

# Pesticide Application Equipment 12

(updated September 2008)

## Sprayer Basics

### High-Volume Sprayers

Conventional pesticide application involves chemicals diluted in large amounts of water. The large amounts of water (high-volume) are used because conventional sprayers produce large spray droplets (100 to 400 microns in diameter) and the spray is applied until the foliage is visibly, thoroughly sprayed to get uniform coverage. High-volume or dilute sprays are well suited to low pressure back-pack sprayers, whereas using low-volume back-pack sprayers it is next to impossible to achieve uniform coverage. Run-off occurs if excessive high-volume spray is used and the active ingredient will not cover the foliage well with the large droplets if too little spray is applied. The large droplets minimize the risk of drift in field conditions. High-volume spraying is sometimes referred to as dilute spraying.

### Low-Volume Sprayers

Low-volume is a relative term that is used differently by various groups. A low-volume rate for field application is not the same as a low volume rate in greenhouses. Low-volume (LV) pesticide application normally refers to spraying pesticides at the labelled rate (per area) with much less water, resulting in a more concentrated spray mixture. Thus low-volume equipment applies the same quantity of pesticide active ingredient to a given area as high-volume spraying equipment. The term low-volume refers to the small amount of water or diluent used to apply the pesticide. Low-volume spraying is sometimes referred to as concentrate spraying. Conventional field sprayers can be operated as both high and low volume sprayers depending on nozzle selection and travel speeds. Low volume in greenhouses is typically associated more with misters and foggers that are used only in greenhouses. Misters and foggers are ultra-low-volume when compared to most field sprayers.

## Droplet Size

Spray droplets are categorized based on their size and size can vary greatly depending on the spray equipment. Spray droplet size and typical uses are shown in Table 12.1.

Very small droplets are typically used in greenhouse misting or fogging operations and are generally termed low-volume, or even ultra-low-volume applications. The droplets are tiny enough to remain suspended in the air for long periods.

Spraying with smaller droplets results in less spray used to cover the surface. Because the volume of the droplet is based on the cube of the droplet diameter, one thousand 10-micron diameter droplets have the same volume of water as one 100-micron diameter droplet. Relative to a single large droplet, the 1,000 small droplets will cover the surface area much better, are less prone to run-off, and are more easily carried by the swirling airstream to the undersides of leaves. While the science behind droplet transport and impact on plant surfaces is complicated the results are not; smaller droplets mean more area is covered with less water and less run-off.

The disadvantage of smaller droplets is that they are more prone to drift in field applications due to wind conditions. Smaller droplets are also more vulnerable to dry air conditions which may cause the water carrier to evaporate before the droplet lands on the target. In greenhouses this may restrict mister and fogger use to night-time when workers are not present and when the venting systems can be closed to contain the mist and fog within greenhouses. This would cause overheating during warm, sunny days. The air circulation system of LV sprayers is used to help distribute the pesticide spray throughout the greenhouse, so it is possible to apply pesticides without any workers in the greenhouse. By venting the greenhouses and observing the re-entry times, potential worker exposure to pesticides is reduced.

In field operations, reducing droplet size is limited by the greater risk of smaller droplets drifting away from the application area.

<b>Type of Spray</b>	<b>Average Droplet Size (microns)</b>	<b>Examples of Uses</b>
Fog	0.1 - 5.0	greenhouse foggers
Fine mist	5.0 - 50	greenhouse misters
Coarse mist	50 - 100	air-blast and high pressure boom sprays of insecticides or fungicides
Fine spray	100 - 250	typical insecticide or fungicide sprays
Medium spray	250 - 500	typical flat fan nozzle herbicide sprays
Coarse spray	500 - 700	low pressure flat fan nozzle herbicide sprays
Very coarse spray	700 - 1,000	large droplet flooding fan and raindrop nozzle sprays for soil applied herbicides

## Monitoring Spray Coverage

Decisions on the type of pesticide application equipment to use and whether to use high or low volume spraying should be based on which provides the best coverage. If purchasing new equipment, arrange a trial where the new technology can be tested for coverage. Obtaining complete coverage is critical to good pest control and good coverage is not as obvious when spraying with lower volumes that do not “wet the crop to the point of run-off”.

Water sensitive paper available from most sprayer supply companies can be attached to tops and bottoms of leaves with paper clips. Spray drops of water will be visible as small coloured dots on the paper. Very fine droplets such as fogs and smaller mist droplets may be too small to register on the water sensitive paper. For these sprays buy a florescent dye to be mixed in the water then view the leaves under a black light to see the coverage of the spray droplets. Contact your local Ministry of Agriculture and Lands office for more information.

## High-Volume Spraying Equipment

### Backpack Sprayer

The most common spraying equipment on small operations is the backpack sprayer. It is suitable for high-volume or dilute spraying both in field and greenhouse conditions. Basic, low cost backpack sprayers will generate only low pressures and lack features such as diaphragm pumps, agitators, pressure adjustment controls (regulator), and pressure gauges found on commercial grade units.

Low pressure sprayers that lack pressure regulators and gauges should not be used to apply pesticides that require uniform. This is especially true with some of the plant growth regulators where uniform coverage is a crucial part of their effectiveness. These sprayers with their limited control options are better suited for the home gardener situation.

Diaphragm pumps and agitators will allow sprayers to be used with wettable powder sprays more effectively. Pressures should be above 80 psi to achieve the finer sprays suitable for applying insecticides and fungicides. Pressure gauges and pressure regulators enable the sprayer to operate at higher pressures (80 to 200 psi) and the operator to achieve a more uniform output from the sprayer. Note that a smooth, uniform walking speed and spray wand motion is also required to achieve uniform coverage. Nozzles must be selected for the operating pressure of the sprayer and spraying conditions. Backpack sprayers should have a positive shut-off spray control valve to eliminate pesticide drips from the wand and nozzle. Drip-proof nozzle assemblies are also available as an alternative. Ball check valves in the nozzle body require 5 to 10 psi of liquid pressure to start spraying and close when the pressure drops below this level to prevent drips.

### Powered Boom Sprayers

Electric or gas engine powered backpack sprayers can be compared to tractor mounted low powered boom sprayers for field use or to cart mounted boom systems for greenhouse use. These sprayers are typically classed by the pressures they attain; low pressure (up to 60 psi) hydraulic sprayers forming

coarse droplets are suitable for herbicide applications and high pressure systems (80 - 300 psi) forming finer droplets are suitable for insecticide and fungicide applications. The higher pressure causes the spray to travel at higher speeds, creating air currents and penetrating plant canopies more effectively than the low pressure coarse sprays. The downside is that the risk of off-target spray drift is much greater with high pressure, fine droplet sprays than with low pressure, coarse droplets. Tractor operated sprayers have an advantage over hand operated sprayers because they can maintain a steady forward speed. With a properly set-up boom, tractor based sprayers provide a more uniform coverage than hand operated sprayers, especially when smaller droplets and lower spray volumes are used.

## Specialized Greenhouse Pesticide Equipment (LVMs)

*Pesticide application equipment for greenhouses is often differentiated by the kind of particle they produce, namely mists, fogs, or smokes. A more accurate method to group them is by the method used to make the droplets rather than by the particle size. Technically the four pesticide applicators, mist blowers, thermal foggers, high pressure applicators, and compressed air systems, are all low volume mist (LVM) systems. They produce fine droplets, less than 100 microns in size and they use very low water volumes. However, industry terminology generally only refers to the compressed air systems as LVMs. Table 12.2 compares the four specialized greenhouse sprayers.*

### Mist Blower

A small engine and fan creates an air stream with a velocity of 100 to 200 mph. Concentrated spray injected into the air stream by a special nozzle is carried to the target by the air. Application is done by the applicator walking through the greenhouse directing the nozzle into the plant canopy to get good penetration and coverage. Nozzles held too close to the plants may cause blast damage. For good coverage, the nozzle should be moved at a pace that replaces the air within the canopy with air from the mist blower. They are suitable for large and small treatment areas. Greenhouses do not have to be tightly sealed during application; vents may remain open, but fans should be turned off. Rotary misters use a spinning disc to break up the spray into small droplets. The spray stream must be directed at

the crops and moved up and down to take advantage of air turbulence and get good distribution. Some manufacturers also include a fan behind the disc to propel the spray towards the target and create a turbulent air stream. They are also referred to as controlled droplet applicators and rotary atomizers. Trade names include: “Ulvafan”, “Electrafan”, “Motafan”, and “Turbair”.

### Thermal Fogging Machines

Thermal foggers have been used for many years. They are usually gasoline-powered backpack or cart mounted units that are moved throughout the greenhouse as they operate. The pesticide is sprayed onto a hot element and evaporates. As it condenses it produces a heavy fog that drifts through the greenhouse and penetrates the foliage. It covers both upper and lower surfaces of the crop. Thermal foggers require specialized carrier solutions to produce a visible fog, eliminate the evaporation of droplets, and to ensure uniform particle sizes. The pesticide usually is sold as a ready to apply mixture with the carrier. Greenhouses must be tightly sealed during application and for several hours afterwards to allow the fine particles to settle out of the air. Trade names include: “Pulsfog”.

### High Pressure Pesticide Applicator

This specialized greenhouse pesticide applicator uses extremely high pressures (1,000 to 3,000 psi) to create extremely fine sprays. Sprayers working at 3,000 psi can produce spray droplets averaging 30 to 60 microns in diameter that are projected 20 to 25 feet from the spray gun. A small spray tank, motor, pump, long high pressure hose, and hand gun are all mounted on a small wheeled hand cart. Applicators walk slowly through the greenhouse directing the spray ahead and into the crop. They do not require special fogging solutions. It is not necessary to tightly seal the greenhouse during application; vents may remain open, but fans should be turned off. They are also referred to as mechanical foggers. Trade names include: “Coldfogger”.

### Compressed Air or Aerosol Generators

These devices use compressed air to break the spray liquid into small drops using an air atomizing nozzle. The nozzles are typically placed in front of a fan which disperses the spray into the greenhouse space. These units are often used as stationary sprayers that rely on the greenhouse’s air movement system to circulate the spray throughout the area to be treated and through any dense foliage.

<b>Sprayer</b>	<b>Droplet size (microns)</b>	<b>Tightly sealed greenhouse</b>	<b>Moved by applicator or stationary</b>	<b>Special carrier solution</b>
Mist blower	60 - 80	no	moved by applicator	no
Thermal fogger	12 - 25	yes	moved by applicator	yes
High pressure	30 - 60	no	moved by applicator	no
Compressed air	5 or less	yes	stationary	no

These sprayers are designed to operate unattended from a single location in the greenhouse. The spray mixture is placed in the tank and a timer set to start the application when staff are not present. Good coverage depends upon proper placement in the greenhouse and good air movement throughout the greenhouse. Special fogging solutions are not required. Greenhouses must remain tightly sealed during application and for several hours afterwards. Trade names include: “Autofog”.

### Electrostatic Sprayers

These are not a separate class of sprayers, rather it’s a feature that is found on some of the previously mentioned sprayers. Electrostatic sprayers electrically charge droplets as they leave the nozzle. The charged droplets penetrate the foliage and adhere to all plant surfaces, including the underside of leaves.

### Smoke Fumigators - Cans

A pesticide fog or smoke that comes in ready-to-use cans. When the fumigant is ignited, the smoke carries the pesticide throughout the greenhouse on greenhouse air currents. Each can is sufficient for a certain volume of greenhouse. Greenhouses must be tightly sealed during and after application. They should only be used when there are not any staff present.

## Sprayer Components

### Power Source

The power-sprayer is normally driven by the PTO (power take off) of the tractor or by an auxiliary engine. The power rating of these should be double the theoretical power required by the pump.

### Pumps

A pump creates the pressure required for atomization and penetration of the spray. Choose a pump that

has the specifications required for your job. The capacity of the pump should be determined by the highest rate of application the sprayer is expected to deliver, plus an adequate volume for agitation.

Common pumps include:

- roller pump: excessive wear can occur with wettable powders
- piston pump
- diaphragm pump

### Tanks

The size of the spray tank will depend on the intended rate of application and the mounting space available. For proper mixing, it is important to know the volume capacity of your spray tank. The tank should be equipped with a large screened opening for easy filling and cleaning. Tanks may be constructed of steel, stainless steel, epoxy-coated steel, fibreglass, aluminum or polyethylene. Stainless steel, polyethylene, and fibreglass tanks are preferred because of their rust and corrosion resistance. Neither the herbicide glyphosate (Roundup or Touchdown) nor liquid nitrogen should be put into galvanized steel tanks as hazardous chemical reactions can occur. The rusting of steel tanks can be reduced by proper draining, cleaning, and airing of the tank after use and by the use of rust-proofing compounds. Either hydraulic by-pass or mechanical agitation must be provided. If hydraulic agitation is used in the spray tank, additional pump capacity is required. Mechanical agitation is preferred if wettable powders are to be used.

### Nozzles

The size of droplet produced by various nozzles depends upon operating pressure and nozzle design. The droplet size decreases with an increase in pressure and with a decrease in nozzle orifice diameter.

## Types

The main nozzle types used for chemical application are (see Figure 12.1):

- Tapered flat-fan spray nozzles are used for low volume, low pressure spraying such as the application of herbicides and insecticide drenches. They are also known as fan type or T-jets. They produce a fan type pattern with less material applied along the edges of the spray pattern. By properly over-lapping the spray, a uniform application is produced across the area covered by the spray boom. Nozzle spacing on the boom and height of the boom above the target are critical in obtaining a uniform coverage. Sprayer equipment suppliers can advise growers as to the correct height of the boom at different nozzle spacings.
- Even flat-fan spray nozzles produce an even spray pattern across the entire fan width. These nozzles are used in band spraying of herbicides where there is no overlap from other nozzles.
- Cone nozzles are used for high pressure spraying (mostly fungicides and insecticides). These nozzles produce a swirling mist so the spray material can reach the undersides of leaves. They are available as either hollow cone or solid cone types - both produce the same swirling mist but the solid cone nozzles are used when larger volumes are required. The most commonly used cone nozzles are the two-piece disc-core nozzles. They must be correctly installed with the rear nibs facing the nozzle body. See Figure 12.2.
- The size of droplet produced by various nozzles depends upon operating pressure and nozzle design. The droplet size decreases with an increase in pressure and with a decrease in the orifice and swirl plate openings. Various sizes of swirl plates and orifices can be fitted in the same nozzle body.

## Sizes

Various sizes of flat and cone nozzles may be used to obtain the volume of water desired. Your sprayer equipment supplier should have information on nozzle flow rates for different nozzle sizes.

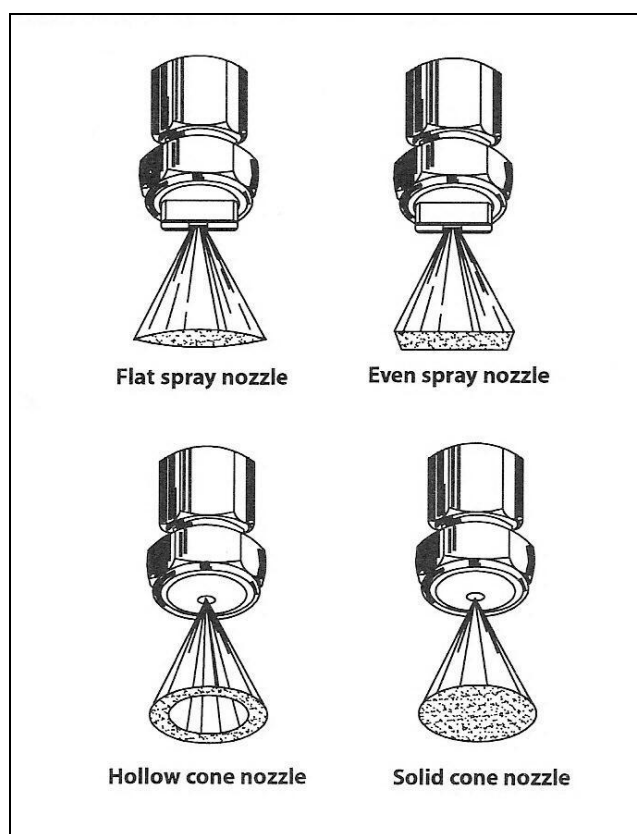
## Materials

Nozzles are made from a variety of materials. Choice of material depends upon the abrasiveness of the spray mixture. Wettable powders are more

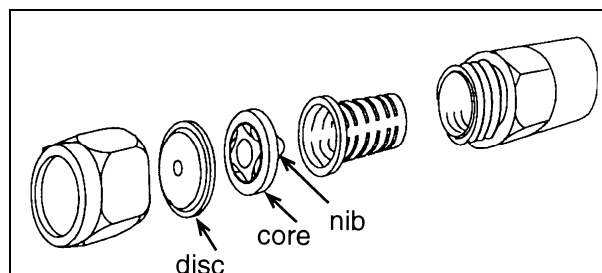
abrasive than emulsions. Brass tips are cheap but the metal is softer and the tips wear faster. In sequence of durability the following materials are used: brass, stainless steel, hardened stainless steel, ceramic, and tungsten carbide.

As nozzles wear out, the rate of application increases. Tests have shown that some wettable powders wear nozzles sufficiently to increase the rate as much as 12% after spraying only 20 ha. For this reason, frequent calibration of equipment is necessary. Spray patterns are distorted and uneven applications result from worn nozzles.

**Figure 12.1: The Main Nozzle Types Used for Chemical Application**



**Figure 12.2: Assembly of Disc-core Cone Nozzles**



## Screens

Screens prevent larger particles from entering the system, clogging nozzles, and wearing out the pump.

There should be screens in the tank opening, between the tank and the pump, and in the nozzle tips. Suction strainers, line strainers and nozzles should all be equipped with 50 mesh screens when wettable powders are to be used. Screens finer than 50 mesh, for example 100 mesh, may prevent the unrestricted flow of some wettable powders. Screens are generally used in fine nozzles, but slotted strainers can be used in those that have a larger opening, and with cone nozzles. Clean screens and strainers are essential to the efficient operation of the spray system. They should be cleaned often and checked for breaks in the mesh.

## Mixing Chemicals

When mixing the chemical in the sprayer tank, **NEVER** put the chemical in first and then top up with water. Always fill the tank  $\frac{1}{3}$  to  $\frac{1}{2}$  full with clean water, start the agitator and then add the required quantity of chemical. Continue the agitation while continuing to fill the tank. If two or more chemicals are to be applied together, first check the labels for compatibility and then add the first chemical at the  $\frac{1}{3}$  to  $\frac{1}{2}$  full stage and the second chemical at the  $\frac{2}{3}$  to  $\frac{3}{4}$  full stage. Mixing by this method will ensure that the chemical is completely mixed in the water. Wettable powders can be premixed before being added to the spray tank. Make a slurry of wettable powder and water and then pour it into the spray tank. Always follow manufacturers' directions when mixing. Always keep the agitator running once the spray materials have been added to the tank.

## Sprayer Cleaning

Immediately after use, drain and collect any excess spray mixture. This excess solution can be very difficult to dispose of properly, therefore spray applications should be properly calibrated to avoid any excess. Flush the sprayer with soapy water and then rinse with clean water. Select a cleaning area where water will not contaminate wells, streams, or crops.

Separate equipment is recommended for applying 2,4-D, MCPA or similar hormone-type herbicides. If this is not possible, use separate sprayer hoses when using these chemicals as they cannot be properly washed out of the hose lines. To thoroughly clean equipment after applying 2,4-D, MCPA, etc., follow these steps:

- Drain and collect any excess spray solution from the tank.
- Rinse tank, lines, screens, pumps, and nozzles thoroughly with warm water.
- Remove pressure chamber and line strainer and drain.
- Fill tank with 100 L of warm water and then add one of the following:
  - 1 litre of household ammonia or Agri-Kleen; or
  - 500 g washing soda, lye or Nutrasol.
- Spray out small amount of solution and leave remainder in tank overnight.
- Drain and rinse the equipment several times with warm soapy water. Rinse out the soapy water with clean water.

Even stainless steel nozzles will rust if left in the sprayer. Nozzles and nozzle screens should be removed and cleaned each fall and stored in a can of light oil or diesel fuel if the sprayer is not going to be used over the winter. After a spray application the nozzles should be cleaned and coated with a light coat of oil to prevent corrosion. Ceramic nozzles are not subject to corrosion. Before winter storage, remember to drain the pump, boom, and all the lines to prevent frost damage. Add light oil or antifreeze during the last rinsing to leave a protective coating on all parts.