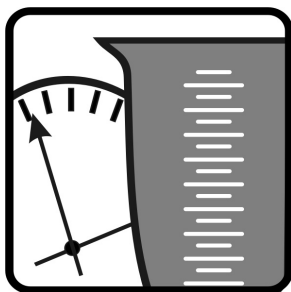

Section 20

Calibration of Application Equipment

What is Calibration?



Calibration is a test measurement of the output of your application equipment under typical operating conditions.

You should calibrate:

- ▶ before you use new application equipment
- ▶ when you change the pesticide product or dilution
- ▶ when replacing nozzles, pressure regulators or pumps
- ▶ at regular intervals to determine whether wear has changed the output of application equipment. For example:
 - sprayers with brass nozzles should be recalibrated after each 25 hours of use.
 - sprayers with stainless steel nozzles should be recalibrated twice per year.
 - sprayers used for abrasive products such as wettable powders and micronutrients should be recalibrated often.

Why Calibrate?

It is very important to take time to calibrate your application equipment. You must make sure that:

- ▶ the pesticide is being applied at the application rate recommended on the label. This is determined by measuring the output of the sprayer or application equipment.
- ▶ the pesticide is being applied evenly over the whole field. This is determined by measuring the output from every nozzle or hopper (for granular pesticides).

Output

What Output Is Required?

The first step is to find out what output is required for the pesticide you are using.

For granular pesticides, the applicator output is given on the label as weight per unit of area (for example - 45 kilograms per hectare - 45 kg/ha).

For liquid pesticides, the sprayer output is the amount of spray applied per unit of area. Some labels tell you exactly what the sprayer output should be – for example: “Apply 5 L of pesticide in 600 L of water per hectare”. The sprayer output should be 600 L of water per hectare.

Some labels will not give you the exact output. For example, the label may say, “Apply 2 L of pesticide in up to 500 L of water per hectare”, or “in 200 to 600 L of water per hectare”.

If the label does not tell you the exact output, you must select the output that is right for the treatment. If you are using liquid spray equipment, keep the following things in mind:

- ▶ **the coverage required** – Spraying to runoff requires a greater sprayer output than spraying only to wet the surface.
- ▶ **the surface to be treated** – Dense foliage or porous surfaces may require a greater sprayer output.
- ▶ **droplet size** – A high sprayer output generally means a coarse spray can be used.
- ▶ **mixing requirements** – A high sprayer output may require large spray tanks or frequent stops to fill your tank.

Here are some general guidelines:

- ▶ Herbicides are generally sprayed in 150 to 600 L of water per hectare.
- ▶ Insecticides and fungicides are generally sprayed in 500 to 1,000 L of water per hectare.
- ▶ Aerial applications may use lower sprayer output, for example, from 25 to 200 litres per hectare.

Factors that Affect Output

The three factors which determine the output of pesticides from all types of application equipment are: size of the openings, travel speed, and pressure.

1. Size of the openings

For granular applicators, the operator instructions tell you what setting to use to get a specific output. They will also tell you the speed you should drive to spread it evenly.

For liquid spray equipment, the output depends on the size of the nozzle opening. Nozzle manufacturers provide charts which show specific nozzle output (L/min) for various combinations of nozzle size and pressure. However, you should check the output of each nozzle in the field when you calibrate your equipment. Most charts of nozzle output are based on tests using water, not spray mix. Wear on the nozzle opening will also affect the nozzle output.

2. Travel Speed is the speed that you drive the equipment. The faster you go, the lower the output will be. This is called an inverse relationship. For example – If you double the speed, you will cut the output of your application equipment in half.

Motorized equipment must be operated at a speed suited to the job. The usual speed is between 3 and 12 km/h. If the speed is too fast, the pesticide will drift. If the speed is too slow, it may take too long to apply the product.

Tractor or truck speedometers are not always accurate in the field. It may be necessary to check your driving speed by timing how long it takes you to drive over a measured distance in the field. Use the following formula to calculate the speed in kilometres per hour:

$$\text{Speed (km/h)} = \frac{\text{Distance Travelled (metres)}}{\text{Time to Travel (seconds)}} \times 3.6$$

Make a note of the gear, and throttle setting or engine rpm, so you will know what settings to use when you apply the pesticide.

3. Pressure (force)

For granular equipment no force is needed to push the granules through the openings. Output is determined by the opening size, particle size and the speed.

For liquid spray equipment force is generated by a pump and is measured in kilopascals (kPa). The more force that is applied to the liquid, the higher the output will be. Reduce the force (pressure) and you reduce the output. **Changing pressure changes droplet size.**

The manufacturers of application equipment have developed tables that tell you how these factors interact to give a specific output. However, you should not depend on a manufacturer's chart to be sure of your output. You must test your equipment in the field. Even a small change in any of these factors will affect the amount of pesticide that is applied.

Always test your equipment in the field to be sure of your output for the speed, pressure, and nozzle or gauge setting you are using.

This test is the calibration of your equipment.

How to Calibrate Application Equipment

The following pages tell you how to calibrate the following applicators:

- ▶ hand held and backpack sprayers
- ▶ motorized pressure sprayers
- ▶ granular application equipment.

For information on how to adjust Air Blast Orchard sprayers, refer to OMAFRA Publication 360 - **Fruit Production Recommendations.**

Hand Held/ Backpack Sprayers

Often a grower needs to treat a small area of his crop with a pesticide – a “spot” treatment. A small garden sprayer or compressed air sprayer can be used. Calibration of these portable sprayers is used to check the spray pattern and the sprayer output.

Calibrating the Sprayer

- 1. Measure out an area that is 100 m².**
(for example 10 m X 10 m, or 25 m X 4 m)
- 2. Fill the spray tank with water.** Mark the level on a measuring stick. Pump to the pressure which will be used during the pesticide application.
- 3. Spray the water over the 100 m² area.** Walk at a steady pace, taking care to apply it as evenly as possible, just as you would when applying pesticide.
- 4. Measure the amount of water needed to refill the spray tank to the mark on the measuring stick.** This amount will be the sprayer output per 100 m².

If the spray tank is not large enough to cover an area of 100 m², use the following calibration procedure:

- 1. Measure the amount of water needed to fill the sprayer.**
Pump to the pressure you will use during the pesticide application.
- 2. Spray an area as evenly as possible, walking at a steady pace.** Spray until the tank is empty.
- 3. Measure the number of square metres covered.** For example, an area:
$$6 \text{ m} \quad \times \quad 10 \text{ m} \quad = \quad 60 \text{ m}^2$$
$$8 \text{ m} \quad \times \quad 3 \text{ m} \quad = \quad 24 \text{ m}^2$$
- 4. Use the recommended amount of pesticide for this number of square metres each time you fill the tank.**

To convert the application rate of any pesticide to the amount required for a small area, follow this guide:

- ▶ 1 kg per hectare is equal to 10 grams per 100 square metres.
- ▶ For liquid measure, 100 litres per hectare is equal to 1 litre per 100 square metres. (One level tablespoon equals 15 mL.)

Motorized Pressure Sprayers

All motorized pressure sprayers require similar adjustments and calibration. You must first determine the nozzle output before you can calibrate a motorized pressure sprayer.

Nozzle Output

Nozzle output depends on the size of the nozzle opening and pump pressure.

Nozzle manufacturers usually provide detailed charts to help you choose the right nozzle tip. Some charts show the nozzle tip that will produce a certain sprayer output (L/ha) for a given travel speed (km/hr), pressure (kPa), and nozzle spacing. This kind of chart is shown on page 217.

Choose nozzles which are as close as possible to the desired output, travel speed, pressure, and nozzle spacing required.

How to Calculate Nozzle Output

Some nozzle charts only list the output rates for a nozzle at a given pressure. You must calculate the nozzle output (L/min) which will give the correct sprayer output (L/ha), taking into account your travel speed and nozzle spacing. To calculate the nozzle output, you can use the formula shown below.

$$\text{Nozzle Output (L/min)} = \frac{\text{sprayer output (L/ha)} \times \text{speed (km/h)} \times \text{nozzle spacing (m)}}{600^*}$$

*The number 600 is a constant. It allows you to calculate the nozzle output in litres per minute from a sprayer output in litres per hectare, the speed in kilometres per hour, and the nozzle spacing in metres. The constant results from the following calculation:

$$\frac{1 \text{ ha}}{10,000 \text{ m}^2} \times \frac{1,000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ h}}{60 \text{ min}} = \frac{1}{600}$$

Note, to use this formula:

Choose the sprayer output (L/ha) from the range given on the label. Determine the speed by using the formula described on page 213. The nozzle spacing must be in metres, for example 0.5 m.

Example:

What should the nozzle output (L/min) be in order to apply a total sprayer output of 110 L/ha, when the travel speed is 10 km/h and the nozzle spacing is 50 cm?

$$\text{Answer} = \frac{110 \text{ L/ha} \times 10 \text{ km/h} \times 0.5 \text{ m}}{600}$$

$$\text{Answer} = 0.92 \text{ L/min}$$

The nozzle output should be 0.92 litres per minute.

Check this nozzle output against the chart. Then choose the nozzle tips with the closest output. Using this example and the sample chart below, you could use Teejet 8003 or 6503 nozzles or Delavan FL-3 nozzles.

Nozzle and Sprayer Output for Various Fan Nozzle Types, Pressures, and Travel Speeds

Delavan Nozzles	Teejet Nozzles		Pressure (kPa)	Output (L/min)	Sprayer Output (L/ha) at			
	65° & 80°	65°			80°	6 km/h	8 km/h	10 km/h
LF-0.67	650067	800067	200	0.22	43	32	26	22
			275	0.25	51	38	31	25
LF-1	6501	8001	200	0.32	64	48	39	32
			275	0.38	76	57	45	38
LF-1.5	65015	80015	200	0.48	97	73	58	48
			275	0.57	113	85	68	57
LF-2	6502	8002	200	0.64	129	97	77	64
			275	0.76	151	113	91	76
FL-3	6503	8003	200	0.97	193	145	116	97
			275	1.13	227	170	136	113
LF-4	6504	8004	200	1.29	258	193	155	129
			275	1.51	302	227	181	151

Note: These figures are based on nozzles spaced at 50 cm.

How to Adjust the Nozzles and Boom

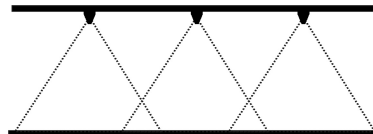
Install the nozzle tips on a boom using the spacing and boom height recommended by the manufacturer.

Overlapping Nozzles

Nozzle tips should be lined up carefully. If they are not set up properly you may get uneven coverage. Space tips evenly on a boom. The boom must also be parallel to the field surface. If not, the spray pattern will be uneven.

Offset the nozzle tips about 10° on the boom so that the patterns do not interfere with one another.

When using overlapping nozzles on a boom, the manufacturers often recommend a 50% overlap of spray from each flat fan nozzle. This means that each nozzle should overlap at least 25% of its spray width with each adjacent nozzle. The height of the boom will change the amount of overlap. Set the boom at the height recommended by the nozzle manufacturer, then adjust it during calibration if necessary. The amount of overlap will vary depending on the spray angle of the nozzles. The larger the spray angle the more overlap.



Wide Angle Nozzles

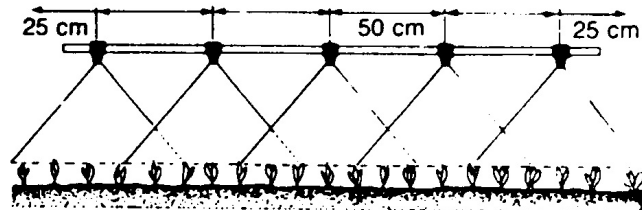
Some farmers are beginning to use wide angle nozzles (110°) with 100% overlap of spray. This complete overlap reduces the chance of spray skips. Nozzles with a wide spray angle also allow you to use a lower boom height, and reduce the amount of spray drift. The wide angle can also give better penetration into the canopy or around crop residue left on the soil surface.

It may be necessary to adjust the boom height from time to time to maintain proper nozzle-to-target distance.

How to Measure the Spray Width

Broadcast Spray

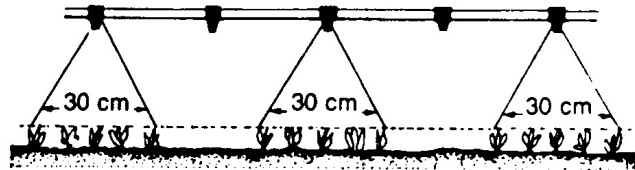
The spray width of a boom sprayer with overlapping spray patterns is the width between nozzles (or drop pipes) multiplied by the number of nozzles. Note that the spray width will be wider than the total distance between the outermost nozzles.



$$\text{Spray width} = 5 \text{ nozzles} \times 50 \text{ cm spacing} = 2.5 \text{ m}$$

Band Spray

On a boom sprayer used for band applications, the boom height affects the width of the band the nozzle sprays. The boom height must be adjusted to get the band width needed for the angle of nozzle selected. The spray width of a band sprayer is the sum of the widths that each nozzle sprays.



$$\text{Spray width} = 3 \text{ nozzles} \times 30 \text{ cm band width} = 90 \text{ cm}$$

Boomless Spray

On a boomless sprayer, nozzle selection charts often show the spray width produced by nozzles when they are set at a certain height. An overlap percentage may also be recommended. In this case, the spray width includes half the width of overlap between nozzles.

Calibrating the Sprayer

After the sprayer is set up, it should be calibrated (or tested) to make sure that it is working properly under field conditions.

It is not necessary to spray over a whole hectare or acre to calibrate a sprayer. It is possible to calibrate a sprayer by knowing a few facts and doing some calculations.

There is more than one way to calibrate your sprayer. One method of calibration is outlined below. This method gives you sprayer output in **litres per hectare**. With this method you need to know three things:

- ▶ time to travel 50 metres
- ▶ average nozzle output measured in millilitres
- ▶ nozzle spacing in metres.

1. Measure the time

- ▶ Place 2 stakes 50 metres (164 feet) apart in the field.
- ▶ Select the gear in which you will spray.
- ▶ Drive the distance between the stakes three times, timing each pass. Each time, make sure the tractor is at the desired spraying speed as you pass the first stake. Keep driving at this speed until you pass the second stake.
- ▶ Take the average time of three passes.

2. Measure the Average Nozzle Output

- ▶ Park the sprayer with the PTO engaged and the throttle adjusted to reach the PTO speed set in the test run.
- ▶ Adjust the pressure regulator to the desired working pressure with full flow to the boom.
- ▶ Collect the output from each nozzle for the average length of time needed to travel the 50 metres (164 feet) in the test run. **If any nozzle is more than 5% above or below the average output, it should be cleaned or replaced.**
- ▶ Add up all of the nozzle outputs and divide by the number of nozzles. This will give you the average output per nozzle. Make sure your measurement is in **millilitres (mL)**.

3. Measure the Spacing Between Nozzles in Metres

4. Use the Following Formula to Determine the Sprayer Output:

$$\text{sprayer output (litres/hectare)} = \frac{\text{average nozzle output (mL)}}{\text{nozzle spacing (m)}} \times 0.2^*$$

*0.2 is a constant factor used to convert the units to litres/hectare

Growers who prefer to measure in litres/acre or gallons/acre, can use the following guide to convert:

▶ litres per hectare	X	0.40	=	litres per acre
▶ litres per hectare	X	0.09	=	Imperial gallons per acre
▶ litres per hectare	X	0.11	=	U.S. gallons per acre

How to Adjust the Sprayer Output

If calibration shows that your equipment is not delivering the output you want, you should adjust the sprayer and test it again. You can adjust the sprayer output in one of three ways:

- ▶ **Change the nozzles.** Changing the nozzles is the recommended way to make a **large adjustment** to sprayer output.
- ▶ **Change the operating pressure.** Lower pressure means less spray delivered – higher pressure means more spray delivered. Make only minor adjustments in pressure because any adjustments will change the size of the spray droplets, and the nozzle pattern.
- ▶ **Change the travel speed.** Slower speed means more spray delivered per unit of area. Faster speed means less spray delivered. This is an easy way to make small adjustments to sprayer output.

Use the following formula:

$$\text{Required Speed} = \frac{\text{present speed (km/h)} \times \text{present sprayer output (L/ha)}}{\text{desired sprayer output (L/ha)}}$$

Check your Sprayer Output

You may need to test your sprayer to check its output. Fill your sprayer at least half full of water. Measure this amount. Operate your sprayer over a test area (under normal field conditions), then measure the amount of water you need to refill the spray tank to the original measured amount. You can calculate the output of your sprayer.

1. Find the area of the test area:

$$\text{Length (metres)} \quad \times \quad \text{Width (metres)} \quad = \quad \text{area (square metres)}$$

2. Change the area in square metres (m²) to hectares (ha):

$$\frac{\text{number of square metres}}{10,000 \text{ square metres per hectare}} \quad = \quad \text{number of hectares}$$

3. Find the sprayer output:

$$\frac{\text{number of litres to refill the tank}}{\text{number of hectares of the test area}} \quad = \quad \text{sprayer output (L/ha)}$$

Example:

You test your boom sprayer by spraying a test strip **500 metres long by 10 metres wide**. It takes **150 litres** of water to replace the water in your sprayer. What is the output of your sprayer in **litres per hectare**?

1. Find the area of the test area:

$$500 \text{ m} \quad \times \quad 10 \text{ m} \quad = \quad 5,000 \text{ m}^2$$

2. Change the area in square metres (m²) to hectares (ha):

$$\frac{5,000 \text{ m}^2}{10,000 \text{ m}^2/\text{ha}} \quad = \quad 0.5 \text{ ha}$$

3. Find the sprayer output:

$$\frac{150 \text{ L}}{0.5 \text{ ha}} \quad = \quad 300 \text{ L/ha}$$

Granular Application Equipment

Granular application equipment may use gravity feed, whirling discs (spinners) or air-blast methods to apply the granules.

The applicator output per hectare (kg/ha) depends on the travel speed of the equipment, the nozzle spacing and the output of granules per minute (kg/min).

The output of your equipment per minute depends on the size of the adjustable hopper openings, the size, weight, and shape of the granules and the roughness of the field. Calibrate your equipment for each batch of product used and for new field conditions.

Follow the manufacturer's instructions in the equipment manual for the first settings. Use the recommended output settings for the type of granules you are using. Use the recommended speed unless the surface is soft, muddy or uneven, then use a lower speed.

Calibrating Granular Application Equipment

1. Check the width of the application and the application pattern.

Fill the hopper with some granules. Drive a short distance at the desired speed. Measure the width of the application area and check that the granules are distributed evenly along the area. If the granule pattern is uneven, you may need to adjust the speed of the spinner, or the spot on the spinner where the granules land.

2. Determine the applicator output by measuring the actual amount applied to a measured test area.

- ▶ Fill the hopper half-full of granules.
- ▶ Mark out a distance of 200 m or more.
- ▶ Collect the material discharged from the spreader in a bag or box while driving the tractor over the 200 m distance.
- ▶ Weigh the granules discharged into the container and calculate the applicator output per hectare by the following formula:

$$\text{Output (kg/ha)} = \frac{\text{amount applied to test area (kg)} \times 10,000 \text{ m}^2/\text{ha}}{\text{distance travelled (m)} \times \text{width of applicator (m)}}$$

3. **Adjust the applicator output** if the calibration shows that the equipment is not delivering the required application rate.

To change the applicator output, you can:

- ▶ Adjust the granule output setting on the spreader, then do the calibration again.
- ▶ Adjust the travel speed.

Use the following formula to calculate the speed required to obtain the desired output:

$$\text{Required Speed (km/h)} = \frac{\text{present speed (km/h)} \times \text{present applicator output (kg/ha)}}{\text{desired applicator output (kg/ha)}}$$

4. You test your boom sprayer by spraying a test strip **450 feet long by 20 feet wide**. It takes **5 gallons** of water to replace the water in your sprayer. What is the output of your sprayer in **gallons per acre**? (1 acre = 43,560 ft²)

Use the sprayer output table to answer the following question.

5. If you want to apply a sprayer output of around 150 L/ha while driving at 6 km/h, which nozzle should you select?
6. You can **increase** the sprayer output if you:
- a) decrease the pressure.
 - b) increase the speed of the application equipment.
 - c) raise the level of the boom to the crop.
 - d) select nozzles with larger openings.