IPARC Guide 2
MOTORISED KNAPSACK MISTBLOWERS

Summary

Where droplets have to be projected upwards into a tree canopy, the sprayer should provide an air-stream, thus the manually carried motorised knapsack sprayer is needed, despite a higher capital cost and being more expensive to operate and maintain.

These sprayers are best used on tree crops, but are also widely used in some countries to treat bushes and row crops where penetration of the crop canopy is needed. In selecting this equipment users must accept the equipment is much more expensive and will require more maintenance. Knapsack mistblowers may also be converted for application of granules and dusts.

Introduction

Conventional hydraulic sprayers can only project spray droplets generally over a short distance from the nozzle. Thus to project spray upwards into trees or across several rows of crops, it is necessary to add an air-stream to carry droplets towards the target. The manually carried sprayer with a fan to create the air-stream is generally known as a motorised knapsack mistblower. They are designed to produce a very fine spray or 'mist' (50 - 100 µm VMD droplets) and apply lower volumes than conventional knapsack sprayers (*e.g.* 20 1/ha rather than 200 1/ha), but most machines can also be adapted to apply granules and dusts.

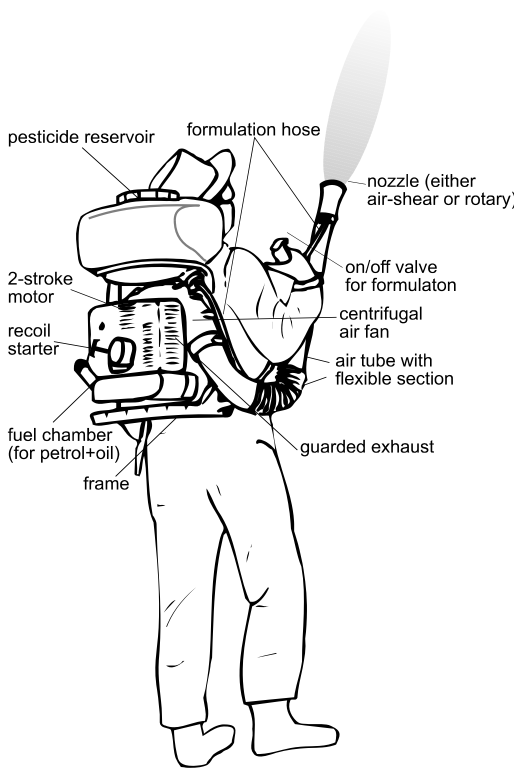

Fig. 1. A motorised knapsack mistblower in use for spraying trees

These sprayers consist of a 35 - 70 cc two-stroke engine, which drives a centrifugal fan. The larger size engine is required to drive a fan with a greater output of air volume. These heavier sprayers are needed to spray taller trees as the greater volume of air emitted can project droplets higher than the small mistblowers. It is rarely possible to project droplets higher than 10m vertically even with the larger motorised knapsacks.

These engines need specialist maintenance, so their large-scale use should be restricted to areas with qualified mechanics who are able to service the equipment. In extensive areas of small farms, mobile workshops are an effective way of assisting users who would otherwise have difficulty in transporting their equipment to a central workshop.

Construction

The engine and fan unit are attached by anti-vibration mountings to a knapsack frame, designed to allow the sprayer to stand upright on the ground. The frame, with straps, also carries a pesticide tank, spray deliver tube, fuel tank and an air delivery hose. A nozzle is mounted at the end of the air delivery tube. The volume of spray liquid emitted is controlled by a variable or fixed restrictor, and there is an on/off tap also attached to the air delivery tube (see Fig. 1).

The tank is usually of 10 litre capacity. Some with larger tanks are made, but the extra weight in addition to the fan and engine, is considered unacceptable. The tank has a wide opening to facilitate pouring liquid into it. The floor of the tank should also slope to a low outlet point.

Some air is fed from the fan into the spray tank and usually ducted to the base of the filler hole filter to provide low pressure (0.25 bar; 25 kPa) to deliver the spray liquid to the nozzle. This air pressure is most important if the standard air delivery tube is pointed upwards, when the nozzle may be above the level of liquid in the tank. The large lid on the tank must therefore have an air-tight fit. On some machines, instead of relying on this air pressure, there is a separate pump, especially if the air delivery tube is extended to treat very tall trees. This pump is usually mounted directly on the same drive shaft as the fan, but may be driven by a belt.

The Engine

The two-stroke engine is operated with a fuel containing standard petrol and oil mixed in a particular proportion. The mixture, often 1 part of oil to 25 parts of petrol should be clearly indicated, preferably by an embossed marking on the fuel tank. SAE 30 oil may be used, but manufacturers advise avoiding any multigrade oil, as the additives in these products will adversely affect the life of the engine.

When starting the engine, the CHOKE on the CARBURETTOR is closed to enrich the fuel mixture delivered to the engine. A float valve on some carburettors may need to be depressed to assist flow of the fuel to the engine. With the THROTTLE closed, the engine is then started by pulling the recoil starter rope sharply and evenly. The rope should be allowed to rewind slowly and not to snap back, nor should it be pulled to its full extent. The rope/handle may need several pulls before the engine starts. If it fails to start, the spark plug may need to be removed and cleaned. When the engine has started, the throttle can be opened up slightly, then the choke is opened. When the engine is then running, its speed can be increased using the throttle. If the recoil starter is missing or broken, it is possible to use a strong piece of rope to start the engine. These engines should always be used at their full speed to ensure proper lubrication of the moving parts. At the proper speed the fan draws sufficient air over the engine to cool it. The speed can be checked by using a tachometer such as a 'Vibratak'. This has a wire, the length of which can be adjusted until it oscillates at its maximum. The speed of the engine and fan can then be read from the scale. The engine should never be allowed to idle at low speeds for long periods as this results in overheating and carbon build-up in the exhaust.

On the completion of spraying, the engine can be stopped by closing the throttle or short-circuiting the spark plug. However, it is better to turn off the fuel tap and allow the engine to run until it is starved of fuel. If fuel is left in the carburettor and engine, the petrol will evaporate and leave an oily deposit on the spark plug and block the fuel metering orifices. This makes it difficult to start later. The fuel tank and carburettor should be drained of fuel, if the equipment is not going to be used again within three days. This is particularly important in the tropics where high temperatures increase the evaporation of the volatile component of the fuel.

Always make sure the air filter is clean and the engine exhaust is covered by a guard. Avoid touching the guard, as this can also get very hot after the engine has run for some minutes. As the noise level will exceed 90 decibels, the operator should wear ear protection, in addition to any other personnel protective clothing recommended.

The Fan

The centrifugal fan is designed to produce a high velocity air jet (60 - 80 m/s) that on most machines is used to shear the spray liquid into droplets. If the nozzle is held too close to the crop, this high velocity of air may damage foliage and spray will be blown off leaf surfaces. This initial air velocity rapidly diminishes within the first 2m from the air delivery tube. The aim should be to hold the nozzle at least 2 metres from foliage.

Nozzles

The simplest of mistblowers have a single tube to direct the spray liquid into the high velocity air-stream. However, several manufacturers have developed alternative ways of spreading the liquid thinly into the air-stream. This may be an aerodynamic wing section across the airflow, or a circular disc. On some machines, the disc can rotate and there are special rotary nozzles that can be fitted to most mistblowers; these can provide a more uniform spray droplet size distribution, but the quality of these devices does vary considerably. Flow rate and air velocity can also have a major effect on droplet size.

On these sprayers the flow rate is not determined by the nozzle, but by a restrictor mounted in line with the nozzle. On many sprayers, there is a variable restrictor, often with four settings. Users will frequently set this restrictor to the maximum open setting to empty the tank as quickly as possible. This may lead to poor atomisation, so the recommendation is to use a sprayer with separate fixed restrictors. When the appropriate restrictor is in place, it cannot be changed in the field.

On most machines it is possible to fit a very low output restrictor for spraying at ultra-low volume, but the droplet spectrum should be checked and a suitable spinning disc nozzle fitted, if necessary, to avoid wastage of spray in droplets which are too large. Low flow rate ULV adapters are available, achieving VARs of as little as 2 litres/hectare with oil-based formulations. Atomisation occurs either conventionally with an air-shear nozzle, or with a rotary atomiser: supplied separately or (more economically) from the mistblower manufacturers (see Fig. 2). The more expensive option is to retro-fit nozzles such as the Micronair AU 8000 or the Micron 'Micronex': units that can be adapted to fit onto the air outlet of most mistblowers. When ULV adaptors are used a filter should be fitted to the tank outlet to prevent the small metering orifice being blocked. These may increase the uniformity of droplet size spectra (over air shear nozzles) but the improvement may be marginal and the spray cloud may become excessively dispersed.

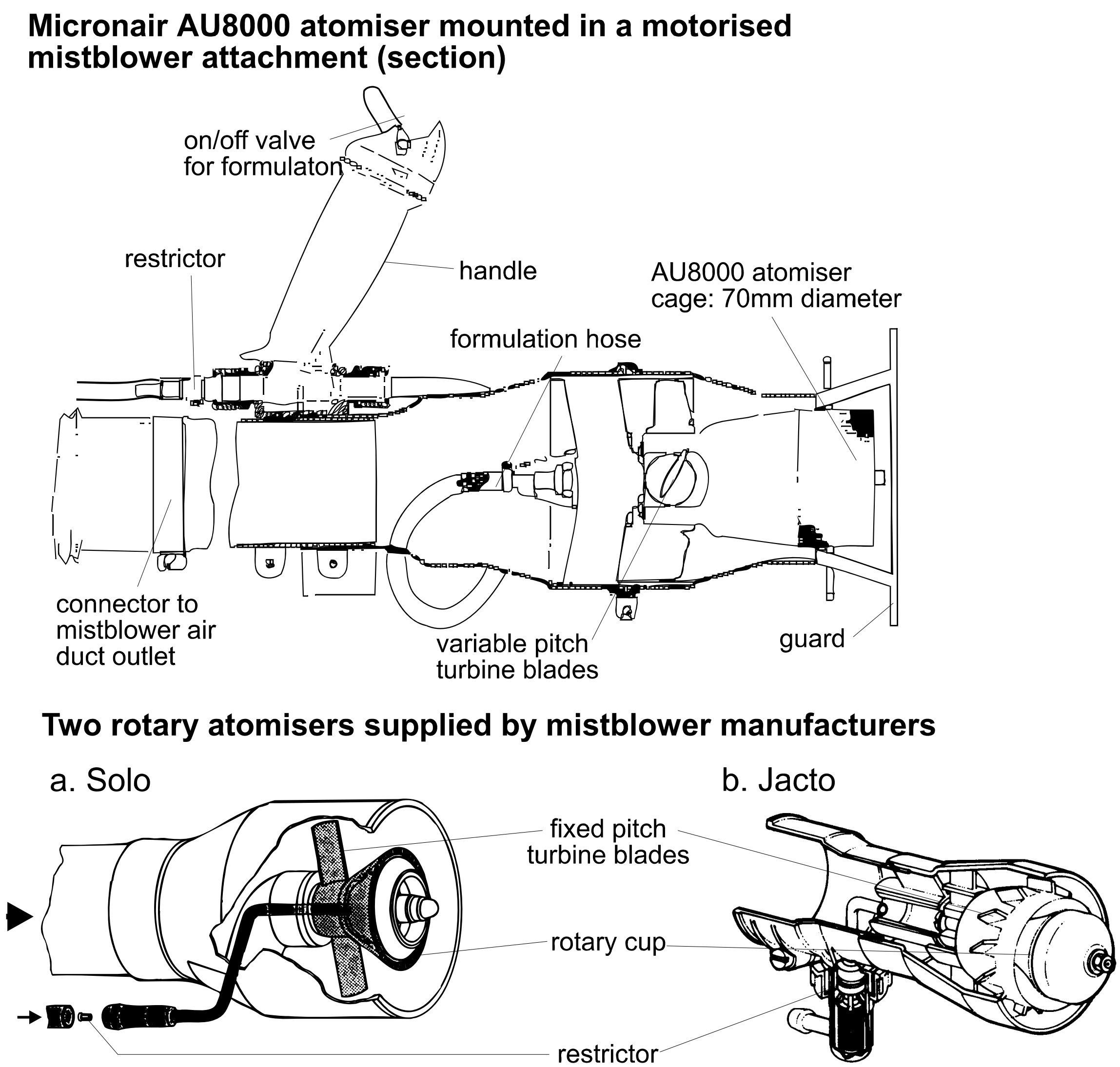

Fig. 2 Rotary atomiser attachments for motorised mistblowers

Calibration of Mistblowers

With motorised mistblowers, collection of the spray in an air stream is very difficult; simply measuring the flow of liquid in the formulation line past the restrictor will always give a substantial (often >30%) under-estimate of operational flow since there is no tank pressure or “suction effect” at the twin-fluid nozzle. The flow rate can vary substantially with the angle at which the nozzle tube is directed (*e.g.* spraying upwards into trees vs. horizontally into crops). Tank pressurisation may thus be inadequate for consistent formulation flow, and we recommend that sprayers should be selected with an independent pump. Attempting to measure flow rates of mistblowers having a formulation pump system obviously will not work with the engine off.

Accurate calibration involves the following procedure:

1. Place the sprayer on a firm horizontal surface and note (or mark) a level in the upper half of the pesticide tank;
2. make sure that the formulation tap is off; fill the tank with clean water (or blank formulation) to the reference level;
3. start the engine and operate at normal operating speed (full throttle);
4. spray normally, with the nozzle directed at a typical working height and angle (on the crop itself if possible), for a measured length of time (usually 2 minutes);
5. turn the engine off and place the sprayer on the same horizontal surface as in (1);
6. using a measuring cylinder, carefully find out how much water is needed re-fill to the reference mark;
7. calculate flow rate **F** = volume/time (e.g. 700 ml in 2 minutes = 350 ml/min).

The canopy volume of trees and bushes can vary enormously between crops and their stages of development. This makes single rates for volume application and amount of pesticide inappropriate (recommended mixing rates for chemical pesticide are therefore usually given as a concentration or ratio rather than per hectare). For manual and motorised knapsack spraying to larger trees it is perhaps most useful to work on a spray volume (spraying time) per tree basis, therefore an accurate assessment of planting rates must be made if converting from VAR per hectare. Spraying may be confined to a single row and the volume per tree calculated on the basis of the time needed to project spray to all sides of a tree. Sufficient time should be given for the volume of air in each tree to be replaced with the air carrying spray droplets.

Examples:

A. Flow rate 0. 5 litres per minute;
Swath 2 metres;
Walking speed 60 metres per minute.
Walking speed should be measured accurately by measuring the time to walk a measured distance, usually at least 100m at the speed the user would walk while spraying.

Then the application rate (VAR) is 41.67 litres per hectare.

B. Flow rate 0.24 litres per minute
Time required to treat individual tree is 0.5 minute
i.e. 0.12 litres per tree; if 1000 trees per hectare,

Then VAR = 120 litres per hectare.