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 minimise, 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 boom and airblast 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 calibrating your sprayer to apply pesticides.

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 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.** Recording 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

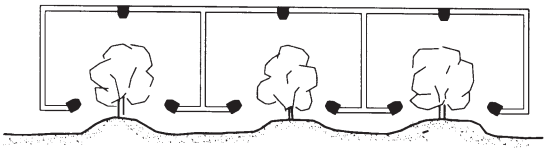
Before calibrating your sprayer, you should know how much spray mixture should be sprayed in your field. The recommended amount of spray mixture (spray volume) can usually be found on the pesticide label or in this guide. The spray volume (and amont of water) will depend on crop, stage of growth, the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

For herbicides, spray 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, for berry crops, most herbicides are 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. Refer to page 248.

Revised: March 2012

For fungicides and insecticides, spray 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 strawberries will permit lower spray volumes than a conventional straight boom (see the figure below). Airblast sprayers may be operated at lower spray volumes than hydraulic boom sprayers. To maintain effective coverage of the foliage, lower spray volumes require finer droplets 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. Also monitor spray drift.



A 3-row spray boom for applying fungicides and insecticides to strawberries. Note the use of 3 cone-type nozzles for each row of plants.

Adjusting Spray Volume for Blueberry Bush Size

Blueberry bushes increase in size from the time they are planted to when they reach maturity. The spray volume needed to get good coverage of the plant (stems and leaves) changes as the plant grows. Application rates on labels for pesticides applied to blueberries are set for mature plants. Less spray should be used for smaller plants.

To minimise the off-target spray, reduce the spray volume by the same proportion that the blueberry plant is smaller than a mature plant. A simple way of comparing size of plants is to compare heights. If the plants are one half the height of mature plants then use one half the spray volume. If the sprayer will cover 5 acres of mature plants with a full tank then it will cover 10 acres of half-size plants. Add enough pesticide to the tank to spray 5 acres of (mature) blueberries so that the concentration stays the same. The same spray mixture can then be applied to 5 acres of mature blueberries or 10 acres of half-size blueberries.

If the fields have both large (mature) and small bushes, set up the nozzles on the sprayer's boom to give even coverage on the large bushes. Then check the nozzle setup in the smaller bushes. Close the top nozzles with blanks if they spray over the top of the smaller bushes. Special nozzle bodies are available that allow the nozzles to be shut off by simply turning the body. Some growers connect the top section of the boom to the pump through a separate hose and boom valve. This provides control from the tractor seat.

Comparing the number of nozzles used for small plants to the number used for large mature plants provides the size of reduction in spray volume (assuming the nozzles are of the same size). For example, if 10 nozzles are used to spray a mature bush and only 6 nozzles are used for a small bush, then the small bush would be sprayed by only (6 nozzles/10 nozzles) 60% of the spray volume used on the mature bushes. If 5 acres of mature bushes are covered with a full tank, then (5 acres x 10 nozzles/6 nozzles =) 8.33 acres of smaller bushes (6 nozzle bushes) would be sprayed by the same full tank.

A better way to reduce spray volume is to compare the surface area of the targets. In tree fruits, tree row volume (the volume that the tree canopy occupies) is used to approximate the surface area of the trunks, limbs and leaves. Small blueberry bushes are not

Revised: March 2012

only shorter but they are also smaller in diameter than large mature plants. The "volume" of foliage reduction is greater than the reduction in height for small plants compared to large mature plants. If plant height alone is used as the basis for spray volume reduction the effect is to use spray volumes somewhat greater than actually required to give similar coverage on mature plants.

Selecting Nozzle Pressure

Herbicides are generally applied with flat spray nozzles at low pressures (200 to 275 kPa or 30 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 including pressures as low as 100 kPa or 15 psi.

Insecticides and fungicides are applied with disc-core nozzles at pressures up to 2000 kPa (300 psi) depending upon the pest to be controlled and the density of the foliage. For example, strawberry mites and fruit rot are more efficiently controlled with a drop-pendant boom at high pressures to penetrate and cover the foliage while raspberry crown borers require a drench using large water volumes at low pressures applied to the soil. The drenches would generally be applied with flat spray nozzles.

Many nozzle manufacturers have chosen to report nozzle outputs with pressures in "bar" 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. Be careful not to damage the pressure gauge by exposing it to excessive pressures when using a high pressure pump.

Selecting Air Volume (Airblast Sprayer)

Airblast sprayers designed for tree fruits are capable of moving large volumes of air at high velocities that can deliver the spray droplets into the tops of the fruit trees spaced 6 m (20 feet) or more apart. If the same sprayer is used for blueberries, the air volume may need to be reduced to prevent the spray mixture from blowing through the plants. Some sprayers are equipped with gear boxes in the fan drive allowing the operator to choose a slower fan speed. Another option provided by manufacturers is a variable pitch blade where the angle of attack and air volume can be adjusted. Some growers adjust fan speed by reducing the tractor throttle from the 540 rpm PTO setting. Reducing the throttle setting will change forward speed and sprayer pump output, both of which will affect the sprayer delivery rate. To maintain the same forward speed a higher gear and lower throttle setting can be used, however the pump must still deliver enough spray mixture at the lower rpm. A better option is to choose a sprayer with a smaller fan more suited to spraying small plants that are grown close together like blueberries.

Determine Sprayer Swath Width

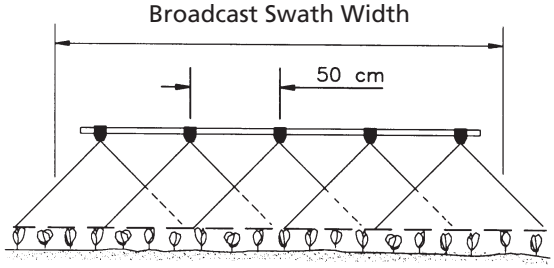
Swath width is the width of treated area over which spray droplets or granules are distributed in one pass of the applicator. In a broadcast spray, it is the nozzle spacing multiplied by the number of nozzles (see figure below) and for band treatments it is the sum of the treated band widths (see figure below). For row crops it is the row spacing (from center-to-center) multiplied by the number of rows (see figure below). 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 (see the examples on pages 248 and 249).

When blow-through cannot be adequately reduced with airblast sprayers on small plants, some growers use alternate row spraying by skipping every other row. If uniformity or coverage are critical then spraying should be carried out on every row. Note that when alternate row spraying, the effective swath width of the sprayer is two rows wide.

Revised: March 2012

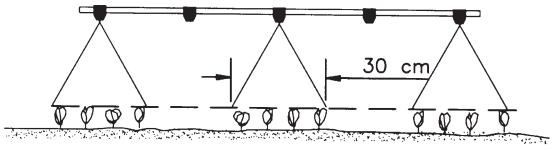
When sprayers are set-up during calibration, check to make sure that the driving pattern used in spraying does not cause skips—areas of the field not sprayed between successive passes of the sprayer. The sprayer boom may also overlap the first pass when spraying the next strip or swath. Both skips and overlaps can be caused by not matching the nozzles on the boom to the driving pattern of the sprayer. 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



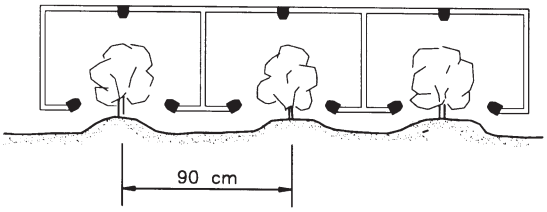
Broadcast swath width
= # of nozzles X spacing
= 5 nozzles X 50 cm
= 250 cm
= 2.5 m

Band Swath Width



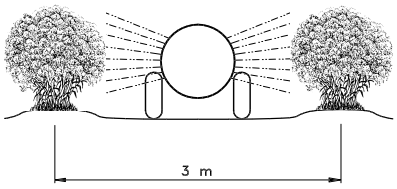
Band swath width
= # of bands X band width
= 3 nozzles X 30 cm
= 90 cm
= 0.9 m

Row Crop Swath Width: Strawberries



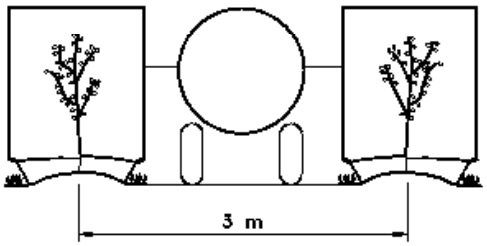
Swath width: Strawberries
= # of rows X row width
= 3 rows X 90 cm
= 270 cm
= 2.7 m

Row Crop Swath Width: Blueberries



Swath width: Blueberries
= # of rows X row width
= 2 X (1/2 row) X 3 m
= 1 row X 3 m
= 3 m

Row Crop Swath Width: Blackberries, Blueberries, or Raspberries



Swath width: Blackberries, Blueberries, or Raspberries
= # of rows X row width
= 2 rows X 3 m
= 6 m

Revised: March 2012

Measuring Delivery Rate

There are two basic methods used to measure sprayer delivery rates—the test area method and the timed output method. 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. 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 again. The timed output method can avoid these problems, however it will require more calculations.

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 before making large changes in delivery rate. Check with the nozzle supplier or agricultural advisor. Obtain a catalogue listing nozzles and nozzle outputs in litres per minute (L/min).

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. On airblast sprayers the air-velocity and volume will also be constant with constant PTO rpm.

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 minimise left over spray mixture in the tank when you are finished spraying.

Revised: March 2012

Calibration Worksheet Examples

Refer to the "Calibration Worksheets" (for boom or airblast sprayers) at the back of this section when working through the following examples.

Example 1: Sprayer Calibration (Hectares)

A grower has set-up a 1000 L sprayer to spray Captan 50W on strawberries at the recommended rate of 4.75 kg/ha in 1000 L/ha of water to control fruit rot. The sprayer boom uses drop pendants and covers 4 rows spaced at 1.2 m apart. After spraying a 100 m test strip with two 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 ❶ – Swath Width,

Row crop swath width = 4 rows X 1.2 m = 4.8 m

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

Follow Steps 1 – 8, Measuring Delivery Rate ❷ –Test Area Method, from the Calibration Worksheet

Test area = 100 m X 4.8 m X 2 runs
= 960 m^2

Follow Step 9, Measuring Delivery Rate ❷ – Test Area Method, from the Calibration Worksheet

Delivery rate = 105 L ÷ 960 m^2 X 10,000 m^2/ha
= 1090 L/ha

The sprayer is operating at a delivery rate of 1090 L/ha. The delivery rate is close enough to the desired spray volume of 1000 L/ha. Use the delivery rate of 1090 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 ❷ ⓐ – Full Tank, from the Calibration Worksheet

Area = 1000 L ÷ 1090 L/ha = 0.92 ha

One full tank of spray will cover 0.92 ha.

(d) How much Captan 50W must be added to a full tank of water?

Follow Calculating How Much Pesticide to Add to the Tank ❷ ⓐ – Full Tank, from the Calibration Worksheet

Pesticide = 4.75 kg/ha X 0.92 ha = 4.37 kg

Add 4.37 kg of Captan 50W to make one full sprayer tank of spray mixture.

Revised: March 2012

Example 2: Sprayer Calibration (Acres)

A grower has set-up a 1200 L sprayer to spray raspberries with Captan 50W (PCP No. 4559.00) to control fruit rot at the label rate of 2 kg/1000 L. The grower chooses an approximate 400 L/acre delivery rate. The sprayer has two over-the-row spray booms that cover two rows of raspberries in each pass of the sprayer. The raspberry rows are spaced 10 ft apart. After spraying a 330 ft test strip with two passes (to discharge enough water from the spray tank to accurately measure it), 115 L of water were required to refill the tank.

(a) What is the sprayer swath width?

From Calibration Worksheet under Set-up ❶ – Swath Width,

Row crop swath width = 2 rows X 10 ft.
= 20 ft.

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

Follow Steps 1 – 8, Measuring Delivery Rate ❷ – Test Area Method, from the Calibration Worksheet

Test area = 330 ft X 20 ft X 2 runs = 13,200 ft^2

Follow Step 9, Measuring Delivery Rate ❷ – Test Area Method, from the Calibration Worksheet

Delivery Rate = 115 L ÷ 13,200 ft^2 X 43,560 ft^2 /acre
= 380 L/acre

The sprayer is operating at a delivery rate of 380 L/acre. The grower decides this is close enough to the 400 L/acre spray volume (target rate).

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

Follow Calculating How Much Pesticide to Add to the Tank ❻– Full Tank, from the Calibration Worksheet

Area = 1200 L ÷ 380 L/acre
= 3.16 acres

One full tank of spray will cover 3.16 acres.

(d) How much Captan 50W must be added to a full tank of water?

Follow Calculating How Much Pesticide to Add to the Tank ❻ – Full Tank, from the Calibration Worksheet

Pesticide = 2 kg/1000 L X 1200 L tank
= 2.4 kg

Add 2.4 kg of Captan 50W to make one full sprayer tank of spray mixture.

Revised: March 2012

Example 3: Sprayer Calibration for Applying Herbicides in Bands (Hectares)

A grower has set-up a 900 L sprayer to spray a strawberry planting with row spacings of 120 cm. The grower wants to spray Princep Nine-T in bands that are 60 cm wide centred over each row. The label says to spray 2 kg/ha in a minimum of 300 L/ha of water (broadcast). The sprayer boom sprays 4 rows in one pass. After spraying a 226 m long strip four times, the discharge was measured to be 95 L. The strawberry field is 7.6 ha.

(a) What is the sprayer swath width?

From Calibration Worksheet under Set-up ❶ – Swath Width,

Band swath width = 4 bands X 60 cm
= 240 cm
= 2.4 m

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

Follow Steps 1 – 8, Measuring Delivery Rate ❷ – Test Area Method, from the Calibration Worksheet

Test area = 226 m X 2.4 m X 4 runs
= 2170 m^2 (treated area)

Follow Step 9, Measuring Delivery Rate ❷ – Test Area Method, from the Calibration Worksheet

Delivery rate = 95 L ÷ 2170 m^2 X 10,000 m^2/ha
= 438 L/ha (of treated area)

The sprayer is operating at a delivery rate of 438 L/ha. The delivery rate is above the 300 L minimum and is okay.

(c) How many hectares (of treated area) 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

Area = 900 L ÷ 438 L/ha
= 2.05 ha (treated area)

One full tank of spray will cover 2.05 ha. of treated area.

(d) How much Princep Nine-T 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

Pesticide = 2 kg/ha X 2.05 ha
= 4.10 L

Add 4.10 L of Princep Nine-T to make one full sprayer tank of spray mixture.

(e) How many hectares of total field area of strawberries will be sprayed by one tank?

The grower wants to know how many hectares of strawberries are sprayed by one tank. To know how many tanks of spray are required, refer to "Table 38. "Conversion factors for strawberries" on page 250. Look up strawberries spaced at 120 cm and band widths of 60 cm; the conversion factor is 2.

Total field area = 2.05 ha/tank X 2
= 4.10 ha/tank

The 7.6 ha strawberry field will require (7.6 ha ÷ 4.10 ha/tank) = 1.85 tanks.

(If a grower knows how many hectares of total field area are covered by one sprayer tank, then divide the total hectares by the conversion factor to calculate the treated area (4.10 ha total field area ÷ 2 = 2.05 ha treated area). Use the treated area covered by a tank to calculate how much pesticide to put into the tank (step (d) above).

Revised: March 2012

Example 4: Sprayer Calibration for Applying Herbicides in Bands (Acres)

A grower has set-up a 1100 L sprayer to spray blueberries with Simazine 80 W to control weeds before they have emerged at the label rate of 1.1 to 1.7 kg/acre in at least 120 L/acre of water (broadcast rate). The 1.7 kg/acre rate is for clay and soils high in organic matter which the grower has. The sprayer has two over-the-row spray booms that covers two rows of blueberries in each pass of the sprayer. The nozzles on the bottom of the booms spray a 3 ft wide strip centred on the blueberry row. The blueberry rows are spaced 10 ft apart. After spraying a 900 ft test strip with six passes (to discharge enough water from the spray tank to accurately measure it), 105 L of water were required to refill the tank. The blueberry field is 14.6 acres.

(a) What is the sprayer swath width?

From Calibration Worksheet under Set-up ❶ – Swath Width,

Band swath width = 2 bands X 3 ft/band
= 6 ft

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

Follow Steps 1 – 8, Measuring Delivery Rate ❷ – Test Area Method, from the Calibration Worksheet

Test area = 900 ft X 6 ft X 6 runs
= 32,400 ft^2 (treated area)

Follow Step 9, Measuring Delivery Rate ❷ – Test Area Method, from the Calibration Worksheet

Delivery rate = 105 L ÷ 32,400 ft^2 X 43,560 ft^2 /acre
= 140 L/acre

The sprayer is operating at a delivery rate of 140 L/acre. The grower decides this is above 120 L/acre and okay.

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

Follow Calculating How Much Pesticide to Add to the Tank ❷ – Full Tank, from the Calibration Worksheet

Area = 1100 L/tank ÷ 140 L/acre
= 7.86 acres/tank

One full tank of spray will cover 7.86 acres (of treated area).

(d) How much Simazine 80 W must be added to a full tank of water?

Follow Calculating How Much Pesticide to Add to the Tank ❷ – Full Tank, from the Calibration Worksheet

Pesticide = 1.7 kg/acre X 7.86 acres/tank
= 13.36 kg

Add 13.36 kg of Simazine 80 W to make one full sprayer tank of spray mixture.

(e) How many acres of total field area (or blueberries) will be sprayed by one tank?

The grower wants to know how many acres of blueberries are sprayed by one tank to know how many tanks of spray are required. Refer to "Table 39. Conversion factors for band spraying for raspberries, blueberries and blackberries" on page 250. Look up blueberries spaced at 10 ft and band widths of 3 ft (36 in); the conversion factor is 3.33.

Total field area = 7.86 acres/tank X 3.33
= 26.17 acres/tank

The 14.6 acre blueberry field will require (14.6 acre ÷ 26.17/tank) = 0.56 tanks.

(If a grower knows how many acres of total field area are covered by one sprayer tank, then divide the total acreage by the conversion factor to calculate the treated area (26.17 acres total field area ÷3.33 = 7.86 acres treated area). Use the treated area covered by a tank to calculate how much pesticide to put into the tank (step (d) above). Pesticide to add to partial tank (0.56) = 0.56 tank x 13.26 kg/tank = 7.48 kg.

Revised: March 2012

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 co-ordinate the walking speed with uniform back and forth movements of the nozzle. The back and forth movements determine the swath width.

Most pesticide labels for berries give instruction 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) X 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.

Revised: March 2012

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 water level (or volume 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 calibrate the sprayer:

(a) Calculate the test area:

Test area (ft^2) = 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 blueberry bushes with Captan 80W at a rate of 0.9 kg/400 L of water per acre. A test strip of 60 ft long covering one side (one half) of the bushes is sprayed with one pass of with water to measure delivery rate. The blueberries are in rows 10 ft apart. To refill the spray tank 2.9 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 5 ft (one side only) X 1 run
= 300 ft^2

(b) Delivery Rate
= 2.9 L ÷ 300 ft^2 X 43,560 ft^2/acre
= 421 L/acre

(c) Area sprayed (by full tank)
= 12 L ÷ 421 L/acre
= 0.0285 acre

(d) How much pesticide to add to one tank
= 0.9 kg/acre X 0.0285 acres
= 0.0257 kg
= 25.7 gm

Revised: March 2012

Band-Spraying Herbicides 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 sprayed. The formulas used in calibration work for either broadcast or band treatments. 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. The herbicide label rates are normally given as broadcast rates as if the entire field is treated, however, when band spraying only part of the field is sprayed.

Example: If you apply 12 in bands to strawberry rows that are 48 in apart, you're really spraying only one quarter of the field. If your delivery rate shows that one tank will treat 1 acre (within the bands), that means you will be able to spray a total field size of 4 acres.

(In this example, 1 acre will be treated within the bands and 3 acres will be untreated between the bands. The conversion factor between treated area and total field size is "4", see Table 38.)

Do not apply the "broadcast rate" given on labels to one hectare or acre of total crop area when you are actually band spraying. In the example given above, you would apply "4" times too much herbicide! The amount of herbicide and water sprayed within the bands (treated area) must be the same as the "label broadcast rate".

When you know how much total field area is sprayed by a full tank.

Most farmers know the "total field size" of their crops and do not automatically know the size of the "treated area" when they are band spraying. Growers need to calculate the treated area covered by a full tank to determine how much pesticide to put in a full tank. Growers can also calculate the sprayer's delivery rate (always measured per treated area) to compare to the spray volume given on the label. If you know how much total field area is sprayed by a full tank (not the treated area in bands), then you can calculate the treated area as follows:

Example:

A grower wants to spray strawberries with Simazine 80 W and the label gives the broadcast application rate as 2.25 kg/ha in a minimum of 300 L/ha of water (910 g/acre in a minimum of 120 L/acre of water). The 1000 L sprayer is set-up to spray 12 inch wide bands on strawberries rows spaced 48 inches apart. The total field area covered by a full tank is 27 acres. What is the treated area covered by a full tank? What is the sprayer's delivery rate (within the treated area)? How much pesticide do you add to a full tank?

Answer:

(a) Determine the conversion factor for band spraying in this case (strawberries: 12 inch bands and 48 inch rows);

From Table 38; conversion factor = 4

(You could calculate it using the formula: conversion factor = row width ÷ band width)

(b) What is the treated area covered by a full tank?

Treated area = total field area ÷ conversion factor

= 27 acres ÷ 4

= 6.75 acres

Continued...

Revised: March 2012

(c) What is the sprayer delivery rate? (Note, this is always measured within the treated area)

Delivery rate = tank size ÷ treated area
= 1000 L ÷ 6.75 acres
= 148 L/acre

The delivery rate of 148 L/acre is greater than the 120 L/acre minimum spray volume listed on the label, therefore, the delivery rate is okay. (The broadcast spray volume on the label should be the same as the delivery rate and delivery rate is always measured within the treated area.)

(d) How much Simazine 80 W do you add to a full tank?

Pesticide to add to a full tank = application rate X area treated by a full tank
= 910 g/acre X 6.75 acres
= 6142.5 g
= 6.14 kg

You want to calibrate your sprayer for band spraying

When you calibrate your sprayer for band spraying, be sure to use the band swath width for the sprayer (see the "Determine Sprayer Swath Width" in this section or the "Calibration Worksheet"). The "Band Swath Width" for the sprayer is the number of bands multiplied by the width of each band. In the calibration formulas, this will give the actual area treated (treated area). All delivery rates will be per treated area which should match the broadcast rates on the label.

Example:

You want to spray 12 in bands on rows of strawberries spaced 48 in apart with Simazine 80 W. The label gives a broadcast rate of 910 g/acre in at least 120 L/acre of water. Your spray tank holds 1000 L. You measure your sprayer's delivery to be 150 L/acre. How many acres of treated area are sprayed with a full tank? How much Simazine 80 W do you put in a full tank?

Answer:

(a) Determine the conversion factor for band spraying (strawberries: 12 inch bands and 48 inch rows):

From Table 38; conversion factor = 4
(You could calculate it using the formula: Conversion factor = row width ÷ band width)

(b) Measure the delivery rate of your sprayer. By using the "test area" method or "timed output" method (see the "Calibration Worksheet"), you determine that the delivery rate is 150 L/acre of treated area. (The calibration formulas always give delivery rate per treated area.)

(c) How many acres of treated area are sprayed by a full tank?

Area covered = tank capacity ÷ delivery rate
= 1000 L ÷ 150 L/acre
= 6.67 acres (treated area)

(The total field area = treated area X conversion factor; total field area = 6.67 acres X 4 = 26.7 acres)

(d) How much pesticide to add to a full tank?

Pesticide to add to the tank = Pesticide label application rate X treated area covered by one tank
= 910 g/acre X 6.67 acres
= 6069.7 g
= 6.07 kg

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Calculating the Conversion Factor

If your row spacings or band widths do not match those in the table, calculate the conversion factor with the following formula:

Conversion factor = row width ÷ band width

Example:

A grower sprays 3 ft bands on raspberry rows spaced 11 ft apart.

Conversion factor = 11 ft ÷ 3 ft

= 3.67

Table 38. Conversion factors for band spraying strawberries

Conversion Factors for Strawberry(in)												
	Rows spaced at 42 in Width of band sprayed (in)			Rows spaced at 44 in Width of band sprayed (in)			Rows spaced at 46 in Width of band sprayed (in)			Rows spaced at 48 in Width of band sprayed (in)		
	12	18	24	12	18	24	12	18	24	12	18	24
Factor	3.50	2.33	1.75	3.67	2.44	1.83	3.83	2.56	1.92	4.00	2.67	2.00

Conversion Factors for Strawberry (cm)												
	Rows spaced at 105 cm Width of band sprayed (cm)			Rows spaced at 110 cm Width of band sprayed (cm)			Rows spaced at 115 cm Width of band sprayed (cm)			Rows spaced at 120 cm Width of band sprayed (cm)		
	30	45	60	30	45	60	30	45	60	30	45	60
Factor	3.50	2.33	1.75	3.67	2.44	1.83	3.83	2.56	1.92	4.00	2.67	2.00

Table 39. Conversion factors for band spraying raspberries, blueberries and blackberries

Conversion Factors for Raspberries, Blueberries and Blackberries (ft, in)												
	Rows spaced at 8 ft Width of band sprayed (in)				Rows spaced at 9 ft Width of band sprayed (in)				Rows spaced at 10 ft Width of band sprayed (in)			
	24	36	40	48	24	36	40	48	24	36	40	48
Factor	4.00	2.67	2.40	2.00	4.50	3.00	2.70	2.25	5.00	3.33	3.00	2.50

Conversion Factors for Raspberries, Blueberries and Blackberries (m, cm)												
	Rows spaced at 2.4 m Width of band sprayed (cm)				Rows spaced at 2.7 m Width of band sprayed (cm)				Rows spaced at 3.0 m Width of band sprayed (cm)			
	60	90	100	120	60	90	100	120	60	90	100	120
Factor	4.00	2.67	2.40	2.00	4.50	3.00	2.70	2.25	5.00	3.33	3.00	2.50

Example:

1. You spray 40 inch bands on raspberry rows spaced at 10 ft. The conversion factor is 3.00 from Table 39.
2. Your raspberry field is 18 acres. The treated area of the bands is 6 acres (18 acres ¸ 3.00 conversion factor).
3. A full sprayer tank covers 10 acres of field area. This is 3.33 acres of treated area (10 acres ¸ 3.00).
4. Use the herbicide broadcast rate on the label multiplied by the treated area of one tank (3.33) to determine how much pesticide to add to the sprayer tank.

See pages 244 – 245 for more examples.

Revised: March 2012

Calibration Worksheet – Airblast 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 Use Calculation worksheet on pages 253 and 254 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?
- ❑ Have tires or pressures changed (speed)?
- ❑ 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 _____

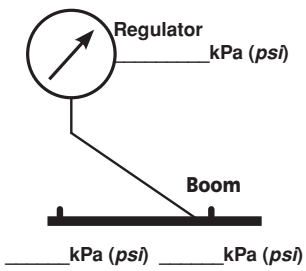
Nozzle screens (check each one)
- ❑ in place? clean? good repair?
- ❑ mesh size correct? _____

Nozzles
- ❑ nozzle type okay
- ❑ all same size/ID#? (record in box above)
- ❑ clean? not worn?
- ❑ aligned for crop?

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

Fan
- ❑ fan blades and housing clean?
- ❑ is fan operating at correct speed?
- ❑ is the air volume & velocity suitable?

Check sprayer pressures
- ❑ measure pressure at regulator and on booms
- ❑ pressure drop less than 10%?
- ❑ pressure gauge working?

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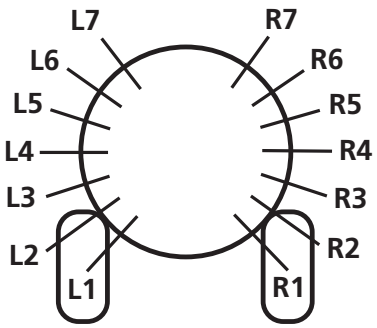
Measuring Nozzle Output

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.



Nozzle Output Litres per ___ sec		
L1.	_____	Litres
L2.	_____	Litres
L3.	_____	Litres
L4.	_____	Litres
L5.	_____	Litres
L6.	_____	Litres
L7.	_____	Litres
R1.	_____	Litres
R2.	_____	Litres
R3.	_____	Litres
R4.	_____	Litres
R5.	_____	Litres
R6.	_____	Litres
R7.	_____	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	÷	# nozzles	=	Average Output Collected
L	÷	noz.	=	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 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

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 You'll use the swath width for the calculation on the next page.

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*

Revised: March 2012

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 ft² ÷ _____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 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.

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 243.)
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 232.
   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)

Revised: March 2012

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 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 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 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 pages 255 and 256 to determine how much pesticide to buy and how much pesticide to add to a full or partial tank.

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4.A 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* 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/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/acre*	=	*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	=	**pesticide 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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4.B 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 line 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*

Revised: March 2012

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 241 and 242 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 245)
- ❑ 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? _____

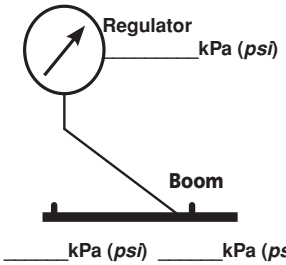
Nozzles:
- ❑ nozzle type okay?
- ❑ all same size/ID#? (record in box above)
- ❑ correct nozzle spacing of _____ cm*(in)*
- ❑ nozzles spaced evenly?
- ❑ clean? not worn?
- ❑ aligned?
- ❑ are there nozzle check valves?

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

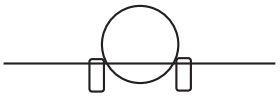
Revised: March 2012

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.

Nozzle pressure is _____kPa (psi)

Horizontal boom
(include drop pendents)



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 if above maximum 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

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

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

Revised: March 2012

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 ft² ÷ _____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 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.

strip length	x	swath width	x	# runs	=	**test area**
m	x	m	x	runs	=	m²
ft	x	*ft*	x	*runs*	=	*ft²*

9. Calculate the Delivery Rate. Divide water sprayed (L) by test area (m² or ft²).

water sprayed	÷	test area	x	conversion	=	**delivery rate**
L	÷	m²	x	10,000 m²/ha	=	L/ha
L	÷	*ft²*	x	*43,560 ft²/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 243.)
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 238.

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)

Revised: March 2012

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 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 rate	=	**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 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 pages 255 and 256 to determine how much pesticide to buy and how much pesticide to add to a full or partial tank.

Revised: March 2012

4.A 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* 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/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/acre*	=	*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

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	=	**pesticide to add to partial tank**
kg or L/ha	x	ha	=	kg or L
kg or L/acre	x	*acres*	=	*kg or L*

Revised: March 2012

4.B 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 line 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

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 dilution rate		spray mix in **x** 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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FORWARD SPEED CALCULATIONS

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)*					

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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 ______

Revised: March 2012