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 these four 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

During sprayer set-up check that the sprayer nozzles, forward speed and spray pressure are correct for the applied pesticide, 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). The sprayer must apply the pesticide uniformly across the width of the boom and over the whole field.

The proper set-up of a sprayer will take more time than all the other steps involved in calibration. The "Calibration Worksheets" at the end of this section give a thorough checklist to use for your sprayer set-up.

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 last page 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.

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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 300 to 1000 L/ha (120 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, 300 L/ha (120 L/acre) 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 tall leafy 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

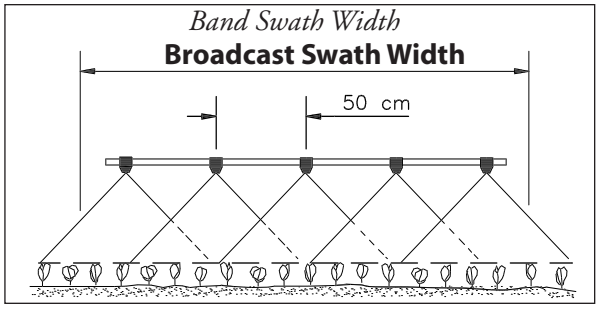
Herbicides are generally applied at low pressures (100 to 275 kPa) or (15 to 40 psi) to keep drift to a minimum. Do not use higher pressures unless they are specifically recommended. Some new nozzles are available which work over extended pressure ranges.

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 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, and 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. When crops are grown in beds, usually the plant canopy covers the whole field area. The sprayer swath width is the bed spacing (from center to center of wheel tracks) multiplied by the number of beds.



Broadcast swath width

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

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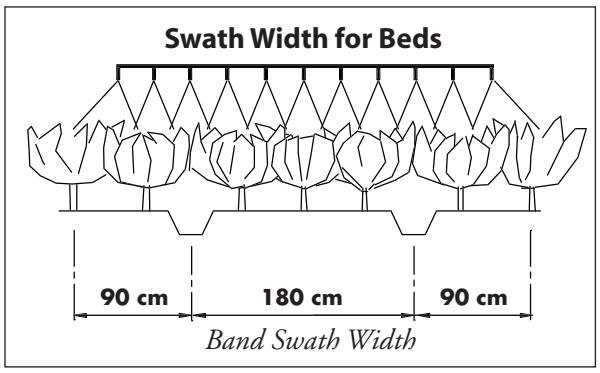
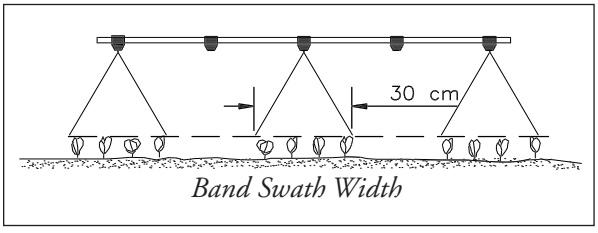
Swath width is usually measured in meters or feet. The swath width is used in sprayer calibration to calculate the sprayer's delivery rate. As the sprayer swath width is based on the treated area, the delivery rate will also be based on the treated area when band spraying herbicides.



Band Swath Width

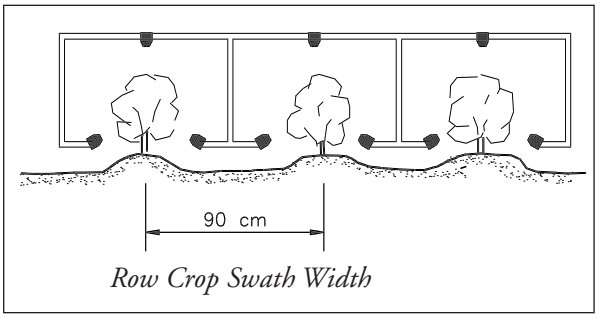
Broadcast swath width
= # of beds x bed width
*= 2 * x 180 cm*
= 360 cm
= 3.6 m

**Note: no. of beds = 1/2 bed + 1 bed + 1/2 bed*
= 2 beds



Band Swath Width

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



Row Crop Swath Width

= 0.9 m

Row Crop swath width
= # of rows x row width
= 3 rows x 90 cm
= 270 cm
= 2.7 m

When sprayers are set-up during calibration, check to make sure that the driving pattern used in spraying does not cause skips — areas of the field not sprayed between successive passes of the sprayer. The sprayer boom may also 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. Sometimes different nozzles are needed at the end of the boom when spraying beds or row crops to get a uniform spray coverage of the crop. 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.*

Measuring Delivery Rate

There are two basic methods used to measure sprayer delivery rates — the test area method and the timed output method.

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 or it is not covered with enough passes 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, however it will require more calculations. By using both the test area and timed output method, the accuracy of your sprayer calibration can be checked.

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Adjusting Delivery Rate

If the measured delivery rate of the sprayer is different than the spray volume 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 large changes in delivery rate are needed. Check with the nozzle supplier or agricultural advisor. Obtain a catalogue listing nozzles and nozzle outputs in litres per minute (L/min). Some of these are given in Sprayer Equipment section of this guide (see Tables 1 and 2).
2. Forward speed changes will adjust the delivery rate. Slower speeds increase the amount sprayed in a field, and faster speeds reduce the amount. If the delivery rate is 112 L/acre at 6 mph, then by halving the speed to 3 mph, the delivery rate is doubled to 224 L/acre.

   Speed changes are usually made by using a different gear in order to keep tractor RPM's and spray pressure constant and within the range recommended for the sprayer pump.
3. Spray pressure should be set for the correct droplet size. Changing pressure is recommended only for very small changes in delivery rates. Otherwise the 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.

Calculating How Much Pesticide to Add to the Spray Tank

When the sprayer delivery rate is known, then 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 also given in 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.

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Calibration Worksheet Examples

Refer to the "Calibration Worksheet" (Boom Sprayers) at the back of this section when working through the following examples.

Example 1: Sprayer Calibration (Hectares)

A grower has setup a 1000 L sprayer to spray potatoes with a fungicide at the recommended rate of 2.5 kg/ha in 500 L/ha of water to control late blight. The sprayer boom uses nozzles spaced at 30 cm and covers 6 rows spaced at 90 cm apart. After spraying a 100 m test strip with four runs (to discharge enough water from the spray tank to accurately measure it), 105 L of water were required to refill the tank.

(a) What is the sprayer swath width?

From *Calibration Worksheet under Set-up – Swath Width,* (page 11):

Row crop swath width = 6 rows × 90 cm = 5.40 m
Note: row width = 90 cm = 0.90 m

(b) What is the delivery rate (litres per hectare) of the sprayer ?

Follow Steps 1 - 8, *Measuring Delivery Rate –Test Area Method*, from the Calibration Worksheet (page 12):

Test area = 100 m × 5.4 m × 4 runs
= 2160 m^2

Follow Step 9, *Measuring Delivery Rate – Test Area Method*, from the Calibration Worksheet, (page 12):

Delivery rate = 105 L ÷ 2160 m^2 × 10,000 m^2/ha = 486 L/ha

The sprayer is operating at a delivery rate of 486 L/ha. The delivery rate is close enough to the desired spray volume of 500 L/ha. Use the delivery rate of 486 L/ha when calculating how much pesticide to add to the tank.

(c) How many hectares will be covered with one full tank of spray?

Follow *Calculating How Much Pesticide to Add to the Tank - Full Tank*, from the Calibration Worksheet, (page 15):

Area = 1000 L ÷ 486 L/ha = 2.06 ha

One full tank of spray will cover 2.06 ha.

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

Follow *Calculating How Much Pesticide to Add to the Tank - Full Tank*, from the Calibration Worksheet, (page 15):

Pesticide = 2.5 kg/ha × 2.06 ha = 5.15 L

Add 5.15 L of pesticide to make one full sprayer tank of spray mixture.

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Example 2: Sprayer Calibration (Acres)

A grower has set-up a 1200 L sprayer to spray broccoli with a pesticide to control aphids at the label rate of 440 mL/acre. The grower chooses an approximate 400 L/acre delivery rate for thorough coverage. The broccoli is planted in beds 72 in. wide (72 in. center to center of wheel tracks). There are three rows of broccoli planted in the bed and have grown a full leaf canopy filling the bed. The sprayer has nozzles spaced 12 in. apart covering 5 beds. After spraying a 330 ft test strip with two passes (to discharge enough water from the spray tank to accurately measure it), 130 L of water were required to refill the tank.

(a) What is the sprayer swath width?

From *Calibration Worksheet under Set-up – Swath Width,* (page 11):

Row crop swath width
= 5 beds × 6 ft. = 30 ft.
Note: row width = 72 in = 6 ft.

(b) What is the delivery rate (litres per acre) of spray applied?

Follow Steps 1 - 8, *Measuring Delivery Rate - Test Area Method*, from the Calibration Worksheet, (page 12):

Test area = 330 ft × 30 ft × 2 runs = 19,800 ft^2

Follow Step 9, *Measuring Delivery Rate - Test Area Method*, from the Calibration Worksheet (page 12):

Delivery Rate
= 130 L ÷ 19,800 ft^2 × 43,560 ft^2 /acre
= 286 L/acre

The sprayer is operating at a delivery rate of 286 L/acre. This is too low. The grower choses a larger nozzle size and retests using 175 L of water resulting in a 385 L/acre delivery rate. The grower decides this is close enough to the 400 L/acre target spray volume.

(c) How many acres will be covered with one full tank of spray?

Follow *Calculating How Much Pesticide to Add to the Tank - Full Tank*, from the Calibration Worksheet, (page 15):

Area = 1200 L ÷ 385 L/acre
= 3.12 acres

One full tank of spray will cover 3.12 acres.

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

Follow *Calculating How Much Pesticide to Add to the Tank - Full Tank*, from the Calibration Worksheet, (page 15):

Pesticide = 440 mL/acre × 3.12 acres = 1372.8 mL = 1.37 L

Add 1.37 L of pesticide to make one full sprayer tank of spray mixture.

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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).

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 × 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.

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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 (ft^2) = strip length (ft) × swath width (ft) × # runs

(b) Calculate the delivery rate:

Delivery rate (L/acre) = water sprayed (L) ÷ test area (ft^2) × 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 × 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 × 3 ft × 1 run = 180 ft^2

(b) Delivery Rate: = 1.6 L ÷ 180 ft^2 × 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 × 0.0310 acres = 0.0155 L = 15.5 mL

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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 operators 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.

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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 at right for future reference.**

Use the pesticide worksheet on pages 15 and 16 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 246)
- ❑ 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? _____

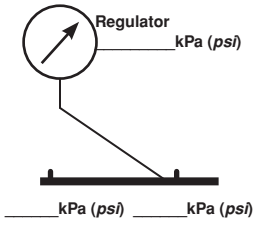
Nozzles:
- ❑ nozzle type okay?
- ❑ all same size/ID#? (record in box above)
- ❑ correct nozzle spacing of _____ cm*(in)*
- ❑ nozzles spaced evenly?
- ❑ clean? not worn?
- ❑ aligned?
- ❑ are there nozzle check valves?

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

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

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?
- ❑ 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%?

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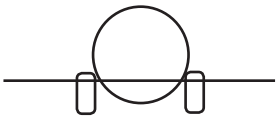
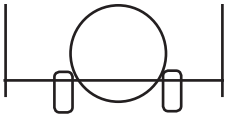
Measuring Nozzle Output

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 eg. 1 minute, 30 sec or 15 sec. Measure in litres.

Horizontal boom (include drop pendents)



Vertical boom (include over-the-row booms)



Nozzle Output Litres per ___ sec	
1.	_____ Litres
2.	_____ Litres
3.	_____ Litres
4.	_____ Litres
5.	_____ Litres
6.	_____ Litres
7.	_____ Litres
8.	_____ Litres
9.	_____ Litres
10.	_____ Litres
11.	_____ Litres
12.	_____ Litres
13.	_____ Litres
14.	_____ Litres
15.	_____ Litres
16.	_____ Litres
17.	_____ Litres
18.	_____ Litres
19.	_____ Litres
20.	_____ Litres
Total	_____ Litres

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	÷	nozz	=	L

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

Minimum Output	=	0.95	x	_____	Average Output	=	_____	L
Maximum Output	=	1.05	x	_____	Average Outpuit	=	_____	L

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

Avereage Ouput per Collection	÷	Collection Time	x	Conversion	=	Average Output	New Nozzle Output	x	Constant	=	Maximum Average Output
L	÷	sec	x	60 sec/min	=	L/min	L/min	x	1.15	=	L/min

4. Clean and retest all nozzles below the minimum output. Replace those still below minimum output after cleaning. If more than 20% of the nozzles need to be replaced, change all of them.

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*

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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.
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 positon 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.

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

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. 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 a 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*

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7. 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 11 .
8. Divide total output by forward speed and swath width and multiply by a constant to get the delivery rate.

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/ac*

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*)					

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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**	=	**new nozzle output**
L/ha	x	km/h	x	cm	÷	60,000	=	L/min
L/acre	*x*	*mph*	*x*	*in*	÷	*5,940*	=	*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 112 L/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 foward 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*	÷	*5,940*	=	*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 and fill in a new Calibration Worksheet.

When your equipment is accurately calibrated and applying the desired delivery rate, you are then ready to spray. Use the Pesticide Use Calculations on the next two pages to determine how much pesticide to buy and how much pesticide to add to a full or partial tank.

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4a CALCULATING HOW MUCH PESTICIDE TO ADD TO A SPRAY TANK — *PER AREA RATE*

Example: Pesticide Labels read: "use 3 L/ha in 1000 L of water" or "use 3 L/1000 L of water/ha".

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* column 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/acres* (*L/acres* = 0.4 x L/ha)
Spray volume	_____ L/ha	_____ *L/acres* (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/acres*

Copy values into the formulas below where needed.

How much pesticide to buy?

field area	x	pesticide label application rate	x	# applications per year	=	**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

Area covered by a full tank?

tank capacity	÷	sprayer delivery rate	=	**area covered**
L	÷	L/ha	=	ha/tank
L	÷	*L/acres*	=	*acres/tank*

How much pesticide to add to a full tank?

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

Number of tankfuls required for area?

field area	÷	area covered by a full tank	=	**tankfuls required**
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.

How much spray mix to make for a partial tank?

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

How much pesticide to add to a partial tank?

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

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4b CALCULATING HOW MUCH PESTICIDE TO ADD TO A SPRAY TANK — PER DILUTION *RATE*

Example: pesticide label reads: "use 1 L/1000 L of water and spray foliage thoroughly".

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* column if you are using *acres*.

	Hectares	***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 dilution rate	_____kg or L/1000 L of water (may be another amount of water)	
Spray volume	_____L/ha	_____ *L/acres* (from label or production guide)

Check your Calibration Worksheets and choose a suitable sprayer setup and Sprayer Delivery Rate
Sprayer Delivery Rate _____ L/ha _____ *L/acres*

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	# applications per year	=	**pesticide to buy**
ha	x	kg or L/1000 L	x	L/ha	x		=	kg or L
acres	*x*	*kg or L/1000 L*	*x*	*L/acre*	*x*		=	*kg or L*

Full tank

Area covered by a full tank?

tank capacity	÷	sprayer delivery rate	=	**area covered**
L	÷	L/ha	=	ha/tank
L	÷	*L/acre*	=	*acres/tank*

How much pesticide to add to a full tank?

pesticide label dilution rate	x	tank capacity	=	**pesticide to add**
kg or L/1000 L	x	L	=	kg or L
kg or L/1000 L	*x*	*L*	=	*kg or L*

Number of tankfuls required for area?

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

Partial tank

How much spray mix to make for a partial tank?

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

How much pesticide to add to a partial tank?

pesticide label dilution rate	x	spray mix in partial tank	÷	1000 L	=	**pesticide to add in partial tank**
kg or L/1000 L	x	L	÷	1000 L	=	kg or L
kg or L/1000 L	*x*	*L*	÷	*1000 L*	=	*kg or L*

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SPRAYER SETUP SUMMARY

Date: ______________________________

Sprayer Setup #

Measured (calculated) Delivery Rate _________ L/acre
__________ *US gal*/acre
Tank Volume __________ L______________ *US gal*
Area Sprayed by a Full Tank _________________ *acre*
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 _________________ *acre*
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 _________________ *acre*
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 _________________ *acre*
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 _________________ *acre*
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 _________________ *acre*
Tractor Gear______________ Throttle__________ rpm
Forward Speed ___________ *mph* ___________ km/hr
# of Nozzles ____________ swath width_________ *ft*
Nozzle (size/type) ______________________________
Pressure @ Regulator ________ @ nozzles________

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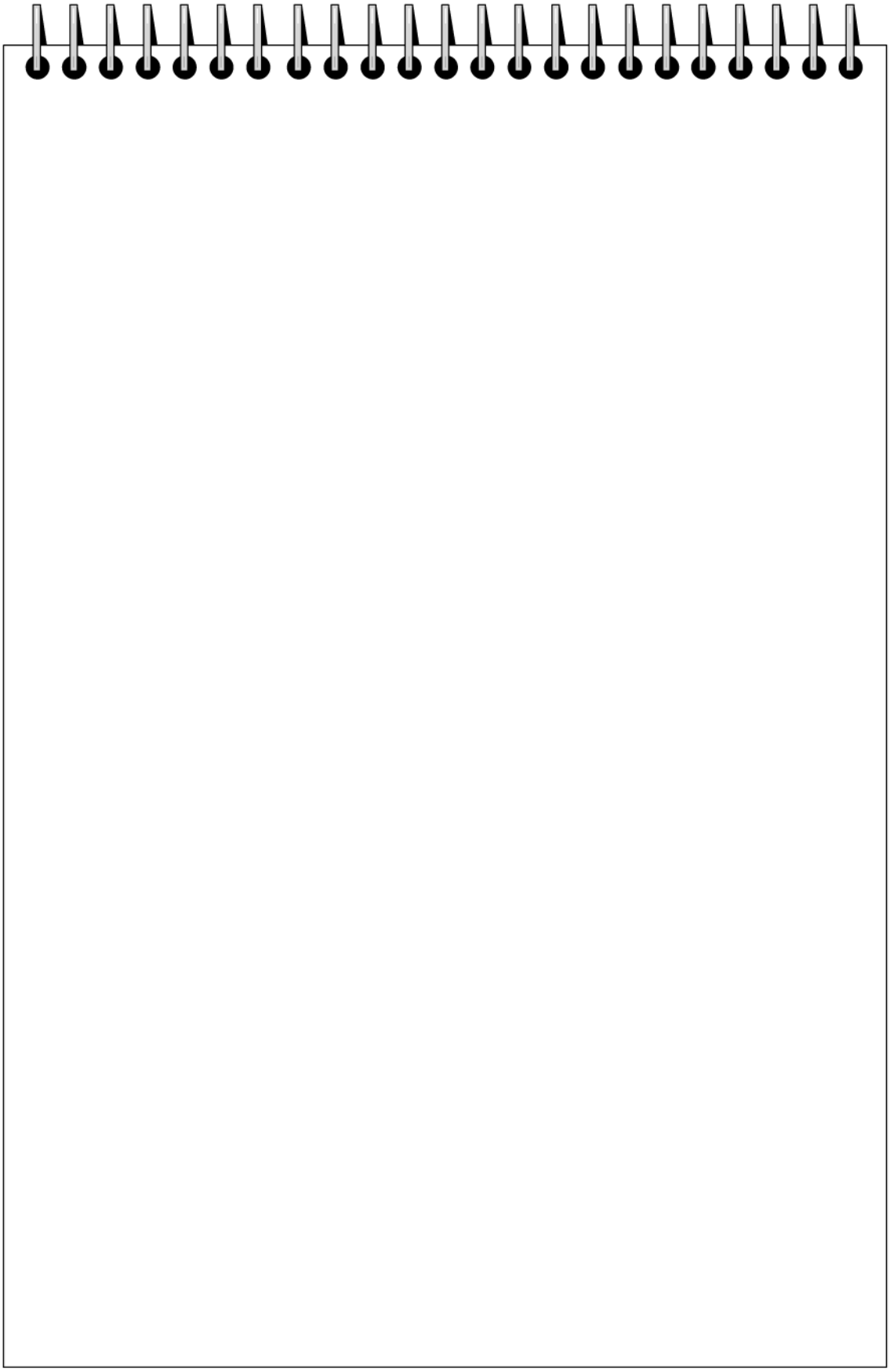
Scratch pad for math calculations



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