Application Equipment and Calibration

6

Pesticide Application Equipment and Sprayer Calibration

Aerial Pesticide Application

Pesticides that have specific instructions on the pesticide label for aerial application may be applied by aircraft (fixed wing or helicopters). Aerial applications must only be applied by properly trained individuals who hold a valid BC pesticide applicator's certificate.

The main advantages of aerial application are that it can be carried out quickly and at times when ground equipment cannot operate. The main disadvantages are the increased possibility of pesticide drift onto neighbouring areas and decreased spray coverage. Aerial applications should not be used for small acreages or in residential areas.

Ground Pesticide Application

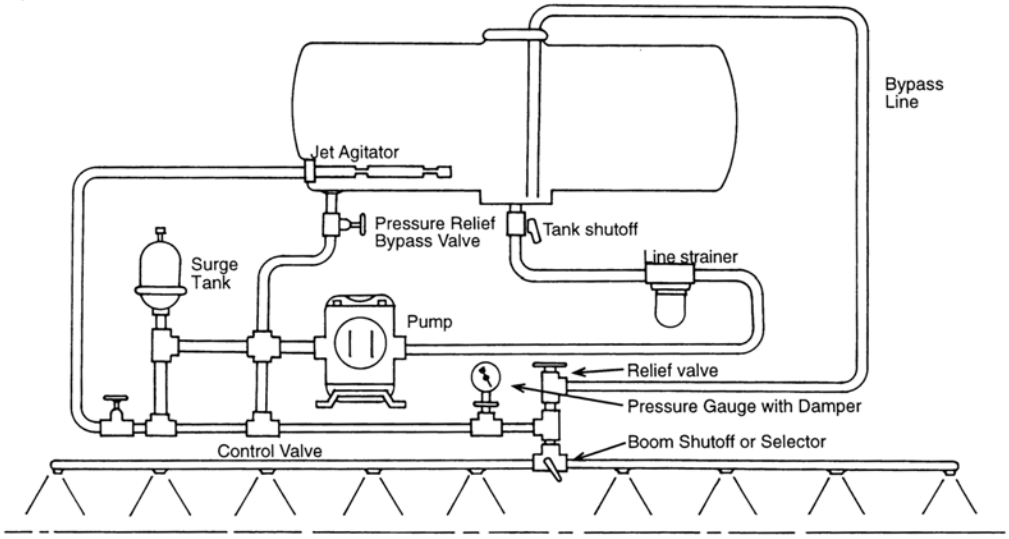
Most farms or ranches use ground-based equipment to apply pesticides. Hand operated or backpack sprayers are commonly used for spot treatments and areas difficult to reach with tractor drawn equipment. Motorized boom sprayers are used to apply pesticides to most field crops.

Operation of Sprayers

Essential components of any chemical spraying equipment are the power source, pump, tank and nozzles. Other components that must be considered are agitators, screens, filters, valves, pressure regulators, booms, hoses, and gauges.

The following diagram of field spraying equipment shows the relative location of the components. These locations can vary depending on the type of pump used.

Components of Field Spraying Equipment



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 on almost all types of sprayers. Choose a pump that has the characteristics required for the job. Common pumps include:

Roller Pump – abrasive formulations such as wettable powders (WP) will cause excessive wear; pressure range 0 – 300 psi

Centrifugal Pump – Can use abrasive formulations; pressure range 0 – 75 psi

Diaphragm pump – pressure range 0 – 850 psi

Piston Pump – Can use abrasive formulations; pressure range 0 – 1000 psi

The pump needs enough capacity to allow for sufficient pressure and flow at the nozzles, adequate bypass agitation and allowance for wear. Determine the capacity of the pump by taking the highest rate of application the sprayer is expected to deliver, add at least 1.5 % for agitation and another 25% for wear (40% for WP formulations). During operation, there should always be flow in the bypass line indicating the pump has sufficient capacity to send some excess to the tank.

Pumps specify the maximum rpm's it should be operated at. Always operate the tractor throttle so that the maximum is not exceeded. Be aware that increasing the pump's rpm will also increase its output. Therefore, the tractor's throttle setting must be fixed during calibration and sprayer operation. Operating at too low an rpm may decrease the pump's output below that required for the sprayer.

Tanks

The size of the spray tank depends on the intended application rate and the mounting space available. 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, fiberglass, polyethylene or aluminum. Fibreglass, stainless steel and polyethylene tanks are preferred because of their rust and corrosion resistance.

The herbicide active ingredient glyphosate and liquid nitrogen fertilizers must not be put in galvanized steel tanks, as a hazardous chemical reaction can result.

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 bypass 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. Mechanical agitation with paddles gives the best mixing for wettable powder formulations. If hydraulic agitation is used, 1/10 to 1/20 of the tank capacity should be recirculated per minute. This flow should be supplied from a separate pressure line, not from the relief valve bypass.

Tanks should be equipped with drains in the lowest part of the tank to allow complete emptying of the tank. Drains should be easy to operate to encourage operators to drain the tank at the end of each day. For proper mixing of pesticide dilutions it is important to know the volume capacity of the spray tank.

Required Pump Output =

$$\frac{[\text{sprayer width (m)} \times \text{forward speed (km/hr)} \times \text{application volume(l/ha)}]}{480} + \text{sprayer width (m)} \times 1.5$$

Hoses

Suction hoses (from the tank) should be reinforced so they will not collapse, be resistant to chemicals and oils, and be of the same diameter as the pump inlet hole. The same type of hose can be used for the bypass line.

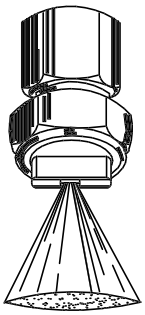
Hoses on the pressure side of the pump must be able to handle pressures higher than the intended use and preferably as high as the maximum pressure the pump can develop. To avoid excessive pressures on the hose, the relief or unloading valve should be released before flow to the boom is shut off.

Nozzles

The size of droplet produced by various nozzles depends upon operating pressures and nozzle design. The droplet size decreases with a higher pressure and with a smaller nozzle tip opening. Droplets that are too big give poor coverage and droplets that are too small drift easily.

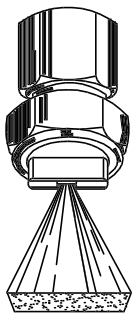
Types of nozzles

• **Flat spray nozzles.** (Also called fan type or TeeJets.) These are used for low-pressure spraying such as the application of herbicides and insecticide drenches. They produce a fan-type pattern with less material applied along the edges of the spray pattern (see figure). By properly overlapping the spray, a uniform application is produced across the spray boom. Offset flat spray nozzles at an angle of 10 degrees to the boom to prevent interference of the overlapping spray patterns. Nozzle spacing on the boom and the height of the boom above the target are critical to obtain a uniform application. Sprayer equipment suppliers and nozzle manufacturers' catalogues can advise growers as to the correct height of the boom at different nozzle spacing and for different nozzle spray angles. Do not operate these nozzles above 400 kPa (60 psi) to prevent excessive wear and fine spray droplets. Refer to manufacturer's specifications for recommended nozzle pressures. Flat spray nozzles are now available for an extended range of pressure (15 – 60 psi), with wider spray angles, with larger droplets (reduce drift), as flood jet nozzles (reduce drift & clogging) or as air induction spray tips (reduce drift). More information is available from your equipment dealer and nozzle catalog.



Flat spray nozzle

• **Even spray nozzle tips.** These produce an even spray pattern across the entire fan width (see figure right). These nozzles are used in band spraying of herbicides where there is no overlap from other nozzles. Align even spray nozzles with the spray boom. These nozzles are designed to operate at low pressures (less than 400 kPa or 60 psi). Refer to manufacturer's specifications for recommended nozzle pressures.

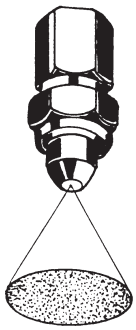


Even spray nozzle

Cone nozzle tips.

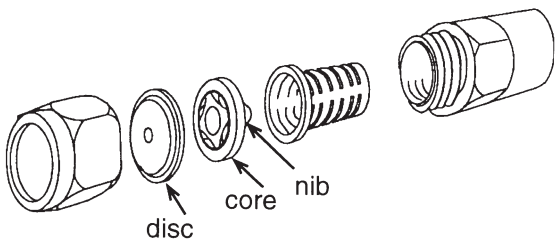
These are used for medium to high-pressure spraying (mostly fungicides and insecticides). These nozzles produce a good swirling mist so the spray material can reach the undersides of leaves. Nozzle spacing should allow the adjacent spray patterns to cover the entire target otherwise skips may occur. Cone nozzles 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 (see figure below).

Hollow cone nozzle



Solid cone nozzle

The cone nozzles most commonly used are two-piece disc-core nozzles that must be installed correctly with the rear nibs facing the nozzle body (see figure below).



Assembly of disc-core cone nozzles

Nozzle sizes

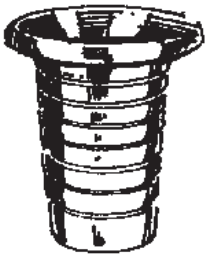
Various sizes of flat, even and cone nozzle tips may be used to obtain the volume of water desired. Consult with your sprayer equipment supplier or nozzle catalogue for information on nozzle outputs for the various nozzle sizes. Ask for a catalogue with nozzle outputs in litres per minute.

Nozzle tip materials

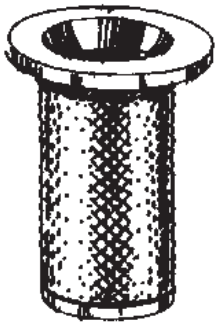
Nozzle tips are made from a variety of materials. Choice of material depends upon the abrasiveness of the spray mixture. Wettable powders are more abrasive than emulsions. Brass tips are cheap but the metal is softer and the tips wear faster. In increasing order of durability the following materials are used: plastic, brass, stainless steel, hardened stainless steel, ceramic and tungsten carbide. By making flat and even spray tips out of coloured plastic with a small amount of stainless steel or ceramic in the centre with the spray orifice, the more durable tips can be made at a very reasonable cost. These nozzles are more cost effective than nozzles made entirely of brass. As nozzle tips wear out, the rate of application increases. Tests have shown that some wettable powders wear nozzle tips sufficiently to increase the rate as much as 12% after spraying only 20 ha. For this reason, frequent calibration of equipment is necessary. Also, very worn nozzles should be replaced because their spray pattern is distorted and uneven application will result.

Screens

Screens prevent foreign material from entering the system, clogging the nozzles and wearing out the sprayer.



Slotted Strainer



Screen Strainer

Suction strainers, line strainers and nozzles should all be equipped with 50 mesh or coarser screens if wettable powders are to be used. Some pesticides may require coarser suction strainers. It may be necessary to have more than one suction strainer for the sprayer.

Screens finer than 50 mesh (100 mesh, for example) may plug with some wettable powders. Screens are generally used in fine nozzles, but slotted strainers can be used in those that have a larger opening. Consult the nozzle manufacturer's catalogue for recommendations on specific screen mesh sizes for specific nozzles. Generally for flat spray nozzles with small holes (TeeJet 80015 or smaller) a 100 mesh nozzle is recommended. Generally larger nozzles (TeeJet 8002 to 8008) should use a 50 mesh screen. Disc-core cone nozzles should normally be used with a slotted strainer equivalent to a 16 mesh screen (any Spraying Systems D3 or larger disc and No. 25 and larger core). A slotted strainer equivalent to a 25 mesh screen should be used with D2 discs.

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 screen. If the nozzle screens are plugging too often, check to make certain the chemicals are properly mixed, the spray tank and plumbing system are properly rinsed and cleaned between sprays, and that the suction and tank screens are in place when filling and using the sprayer. If the plugging problem persists, consider changing to an alternative pesticide formulation. Also check to see if a larger nozzle that has a larger recommended screen size can be used. Do not operate the sprayer without the recommended nozzle screens.

Mixing Chemicals

When mixing the chemical in the sprayer tank, **NEVER** put the chemical in first and then top with water. Always fill the tank 1/3 to 1/2 with clean water, start the agitator and then add the required quantity of chemical. Continue agitating while filling the tank.

For tank-mixes of two or more chemicals, first check the product label for compatibility information. Add the first chemical at the 1/3 to 1/2 full stage and the second chemical at the 2/3 to 3/4 full stage. Mixing by this method will ensure that the chemical is completely mixed in the water. To keep the chemical completely mixed keep the agitator on until you are finished spraying. Never turn off the hydraulic agitation to get enough pump pressure to spray – the chemical will not stay mixed in the water.

For best results, wettable powders should be pre-mixed 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.

Avoid Excess Pesticide in Tank

Avoid mixing surplus spray by carefully calculating rates, calibrating the sprayer and carefully measuring the area of fields to be treated. If too much is mixed, use that material according to label directions on another crop or site listed on the label. If no such area can be found, spray the mixture over an area on the property where it will cause no damage. Never re-spray the treated field with extra tank mix. Spraying an area twice will double the rate and may cause high residues in the crop or soil.

Sprayer Cleaning

Immediately after use, drain and collect any excess spray mixture. This excess material can be very difficult to dispose of properly. Sprayers must be properly calibrated to avoid any excess.

Flush the sprayer out with soapy water and rinse with clean water. Have a new drain installed if the current drain is hard to use. 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 pesticides 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:

1. Drain and collect any excess spray mixture from the tank.
2. Rinse tank, lines, screens, pumps and nozzles thoroughly with warm water.
3. Remove pressure chamber and line strainer and drain.
4. Fill tank with 100 L of warm water and then add one of the following:

   • 1.0 L household ammonia or Agri-Kleen; or

   • 500 g washing soda, lye or Nutrasol.
5. Spray out a small amount of solution and leave remainder in tank overnight.
6. 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 for 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 lines to prevent frost damage. Add light oil or antifreeze during the last rinsing to leave a protective coating on all parts.

Boom Sprayer Calibration

Calibration helps ensure good pest control. It also helps prevent crop damage from pesticides, high pesticide residues, and environmental contamination. Calibrate all application equipment to ensure a pesticide will be applied accurately and uniformly at the recommended rate. Calibration involves preparing the equipment so it is working properly, measuring the delivery rate, adjusting the equipment to change the delivery rate, and calculating how much pesticide to add to the sprayer tank. Calibrate equipment regularly (at least once per year) to make sure the output is not changing. Also calibrate equipment when it is new and when making changes that affect the delivery rate. Proper calibration will minimize, if not eliminate, left-over mixed pesticides in the sprayer tank which can be very difficult to properly dispose of.

There are four basic procedures to be carried out when calibrating sprayers. Details on these procedures are given below. (Also refer to the "Pesticide Applicator Course for Agricultural Producers".)

Use the "Calibration Worksheet" in this section to follow four basic procedures when applying pesticides to your crop.

1. Set-up
2. Measuring delivery rate
3. Adjusting delivery rate (if different from recommended rate)
4. Calculating how much pesticide to add to the spray tank

Set-Up

The goal of sprayer set-up is to set the sprayer up so that it will accurately apply the pesticide uniformly across the width of the boom and over the whole field. Set-up takes more time than all the other steps involved in calibration but is a key step to achieve uniform accurate application.

During sprayer set-up check that the sprayer nozzles, forward speed and spray pressure are correct for the pesticides that you will use, the weather and the crop conditions. Check the equipment to ensure all parts are in good condition and working properly (see the sprayer's operating manual). If you complete the "Calibration Worksheets" pages on Set-Up at the end of this section, you will have checked over the most important components of your sprayer. The worksheets have space to record the output of each individual nozzle, the pressure at the pressure gauge and at the boom, the swath width and other information needed to complete calibration.

You must choose which nozzles to use, nozzle pressure, tractor throttle setting and gear (forward speed) before you can move on to the second step in calibration, "Measuring Delivery Rate". The Forward Speed Calculations section on page 230 of the "Calibration Worksheet" gives formulas for checking the speed of your tractor gears. Having the speed of each gear used for spraying will help to make adjustments in the sprayer's delivery rate. To use the calibration formulas you must also determine your sprayer's swath width.

Selecting Spray Volume

Before calibrating your sprayer, you should know how much spray mixture should be sprayed in your field. The recommended amount of spray mixture (spray volume) can usually be found on the pesticide label or in this guide. The spray volume (and amount of water) will depend on crop, stage of growth, the pest, the pesticide, weather and soil conditions and the method of application. Canadian pesticide labels are all available on the internet at:

http://pr-rp.pmra-arla.gc.ca/portal/page?_pageid=34,17551&_dad=portal&_schema=PORTAL

For herbicides, water volumes range from 50 to 1000 L/ha (20 to 400 L/acre). Refer to the product

label for specific recommendations. Pesticide application rates and spray volumes for herbicides are normally given as a broadcast treatment as if the entire field is sprayed. However, in some crops such as corn, herbicides are often applied in bands along the rows spraying only a part of the field. Therefore, to spray only bands and not the entire field, the amount of area actually treated must be calculated to determine how much herbicide to add to the sprayer.

For fungicides and insecticides, volumes of 100 to 1000 L/ha (40 to 400 L/acre) are used. For foliar sprays, just enough water should be used to obtain thorough coverage of the leaves without run-off. Early in the season when growth is light, the smaller amounts of water may be adequate. In situations where foliage is dense and coverage is critical, at least 1000 L/ha (400 L/acre) of water should be used. For drenches (high-volume, low-pressure sprays directed to the soil for control of root maggots and other soil-borne pests), usually at least 2000 L/ha (800 L/acre) is used.

Use of drop pendants in some row crops will permit lower spray volumes and better coverage than a conventional straight boom. To maintain effective coverage of the foliage with lower spray volumes, finer droplets are required to cover the same area. Finer droplets will be more prone to drift in windy conditions. In hot dry weather low ambient relative humidity may cause the water in fine droplets to evaporate before the pesticide reaches the target. This is another cause of drift. Sprayer operators should carefully monitor the foliage including the lower stems and undersides of lower leaves to ensure thorough coverage. Water sensitive spray cards are available to assist in carrying out this task.

Selecting Nozzle Pressure

Herbicides are generally applied at low pressures (100 to 275 kPa) or (15 to 40 psi) to keep drift to a minimum. Do not use higher pressures unless they are specifically recommended. Some new nozzles are available which work over extended pressure ranges.

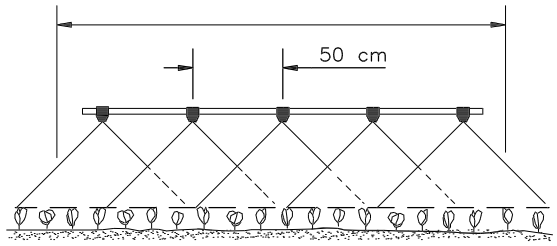
Insecticides and fungicides are applied at pressures up to 2000 kPa (300 psi) depending upon the pest to be controlled, the type of pesticide, and the density of the foliage. For non-systemic pesticides and high dense plant canopies, high nozzle pressures should be used to penetrate and cover the foliage. Systemic pesticides and plants with open canopies can be sprayed at lower nozzle pressures to avoid spray drift.

Many nozzle manufacturers have chosen to report nozzle outputs with pressures in “bars” not kilopascals (kPa). The bar unit is equal to 100 kPa. Pesticide labels report pressures in kPa. Use a pressure gauge on the sprayer marked in both psi and kPa (or bar) so both units can be read directly from the gauge. The maximum pressure on the pressure gauge should be twice the maximum spray pressure used to protect the gauge from damage and allow it to be read accurately.

Determine Sprayer Swath Width

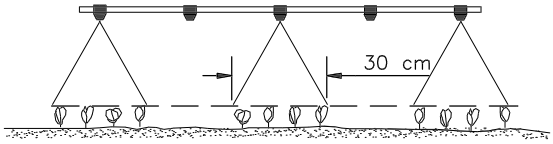
Swath width is the width of treated area over which spray droplets or granules are distributed in one pass of the applicator (see figures below). In a broadcast spray, it is the nozzle spacing multiplied by the number of nozzles. For band treatments it is the sum of the treated band widths. For row crops it is the row spacing (from center-to-center) multiplied by the number of rows covered with each pass of the sprayer. Swath width is usually measured in meters or feet. The swath with is used in sprayer calibration to calculate the sprayer’s delivery rate. As the sprayer swath width is based on the treated area, the delivery rate will also be based on the treated area when band spraying herbicides.

When using sprayers with wide booms for broadcast applications, use a suitable marking system to guide the tractor driver to avoid skips or overlaps with successive passes of the sprayer. When spraying in row crops, match the boom’s nozzle arrangement to the driving pattern. The sprayer boom may overlap the first pass when spraying the next strip or swath. Both skips and overlaps can be caused by not matching the nozzles on the boom to the driving pattern of the sprayer. With skips and overlaps, either pests will go uncontrolled or high spray residues can occur which may be dangerous to humans, plants and the environment. While spraying, the true swath width of the sprayer is determined by the driving pattern of the sprayer through the field.



Broadcast swath width

= # of nozzles x spacing
= 5 nozzles x 50 cm
= 250 cm
= 2.5 m



Band swath width

= # of bands x band width
= 3 bands x 30 cm
= 90 cm

Measuring Delivery Rate

There are two basic methods used to measure sprayer delivery rates — the test area method and the timed output method. Refer to Section 2 of the "Calibration Worksheet".

a) The test area method uses fewer calculations; however, it can take longer to carry out. If an entire acre or hectare is used as the test area, the measured discharge of water is the delivery rate per acre or hectare and no calculations are required. The most common problem with the test area method is measuring the amount of spray water discharged. If too small a test area is used the actual amount of water discharged is too small to accurately measure in the tank. At least 10% of the tank's volume should be discharged in the test. The tractor and sprayer tank should be parked in the exact same location and the water must settle in the tank after stopping, before measuring the tank level after spraying.

b) The timed output method can avoid these problems. Tables 17 and 18 will assist in undertaking a timed output calibration. By using both the test area and timed output method, the accuracy of your sprayer calibration can be checked.

Adjusting Delivery Rate

If the measured delivery rate of the sprayer is different than the spray volume listed on the pesticide label it can be adjusted in three ways: changing nozzle size (for large adjustments), changing forward speed, and changing spray pressure (only for small changes). Refer to Part 3 of the "Calibration Worksheet". After making the adjustments, measure the delivery rate again.

Calculating How Much Pesticide to Add to the Spray Tank

After the sprayer delivery rate is known, calculate how many acres can be sprayed by a full tank and how much pesticide to add to the spray tank. Formulas to use when spraying only a partial spray tank are in part 4 of the "Calibration Worksheet" at the end of this section. Be very careful to accurately measure the area to be covered by the last tank to minimize left over spray mixture in the tank when you are finished spraying.

Sprayer Calibration (Timed Output by Charts)

Example: A grower has set-up a 1200 L sprayer to spray a post-emergence pesticide on corn at the label rate of 550 g/ha using a spray volume of 100L/ha (40 L/acre). The corn is planted in 75 cm rows. The sprayer has a 33 nozzle boom with nozzles spaced at 50 cm which co vers 22 rows of corn (row-crop spacing). A 15 minute stationary operation of the sprayer discharged 400 L (measured from the tank calibration strip).

(a) Sprayer Set-up

Be sure to follow the sprayer set-up details in the "Calibration Worksheet", including measuring individual nozzle outputs.

To use the chart, the following data is taken from the above example:

Spray volume = 100L/ha

Number of nozzles = 33

Litres per 15 min. = 400

(b) Use chart to get travel speed

Start at the top left hand column of Table 17 and choose the 100 L/ha column. Go down the column until 400 (litres sprayed in 15 min.). Go across the row to the column that corresponds to the number of nozzles on the spray boom (33). The correct speed to travel is therefore 9.7 km/h.

(c) Test the forward speed

Refer to the speed chart Table 18. It should take 4 min. and 57 sec. to travel 800 m (1/2 mile).

Table 17. Timed Output Calibration Chart

LITRES PER 15 MINUTES TO APPLY		NUMBER OF NOZZLES - 50 cm SPACINGS												
50 L/ha	100 L/ha	22	24	26	27	30	33	34	35	36	37	41	42	49
70	140	5.1	--	--	--	--	--	--	--	--	--	--	--	--
80	160	5.8	5.3	4.9	--	--	--	--	--	--	--	--	--	--
90	180	6.5	6.0	5.5	5.3	4.8	--	--	--	--	--	--	--	--
100	200	7.3	6.7	6.2	5.9	5.3	4.8	--	--	--	--	--	--	--
110	220	8.0	7.3	6.8	6.5	5.9	5.3	5.2	5.0	4.9	--	--	--	--
120	240	8.7	8.0	7.4	7.1	6.4	5.8	5.6	5.5	5.3	5.2	--	--	--
130	260	9.5	8.7	8.0	7.7	6.9	6.3	6.1	5.9	5.8	5.6	5.1	5.0	--
140	280	10.2	9.3	8.6	8.3	7.5	6.8	6.6	6.4	6.2	6.1	5.5	5.3	--
150	300	10.9	10.0	9.2	8.9	8.0	7.3	7.1	6.9	6.7	6.5	5.9	5.7	4.9
160	320	11.6	10.7	9.8	9.5	8.5	7.7	7.5	7.3	7.1	6.9	6.2	6.1	5.2
170	340	--	11.3	10.5	10.1	9.1	8.2	8.0	7.8	7.6	7.4	6.6	6.5	5.5
180	360	--	12.0	11.1	10.7	9.6	8.7	8.5	8.2	8.0	7.8	7.0	6.9	5.9
190	380	--	--	11.7	11.3	10.1	9.2	8.9	8.7	8.4	8.2	7.4	7.2	6.2
200	400	--	--	--	11.9	10.7	9.7	9.4	9.2	8.9	8.6	7.8	7.6	6.5
210	420	--	--	--	--	11.2	10.2	9.9	9.6	9.3	9.1	8.2	8.0	6.9
220	440	--	--	--	--	11.7	10.7	10.4	10.1	9.8	9.5	8.6	8.4	7.2
230	460	--	--	--	--	--	11.1	10.8	10.5	10.2	9.9	9.0	8.8	7.5
240	480	--	--	--	--	--	11.6	11.3	11.0	10.7	10.4	9.4	9.1	7.9
250	500	--	--	--	--	--	--	11.8	11.4	11.1	10.8	9.8	9.5	8.2
260	520	--	--	--	--	--	--	--	11.9	11.6	11.2	10.1	9.9	8.5
270	540	--	--	--	--	--	--	--	--	12.0	11.7	10.5	10.3	8.8
280	560	--	--	--	--	--	--	--	--	--	--	10.9	10.7	9.1
290	580	--	--	--	--	--	--	--	--	--	--	11.3	11.0	9.5
300	600	--	--	--	--	--	--	--	--	--	--	11.7	11.4	9.8
310	620	--	--	--	--	--	--	--	--	--	--	--	11.8	10.1
320	640	--	--	--	--	--	--	--	--	--	--	--	--	10.5

For other application volumes or numbers of nozzles use this formula:

$$\text{Forward Speed (km/h)} = \frac{\text{(litres per 15 min) x 80}}{\text{(number of nozzles) x (desired application volume)}}$$

Example: Sprayer with 28 nozzles (50 cm spacing) uses 330 litres in 15 min.
Desired application volume is 150 L/ha.
Correct forward speed = $\frac{330 \times 80}{28 \times 150}$ = 6.3 km/h

Select the gear to give this speed. Drive the tractor with the sprayer half full across the field to get the right time. Adjust the throttle until the correct time (and speed) is reached. Adjust the pressure regulator to get the desired spray pressure (the same used for the 15 min. discharge). If the throttle setting is too low (for the pump) choose a lower gear and higher throttle setting then retest.

(d) Determine area covered by one full tank of spray?

Area = 1200 litre sprayer ÷ 100 L/ha = 12 ha

(e) How much pesticide must be added to a full tank of water?

Pesticide = 550g/ha x 12 ha/tank = 6600 g = 6.6 kg

Table 18. Speed Chart

Tractor speedometers are often inaccurate so the actual forward speed should be checked in the field using the following chart.

km/h	mph	*Time to Travel 800 m (1/2 mile)* (min:s)
5.0	3.1	9:36
5.2	3.2	9:14
5.4	3.4	8:52
5.6	3.5	8:34
5.8	3.6	8:17
6.0	3.8	8:00
6.2	3.7	7:44
6.4	4.0	7:30
6.6	4.1	7:16
6.8	4.2	7:04
7.0	4.4	6:52
7.2	4.5	6:40
7.4	4.6	6:29
7.6	4.7	6:19
7.8	4.8	6:09
8.0	5.0	6:00
8.2	5.1	5:51
8.4	5.2	5:43
8.6	5.3	5:35
8.8	5.5	5:27
9.0	5.6	5:20
9.2	5.7	5:13
9.4	5.8	5:07
9.6	6.0	5:00
9.8	6.1	4:54
10.0	6.2	4:48
10.2	6.3	4:43
10.4	6.5	4:38
10.6	6.6	4:32
10.8	6.7	4:27
11.0	6.8	4:22
11.2	7.0	4:17
11.4	7.1	4:13
11.6	7.2	4:08
11.8	7.3	4:04
12.0	7.5	4:00

Band Spraying Herbicide Within Crops

Herbicides are often sprayed either broadcast where the entire field is sprayed or in bands where only a part of the field is treated. The formulas used in calibration work for either broadcast or band treatment. For band treatments, the sprayer swath width is equal to the width of all the bands sprayed in one pass of the sprayer. This automatically adjusts for the partial coverage of the field in the calculations. Herbicide label rates are normally given as broadcast rates as if the entire field is treated so must be adjusted for band spraying.

Example: If you apply pesticide to 25 cm wide bands over corn rows that are 75 cm apart you're really spraying only one third of the field. Thus for every 1 hectare treated (bands sprayed), 3 hectares of corn field are covered. In this example, 1 hectare will be treated within the bands and 2 hectares will be untreated between the bands.

Do not apply the "broadcast rate" given on labels to one hectare of total crop area when you are actually band spraying. In the example given above, you would apply "3" times the herbicide that should be sprayed! The amount of herbicide and water (spray volume) sprayed within the bands (treated area) must be the same as the "label broadcast rate".

Calibrating Hand Operated Sprayers

Sprayer Set-up

Hand-operated sprayers should be checked to make sure there are no leaks, especially where the hose enters the tank and around the trigger valve. The nozzle should deliver a uniform spray pattern. Many nozzles can be adjusted to produce the desired droplet size. Adjust the nozzle to produce a coarse spray (larger droplets) for herbicides and medium to fine spray (smaller droplets) for insecticide and fungicide applications.

For uniform spray application it is important to maintain constant spray pressure and coordinate the walking speed with uniform back and forth movements of the nozzle. The back and forth movements determine the swath width.

Most pesticide labels give instructions as a specific amount of pesticide per unit area (e.g., apply 2.4 L/ha). Some pesticides like Roundup give directions to dilute an amount of pesticide in water and apply with thorough and complete coverage (e.g., Roundup –1 L of product in 100 L of water).

Measuring Delivery Rate

Application Rate Given as Amount of Pesticide per Acre

Measuring delivery rate of the hand-operated sprayer follows the same basic steps as with the tractor mounted boom sprayer but on a smaller scale. Remember during set-up of the sprayer that a steady walking speed and swath width must be used.

1. Mark out a measured length of test strip at least 60 feet long.
2. Fill the tank about half full with water and record the volume or level of water. Pump the tank to the pressure level that will be used.
3. Carefully spray the measured test strip while maintaining a steady forward speed and pumping action. Repeat enough runs over the test area until at least 10% of a full tank has been sprayed.
4. Measure the volume of water sprayed in the test strip by refilling the tank to the starting level.

Follow these steps to determine the application rate:

(a) **Calculate the test area:**

Test area (ft2) = strip length (ft) x swath width (ft) x # runs

(b) **Calculate the delivery rate:**

Delivery rate (L/acre) = water sprayed (L) ÷ test area (ft^2) x 43,560 ft^2/acre

Adjust the delivery rate as necessary by changing the walking speed.

(c) **Calculate the amount of area sprayed by a full tank:**

Area sprayed (by full tank) = tank volume (L) ÷ delivery rate (L/acre)

(d) **Calculate how much pesticide to add to the spray tank:**

Amount of pesticide to add to tank = application rate x area sprayed by one tank

Example: A grower wants to spray a herbicide on some weeds at a rate of 0.5 kg/400 L of water per acre. A test strip of 60 ft long and 3 ft wide is sprayed with one pass of water to measure delivery rate. To refill the spray tank 1.6 L of water is required. Determine the delivery rate, area sprayed by a full tank and the amount of pesticide to add to a 12 L tank.

Answer:

(a) **Test area:** = 60 ft x 3 ft x 1 run = 180 ft^2

(b) **Delivery Rate:** = 1.6 L ÷ 180 ft^2 x 43,560 ft^2/ acre = 387 L/acre

(c) **Area sprayed (by full tank):** = 12 L ÷ 387 L/acre = 0.0310 acre

(d) **How much pesticide to add to one tank:** = 0.5 kg/acre x 0.0310 acres = 0.0155 L = 15.5 mL

Application Rate Given as a Dilution with Water

When the application rate is given as a dilution rate, then the amount of pesticide to mix in a full tank can be calculated directly.

Example: A label recommends mixing 1 L of pesticide in 100 L of water and applying to foliage with thorough coverage. A 12-litre backpack will be used.

Answer:

The amount of pesticide to add to the tank can be calculated with the following formula: Amount of pesticide = label rate (product amount÷water volume) _ sprayer volume

Amount of pesticide = 1 L product ÷ 100 L water x 12 L tank = 0.12 L product/tank

If only a partial tank full (e.g. 8 L) of pesticide mix is required, use that figure as the "sprayer volume" input in the formula.

Also estimate how much spray mixture is needed so tank mix is not left over. Do this by applying water to a measured test area and determine the total mix needed. Use the same procedures that follow for pesticide application rates given as an amount of pesticide per unit area.

Calibrating Granular Applicators

Calibration of granular applicators involves the same first three steps as a boom sprayer:

1. Set-up.
2. Measuring delivery rate.
3. Adjusting delivery rate.

Granular pesticide formulations may be applied by broadcast, band or in-furrow methods. The in-furrow applications are different from most other pesticides as rates given as weight per length of row. There are several factors that can cause variation in output including: size of meter openings, roughness and slope of the field, forward speed, and granule flowability.

Set-up

Set-up includes inspecting the equipment to make sure it is cleaned, lubricated and operated properly according to the operator's manual. Set the equipment to the approximate settings to deliver the recommended application rate.

Swath width on tractor mounted spinning disc and oscillating spout spreaders will depend on the PTO (and engine) RPM. Proper spreading width, overlap of tapered patterns and swath width will require several test runs to determine settings that will work in your field.

Pneumatic spreaders which use air to carry the granules through hoses to individual distributing nozzles will drop the granules directly over the target. On a smaller scale, gravity drop granular pesticide applicators are available with in-furrow applications or with distributing nozzles for broadcast applications.

Measuring Delivery Rate

Delivery rate is generally determined by measuring the amount of granules discharged while the applicator is run over a test area or test length for in-furrow applications. It is usually necessary to capture the output and weigh it.

- Mark out a measured test strip at least 60 m or 200 ft long.
- Fill the applicator hopper(s) about half full of granules.
- Choose a tractor gear and throttle setting.
- Attach bags or other containers under each downspout to catch the granules during calibration. For granular equipment that uses air flow for distribution, either use porous mesh bags (e.g. nylons) or shut off the air flow and catch the granules from directly under the metering device.
- Drive towards the first stake at the correct speed and discharge granules over the test strip only.
- Repeat until enough granules are discharged to allow for accurate weights to be measured. Record the number of runs.
- Weigh the granules from each bag or container and record the amounts. Compare the individual weights for uniformity across the swath. If outputs are uniform, then add them together. Otherwise, make adjustments and retest.

Determine the delivery rate using the following formula:

Delivery rate (kg/acre) = amount collected in test (kg) x 43,560 (ft^2) ÷ test area (ft^2)

Adjusting Delivery Rate

Increase the meter opening to discharge more granules or decrease the meter opening to discharge less granules and retest.

CALIBRATION WORKSHEET

- BOOM SPRAYER -

Follow this step-by-step procedure to calibrate a sprayer. All liquid volumes are in litres (L), but you can use either metric or imperial units for distance and area (don't mix them). Circle the units used such as 500 (L/ha) L/acre

After you've finished calibrating your equipment, write key data in the box to the right for future reference.

Use the Pesticide Use Calculation worksheet to find the area sprayed by a full tank, and to calculate how much of each pesticide you'll need to buy and add to each tank.

Measured delivery rate	_____ L/ha *L/acre*
Area sprayed by a full tank	_____ ha *acre*
Tractor gear	_____
Throttle	_____ rpm
Forward speed (if Timed Output)	_____ km/h *mph*
Nozzles	_____
Regulator Pressure	_____ kPa(psi)
Date	_____

1. SET-UP

Inspection Before Sprayer Start-Up ☑

- ❑ Tank size is _____ L
- ❑ Calibration strip or dipstick for tank?
- ❑ Tire size & pressures okay? *(Record on p 7)*
- ❑ Hoses in good condition?

Filler opening screen
- ❑ in place? clean? good repair?
- ❑ mesh size correct? _____

Suction screen
- ❑ in place? clean? good repair?
- ❑ mesh size correct? _____

Nozzle screens (check each one)
- ❑ in place? clean? good repair?
- ❑ mesh size correct? _____

Inspection with Sprayer Running ☑

Fill the tank more than half full with clean water.
- ❑ start sprayer pump & run tractor throttle at _____ rpm.
  note pump's maximum rpm is _____.
- ❑ open boom valve to fill lines and begin spraying
- ❑ clean nozzles producing distorted patterns and retest
- ❑ throw out damaged nozzles and replace them

Check and fix any problems
- ❑ leaks?
- ❑ valves working?

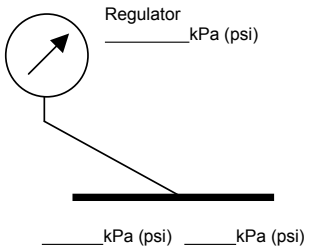
Nozzles:
- ❑ nozzle type okay?
- ❑ all same size/ID#? (record in box above)
- ❑ correct nozzle spacing of _____ cm *(in)*
- ❑ nozzles spaced evenly?
- ❑ clean? not worn?
- ❑ aligned?
- ❑ are there nozzle check valves?

Boom height
- ❑ above target? _____ cm *(in)*
- ❑ is boom level?

Surge tank (piston & diaphragm pumps only)
- ❑ working properly?
- ❑ air pressure correct at _____ kPa*(psi)*

- ❑ agitation okay?
- ❑ bypass flow okay?
- ❑ adjust pressure regulator to get right spray pressure at the nozzles

Measure pressure at regulator and nozzles along boom. Draw extensions of the boom as necessary.

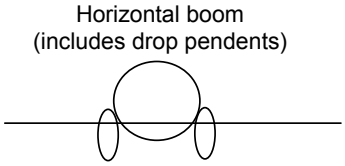


- ❑ Pressure gauge working?
- ❑ Pressure drop less than 10%

Measuring Nozzle Output

Draw nozzle locations on the diagram below and number them to identify which ones may need to be cleaned or replaced after testing. As the sprayer runs, collect and record the output for a set time e.g. 1 minute, 30 sec or 15 sec. Measure in litres.

Nozzle pressure is _____ kPa (psi)



Nozzle Output Litres per __sec		Nozzle Output Litres per __sec	
1.	_____L	26.	_____L
2.	_____L	27.	_____L
3.	_____L	28.	_____L
4.	_____L	29.	_____L
5.	_____L	30.	_____L
6.	_____L	31.	_____L
7.	_____L	32.	_____L
8.	_____L	33.	_____L
9.	_____L	34.	_____L
10.	_____L	35.	_____L
11.	_____L	36.	_____L
12.	_____L	37.	_____L
13.	_____L	38.	_____L
14.	_____L	39.	_____L
15.	_____L	40.	_____L
16.	_____L	41.	_____L
17.	_____L	42.	_____L
18.	_____L	43.	_____L
19.	_____L	44.	_____L
20.	_____L	45.	_____L
21.	_____L	46.	_____L
22.	_____L	47.	_____L
23.	_____L	48.	_____L
24.	_____L	49.	_____L
25.	_____L	50.	_____L
	Total Output		_____L

1. In the box below, divide Total Output in L by the number of nozzles to find the average output per nozzle for collection time.

Total Output Collected	÷	**# of nozzles**	=	**Average Output Collected**
L	÷	noz.	=	L

2. For uniformity, find the maximum and minimum acceptable output (5% more or less than average.) Replace nozzles if above maximum output or below minimum output.

Minimum Output	=	0.95	x	_____Average Output	=	_____L
Maximum Output	=	1.05	x	_____Average Output	=	_____L

3. Replace all nozzles if average output is 15% more than a new nozzle's output (from manufacturer's chart or discharge test).

Average Output per Collection	÷	**Collection Time**	x	**Conversion**	=	**Average Output**
L	÷	sec	x	60 sec/min	=	L/min

New Nozzle Output	x	**Constant**	=	**Maximum Average Output**
L/min	x	1.15	=	L/min

Swath Width Do only ONE of these. You'll use the swath width on the next page.

Broadcast swath: *multiply number of nozzles by nozzle spacing; convert to metres or feet*

# nozzles	x	spacing	÷	conversion	=	**swath width**
noz.	x	cm	÷	100 cm/m	=	m
noz.	x	*in*	÷	*12 in/ft*	=	*ft*

Band swath: multiply number of bands by width of each band; convert to metres or feet

# bands	x	band width	÷	conversion	=	**swath width**
bands	x	cm	÷	100 cm/m	=	m
bands	x	*in*	÷	*12 in/ft*	=	*ft*

Row crop swath: multiply number of rows by width of each row. (Note: rows are stated in metres or feet, so no conversion is needed).

# rows	x	row width	=	**swath width**
rows	x	m	=	m
rows	x	*ft*	=	*ft*

2. MEASURING DELIVERY RATE

You can use either of these methods to determine the actual delivery rate of the sprayer.

Test Area method

1. Mark out a test strip at least 60 m or 200 *ft* long. Your strip was _____ m *(ft)* long.
   Note: A one acre test strip is = 43,560 ft^2 ÷ _____*ft* (swath width) = _____*ft*. long.
2. Fill the tank about half full with water and start sprayer nozzles and agitation. Then set the pressure to what you want. Use the same throttle RPM you'll use in the field. Pressure _____kPa *(psi)*
3. Choose a tractor gear to get desired forward speed. Gear _____ Throttle _____rpm (as in Step 2 above)
4. Record the volume of water in the tank before the test: _____L. Mark where the sprayer is parked so you can return it to the same position to measure water sprayed (level ground is best).
5. Drive towards the first stake at the correct speed, and open the boom valve as you pass it. Check the sprayer pressure. Close the boom valve as you pass the second stake.
6. Repeat until at least 10% of a full tank is sprayed. Record the number of runs (_____runs).
7. Return to the water filling site and park in the same location as in Step 4. Measure the amount of water remaining: _____L. Number of litres discharged during the test was _____L.
8. Calculate the test area. Multiply the strip length by your swath width by the number of runs.

strip length	x	swath width	x	# runs	=	**test area**
m	x	m	x	runs	=	m^2
ft	*x*	***ft***	*x*	***runs***	=	***ft^2***

9. Calculate the Delivery Rate. Divide water sprayed (L) by test area (m^2 or ft^2).

water sprayed	÷	test area	x	conversion	=	**delivery rate**
L	÷	m^2	x	10,000 m^2/ha	=	L/ha
L	÷	***ft^2***	*x*	***43,560 ft^2/acre***	=	***L/acre***

(L/ha=2.5 times L/acre L/acre=0.4 times L/ha)

Timed Output method

1. Measure the forward speed of your tractor and sprayer with a half tank of water in field conditions. (Tractor speedometers need to be checked for accuracy, see page 7.) ___ km/h *(mph)*
2. Measure total nozzle output by spraying for a set time (such as 10 min) and divide volume (L) by time to find total output (L/min) OR use total nozzle output (L/min) from page 2.

   Tank volume at start _____L Tank Volume at finish _____L Discharge time_____min.

   Discharge volume (start-finish) = _____L

   Total nozzle output = (Discharged Volume ÷ Time) = _____L ÷ _____min. = _____L/min.
3. Calculate the Delivery Rate. Divide total output by forward speed and swath width and multiply by a constant.

total nozzle output	÷	forward speed	÷	swath width	x	constant	=	**delivery rate**
L/min	÷	km/h	÷	m	x	600	=	L/ha
L/min	÷	*mph*	÷	*ft*	x	495	=	*L/acre*

(L/ha=2.5 times L/acre L/acre=0.4 times L/ha)

3. ADJUSTING DELIVERY RATE

If the Delivery Rate of your sprayer is different than the rate listed on the pesticide label or recommended in the production guide, it can be adjusted in three ways:

1. **Nozzle size** should be changed if you wish to make large changes in delivery rate. Check with your nozzle supplier or agricultural advisor. Obtain a catalogue listing nozzles and nozzle outputs.
   The following formula can also be used to find nozzle size.

delivery rate	x	forward speed	x	nozzle spacing	÷	constant	=	**nozzle output**
L/ha	x	km/h	x	cm	÷	60,000	=	L/min
L/acre	x	*mph*	x	*in*	÷	5940	=	*L/min*

List your nozzle options by referring to a manufacturer's catalogue.

Nozzle Size					
Nozzle Pressure kPa(psi)					
Nozzle Output L/min					
Forward Speed km/h *(mph)*					
Delivery Rate L/ha *(L/acre)*					

2. **Forward speed** changes will adjust the delivery rate. Slower speeds increase the amount sprayed in a field, and faster speeds reduce it. If your delivery rate is 112L/acre at 6 mph, then by halving your speed to 3 mph you'll double the delivery rate to 224 L/acre.

Use these formulas to calculate alternative combinations of delivery rates and speeds

present forward speed	x	present delivery rate	÷	new forward speed	=	**new delivery rate**
km/h	x	L/min	÷	km/h	=	L/min
mph	x	*L/min*	÷	*mph*	=	*L/min*

Speed changes are usually made by using a different gear in order to keep tractor RPMs within the range recommended for the sprayer pump.

present forward speed	x	present delivery rate	÷	new delivery rate	=	**new forward speed**
km/h	x	L/min	÷	L/min	=	km/h
mph	x	*L/min*	÷	*L/min*	=	*mph*

When you have chosen a new gear, check with your nozzle supplier on which nozzle to use or calculate the new nozzle output (same formula as Step 1).

delivery rate	x	forward speed	x	nozzle spacing	÷	constant	=	**new nozzle output**
L/ha	x	km/h	x	cm	÷	60,000	=	L/min
L/acre	x	*mph*	x	*in*	÷	5940	=	*L/min*

3. **Spray pressure should be set for the correct droplet size.** Changing pressure is recommended only for very small changes in delivery rates. Otherwise your droplet size will change and cause drift or runoff problems. Since pressure must be increased four times to double the delivery rate, this is not a good way to adjust delivery rate.

After making the adjustments, measure the delivery rate again. Fill in a new Calibration Worksheet.

When your equipment is accurately calibrated and applying the desired delivery rate, then you are ready to spray. Use one of the next two pages to determine how much pesticide to buy and how much pesticide to add to a full or partial tank. Choose page 5 if the pesticide is given in a per area rate, otherwise use page 6.

4.A CALCULATING HOW MUCH PESTICIDE TO ADD TO A SPRAY TANK – PER AREA RATE

Example: Pesticide Labels read: "use 3L/ha in 1000L of water" or "use 3L/1000L of water/ha". (Otherwise see page 6.)

Pesticide _____ Pest _____ Crop _____ Date _____

Fill in values for only one column – hectares or *acres*. Use only hectares or only *acres*; don't mix them.
Use litres (L) for all liquid volumes. Use the *italicized* line if you are using *acres*.

Field area	_____ ha	_____ *acres* (hectares = 0.4 x *acres*)
Spray tank capacity	_____ L	_____*L* (L = 3.79 x US gal. L = 4.55 x Imperial gal.)
Pesticide label application rate	_____ kg or L/ha	_____ *kg or L/acre* (*L/acre* = 0.4 x L/ha)
Spray volume	_____ L/ha	_____ *L/acre* (from label or production guide or field test)

Check your Calibration Worksheets and choose a suitable sprayer setup and Sprayer Delivery Rate

Sprayer Delivery Rate	_____ L/ha	_____ *L/acre* (*L/acre* = 0.4 x L/ha)

Copy values into the formulas below where needed.

	field area	x	pesticide label application rate	x	# of applications per year	=	**pesticide to buy**
How much pesticide to buy?	ha	x	kg or L/ha	x		=	kg or L
	acres	*x*	***kg or L/acres***	*x*		=	*kg or L*

Full tank

	tank capacity	÷	sprayer delivery rate	=	**area covered**
Area covered by a full tank?	L	÷	L/ha	=	ha/tank
	L	÷	***L/acre***	=	***acres/tank***

	pesticide label application rate	x	area covered by a full tank	=	**pesticide to add**
How much pesticide to add to a full tank?	kg or L/ha	x	ha/tank	=	kg or L
	kg or L/acre	*x*	***acres/tank***	=	*kg or L*

	field area	÷	area covered by a full tank	=	**tankfuls required**
Number of tankfuls required for area?	ha	÷	ha/tank	=	tanks
	acre	÷	***acres/tank***	=	***tanks***

Partial tank Measure the area to be sprayed by the last tank accurately to avoid mixing too much spray.

	sprayer delivery rate	x	area remaining	=	**spray mix to make in partial tank**
How much spray mix to make for a partial tank?	L/ha	x	ha	=	L
	L/acre	*x*	***acres***	=	***L***

	pesticide label application rate	x	area remaining	=	**pesticide to add to partial tank**
How much pesticide to add to a partial tank?	kg or L/ha	x	ha	=	kg or L
	kg or L/acre	x	*acres*	=	*kg or L*

4.B CALCULATING HOW MUCH PESTICIDE TO ADD TO A SPRAY TANK – PER DILUTION RATE

Example: Pesticide Label reads: "use 1L/100L of water and spray foliage thoroughly". (Otherwise see page 5.)

Pesticide _____ Pest _____ Crop _____ Date _____

Fill in values for only one column – hectares or *acres*. Use only hectares or only *acres*; don't mix them.

Use litres (L) for all liquid volumes. Use the *italicized* line if you are using *acres*.

Field area	_____ ha	_____ *acres* (hectares = 0.4 x *acres*)
Spray tank capacity	_____ L	_____*L* (L = 3.79 x US gal. L = 4.55 x Imperial gal.)
Pesticide label application rate	_____ kg or L/1000L of water (may be another amount of water)	
Spray volume	_____ L/ha	_____ *L/acre* (from label, production guide or field test)

Check your Calibration Worksheets and choose a suitable sprayer setup and Sprayer Delivery Rate

Sprayer Delivery Rate	_____ L/ha	_____ *L/acre* (*L/acre* = 0.4 x L/ha)

Copy values into the formulas below where needed.

How much pesticide to buy?

field area	x	pesticide label dilution rate	x	sprayer delivery rate	x	# of applications per year	=	**pesticide to buy**
ha	x	kg or L/1000L	x	L/ha	x		=	kg or L
acres	*x*	***kg or L/1000L***	*x*	***L/acre***	*x*		=	*kg or L*

Full tank

	tank capacity	÷	sprayer delivery rate	=	**area covered**
Area covered by a full tank?	L	÷	L/ha	=	ha/tank
	L	÷	***L/acre***	=	***acres/tank***

	pesticide label dilution rate	x	Tank capacity	=	**pesticide to add**
How much pesticide to add to a full tank?	kg or L/1000L	x	L	=	kg or L
	kg or L/1000L	x	***L***	=	*kg or L*

	field area	÷	area covered by a full tank	=	**tankfuls required**
Number of tankfuls required for area?	ha	÷	ha/tank	=	tanks
	acre	÷	***acre/tank***	=	***tanks***

Partial tank

Measure the area to be sprayed by the last tank accurately to avoid mixing too much spray.

	sprayer delivery rate	x	area remaining	=	**spray mix to make in partial tank**
How much spray mix to make for a partial tank?	L/ha	x	ha	=	L
	L/acre	x	***acre***	=	***L***

	pesticide label dilution rate	x	spray mix in partial tank	=	**pesticide to add to partial tank**
How much pesticide to add to a partial tank?	kg or L/1000L	x	L	=	kg or L
	kg or L/1000L	x	***L***	=	*kg or L*

FORWARD SPEED CALCULATIONS

Date: _____

Calculate the forward speed of your tractor and sprayer in field conditions encountered during spraying. If you change tires, tire pressures, or tire lugs wear significantly, speeds will change. Also speeds will change between dry and very wet field conditions.

1. Mark out a test strip at least 60 m or 200 *ft* long.
2. Fill the tank about half full with water and move to the test strip.
3. Choose the tractor gear and throttle for the forward speed you want. Gear _____ Throttle _____rpm. Use the same throttle RPM when measuring nozzle output (Step 7).
4. Measure the time in seconds required to pass through the test strip on four runs. Reach the desired speed *before* entering the test strip, and hold that speed constant throughout the test run.

   1st run ____ + 2nd run ____ + 3rd run _____ + 4th run _____ = _____ seconds total time.
5. Calculate total distance travelled. Multiply test strip length (Step 1) by the number of runs. Your strip was _____ m(*ft*) long x _____ runs = _____ m(*ft*) total distance.
6. Calculate forward speed using the formula in the box at right.

total distance	÷	total time	x	constant	=	**forward speed**
m	÷	sec	x	3.6	=	km/h
ft	÷	sec	x	0.68	=	*mph*

Tractor #1 _____ Tire Size _____ Tire Pressure _____

Gear						
Throttle	rpm					
Time	sec					
Total distance	in *(ft)*					
Forward speed	km/h *(mph)*					

Tractor #2 _____ Tire Size _____ Tire Pressure _____

Gear						
Throttle	rpm					
Time	sec					
Total distance	in *(ft)*					
Forward speed	km/h *(mph)*					

SPRAYER SETUP SUMMARY

Sprayer ____________________ **Tractor** ____________________ **Date** ______________________

Sprayer Setup #

Measured (calculated) Delivery Rate ______L/acre
_________US gal/acre
Tank Volume _________L ____________US gal
Area Sprayed by a Full Tank ____________
Tractor Gear _________throttle ________rpm
Forward Speed ______mph ___________km/hr
# of Nozzles _________swath width _______ ft
Nozzle (size/type) _______________________
Pressure @ Regulator ____@ nozzles______

Sprayer Setup #

Measured (calculated) Delivery Rate ______L/acre
_________US gal/acre
Tank Volume _________L ____________US gal
Area Sprayed by a Full Tank ____________
Tractor Gear _________throttle ________rpm
Forward Speed ______mph ___________km/hr
# of Nozzles _________swath width _______ ft
Nozzle (size/type) _______________________
Pressure @ Regulator ____@ nozzles______

Sprayer Setup #

Measured (calculated) Delivery Rate ______L/acre
_________US gal/acre
Tank Volume _________L ____________US gal
Area Sprayed by a Full Tank ____________
Tractor Gear _________throttle ________rpm
Forward Speed ______mph ___________km/hr
# of Nozzles _________swath width _______ ft
Nozzle (size/type) _______________________
Pressure @ Regulator ____@ nozzles______

Sprayer Setup #

Measured (calculated) Delivery Rate ______L/acre
_________US gal/acre
Tank Volume _________L ____________US gal
Area Sprayed by a Full Tank ____________
Tractor Gear _________throttle ________rpm
Forward Speed ______mph ___________km/hr
# of Nozzles _________swath width _______ ft
Nozzle (size/type) _______________________
Pressure @ Regulator ____@ nozzles______

Sprayer Setup #

Measured (calculated) Delivery Rate ______L/acre
_________US gal/acre
Tank Volume _________L ____________US gal
Area Sprayed by a Full Tank ____________
Tractor Gear _________throttle ________rpm
Forward Speed ______mph ___________km/hr
# of Nozzles _________swath width _______ ft
Nozzle (size/type) _______________________
Pressure @ Regulator ____@ nozzles______

Sprayer Setup #

Measured (calculated) Delivery Rate ______L/acre
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Tank Volume _________L ____________US gal
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Tractor Gear _________throttle ________rpm
Forward Speed ______mph ___________km/hr
# of Nozzles _________swath width _______ ft
Nozzle (size/type) _______________________
Pressure @ Regulator ____@ nozzles______