

APPLICATION TECHNOLOGY

The goal of a pesticide application is to apply the pesticide evenly to the desired target at the recommended label rate. Contamination of non-target areas should be avoided. To do this, choose the proper application equipment for the job and understand how it works. Make sure that equipment is used, calibrated, and maintained properly. This chapter deals with selection of sprayers and granular application equipment. Calibration, calculations and environmental conditions during an application are also covered.

Learning Objectives

Completing this chapter will help you to:

- **Know the basic parts of common types of application equipment. This ensures proper selection and use.**
- **Understand that calibration ensures that correct amounts of liquid or granular pesticides are applied.**
- **Know basic procedures for cleaning and maintaining liquid and granular application equipment.**
- **Know the effect of environmental conditions on common types of application equipment.**
- **Know how to calculate the correct amount of pesticide required.**

Liquid Application Equipment

You must choose proper equipment and understand its parts. This ensures that pesticide particles or droplets reach the target pest. The following section describes common equipment used in landscape and turf pest management.

Equipment Selection

The Application equipment used in landscape pest management can be placed in one of two groups based on whether a liquid or granular formulation is applied. In both cases, the aim is to apply the correct amount of pesticide to the target with maximum effect and minimum off-target movement.

The type of equipment chosen to apply pesticides depends on:

- The type of pesticide to be sprayed
- The rate and pesticide formulation
- Label recommendations
- The size and location of the treatment area
- Distance from sensitive areas
- The pest

Hand-held Pressure Sprayers

Hand-held pressure sprayers are often used to treat small areas. The sprayer contains a small tank. Applications are made from a small hose with a single nozzle. The sprayer handle is pumped to build up pressure in the tank. Droplet size and density varies. This depends on tank pressure and type of nozzle used.

Backpack Sprayers

Backpack sprayers are often used to treat small areas. The sprayer has a small tank strapped to the applicator's back. Applications are made from a small hose and single nozzle. The applicator pumps the sprayer handle to build up tank pressure. Some backpack sprayers have small motors to create pressure. Droplet size and density varies with the pressure in the small pressure chamber.

Boom Sprayers

Boom sprayers have a number of nozzles evenly spaced over the length of the boom. Most boom sprayers are horizontal. A pump creates pressure to bring the spray mix to the boom. Droplet size and spray density is controlled by changing pump pressure and choosing the proper nozzle type. Boom sprayers are often used on municipal parks, golf courses and sports fields. They are commonly used to apply spray liquid herbicides.

Power Hose Sprayers

Power hose sprayers have parts that are similar to motorized boom sprayers. Spray is spread onto vegetation through one or more hose spray guns. Many hand sprayers, small power sprayers, and mist blowers have the spray gun built in as part of the sprayer or supplied as standard equipment.

Spray guns may have a shut-off valve and nozzle. This may be in two parts, or one unit that combines both functions. Spray guns come in a wide range of models and sizes. They can be made of plastic, brass, aluminum, stainless steel, or a combination of these. The material that you choose depends on:

- The pesticide spray mixture
- Required pressure
- How often the guns are used

Some guns are rated for pressures between 200 and 5,000 kPa. Others are rated for different pressure ranges or pressures less than 1,500 kPa. Select the one that best matches the sprayer operating pressure. Spray gun nozzles must be set to deliver spray at the proper volume, angle and distance. Some nozzles can be adjusted to produce patterns ranging from solid streams to fine cone sprays.

The hose is often stored on a powered reel mounted on the spray vehicle. These sprayers may have high-pressure pumps that can send spray (above 1.5 metres) to tree height or through thick foliage.

Spray gun types include the following:

- **Hand Held Spray Wand:** Hand held spray wands are most commonly used for lawn spraying. The nozzle is held close to the ground (30-45 cm). A flat fan spray nozzle pattern is often used with different spray widths and flow rates. Nozzle tips can be changed.
- **Handgun-Type:** Handgun-type spray guns are used in a number of situations. This includes the spraying of large trees, shrubs, greenhouses, and lawn applications. Most handgun-type spray guns have a 'shower head' type nozzle. These have a number of holes, depending on required flow rate and droplet size. This type of spray gun gives excellent coverage on coarse textured surfaces such as a shrubs or tree canopies. Handgun-type spray guns can spray long distances in applications more than 3M above ground (e.g., tall tree canopy). Hand held tree guns have special nozzles with high flow rates and a solid stream spray pattern.
- **Boom-Type:** Boom-type spray guns have a wand with a spray boom at a right angle on the end. They have a number of nozzles to cover a wider area. Flat fan spray nozzles with a slight overlapping spray pattern are often used. Boom-type spray guns are used for large area applications. They can be mounted on equipment (e.g., tractor) or hand-held. Large hand-held boom-type spray guns often have flotation wheels to support their weight.

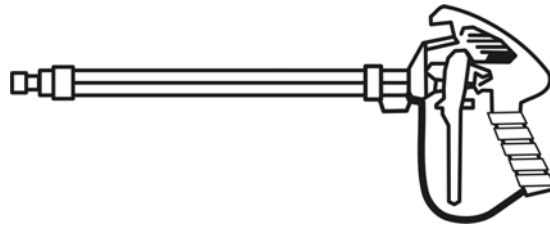


Figure 9-1: Power hose sprayer: Hand-held spray wand.

Air-Blast Sprayers

Air-blast sprayers are often used on orchards, grapes and blueberries. Air-blast sprayers have tank sizes from 400-3000 litres. Air-blast sprayers do not have a boom held over the target. Nozzles are placed in a high-speed air stream produced by a fan. The air stream sends the fine spray droplets to the target. The air stream also creates leaf movement. This allows better coverage of insecticides and fungicides. Air-blast sprayers can be used to treat large ornamental trees in parks and golf courses.

Wick Application Equipment

Wick application equipment is used where targets are very specific or no drift can be tolerated. A tank is connected to a wick. The wick absorbs and holds spray mix. The applicator wipes the wick across the pest species. Wick applicators are often used to apply non-selective herbicides to selected weeds when sensitive plants are growing nearby.

Tree Stem Injectors

Some equipment injects pesticide into tree stems. Systemic pesticide is injected under the bark and into the tissues. It then moves up into shoots or down into roots. Injection equipment may include a tool to cut through the bark and manually operated sprayer. This could be a hatchet and backpack mounted pressure sprayer. Lance injectors are also common. The lance both cuts through the bark and injects pesticide into the tree just below the bark.

Brush Saw Application Equipment

A small herbicide reservoir is attached to the bottom of the brush saw. A pump and dispensing system are active during the saw's brush cutting action. Brush is cut and sprayed at the same time. This improves the herbicide's movement through the cambium layer. This application equipment is very selective. It does not produce drift.

Granular Application Equipment

Granular application equipment is used to apply granular pesticides. Types of granular application equipment include gravity broadcast, centrifugal, and airblast.

Gravity Broadcast

Gravity broadcast spreaders meter pesticide granules out using paddles. The granules fall through adjustable slots and are dropped to the ground. Application uniformity is affected by granule size, ground speed, humidity, turns, and rough ground conditions.

Centrifugal

Centrifugal spreaders meter pesticide granules out through a rotary paddle distributor. Application uniformity is affected by ground speed, and wind.

Airblast

Airblast spreaders meter pesticide granules into a high volume air stream generated by a powered fan. This is usually done from a ground drive. Airflow transports granules through hoses and flow divider pots to individual outlets. This is more accurate than gravity broadcast and centrifugal systems.

In Review

There is a variety of equipment for landscaping. These include backpack sprayers, air blast sprayers, and brush saw applicators. Applicators must choose the best type for the job based on:

- **The pest**
- **The pesticide**
- **The treatment area**
- **Distance from sensitive areas**
- **How the equipment works**

Basic Components of Motorized Sprayers

Applicators need to know how the parts of a sprayer work together to deliver the right amount of liquid pesticide. This information is used to calibrate and fine-tune the equipment. This section describes how the parts of a sprayer work.

Spray Tanks

The spray tanks hold the spray mixture. Tanks come in a number of shapes, sizes and materials. Choose a tank that is strong, resists corrosion, and will not react with the pesticides being used. Tanks should have graduated markings. They should be equipped with baffles to prevent sloshing. The tank shape should promote agitation. The tank should be easy to fill, clean, and drain completely. Oval and cylindrical tanks are common. Rectangular and flat-bottomed tanks are harder to agitate and clean. Tank size should suit the sprayer boom width and output.

Pumps

Pumps move the spray from the tank to the nozzle. They may be powered by a number of means. Choose a pump that is suited to move the pesticide and carrier to be used.

To choose a pump that will provide required output and pressure, determine:

- The number and output of nozzles
- The extent of agitation
- Whether bypass filtration is required

Pump flow capacity should be 20% greater than needed. This ensures proper pressure and flow over time as the pump wears. A properly sized pump will allow for an increase in travel speed or an increase in the number of nozzles on the boom if needed.

Pump type affects the controls needed. Refer to the pump manufacturer's instructions for details. Piston and diaphragm pumps require a pulsation damper to reduce pressure changes. Roller pumps can wear quickly. They are not advised when using abrasive formulations.

Agitators

Agitation mixes the pesticide with the carrier (usually water). It prevents suspended pesticides from settling out. The amount of needed agitation depends on the type of formulation used. Proper agitation must be used when applying pesticides. Under and over agitation can reduce pesticide performance.

Mechanical and hydraulic agitation systems are common. Mechanical systems use paddles to stir the contents of the tank. Hydraulic systems use special agitation nozzles in the tank. This creates spray mixture movement. More pump capacity is needed for hydraulic agitation.

Strainers

Strainers keep debris and un-dissolved pesticides in the spray mixture from damaging the pump or plugging the nozzles.

Strainers can be installed in the following locations:

- The tank opening (prevents debris from getting into the tank during filling)
- Between the tank and pump (protects the pump from damage)
- After the pump (keeps fine particles from getting into the spray lines)
- In the nozzle body (prevents the nozzle from clogging)

Coarser mesh strainers should be at the tank opening. Finer mesh strainers are used at the nozzle. Smaller nozzles require finer strainers. More coarse strainers are needed to use wettable powders or flowable formulations. Follow the manufacturer's guidelines on strainer size needed to protect nozzles and pumps.

Permanently removing the strainers is not a good way to solve clogging problems. Strainers protect sprayer parts and should not be removed. If there is repeated clogging, you may need to change the type of pesticide formulation used.

Controls

Control systems can be manual or electronic. There are two common control systems:

- Pressure control systems use a pressure-regulating valve (PRV). This maintains a constant operating pressure. These are often found on hand-held and backpack equipment.
- Volume control (volumetric) systems allow operating pressure/nozzle output to vary with travel speed/engine RPM. These are often found on boom and airblast sprayers.

Spray monitors may further improve the application of pesticides. They give the operator more information.

Plumbing

The size of hoses and fittings affect system capacity and pressure. Under-sized hoses and fittings can reduce pump capacity. Suction hose diameter should be at least as large as the pump intake opening. Flow restrictions can create a drop in pressure. This can cause uneven nozzle output and irregular spray pattern. Uneven nozzle output can also be caused by changes in flow or variations in hose length along the boom.

Flow may be restricted by:

- Under-sized boom plumbing
- Under-sized controls or fittings
- Kinked hoses
- Under-sized or clogged strainers

Hoses and fittings on the pressure side of the pump must be able to handle the maximum pump pressure. These must also be able to withstand pressure surges.

Boom Design

The boom supports and supplies spray mix to the nozzles. The boom should have end caps to allow flushing of the boom and nozzles. Design and use of the boom can affect application uniformity.

Sprayers should be used at travel speeds that reduce boom movement. Too much boom movement during application can cause uneven spray coverage. It can also damage the boom. Booms should also have support. Suspension systems may support the sprayer chassis and/or boom. These can reduce boom movement. When spraying in strips or bands, nozzles should be aligned to cover the area evenly. They should be arranged to avoid skips or overlaps between passes of the sprayer.

Pressure Gauges

Pressure gauges measure the operating pressure. They are used before spraying to set the sprayer to the desired pressure. During the application, gauges should be watched for changes in pressure. These can indicate problems. Gauges should measure pressure near the nozzles. Gauges should be checked for accuracy. Adapters are available to attach pressure gauges to nozzle bodies. These can be used to spot-check nozzle pressure and find pressure drops along the sprayer's plumbing.

Gauges can be liquid-filled or dry. Liquid-filled gauges dampen pressure pulsations. This gives a steadier reading. They also respond slower to changes in pressure. Pulsation dampers can be used on dry gauges. Gauges should give pressure in commonly used units (psi, Kpa, bar).

The maximum pressure given on the gauge should be roughly twice the proper operating pressure. This allows accurate reading of pressure. If the pump can produce higher pressures than the gauge can read, ensure that there is enough pressure relief to prevent damage to the gauge.

Nozzles

The main functions of a nozzle are:

- Metering (measuring) the amount of spray delivered (nozzle output)
- Atomizing (breaking up) liquid into droplets
- Dispersing (scattering) droplets in a given pattern

A nozzle is made up of a nozzle body, a strainer, a tip, a cap and one or more washers. The nozzle body holds the strainer and tip in place. The cap is used to secure the strainer and tip to the body. The nozzle screen or strainer catches any debris that can clog the nozzle. The nozzle tip helps create the spray pattern. Rubber washers prevent leakage.

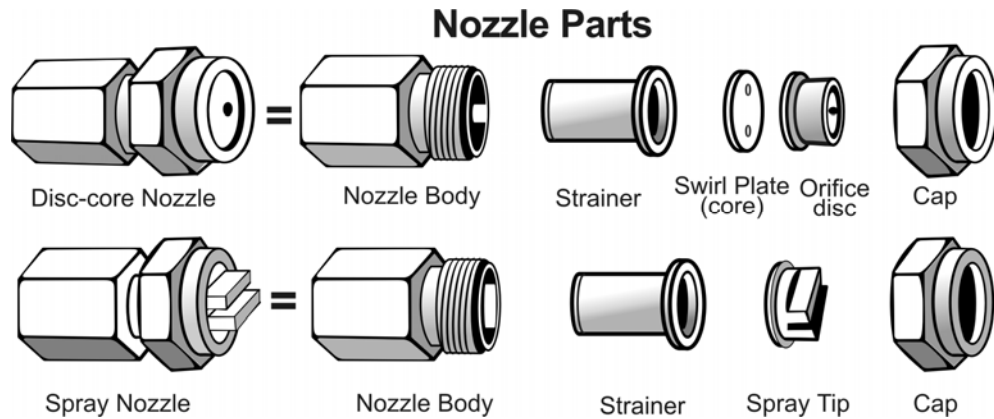


Figure 9-2: Parts of typical nozzles.

Nozzles come in a range of types, sizes and materials. They are classed by spray pattern. Nozzles on some hand-held or backpack sprayers can be adjusted for flow rate, droplet size, and spray pattern. Most other sprayers use non-adjustable nozzles. These must be changed to get different flow rates or patterns. Pesticide labels may call for certain types and sizes of nozzles (and droplet sizes). Follow label directions. Nozzle types come in a number of nozzle outputs (L/min) and spray angles.

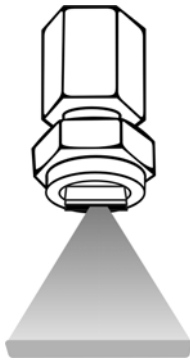
Spray Angle

Nozzle spray angle is the angle formed by a single nozzle at a given pressure. Spray angle varies with pressure. Nozzles can be purchased in a number of standard spray angles. The angle specified by the manufacturer is only obtained when pressure is in the recommended range.

The most common flat fan nozzle angles are 65°, 80° and 110°. For a given nozzle type, wider angles decrease droplet size. This assumes that pressure and nozzle output remain constant. Wider nozzle angles may give an even application with lower boom heights. Proper boom height depends on the spray angle and

nozzle spacing. Refer to the nozzle manufacturer or provincial guidelines on the required amount of overlap to get an even application.

Flat Fan Nozzles



Flat fan nozzles are often used for herbicide applications. These provide good application uniformity. Flat fan nozzles are used at low pressures (usually between 100 and 400 kPa).

Tapered edge flat fan nozzles are the most common flat fan nozzles. These produce an oval pattern with tapered edges. Spray patterns should overlap to achieve uniformity. For example, one nozzle spray angle can overlap the next nozzle spray angle. Offset the tapered flat fan nozzles slightly (5-10 degrees) from the boom. This prevents spray interference that can reduce uniformity.

Figure 9-3: Flat-fan nozzle.

Even flat fan nozzles are available for banding applications. These should not be overlapped with other nozzles. Low pressure, pre-orifice, and air-induced flat fan nozzles use reduced pressure and liquid turbulence. This creates coarse sprays. These nozzles reduce drift by 50 to 90%. Minimum operating pressures are often higher than those of conventional nozzles.

Boomless Nozzles

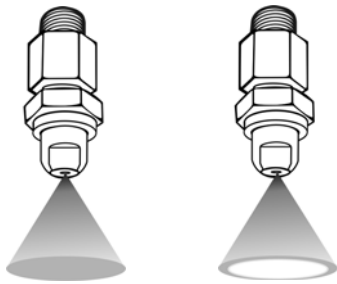
Boomless nozzles are used singly or in clusters. They include:

- Off-centre nozzles
- Accutrol nozzles
- Radiarc spray systems
- Controlled droplet application equipment

Off-centre nozzles produce a wide flat spray. The spray is off to the side of the nozzle. The spray is fairly even along its width. Off-centre nozzles are often mounted on the sides of trucks or short booms. They are used for spraying along

roadsides, ditches, pastures, and places with many obstacles (e.g., brush and fences). These nozzles cover up to 10 metres, depending on nozzle size, pressure and wind.

Full (Solid) and Hollow Cone Nozzles



Full and hollow cone nozzles are used to apply fungicides and insecticides. They produce fine spray droplets for complete coverage. These nozzles are best suited for directed sprays where even application is not a must. They can be used over a wide range of nozzle pressures (200 to 2000 kPa).

Figure 9-4: Solid and hollow core nozzles.

Nozzle Pressure

Lower pressures tend to produce larger droplets. This reduces drift. For standard flat fan nozzles, pressures above 350 kPa (50 psi) produce fine droplets. Droplet size information (spray quality) can be obtained from the nozzle manufacturer.

Herbicides are often applied between 150-275 kPa (20- 40 psi). This keeps drift at a low level. Insecticides and fungicides are applied at higher pressures, between 300-2,000 kPa, (40-300psi). This gives a finer spray and better coverage. Different nozzle arrangements require different pressures.

Spray pressure also affects nozzle flow rate and spray pattern. Pressure should only be used to achieve small changes in flow rate. Pressure must be increased four times to double the flow rate. Low pressures create narrow fan angles. These can cause uneven patterns.

Spray Droplet Size

A nozzle can produce a range of droplet sizes. The number of fine droplets increases with spray pressure. Fine droplets also increase as the size of the nozzle orifice is decreased.

Nozzles are classified using an International scheme based on droplet size. Droplet diameter is measured in units called microns (1 micron equals 1/1000

mm). Volume Median Diameter (VMD) is a measure of the mean droplet size. For a given VMD, half of the spray volume is comprised of droplets that are smaller than this number. The other half of the spray volume is made up of droplets that are larger than this number.

In product catalogues, nozzle manufacturers often report nozzle spray quality over a range of pressures and flow rates.

Newer nozzles follow an International Standards Organization (ISO) standard colour coding system. This system identifies nozzle output in US gallons per minute at 40 psi

Table 9-1: International Standards Organization (ISO) standard colour coding system.

<i>Colour Code</i>	<i>Nozzle Output</i>
Orange	0.1 gal/min
Green	0.15 gal/min
Yellow	0.2 gal/min
Turquoise	0.25 gal/min
Blue	0.3 gal/min
Red	0.4 gal/min
Brown	0.5 gal/min
Gray	0.6 gal/min
White	0.8 gal/min

Table 9-2: International spray nozzle classification scheme

<i>Classification</i>	<i>Volume Median Diameter (VMD)</i>
VF (very fine)	less than 100 microns
F (fine)	100-175 microns
M (medium)	175-250 microns
C (coarse)	250-375 microns
VC (very coarse)	375-450 microns
XC (extremely coarse)	greater than 450 microns

Nozzle Materials

The rate of nozzle wear depends on the nozzle material, pesticide formulation, operating pressure, nozzle size, amount of use, and time used.

Nozzles made of harder material last longer. These are more costly to buy. Brass is one of the softest nozzle materials. Ceramic is one of the hardest nozzle materials. Other materials (e.g., stainless steel and plastics) fall between the two. Plastic and stainless steel have similar wear rates. Nozzle-wear increases with:

- More abrasive formulations
- Higher operating pressures
- Smaller nozzle sizes
- Longer use

Nozzle Replacement

The nozzle output and spray pattern changes with wear. This reduces application uniformity. To find the amount of wear, compare a worn nozzle's output to manufacturer specifications. Make sure that nozzle output is even across the boom. Replace nozzles that differ by more than 5% from the mean output of the other nozzles. Replace nozzles if mean output exceeds manufacturer specified output by more than 10%.

Clean Water Tanks

All motorized sprayers should have a clean water tank. This is a source of clean water for emergencies. A clean water tank supports routine tasks such as nozzle and hand cleaning.

Additional Components

Added components can be used to enhance the sprayer operation. Exposure is reduced and convenience increased through:

- Electronic controls
- Hydraulic or electric booms
- Induction systems
- Injection systems
- Enclosed cabs

Air-assistance, air blast, electrostatic, and spray hood systems can improve sprayer performance and reduce drift.

Items such as spray monitors and controllers can improve application. They supply information that can be used to maintain a constant application rate.

Drift control agents may change fluid viscosity. This affects distribution patterns, spray monitors, and controllers.

In Review

Parts of a sprayer include the spray tank, pump, agitator, strainers, control, and nozzles. These work to transfer liquid pesticides to the pest. Knowing how they work will help:

- **Promote effective use**
- **Ensure personal safety**
- **Project a professional image**
- **Protect bystanders**
- **Protect the environment**

Calibration

Calibration determines the amount of pesticide applied through a sprayer nozzle, duster, or granular applicator to a given area. This ensures the proper amount is applied to the target area or pest. Application equipment must be correctly calibrated. The following section details factors that need to be kept in mind to calibrate a number of equipment types.

Sprayer Calibration

A calibration process should:

- Ensure the sprayer and its parts are working.
- Ensure the sprayer is able to apply spray mixture evenly.
- Ensure a nozzle pressure to produce a droplet size that promotes good coverage and limits drift.
- Determine the equipment application rate. This rate must meet the label requirements.
- Determine the amount of pesticide to add to the spray tank.

Sprayers should be calibrated:

- When the sprayer is new
- At the start of each season
- When travel speed, nozzle spacing, or nozzles are changed
- When sprayer output changes
- When the sprayer is modified
- When parts are replaced

To calibrate equipment:

1. Set up the sprayer.
2. Measure equipment application rate.

3. Correct the equipment application rate and volume if needed.
4. Figure out the amount of formulated pesticide to add to the spray tank (see Pesticide Use Calculations).

Sprayers can be calibrated using the above steps. There are also some differences in spray equipment.

- Boomless nozzles, airblast sprayers, and hand-operated sprayers require a reading of total sprayer volume, spray width, and effective treatment width. Nozzle spacing and average nozzle output cannot be used.
- Directed sprays and banding equipment for row crops require knowledge of the total treated width per nozzle and the number of nozzles on the boom. The total output of the sprayer must also be known. Nozzle spacing and average nozzle output cannot be used.
- Some tree-fruit growers use a modified calibration process based on tree row volume. Volume of tree foliage is used to determine the amount of pesticide to apply. This is based on row volume.
- Air blast sprayers should have the liquid spray mixture and air delivery systems calibrated.
- Most broadcast sprayers are made with regularly spaced overlapping nozzles on horizontal booms. These provide an even application. For these sprayers, look at either:
 - Total boom output and total spray width
 - Average nozzle output and total spray width
 - Average nozzle output and nozzle spacing

Sprayer Setup

Sprayer setup involves finding the required equipment application rate. If needed, changes should be made to deliver this rate. Check to confirm that the sprayer is working properly.

Determine the Required Sprayer Output

The required sprayer output is found on the pesticide label. This is the amount of spray mixture applied per unit area. Sprayer output depends on:

- The crop
- Stage of growth
- The pest
- The pesticide
- Weather
- Soil conditions
- Method of application

Adjusting Sprayer Output

Once you have identified the sprayer output from the pesticide label calibrate the sprayer to deliver this amount. Sprayer output depends on:

- Spray width (or nozzle spacing)
- Total nozzle output (or average nozzle output)
- Travel speed

For broadcast spraying, with evenly spaced nozzles on a horizontal boom, average nozzle output and nozzle spacing can be used. Otherwise, spray width and total nozzle output are used.

FACTOR # 1 - SPRAY WIDTH OR NOZZLE SPACING:

When broadcast spraying with a horizontal boom:

Swath width of the sprayer = the # of nozzles X nozzle spacing

For band spraying with even flat fan nozzles:

Total swath width = spray width of each nozzle X the # of nozzles

When calculating sprayer output, the rate is for the treated area only. When using a single nozzle (e.g. hand sprayer), spray width is the width of spray on each pass.

For air blast or vertical boom sprayers:

Spray width = row width X the number of rows sprayed

Spray width should equal the distance between sprayer passes measured centre to centre. Nozzle arrangement and sprayer movement affects application uniformity. Some pesticide labels give nozzle guidelines.

FACTOR #2 - TOTAL AND AVERAGE NOZZLE OUTPUT:

Nozzle output is the volume of spray delivered by a nozzle in a given time period. Nozzle output is often rated in litres (L) or gallons per minute (gpm). To measure nozzle output, run the sprayer with water at the chosen pressure for a given time (e.g., 30 seconds). Collect the spray from each nozzle in a measuring cup. Divide total output of all of the nozzles by the number of nozzles. This gives average nozzle output.

Nozzle output depends on nozzle size and pressure. Increasing nozzle size and/or operating pressure will increase nozzle output. Nozzle type, size, and pressure affect droplet size. This affects spray coverage and drift.

Manufacturers give nozzle outputs in metric or U.S. units. Nozzle catalogues seldom use Imperial units. Be sure which units are being used. Manufacturers often list nozzle output over a range of acceptable operating pressures.

FACTOR #3 - TRAVEL SPEED:

Travel speed of the sprayer affects the calibrated sprayer output. For a given nozzle output, increasing travel speed decreases calibrated equipment application rate. Travel speeds for pull type boom sprayers often range from 8 to 13 km/h (5-8 mph). For self-propelled sprayers, travel speeds range from 15 to 30 km/h (10-20 mph).

Increasing travel speed decreases the calibrated equipment application rate or calibrated sprayer output (1:1 ratio).

Excess travel speeds cause boom movement. This causes uneven application. Choose a travel speed that minimizes boom movement. Travel speed is also an issue for air blast sprayers, especially when spraying large trees. Slow speeds are needed to provide good coverage. Going up and down hills changes speed. This changes sprayer output.

For hand held equipment, measure travel speed in the area where you plan to spray. Walk with the sprayer half full of water at a steady pace. Repeat in the opposite direction. Average the results. Walking speed varies with the applicator.

Example: Calculating Travel Speed

Travel Speed = test distance X constant ÷ time

Metric Units: km/h = metres X 3.6 ÷ seconds

Imperial Units: mph = feet X 0.68 ÷ seconds

Example:

A 60-metre test distance took 27 seconds to complete. The second run also took 27 seconds. The total time was 54 seconds. Total distance was 120 metres (60 X 2).

$$\text{Travel Speed (km/h)} \frac{120\text{m} \times 3.6}{54 \text{ sec}} = 8 \text{ km/h}$$

The travel speed required for nozzles can be calculated. Required sprayer output, nozzle output, and spray width must be known. Use average (not total) nozzle output.

Travel speed = required sprayer output x average nozzle output X spray width (or nozzle spacing for broadcast boom) ÷ constant.

Values of constants:

Metric: km/h = (L/ha) X (L/min) X cm ÷ 60,000.

Checking the Sprayer Operation

The last part of sprayer set-up is to make sure that the sprayer is working properly. It must apply the pesticide evenly. Uneven application leaves areas with too much or too little treatment. This can cause crop/plant damage. It can reduce pesticide effectiveness.

Non-uniform application can occur from variations across the width of the boom or local variations within the application area.

Variations in application across the width of the boom are caused by:

- Variations in nozzle output caused by mismatched nozzles
- Worn or plugged nozzles
- Changes in pressure across the width of the boom
- Poor alignment of flat fan nozzles
- Variations in nozzle spacing
- Improper boom height

Variations over the application area can be caused by:

- Changes in sprayer output caused by changing travel speed or pressure
- Too much boom movement
- Skips or a large overlap between passes of the sprayer
- Poor mixing or agitation of the pesticide
- A malfunctioning spray monitor

A number of checks should be performed during calibration. This ensures even application. Before starting the sprayer:

- Check all strainers and screens. This includes filler, suction and nozzle strainers. Check mesh size, holes, and cleanliness.
- Check all nozzles for correct type, size, spacing, and alignment on the boom.
- Check the boom for height above spray target. Ensure that height is level across the boom.
- Check the condition of the pressure gauge and pulsation damper air pressure.

Fill the sprayer with water. With the sprayer running, check the following:

- Set engine throttle at proper rpm to attain correct travel speed
- Flush lines with nozzles removed (if required)
- Check for leaks. Make sure that valves, agitation, and bypass flow are working
- Clean nozzles (and nozzle strainers) with distorted patterns. Discard damaged nozzles
- Adjust the pressure regulator. Check the pressure gauge. Measure pressure drop using a second pressure gauge. Use a nozzle adapter to connect it to the boom. Boom pressure should be uniform. This allows uniform nozzle output.
- Check for wear to nozzle openings. Measure the output of each nozzle.
- Calculate average nozzle output. Replace nozzles with outputs that are 5% greater or less than the average. Replace all nozzles when average output is more than 10% of a new nozzle.
- Check that nozzles and boom are arranged to provide even target coverage.
- Find the best swath width of the sprayer.
- Check air delivery systems of air assist and air blast sprayers. Ensure uniform air output and velocity.

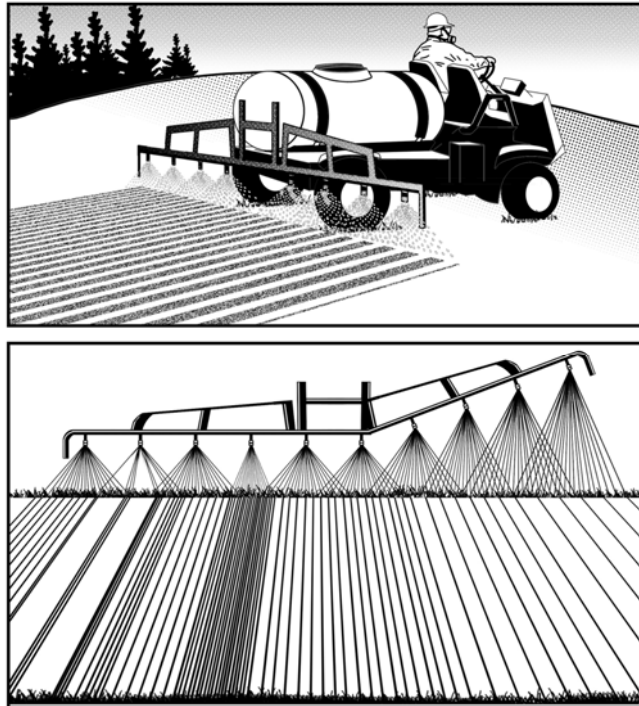


Figure 9-5: Improper boom height and clogged or worn nozzles can result in uneven application of pesticide and poor control of the pest.

Measuring Sprayer Output

Sprayer output is the spray mixture (pesticide and carrier) applied to a unit area (e.g., hectare, acre or meter of row). Sprayer output must meet label requirements. This allows the applicator to figure out the correct amount of pesticide to add to the tank.

A sprayer output may be given on the label. Sprayer outputs for broadcast treatments may be expressed as:

- An amount of spray mixture or product per hectare
- A range (e.g., 100 to 300 L/ha)
- Band treatments in amount per length of row (e.g., mL/m)
- Individual trees (L/plant)
- Spray to wet or runoff

Sprayer output can be measured by two methods: test area method and timed output method.

- The test area method uses fewer calculations. It may take longer to perform. When an entire acre or hectare is used, the measured discharge of water is the sprayer output per acre or hectare. No further calculation is required. The most common problem with test area method is measuring the amount of spray water discharged. The test area may be too small. The area may not be covered with enough passes. The amount of water discharged will be too small to measure. The tractor and sprayer tank should be parked in the exact same location. Water must settle in the tank after stopping, before measuring tank level again.
- The timed output method avoids the problems. Airblast sprayers or vertical booms can be used to spray row crops (e.g., raspberries). Total nozzle output and swath width of the sprayer are used to calculate the sprayer output. For broadcast sprayers with evenly spaced nozzles, the average nozzle output can be substituted for total nozzle output. Nozzle spacing can be used as the spray width. Nozzle spacing equals the spray width for one nozzle.

Using the Test Area Method

- Mark out a test strip.
- Fill the tank about half full with water. Start the sprayer nozzles and agitation. Adjust the pressure regulator to the desired pressure. Use the same engine rpm for the desired travel speed. Record the volume of water in the tank before the test. Mark the location where the sprayer is parked. This will allow you to return to the same position and measure the water sprayed. Level ground is best.
- Choose the tractor gear that will give the desired travel speed.
- Drive towards the first stake at the correct speed. Open the boom valve as you pass it.
- Check sprayer pressure again. Close the boom valve as you pass the second stake.

- Repeat until at least 10% of a full tank is sprayed. Record the number of runs.
- Return to the starting location. Measure the volume of water sprayed.
- Calculate the test area.
- Calculate the sprayer output.

Example: Test Area Method

Test Area = strip length X spray width X number of runs

Example: You test a hand-operated sprayer on a 10 m strip that is 2.5 metres wide. If you spray the strip twice, what is the area?

Test Area = Strip length X spray width X number of runs
 = 10 m X 2.5 m X 2 runs
 = 50 m²

Metric Units: m² = m X m X number of runs
Imperial Units: ft² = ft X ft X number of runs

Sprayer Output = volume of water sprayed X constant ÷ test area

Example: A sprayer uses 15 L of water in a test area of 100 m². What is the sprayer output per hectare?

Sprayer Output = volume of water sprayed X constant ÷ test area
 = 15 L X 10000 ÷ 100m²
 = 1500 L/ha

Values of constants:

Metric Units: L / ha = L/m² X 10,000
Per Acre Units: L/acre = L / ft² X 43,560
American Units: GPA = gal/ft² X 43,560

Using the Timed Output Method

Fill the sprayer tank half full of water (see sprayer set-up).

Measure the travel speed of equipment in field conditions.

Measure total nozzle output (L/min) by spraying for a set time (e.g., 10 min) OR use the total nozzle output from measuring individual nozzle uniformity (see sprayer set-up).

Calculate the sprayer output for a single nozzle sprayer.

Example: Timed Output Method – Single Nozzle Sprayer

$$\text{Sprayer output} = \frac{\text{total nozzle output} \times \text{constant}}{\text{speed} \times \text{spray width}}$$

Example: You calculate total nozzle output to be 2 litres per minute. Forward speed is 3 km/h. Swath width is 100 cm.

$$\begin{aligned} \text{Sprayer Output} = (\text{L/ha}) &= \frac{2 \text{ L/min} \times 60000}{3 \text{ km/h} \times 100\text{cm}} \\ &= 400 \text{ L/ha} \end{aligned}$$

Values of Constants:

$$\begin{aligned} \text{Metric Units: L/ha} &= (\text{L/min}) / (\text{km/h}) / \text{cm} \times 60,000 \\ \text{Per Acre Units: L/acre} &= (\text{L/min}) / \text{mph} / \text{inches} \times 5,940 \\ \text{American Units: GPA} &= \text{gpm} / \text{mph} / \text{inches} \times 5,940 \end{aligned}$$

For broadcast sprayers, average nozzle output and nozzle spacing can be used instead of total nozzle output and spray width.

Calculate the sprayer output for a boom sprayer.

Example: Timed Output Method – Boom Sprayer

**Sprayer output = average nozzle output X constant
÷ (speed X nozzle spacing)**

Example: You calculate average nozzle output to be 2.5 litres per minute. Forward speed is 6 km/h. Nozzle spacing is 50 cm.

$$\begin{aligned} \text{Sprayer Output} = (\text{L/ha}) &= \frac{2.5 \text{ L/min} \times 60000}{6 \text{ km/h} \times 50\text{cm}} \\ &= 500 \text{ L/ha} \end{aligned}$$

Values of Constants:

$$\begin{aligned} \text{Metric Units: L/ha} &= (\text{L/min}) / (\text{km/h}) / \text{cm} \times 60,000 \\ \text{Per Acre Units: L/acre} &= (\text{L/min}) / \text{mph} / \text{inches} \times 5,940 \\ \text{American Units: GPA} &= \text{gpm} / \text{mph} / \text{inches} \times 5,940 \end{aligned}$$

Adjusting Sprayer Output

If the measured sprayer output is different than what is required, it can be adjusted in one of three ways:

1. **Nozzle size** should be changed if large changes in sprayer output are needed. If needed, get help from the nozzle supplier or application equipment expert. Nozzle catalogues are available. These list nozzle outputs in litres per minute (L/min). Desired output of new nozzles can be calculated. The required sprayer output and travel speed must

2. **Forward speed** can be changed to adjust the sprayer output. Slower speeds increase the rate. Faster speeds reduce the rate. Traveling fast can cause the sprayer boom to bounce. This may prevent proper target coverage.

Calculate required speed with the following formula:

Example: Adjusting Forward Speed

Required speed = present speed X present sprayer output ÷ desired sprayer output

Example: You have just calibrated a sprayer. You calculate the present speed to be 8 km/h. Sprayer output is 100 L/ha. The pesticide label indicates that you must apply the pesticide in 120 L/ha of water. Calculate a new required speed that will give you a sprayer output of 120 L/ha.

New required speed = $\frac{\text{present speed X present sprayer output}}{\text{Desired sprayer output}}$

New required speed = $\frac{8 \text{ km/h X } 100 \text{ L/ha}}{120 \text{ L/ha}}$

= 6.7 km/h

Use this speed to see if the required label recommendations are met in the next example.

Calculate a new sprayer output if another tractor/truck gear and speed is chosen (rpm may be fixed because of the pump):

Example: Adjusting Sprayer Output

New sprayer output = present speed X present sprayer output ÷ new speed

Example: You calculate the present speed to be 8 km/h. Present application rate is 100 L/ha. The speed of your tractor slows to 6.7 km/h. Does the new reduced speed meet the label recommendations?

New sprayer output = $\frac{\text{present speed X present sprayer output}}{\text{new speed}}$

$$= \frac{8 \text{ km/h} \times 100 \text{ L/ha}}{6.7 \text{ km/h}}$$

$$= 120 \text{ L/ha}$$

Yes, this meets the required sprayer output on the label.

1. **Spray pressure** should be set for the proper droplet size. Changing pressure is only advised for small changes in delivery rates for most nozzle types. Droplet size changes can cause drift or runoff. This is often not a good way to adjust application rate.

Pressure must be increased by four times to double the delivery.

Pesticide Use Calculations

Large Area Calculations

Pesticide-use calculations are required to determine the:

- Size of the treatment area
- Correct amount of pesticide required for the treatment area
- Amount of pesticide to add to the spray tank
- Area covered by the spray tank
- Total number of tanks required
- Volume of spray mix required for the final load
- Amount of pesticide required for the final load

These calculations are based on the pesticide rate chosen by the applicator from the label.

Before applying a pesticide, perform the calculations on the following pages:

1. Determine the size of the treatment area.

It can be obtained by measuring or from other sources (e.g., property maps or deeds). Any area that is not to be treated should be subtracted from the total area.

Example: Determining the Size of the Treatment Area

Area of a four-sided shape = length X width.

Example: You measure a treatment area as being 50 m by 150 m. What is the total area?

$$\begin{aligned} \text{Hectares} &= \frac{\text{Length (m)} \times \text{Width (m)}}{10,000 \text{ m}^2 / \text{ha}} \\ &= \frac{150 \text{ m} \times 50 \text{ m}}{10,000 \text{ m}^2 / \text{ha}} \\ &= 0.75 \text{ ha} \end{aligned}$$

Values of Constants:

Metric: Hectares = Length (m) X Width (m) ÷ 10000 m²/ha.

Imperial: Acres = Length (ft) X Width (ft) ÷ 43560 ft²/acre.

2. Determine the total amount of pesticide required. Use the following calculations:

Litres = Hectares X litres / hectare

Litres = Acres X litres / acre

Litres = square metres X litres / 100 m²

Example: Determining the Total Amount of Pesticide Required

You need to treat an area of 0.75 ha. The pesticide application rate on the label is 2.0 L/ha.

The total pesticide required = treatment area x pesticide application rate

Example: The label rate is 2.0 L/ha. What is the total amount of pesticide required?

$$\begin{aligned}\text{Litres of pesticide} &= \text{Hectares X Litres / hectare} \\ &= 0.75 \text{ ha X } 2.0 \text{ L/ ha} \\ &= 1.5 \text{ L}\end{aligned}$$

3. Determine the area covered by each tank. Use the following calculations:

$$\text{Hectares/ tank} = \text{litres} \div \text{litres/hectare}$$

$$\text{Acres/tank} = \text{lites} \div \text{litres/acre}$$

$$\text{Acres/tank} = \text{gallons} \div \text{gallons/acre}$$

Example: Determine the Area Covered by Each Tank

Area covered by tank = tank size \div sprayer output

Example: Your tank holds 500 L. The pesticide label advises a sprayer output of 1000 L/ha. What is the area that will be covered by a full tank?

$$\text{Area covered by tank} = \text{litres} \div \text{litres/hectare}$$

$$= \frac{500 \text{ L}}{1000 \text{ L/ha}}$$

$$= 0.5 \text{ Ha}$$

4. Pesticide to add to the full spray tank.

a. When pesticide rate is expressed as a rate per area:

$$\text{Litres} = \text{Litres/hectare} \times \text{hectares/tank}$$

$$\text{Litres} = \text{Litres/acre} \times \text{acres/tank}$$

$$\text{Litres} = \text{litres/100 m}^2 \times 100 \text{ m}^2/\text{tank}$$

Example: Determining the Amount of Pesticide to Add when Label Rate is Given Per Unit Area

$$\text{Pesticide per tank} = \text{pesticide application rate} \times \text{area covered per tank}$$

Example: The pesticide label calls for an application rate of 2.0 L/ha. Your tank covers 0.5 ha. What is the amount of pesticide required for a full tank?

$$\text{Litres} = \text{Litres/hectare} \times \text{hectares/tank}$$

$$= 2.0 \text{ L/ha} \times 0.5 \text{ ha}$$

$$= 1 \text{ L}$$

b. When the pesticide application rate is expressed as a dilution factor:

Example: Determining the Amount of Pesticide to Add when Label Rate is given as a Dilution Factor

$$\text{Pesticide per tank} = \text{tank size} \times \text{dilution factor}$$

Example: The pesticide label calls for a pesticide application rate of 2.5L/100L. Your tank holds 250 L. What is the amount of pesticide required for a full tank?

$$\text{Litres} = \text{Litres} \times \text{Litre/Litres}$$

$$= 250 \text{ L} \times 2.5 \text{ L/100 L}$$

$$= 6.25 \text{ L}$$

5. Determine the total number of tanks needed. Use the following calculations:

Tanks = hectares ÷ hectares/tank

Tanks = acres ÷ acres/tank

Total number of tanks can include a partial tank

Example: Determining the Total Number of Tanks Needed

Total number of tanks = treatment area ÷ area covered per tank

Example: The area to be treated is 0.75 ha. Your tank covers 0.5 ha. How many tanks do you need to fill to complete the treatment?

Tanks = hectares ÷ hectares/tank

$$= .75 \text{ ha} \div 0.5 \text{ ha/tank}$$

$$= 1.5 \text{ tanks}$$

6. Determine the hectares left to be sprayed. Use the following calculations:

Example: Determining the Hectares Left to be Sprayed

Area (hectares) left to be sprayed = total area (hectares) - area (hectares) already sprayed

Example: You complete spraying 0.5 ha before lunch. The total area is 0.75 ha. What is the area left to be sprayed after lunch?

Area (ha.) left to be sprayed = total area (ha) - area (ha) already sprayed

$$= 0.75 \text{ ha} - 0.5 \text{ ha}$$

$$= 0.25 \text{ ha}$$

7. Determine the volume of spray mixture needed for a partial tank.
Use the following calculations:

Litres = hectares X litres/hectare.

Litres = acres X litres/acre.

Gallons = acres X gallons/acre.

Example: Determine the Volume of Spray Mixture Needed for a Partial Tank

Volume of spray mixture (pesticide + water) for a partial tank = area left to be sprayed X sprayer output

Example: The sprayer output is 1000 L/ha/ha. The area left to be sprayed is 0.25 ha. What is the required volume of spray mixture in the tank?

Litres = hectares X litres/hectare

$$= 0.25 \text{ ha} \times 1000 \text{ L/ha}$$

$$= 250 \text{ L}$$

8. Determine the volume of pesticide needed for a partial tank. Use the following calculations:

**Pesticide for a partial tank = treatment area left X
pesticide application rate**

Litres = Hectares X Litres/hectare

Litres = Acres X Litres/acre

Example: Determine the Pesticide Needed for a Partial Tank

Pesticide for a partial tank = area left to be sprayed X pesticide application rate

Example: The pesticide application rate is 3.5 L/ha. The area left to be sprayed is 1.1 ha. What is the required volume of spray mixture in the tank?

Litres = hectares X litres/hectare

= 0.25 ha X 2.0 L/ha

= 0.5 L

In Review

A full tank has 1 L of pesticide in 500 Litres (1 ÷ 500 = 0.002)

A part tank has 0.5 L of pesticide in 250 Litres (0.5 ÷ 250 = 0.002)

The ratio of 0.002 is the same

Small Area Ground Beds Calculations

For potted plants, a 1000 litre solution should cover roughly 5,000 m² of total greenhouse area. Ensure that proper volume of spray mix is being delivered to the treatment area.

$$\text{Area (m}^2\text{)} = \text{length (m)} \times \text{width (m)}$$

$$\text{Hectares} = \text{length (m)} \times \text{width (m)} \div 10,000\text{m}^2$$

Example: Calculating a Small Area

You measure a small treatment area as 50 m by 150 m. What is the total area?

$$\begin{aligned} \text{Hectares} &= \text{length (m)} \times \text{width (m)} \div 10,000 \text{ m}^2/\text{ha} \\ &= 150 \text{ m} \times 50 \text{ m} \div 10,000 \text{ m}^2/\text{ha} \\ &= 0.75 \text{ ha} \end{aligned}$$

In Review:

A sprayer can be set up by measuring and changing sprayer application rates. Pesticide use calculations must be made. All of these methods must be used to be sure that a correct application will be made.

Environmental Considerations for Using Boom Sprayers

Before any application, check environmental conditions at the application site. Be mindful of sensitive non-target areas nearby. Spray and vapour drift must be minimized. Water quality can affect pesticide performance or application equipment. The following section deals with environmental factors that impact pesticide application.

Buffer Zones

Pesticide labels may include statements on buffer zone distances from sensitive areas. A buffer zone is the distance from the downwind edge of direct pesticide application to the nearest upwind edge of the sensitive area. Buffer zones protect sensitive non-target areas from pesticide damage. In some cases, buffer zone width may depend on weather and application methods.

Spray and Vapour Drift

Before any application, make note of weather conditions at the site. This indicates spray drift potential. Consider:

- Air and ground temperature
- Relative humidity
- Wind speed and direction
- Forecast weather conditions

Consider factors that may put areas around the application site at risk to effects of drift. Factors include nearness to:

- Surface water
- Sensitive plants
- People or animals
- Other sensitive areas

Reduce spray drift by only spraying in favorable weather. High temperatures and low humidity combine to increase evaporation. This results in small droplets that can drift off target. Higher wind speeds can cause drift in the direction of the

wind. Maximum wind speeds during application may be given on the label or by provincial guidelines/laws. Wind speed indicators (anemometers) and pictorial comparisons can be used to judge wind speed. Applicators should use accurate hand-held anemometers to gauge wind speed and direction at the time of spraying. If spray drift occurs, stop the application. Do this, even if wind speeds are acceptable. Avoid variable wind conditions (e.g., gusting or windless conditions). Changing wind conditions may blow droplets onto non-target plants/organisms.

If spray drift is a concern, consider doing the following:

- Increase droplet size by lowering pressure.
- Use a low drift nozzle.
- Use a coarser spray quality (droplet size).
- Use a spray guard or shroud.
- Use equipment that reduces or eliminates drift (e.g., wick application equipment).
- Use drift control agents.
- Lower boom height or hold the spray gun closer to the target. Nozzles can be tilted forward to maintain boom height for proper overlap and even application. It should be noted that lowering the boom and using nozzles with wider spray patterns (finer droplets) may not reduce drift.

Minimize vapour drift by doing the following:

- Choose a less volatile pesticide (e.g., amine versus ester formulation).
- Apply pesticide under proper wind conditions. Windless conditions can cause vapours to remain in the air. These can damage non-target areas. A 2 km/h wind away from non-target areas generally reduces risk.
- Apply the pesticide under proper temperature and humidity. High temperatures and low humidity increase volatilization.

Temperature inversions occur when cooler air lies underneath warm air. Temperature inversions sometimes occur with the large high-pressure systems

depicted on weather maps. These systems often combine temperature inversion conditions and low wind speeds. Temperature inversions can cause spray or vapour drift to stay concentrated. This increases risk from downwind movement. Pesticides should not be applied during temperature inversions. Wind directions can change during these times. Apply pesticides on sunny days with low wind speeds in a constant and predictable direction.

Increase Droplet Size

Insecticides and fungicides are often applied with smaller spray droplets than herbicides. Smaller droplet size improves coverage (number of drops per leaf). This allows the spray to pass through a dense canopy. Using large droplets to apply insecticides and fungicides may reduce effect. Insecticide and fungicide use may require a compromise between drift reduction and pesticide effect. Applicators can reduce spray drift by using larger droplet size. Droplet size gets larger as nozzle orifice size increases and pressure decreases.

A nozzle with a small orifice used at high pressure may have the same output as a larger nozzle used at a lower pressure. Risk of drift is much greater for a nozzle with small orifices. Increasing spray angle on nozzles decreases droplet size at the same pressure. Some nozzles are designed to provide larger droplets as well (e.g., low-drift, drift guard, and air induction). Changing nozzle types may increase droplet size for the same nozzle flow rate and pressure.

For standard nozzles, when a larger orifice is chosen and the same pressure used, there may be higher nozzle output. The applicator can increase travel speed to compensate for this or accept a higher equipment application rate. It may be possible to balance both of these factors. But, travel speed should not be excessive. Application rate must not exceed the maximum application rate stated on the label. For all nozzles, pressures should remain within the manufacturer's guidelines.

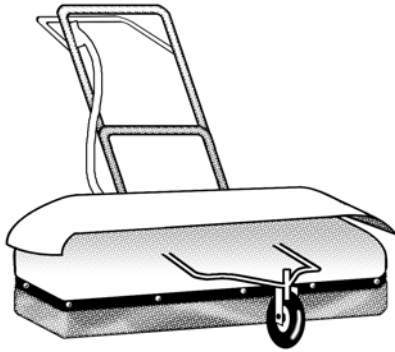
Drift Control

Wind Cone Spray Wands

Hand held spray wands can be shrouded with a windcone. This is mounted near the nozzle tip. The wind cone will reduce drift from wind gusts. It also promotes good target coverage. This reduces contact with non-target objects that are nearby (e.g., shrubs). Wind cone spray wands are safe for the applicator. They allow one

to control the application target area. Manufacturers report that spray drift can be controlled in up to 20 km/hr winds.

Windfoil Spray Booms



Boom-type spray wands can be enclosed in a shrouded canopy. This reduces spray drift by reducing wind contact. Windfoil spray booms have flotation wheels. A front swivel-type wheel can be added for more stability. An airfoil is a flat curved bar mounted on the top of the shroud. This gets rid of updrafts behind the windfoil during spray application. Manufacturers report windfoil spray booms to be effective in reducing drift for up to 30 km/hr.

Figure 9-6: Spray boom equipped with Windfoil.

Water Quality and Pesticide Effectiveness

Temperature, sediment, pH, and mineral ions in water mixed with pesticides may affect pesticide performance. High pH can break down some insecticides. It can also reduce solubility of some herbicides.

The rate of pesticide breakdown depends on:

- pH of water
- Amount of pesticide added to a given amount of water
- Water temperature
- The length of time a solution is left in the spray tank

Silt and organic matter in the water may cause:

- Early pump wear
- Plugged screens
- Reduced pesticide effect

If you suspect a problem with water quality, you should:

- Have the water tested
- Seek another water source
- Obtain advice on pesticide application

Refer to the pesticide label or provincial publications for guidelines.

In Review

Environmental conditions can play an important part in how well pesticides are applied. Attention must be paid to:

- **Buffer zones (to protect sensitive areas)**
- **Water quality (to ensure pesticide effect)**
- **Spray and vapour drift (to avoid the risk of off-target movement)**

Sprayer Maintenance

Liquid application equipment must be maintained to keep it running well. There are also a number of things that must be done when parking or storing a spray vehicle. These topics are discussed in the following section.

Routine Maintenance

Taking care of application equipment minimizes breakdowns. This increases service life, and reduces leaks and spills.

Rinse equipment at the end of each spraying day. Flush clean water through the pump, hoses, and nozzles. Check and clean all screens, strainers, and nozzles. Check the sprayer for wear. Replace worn or damaged parts. Major parts to check include the:

- Agitator
- Regulator
- Pressure gauge (check for accurate operation)
- Couplings and clamps (check for proper seals)
- Hose flex points (check for wear)

Wash the sprayer. Dispose of rinsate where residues will not cause environmental harm. Follow label directions and provincial laws.

Decontaminate the sprayer, when changing pesticide types (e.g., herbicides to insecticides). Steps vary according to the pesticides being used. Check the pesticide label or manufacturer's representative for details.

Temporary Storage of Spray Vehicles

Choose a site with care when parking spray vehicles:

- Do not park near sensitive plants. Herbicide vapours may pose a hazard. Spray solution may move off a vehicle deck during rainfall.
- Do not park where herbicides can drain into storm sewers.

- Do not park where vandalism can occur.
- Do not park in urban areas, particularly with a full spray tank.



Figure 9-7: Secure pesticide containers in a locked area to prevent tampering or theft.

If you must park near sensitive vegetation or in urban areas, lock all valves. This prevents spray solution from escaping in the case of a break-in. Secure pesticide containers to prevent tampering or theft. Equipment should be checked daily for tampering (before application). Ensure that contaminated clothing is stored in a secure location away from clean clothing. All spills on decks must be properly cleaned.

Provincial law may not allow leaving pesticides, spray solutions, and loaded spray equipment unattended. Refer to provincial law and be aware of requirements in your province.

To prepare a sprayer for end of season storage:

1. Thoroughly clean the sprayer and drain it completely. Drain all components that can retain water. Follow the manufacturer's guidelines on adding antifreeze solution.
2. Check the sprayer for worn parts. List all parts that need replacement. Order parts well before the next spraying season.
3. Remove the pump. Follow the manufacturer's guidelines for storage.
4. Seal openings to prevent entry of dirt, debris, insects, or rodents.

5. Store the sprayer where it cannot be damaged by other equipment, livestock, or weather.
6. Store polyethylene tanks under cover. This prevents breakdown by sunlight.
7. Keep galvanized steel tanks dry to prevent rusting.

In Review

Sprayers should be rinsed after each day's use. Many sprayer parts should be checked regularly for dirt and wear. Decontaminate equipment when one pesticide type is replaced by another. This avoids harmful residues or other damage. Spray vehicles must be parked to prevent tampering or accidental release. End of season storage requires complete drainage and protection from damage.

Granular Application Equipment

Pesticide granules must reach the target pest. To ensure that they do, you must choose proper equipment and understand its parts. The following section describes common landscape granular application equipment.

Components of Granular Application Equipment

Components of granular application equipment include:

- Storage hoppers
- Metering mechanisms
- Distribution systems

Storage Hopper

Storage hoppers hold granular pesticides. They come in a number of shapes, sizes, and materials. A hopper should:

- Be corrosion resistant
- Be strong
- Be shaped to promote granule flow
- Be easy to fill
- Have graduated markings
- Be easy to clean

Agitators can be installed in hoppers to prevent bridging (blockage) of granules. A granular pesticide may bridge because of:

- Pesticide characteristics (type, shape, and size of formulated granule)
- The shape of the hopper
- Air temperature and humidity

Coarse screens can be installed on hoppers. These prevent pieces of the pesticide bag or clumps of product from entering the hopper. This will prevent the drive mechanism from clogging.

Metering Mechanism

There are two main types of metering mechanisms used in granular pesticide application equipment:

Gravity flow metering mechanisms use openings that can be manually adjusted in size. These regulate flow of pesticide from the hopper. A hopper agitator is often used to promote a steady flow of granules to the opening.

Positive metering mechanisms use an auger or fluted-feed roll at the bottom of the hopper. This regulates the flow of granules from the hopper. A ground driven wheel often powers positive metering mechanisms. These are more accurate than gravity flow metering mechanisms.

Distribution System

Granular application equipment is classed by the kind of distribution system it has. Broadcast and banding are two common types of distribution systems.

Broadcast application equipment applies granules over the entire field surface. This equipment often uses:

- A very wide hopper with closely spaced gravity flow openings
- A single gravity flow opening with a mechanical spreader
- A pneumatic delivery system

Band application equipment applies granules in narrow bands. This often corresponds to crop rows. Untreated areas are left between the rows. Banding reduces pesticide use. Pesticides are only applied to areas requiring treatment.

Banding application equipment may use:

- Simple spreaders to spread granules across the desired band width on the soil surface
- Small drop tubes or soil openers to place granules under the soil surface near the seed in well-defined bands

In Review

Major parts of granular equipment include storage hoppers, metering mechanisms, and distribution systems. These work to bring granular pesticides to the target pest. Knowing how they work will make pesticide application more effective.

Calibration

Application Uniformity

The goal of equipment calibration is to achieve a uniform application of pesticide. Application uniformity affects pesticide performance. Uneven application leaves areas of over and under-application. This reduces pesticide effect.

Uneven application can result from:

- Changes in granule outputs
- Changes in travel speed
- Changes in discharge heights (when banding)
- Improper overlapping between passes

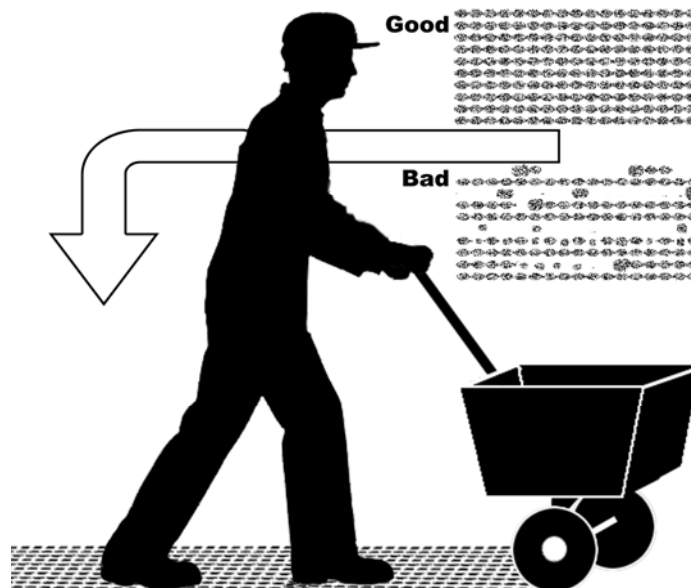


Figure 9-8: To obtain good control ensure granular application rate is uniform.

Equipment Application Rate

Equipment application rate is the weight of pesticide per unit area applied by granular application equipment.

The pesticide rate is the weight per unit area called for on the pesticide label.

Equipment application rate and pesticide rate are often expressed as:

- Broadcast treatment (kg/ha)
- Banding treatment (kg/ha or kg/m of row)

Equipment application rate depends on:

- Granule flow rate
- Travel speed
- Treatment width

GRANULE FLOW RATE

Granule flow rate is the rate at which granules flow from the hopper (weight per time). Granular flow rate depends on:

- The size of the opening
- Granule size and density
- Formulated pesticide characteristics
- Air temperature and humidity

An increase in humidity may decrease granule flow rate.

Larger or less dense granules flow more slowly through the same sized opening (when compared with smaller or denser granules).

Bouncing in rough fields disrupts the steady flow of the granules. This reduces uniformity.

The metering mechanism can be adjusted to set the granule flow rate from the hopper. The correct setting is determined during calibration. Once set, metering mechanisms are not usually changed during application.

The flow rate of gravity flow mechanisms can be adjusted by changing the size of the opening. The rotational speed of the agitator can also affect flow rate.

The flow rate of positive metering mechanisms can be adjusted by changing the size of the opening. The rotational speed of the metering mechanism can also affect the flow rate.

Field conditions can affect flow rate from the hopper. Rough fields cause equipment to bounce. This disrupts steady flow of granules. Changing flow rates reduce uniformity. Sloping fields may also affect uniformity.

The granular flow rate of each discharge opening should be measured. This ensures even application across the total width of the equipment. Measurements should be taken in field conditions.

TRAVEL SPEED

Travel speed affects equipment application rate. Increasing travel speed decreases application rate for granular application equipment using gravity flow metering mechanisms.

If granular application equipment uses positive metering mechanisms, small changes in travel speed will not greatly alter equipment application rate when the metering mechanism is ground-driven.

Travel speed selected during calibration should be maintained during application, no matter what metering mechanism is used.

TREATMENT WIDTH

Treatment width is used to find the equipment application rate. This depends on the type of distribution system used.

For broadcast application equipment, treatment width equals the total width of granules applied in each pass.

For band application equipment, treatment width equals the total of all the individual bandwidths in one pass.

When granules are banded under the soil surface, the application equipment output is generally expressed as kg/m of row. Treatment width is not taken into account.

Granular Application Equipment Calibration

Granular application equipment should be calibrated:

- When application equipment is new
- At the start of each season
- When travel speed, metering mechanism, weather, or pesticides change
- When equipment application rate changes

Calibration Process

1. Determine a proper travel speed. Take field conditions into account. Select a gear/rpm setting that provides desired travel speed. Record this information. Maintain this speed throughout calibration and application.
2. Select a test site. This may be the field where the application occurs. It may be an area with similar soil and terrain conditions. Mark a test distance at least 50 meters in length.
3. Fill the hoppers roughly half full for average weight conditions.
4. Consult the operator's manual for the recommended setting of the metering mechanism. Note: The flow rate called for in the manual may need to be altered based on the type of pesticide, weather, and field conditions. Always calibrate to ensure that granule flow rate is correct.
5. Attach bags or other containers under each opening. This collects granules during calibration. Try to use a blank carrier to avoid exposure. Special collection containers may be available from the pesticide maker. These are calibrated with a scale showing weight. For granular equipment with a pneumatic delivery system, use porous mesh bags (e.g., nylon) OR shut off airflow, and catch granules at the metering mechanism.
6. Run the application equipment over the test distance at the correct gear/rpm. To reduce error, acceleration and deceleration distances should be kept short. Granule flow cannot be controlled from the operator's seat.

7. Remove the bags/containers. Weigh and record the contents in each. Enough material must be collected during the test to allow for accurate weighing on available scales. Do not use a scale that is used for food.
8. Repeat the test in both directions. Average the results.
9. Calculate equipment output. Compare this to pesticide rates on the label. Assess flow rate uniformity by comparing the individual values to the average value. Adjust and recalibrate if necessary.

Be sure that granules are correctly placed during calibration. To adjust band width, spreaders or tubes can be raised or lowered.

Calculate:

- The calibration area
- Total amount collected
- Treatment area
- Total amount of pesticide product required

Calculations

1. Determine treatment area. Use the following calculations:

$$\text{Kg} = \text{Hectares} \times \text{Kg/hectare}$$

$$\text{Kg} = \text{Acres} \times \text{Kg/acre}$$

Example: Determining the Amount of Pesticide Required

$$\text{Treatment area} = \text{length} \times \text{width} \div 10000$$

Example: An area to be treated is 50 m by 150 m. Label application rate is 2 kg/ha. What is the amount of pesticide required?

$$\begin{aligned} \text{Treatment area} &= \text{Length (m)} \times \text{Width (m)} \div 10,000 \text{ m}^2/\text{ha} \\ &= 150 \text{ m} \times 50 \text{ m} \div 10000 \text{ m}^2/\text{ha} \\ &= 0.75 \text{ ha} \end{aligned}$$

$$\begin{aligned} \text{Kg of pesticide} &= \text{Hectares} \times \text{Kg/hectare} \\ &= 0.75 \text{ ha} \times 2 \text{ kg/ha} \\ &= 1.5 \text{ kg} \end{aligned}$$

2. Determine the total weight of granules discharged. Use the following calculations:

Example: Determining the Total Weight of Granules Discharged

Total granules discharged = total weight of individual openings discharged over the test area.

Example: The weights of granules for each opening in a spreader were as follows: 2.2 kg, 2.1 kg, 3.0 kg, 2.7 kg and 2.5 kg. What is the total weight of granules discharged?

$$\begin{aligned} &\text{Total granules discharged} \\ &= 2.2 \text{ kg} + 2.1 \text{ kg} + 3.0 \text{ kg} + 2.7 \text{ kg} + 2.5 \text{ kg} \\ &= 12.5 \text{ kg} \end{aligned}$$

3. Determine the amount of pesticide used per unit area.

a. For Broadcast equipment, use the following calculations:

$$\text{Kg} = \text{Hectares} \times \text{Kg/hectare}$$

$$\text{Kg} = \text{Acres} \times \text{Kg /acre}$$

Example: Determine the Amount of Pesticide Used Per Unit Area for Broadcast Equipment

Broadcast (kg/ha): Equipment Application Rate = total granules discharged X treatment area

Example: A granular spreader applies 100 kg/ha. You need to treat an area of 6.2 ha. How much granular pesticide do you require to treat the area?

$$\text{Kg} = \text{Kg/hectare} \times \text{Hectares}$$

$$= 100 \text{ kg/ha} \times 6.2 \text{ ha}$$

$$= 620 \text{ kg}$$

b. For banding equipment, use the following calculations:

Example: Determine the Amount of Pesticide Used Per Unit Area for Broadcast Equipment

Banding (kg/m): Equipment Application Rate = total granules discharged ÷ distance/band X number of bands

Example: A certain spreader has 3 bands. Each band has an output of 50 kg/1000m. What is the equipment application rate?

Banding (kg/m): Equipment Application Rate = total granules discharged/band X number of bands ÷ distance/band

$$\begin{aligned} \text{Equipment Application Rate} &= 50 \text{ kg} \times 3 \text{ bands} / 1000\text{m} \\ &= 0.15 \text{ kg/m} \end{aligned}$$

4. Determine the total amount of pesticide required. Use the following calculations:

Example: Determining the Total Amount of Pesticide Required

Total pesticide required = treatment area X label pesticide rate

Example: The label pesticide rate is 12 kg/ha. The total area to be treated is 3 ha. What is the total pesticide required?

$$\begin{aligned} \text{Total pesticide required} &= \text{treatment area} \times \text{label pesticide rate} \\ &= 3 \text{ ha} \times 12 \text{ kg/ha} \\ &= 36 \text{ kg} \end{aligned}$$

Environmental Considerations for Granular Application

Before any granular application, look at environmental conditions at the application site. Look for sensitive wildlife areas nearby. The following section details environmental factors that impact the application of pesticides.

Weather Conditions

Before any application, check the weather to assess the risk of problems. High winds may:

- Affect distribution of granules
- Decrease uniformity
- Change band width

A change in humidity can alter the flow rate of the granules. This can affect equipment application rate.

Wildlife

Granular insecticides should be mixed into the soil. This will reduce the risk to wildlife by reducing the chance of ingestion. Refer to the pesticide label for details.

Maintenance

Proper maintenance of granular application equipment keeps it in good running order. A number of things need to be done when equipment is prepared to be stored at the end of the season. These are discussed in the following section.

Taking care of application equipment reduces the chance of breakdowns. This increases service life. Never leave granules in the hoppers for long periods. They may absorb moisture and harden into lumps. Before using equipment, make sure that no moving parts have seized from corrosion. Granules are abrasive. This means that all moving parts of the equipment must be frequently greased or oiled. Too much lubrication can cause a build-up of granules, dust and dirt. This can increase wear and hinder equipment use.

Check tire pressure before use. Air pressure determines the effective size of the tire. This also determines equipment output for ground-driven equipment. Over-

inflated tires cause bouncing. This reduces uniformity. Check the delivery system. Make sure that granules have a clear path from the metering mechanism to the target.

To prepare equipment for storage:

1. Thoroughly clean it.
2. Lubricate all moving parts.
3. Follow the manufacturer's guidelines.
4. Check and replace worn parts.
5. Store it where it will not be damaged by other equipment, livestock, or weather.

In Review

The parts of granular equipment should be often checked for dirt and wear. Granules are abrasive and can harden and clump with time. Care is needed to ensure proper equipment operation. Regularly lubricate equipment and check tire pressure according to manufacturer's guidelines. Store equipment properly at the end of the season to avoid damage.

Summary

Pesticides are potentially dangerous chemicals that must be handled properly to ensure that pests are controlled, while damage to the environment is avoided. To make sure that the pesticide reaches the target pest with the least risk to humans, animals, and the environment, use proper:

- Equipment
- Components of liquid and granular equipment
- Calibration of sprayers and granular spreaders
- Pesticide use calculations
- Equipment maintenance
- Environmental considerations

Self-test Questions

Answers are located in Appendix A of this manual.

1. Name three types of spraying equipment often used in landscape and turf pest management.

2. List the main parts of motorized boom sprayers.

3. Flat fan nozzles are often used for which application types?

- a) Insecticide
- b) Herbicide
- c) Fungicide

4. What are four steps required to calibrate application equipment?

5. What are three factors that affect required equipment application rate?

6. List the weather factors to keep in mind when using pesticides.

7. In addition to spraying only under proper weather conditions, how can you avoid spray drift?

8. How is application equipment maintained?

9. Describe the main parts of a granular applicator.

10. What represents the final treatment width in band application equipment?

11. How is the impact of granular insecticides on wildlife reduced?

12. How is granular equipment prepared for storage?
