follow the safety instructions on the pesticide label when handling and using pesticides;
2. do not spray near people, domestic animals, waterways, rivers or lakes. 200 meters should be applied as buffer zone downwind from where spraying is to take place;
3. do not carry people, bedding, foodstuffs, clothing or animals in the back of the spray vehicle when spraying or when it is contaminated with pesticide;
4. only use a spray vehicle fitted with an enclosed cab;
5. always wash hands, face and body after filling the spray tank, after spraying and before eating or smoking;
6. always carry soap and towels for washing in the cab of the spray vehicle and a supply of petrol, water and rags for cleaning the vehicle and sprayer.

Diesel is recommended for cleaning residues of ULV products, while petrol is not preferred (and dangerous) due to its flammability.

Safety instructions (sprayer)

The fire, damage or hurt of operator could be occurred if the following instructions not followed:

1. When using petrol in the cleaning process, move the sprayer away, and avoid any source of fire till the petrol evaporated;
2. never run the pump dry.
Calibration

When to do calibration?
1. When using a new sprayer;
2. when the type or concentration of a pesticide’s formulation is changed;
3. when the volume application rate, track spacing or forward speed is changed;
4. at the beginning of the control campaign and at intervals during the campaign.

Calibration equipment
1. Graduated measuring cylinder or jug;
2. stop watch;
3. a sufficient amount of the same pesticide as will be used in the control operation;
4. a sufficient amount of kerosene or diesel;
5. two buckets (Graduated Container);
6. anemometer.

Note: Two person are required to carry out the calibration.
5. Orifice restrictor plates

6. Place of interchangeable restrictor orifice plates

7. Adjustable restrictor valve
Calibration steps

For the proper calibration procedure, follow the following steps and record the results in your notes.

1. The sprayer (and tools) should be cleaned by using the kerosene or diesel, through the flushing tank. Determine the forward speed (for vehicle) by measure the elapsed time (in seconds) for the vehicle to cover 100 meters at the speed appropriate for the terrain:

   \[
   \text{Speed (km/hr.)} = 3.6 \times \left( \frac{\text{distance travelled (m)}}{\text{time (seconds)}} \right)
   \]

   Note: Normally, the forward speed:
   - In flat terrain is around 20 km/hr max.;
   - In rugged terrain is around 10 km/hr.

2. according to the previous steps, determine the track spacing, as follows:

<table>
<thead>
<tr>
<th>If the Wind speed (m/sec)</th>
<th>And the Forward speed (km/hr)</th>
<th>Then Track spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3</td>
<td>10-20</td>
<td>Up to 30</td>
</tr>
<tr>
<td>4-6</td>
<td>10-20</td>
<td>Up to 40</td>
</tr>
<tr>
<td>8-10</td>
<td>10-20</td>
<td>Up to 50</td>
</tr>
</tbody>
</table>
3. calculate the Volume Application Rate (l/ha) from the formula:

\[
\text{VAR (l/ha)} = \frac{\text{Recommended dose (g.ai./ha)}}{\text{Concentration (g.ai./L)}}
\]

**Note:**
The recommended dose could be obtained from recommended doses list (page 24), while the concentration could be obtained from the pesticide label (% × 10).

4. Calculate the Volume Application Rate (l/ha) from the formula:

\[
\text{Flow Rate} = \frac{\text{VAR (l/ha)} \times \text{track spacing (m)} \times \text{speed (km/hr.)}}{600}
\]

5. convert the result (of step 5) from l/min to ml/min (multiply by 1 000);

6. ensure that the sprayer is ready to spray (refer to page 10);

7. fill the main tank with known amount of pesticide;

8. run the pump without atomiser, collect the pesticide in the first bucket, before the liquid flows uniformly;

9. start to collect the pesticide in the second bucket, for one minute, only when the pesticide flows uniformly;

10. after collecting the pesticide for one minute, collect the pesticide again in the first bucket, to avoid any waste;

11. switch off the pump, be sure that the spray liquid has stopped, before removing the bucket;
12. pour the collected amount of pesticide (second bucket), into the graduated cylinder, this corresponds to the volume in ml collected in 1 minute (ml/min);

13. if the collected amount of pesticide (step 13) equals the calculated flow rate (step 6), then the calibration has been done correctly, repeat the steps (9 -13), 3 times, to confirm the results;

14. if the collected amount of pesticide in the graduated cylinder (step 13) is greater or less than the required result in step 6, then the calibration has been carried out unsuccessfully, and you have to either readjust the Restrictor valve or change the orifice restrictor plates (in the manual version); Change the setting of the flow control at the control box (in the electronic version).

**NOTE:** Normally, the orifice restrictor plates are used to adjust the flow rate, however, the flow rates that obtained by using the restrictor valve are higher than the flow rates that obtained by using the orifice restrictor plates.
15.A. Calibration by using the restrictor valve (Manual version)

- Do Not Use any of the orifice restrictor plates;
- refer to the table below to select (Increase/Decrease) the setting number that gives a flow rate closest to the required output from the sprayer (flow rate closest to the result obtained from step 6):

<table>
<thead>
<tr>
<th>Position</th>
<th>Flow rate (ml/min) for Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>600</td>
</tr>
<tr>
<td>3</td>
<td>750</td>
</tr>
<tr>
<td>4</td>
<td>950</td>
</tr>
<tr>
<td>5</td>
<td>1150</td>
</tr>
<tr>
<td>6</td>
<td>1350</td>
</tr>
<tr>
<td>7</td>
<td>1600</td>
</tr>
<tr>
<td>8</td>
<td>1800</td>
</tr>
<tr>
<td>9</td>
<td>2050</td>
</tr>
<tr>
<td>10</td>
<td>2300</td>
</tr>
</tbody>
</table>

- adjust the knob of the valve so that the number corresponding to the required flow rate (step 7) is aligned with the line on the ring behind the knob. The knob must NOT be set to an intermediate position between settings numbers;
- repeat the steps (3 times) from 9 to 15 to verify the results;
- then compensate the new result of flow rate, in formula 5 to obtain the new track spacing.
15.B. Calibration by using the orifice restrictor plates (Manual version)

- The variable restrictor valve should be set to its fully open position (knob rotated fully anti-clockwise);
- referring to the table below, select and fit the orifice restrictor plate which gives the flow rate closest to that required (flow rate closest to the result obtained from step 6):

<table>
<thead>
<tr>
<th>Restrictor plates No.</th>
<th>Flow rate (ml/min) for oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>108</td>
</tr>
<tr>
<td>30</td>
<td>149</td>
</tr>
<tr>
<td>39</td>
<td>294</td>
</tr>
<tr>
<td>49</td>
<td>461</td>
</tr>
<tr>
<td>59</td>
<td>581</td>
</tr>
<tr>
<td>68</td>
<td>709</td>
</tr>
<tr>
<td>80</td>
<td>957</td>
</tr>
<tr>
<td>98</td>
<td>1 210</td>
</tr>
</tbody>
</table>

- repeat the steps from 9 to 15 to verify the results (3 times), then compensate the new result of flow rate, in formula 5 to obtain the new track spacing.
17.C. Calibration in the electronic version
With the V4E model, there are ten pre-set flow rates (shown in the table below) which can be ‘dialed in’ on the cab controller and which are independent of viscosity. Dialed the flow rate that closest to that required (flow rate closest to the result obtained from step 6):

<table>
<thead>
<tr>
<th>Position</th>
<th>Flow rate (ml/min) for oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>250</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
</tr>
<tr>
<td>4</td>
<td>400</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
</tr>
<tr>
<td>6</td>
<td>600</td>
</tr>
<tr>
<td>7</td>
<td>800</td>
</tr>
<tr>
<td>8</td>
<td>1000</td>
</tr>
<tr>
<td>9</td>
<td>1250</td>
</tr>
<tr>
<td>10</td>
<td>1500</td>
</tr>
</tbody>
</table>

There is no need, therefore, to measure the flow rate each day. Calibration is thus much simpler. Just compensate the new result of flow rate, in formula 5 to obtain the new track spacing.
Carrying out control

1. Fill the main tank (100 litre) with an amount of pesticide.
2. refer to the steps of checking the pump and atomiser page 10;
3. make sure that the restrictor valve in the correct setting according to calibration;
4. if the spray vehicle is to be stationary, it must be parked upwind of the target area. If the vehicle moving whilst spraying, it must be driven upwind of the target and in a direction at 90° to the wind (e.g. spraying tracks are vertical to wind direction);
5. switch on the pump.

By this, the spraying start (control)

Note:
Pump must be OFF during turns between adjacent spray lines.

After the end of the control process

1. Switch OFF the atomiser;
2. switch OFF the pump.
Daily maintenance after use

1. The pump, atomiser and pipework should be flushed through with a cleaning fluid, such as kerosene or diesel, by using the flushing tank (10 litre), refer to checking sprayer (page 8, steps 10-17), with running the engine;
2. all external surfaces of the machine should be cleaned to remove any spray residues and dirt, by rags soaked in Kerosene/diesel or soapy water;
3. disconnect the cable plug from the control box.

Maintenance

1. Main tank cleaning (100 litre):
   • Unused pesticide (remaining) in the sprayer must be drained by opening the drain valve, then collected in an appropriate container for future use or safe disposal;
   • any remaining of pesticide that could not be collected must be disposed of by flushing tank, at the spray site to avoid the risk of contamination of a non-target area by dilute chemical;
   • the cleaning fluids (kerosene, Diesel) that used by flushing tank could be remain in the tank until it is required again OR drained from the tank and disposed of safely at the spray site.
2. check that all pipe connections are secure and leak free;
3. check that the atomiser spins freely and the gauze cylinder is in good condition;
4. occasionally check the in-line filter is clean;
5. if the pump is obstructed, then it needs to be disassembled and cleaned, see the ULVAMAST Operator’s Manual for details;
6. ensure that the mast in the folded position;
7. replace the protective cover to avoid damage to the atomiser.

Storage

1. Ensure that the pesticide tank are empty;
2. place the sprayer on a raised wooden pallet to keep it away from the ground;
3. store the sprayer in a clean and dry place that is not exposed to the sun and dust;
4. cover the sprayer with a plastic sheet if possible and the dust cover used to protect the atomiser;
5. clean orifice restrictor plates and put them in a separate bag or container to prevent them from being lost;
6. arrange sprayers on shelves, to be easy handled (non-stacked) and leave appropriate spaces between sprayers;
7. ensure that the mast in the folded position.
Troubleshooting

1. **Atomiser does not work**
   
   **Fault remedy**
   
   • Check electrical connections and the fuses in the control box;
   • check the battery condition;
   • check if the atomiser spins freely on the motor.

2. **No flow from pump**
   
   **Fault remedy**
   
   • Check there is sufficient pesticide in the tank;
   • check that the in-line orifice restrictor is not blocked
   • check electrical connections and fuses in the control box;
   • check in line filter is not blocked;
   • check that pump impeller is not obstructed (motor runs but no flow). This will require disassembly of pump head.

3. **Spray liquid is not being emitted from the atomiser gauze**
   
   **Fault remedy**
   
   • Check that the two-way valve is in the correct position,
   • check that the flow valve is open
   • check that the in-line orifice restrictor is not blocked
   • check pump is working;
   • check for plumbing leaks and/or blockages;
   • check that the in-line filter is not blocked;
   • if variable restrictor valve is blocked. Open valve fully and flush through with kerosene. Re-calibrate sprayer after flushing.
4. The atomiser runs out of balance and vibrate

*Fault remedy*

- Spraying 1 – 2 litres of kerosene through the atomiser at the end of each spray job.
Optimum conditions for spraying

Time
The best time for spraying is usually in the morning between 08.00 and 11.00 hours and in the afternoon after 16.00 hours. Effective spraying may be possible before 08.00 hours if the wind is strong enough. It may also be possible to spray effectively between 11.00 and 16.00 hours if it is either cloudy or relatively cool (less than about 30°C) or if there is a steady wind over 4 m/s that will tend to prevent convection.

Wind
The best wind speed for spraying is usually between 2-10 m/sec. Never spray when there is no wind because the spray will not be spread properly over the swath and the operator is likely to be contaminated because the spray is not being carried away from the sprayer.

Sunshine
Never spray when there is strong convection. Convection occurs when the sun rises high in the sky and heats up the ground. The hot ground warms up the air near to it, which then rises and may carry spray droplets out of the target area. Convection usually occurs on hot afternoons but may also occur in the late morning, especially if there is very little wind.

Rainfall
Never spray when it is raining or expected to rain shortly.
Verified dose rates of different insecticides for the Desert Locust

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Dose (g a.i./ha)</th>
<th>overall treatment - adults</th>
<th>overall treatment - hoppers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bendiocarb</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>225</td>
<td>225</td>
<td>225</td>
</tr>
<tr>
<td>Deltamethrin*</td>
<td>12.5/17.5</td>
<td>12.5/17.5</td>
<td>12.5/17.5</td>
</tr>
<tr>
<td>Diflubenzuron</td>
<td>60</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Fenitrothion</td>
<td>450</td>
<td>450</td>
<td>450</td>
</tr>
<tr>
<td>Fipronil</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Lambda-cyhalothrin</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Malathion</td>
<td>925</td>
<td>925</td>
<td>925</td>
</tr>
<tr>
<td>Metarhizium anisopliae</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Teflubenzuron</td>
<td>30</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Triflumuron</td>
<td>25</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

* The higher dose rate may be required if there is a risk of recovery of late instars or at high temperatures.
## Conversions

<table>
<thead>
<tr>
<th></th>
<th>1 km²</th>
<th>=</th>
<th>1 000 000</th>
<th>m²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area</strong></td>
<td>1 km²</td>
<td>=</td>
<td>100</td>
<td>ha</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>1 mile/hr</td>
<td>=</td>
<td>1.61</td>
<td>Km/hr.</td>
</tr>
<tr>
<td></td>
<td>1 Km/hr</td>
<td>=</td>
<td>0.278</td>
<td>m/sec</td>
</tr>
<tr>
<td></td>
<td>1 m/sec</td>
<td>=</td>
<td>3.6</td>
<td>Km/hr.</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>1 litre</td>
<td>=</td>
<td>1 000</td>
<td>ml</td>
</tr>
<tr>
<td><strong>Dose (solids)</strong></td>
<td>1 kg/ha</td>
<td>=</td>
<td>1 000</td>
<td>g/ha</td>
</tr>
<tr>
<td><strong>Dose (liquids)</strong></td>
<td>1 l/ha</td>
<td>=</td>
<td>1 000</td>
<td>ml/ha</td>
</tr>
</tbody>
</table>