Is your spraying equipment well adjusted?

Orchard Spray Equipment: Set Up and Calibration by Greg O'Sullivan

Efficient pest and disease management requires the setting up and calibration of spray equipment so that application of pesticides is controlled and accurate.

With correctly set up and calibrated equipment an operator can accurately control the quantity of chemical and volume of water applied per hectare. This ensures that the legal obligations associated with label rate compliance are met and that spray efficacy is maximised.

Poorly set up and uncalibrated spray equipment can result in excessive application of pesticides resulting in increased expense, plant injury, environmental contamination and undue operator exposure. Low application rates may result in ineffective control and sub-lethal doses that will add to resistance development in pest organisms.

Once the equipment is set up, spray calibration is a fairly simple operation and each sprayer should be calibrated at the beginning of the season and re-checked regularly throughout the season. The three main factors used to calibrate equipment are: travel speed, spray volume (litres/hectare) and nozzle output. The travel speed and spray volume are established first, then, if necessary, modifications are made to the nozzle size and operating pressure to achieve the required output.

Travel Speed

Each type of spray equipment has a recommended speed range in which it should be operated and these can be obtained from the manufacturer. Some general recommendations are presented in Table 1.

Table l. General travel speeds for various spray equipment

Equipment Type	General Speed
Hand-Held Equipment	Comfortable walking speed 3-4km/hr
Boom Type Sprayers (Herbicides)	8km/hr
Air Blast Sprayer	4-7km/hr
Air Shear Sprayers	4-7km/hr

Once the travel speed has been determined and the equipment calibrated, the operating speed must remain constant in all subsequent spray applications. Travelling at greater speeds will apply less pesticide per hectare and, vice versa, travelling slower will increase the rate of pesticide applied. If the travelling speed is to be changed the equipment must be re-calibrated.

Nozzle set up

Correct nozzle selection is vital in optimising pesticide application to obtain effective coverage, maximum control and reduced chemical wastage. Nozzles are designed to produce specific-sized droplets, spray patterns and outputs depending on the pump operating pressure. In general there are three main types of nozzles used in pesticide application - Solid Cone, Hollow Cone and Fan nozzles (as outlined in Table 2).

Different targets catch some droplet sizes better than others and nozzles are designed to provide the optimal droplet size for each target. Table 3 provides guidelines on the optimal droplet size ranges for different targets.

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Table 2. Nozzles type and Uses.

Nozzle Types	Common Use	Operating Pressure	Droplet Characteristics
Solid Cone	High volume application insecticides and fungicides.	High Pressure 4-25 Bar (60-360psi)	Small droplets. Good foliage penetration
Hollow Cone	Low volume application of insecticides and fungicides. Special herbicide applications requiring good foliage cover.	Moderate Pressure 4-8 Bar (60-110psi)	Small droplets. Good foliage penetration.
Fan (tapered or even)	Herbicides.	Low Pressure 1-3 Bar (15-40psi)	Large droplets. Reduced Lift

Table 3. Droplet size ranges for different targets

Target	Droplet Sizes
Flying insects	10-50microns
Insects on foliage	30-50 microns
Foliage diseases	40-100 microns
Herbicide application	250-500 microns

Information on correct nozzle selection, output, operating pressure and droplet size spectrum can be obtained from the manufacturers and must be consulted before nozzle selection is made.

Spray Volume

Spray applications are classified according to the volume of liquid applied. Table 4 provides the classifications for a mature orchard situation.

High volume spraying

High volume sprays are designed to wet the plant surface to the point of run off and generally deliver more than 1000 litres of liquid per hectare. Most spray equipment can be used in high volume spraying as long as sufficient volume is used to obtain thorough wetness. The main disadvantages of high volume spraying is the wastage of up to 50% of the pesticide through run-off to the ground, and downtime involved in more frequent refills.

Low volume spraying

This refers to the application of a volume of water less than that required for high volume spraying.

Less water is applied to the trees but, at the same time, the same amount of chemical is used as would be under the high volume system. For this to be achieved the concentration of product in the spray mixture must be increased as the volume of the water is decreased.

Equipment set up for low volume spraying generates spray clouds of droplets of optimal size for the target (by reducing the proportions of larger and finer droplets), resulting in a more even and efficient coverage than that obtained with high volume sprayers.

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The other advantages of low volume spraying are that there is no wastage through run-off, and downtime associated with refilling is reduced significantly (50 to 80%). Low volume sprays of fungicides and insecticides can only be applied to tree canopies through specially designed air blast sprayers, or air shear mist blowers which generate droplets of controlled size and use air turbulence to direct the spray to the target. Low volume sprays of herbicides, however, can be applied using traditional boom sprays mounted on vehicles such as ATV's or tractors.

For low volume spraying the user selects the rate on the pesticide label as the amount of product per hectare. Therefore the amount of product used in spray mixture will depend on the output of the equipment - not the capacity of the tank.

Table 4. Classification of pesticide sprays according to volume used per unit area

Classification	Volume Applied (litres/hectare)
High Volume (Dilute)	1000+
Low Volume (Concentrated)	200-500

In the past, many labels have not provided a low volume rate and most labels advise users to mix the product in grams or per 100 litres .

Changes are now being made to pesticide labels to help growers choose between low volume and high volume spraying. Labels of most existing products are being updated to include information for low volume spraying.

If for some reason it is not suitable to apply a product through low volume equipment the label will make that clear. This is case with some miticides where a high volume spray to the point of run-off has been found to be more effective that low volume spray.

Several terms have previously been used to describe the application of sprays, such as high volume, low volume, dilute spraying and concentrated spraying. To avoid confusion, the first step in the label revision has been to standardise the terminology so that only two terms are used on the label - dilute spraying (previously high volume) and concentrate spraying (previously low volume).

Steps in Calibration

1. Measure nozzle output

- Partially fill the tank with water.
- Set unit to operate at the recommend pressure for the nozzles used.
- Attach a container or a special reusable bag to each nozzle (or measure each nozzle individually).
- Measure each nozzle output for one minute.
- Replace nozzles differing from the rated output by 5%.
- Calculate total output from nozzles over one minute (nozzle 1 + nozzle 2 etc).

2. Check Travel Speed

- Knowing your actual sprayer speed is an essential part of accurate spraying. Speedometer readings can sometimes be inaccurate because of wheel slippage. Check the time required to cover a 50 or 100 metre distance with a half full tank. Calculate actual speed (km/hr). When the correct speed is obtained mark the speedometer for reference.

3. Measure spray width/coverage

- When spraying herbicide with boomtype spraying equipment, the spray width is approximately equal to the length of the

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boom. With air blast type equipment the area covered is the width of the tree row if both sides of the machine are spraying.

4. Calculate time required to spray one hectare (in minutes)

= 60 / (spray width (m) x speed (km/hr) x 0.1)

5. Calculate sprayer output per hectare

= spray output (litre/min) x time to spray 1 ha (minutes)

Note: If the sprayer output per hectare differs significantly from the limits recommended on the label, the amount sprayed can be increased or decreased by changing the operating pressure or by using nozzles with larger or smaller orifices. Adjusting the operating pressure, however, is limited because nozzles must be operated within the pressure limits recommended by the manufacturer.

6. Calculate product dilution rate

Product dilution rate (litre(L)/ tank) = $\frac{\text{label rate (L/ha) x tank volume (L)}}{\text{sprayer output (L /ha)}}$

Product dilution rate (ml/L) = $\frac{\text{product rate (L/ tank) x 1000}}{\text{tank volume (L)}}$

NOTE: When using dilute (high volume) sprays the calibration process stops at step 5. The product dilution rate does not have to be calculated as it is a fixed rate provided on the label as mls or grams per 100 litres regardless of the quantity of spray used per hectare. Generally dilute rates have been based on a spray output of about 1000 litres per hectare.

Some Examples:

Example 1

A grower using a low volume air blast intends to spray 10 hectares of olives with an insecticide.

- The insecticide label rate for concentrate (low volume) spraying is 2 litres per hectare.
- The recommended speed for the sprayer is 5 km/hr.
- The sprayer has 12 nozzles that each have an output of 1.5 litres per minute when operated at 20 Bar.
- The tank capacity is 2000 litres.

1. Measure nozzle output

= 12 nozzles x 1.51- = 18L / minute

2. Check Travel Speed

5 km/hr

3. Measure spray width/ coverage

Tree rows are 8 m apart

4. Calculate time required to spray one hectare (minutes)

= 60 / (spray width (m) x speed (km/hr) x 0.1)
= 60 / (8 x 5 x 0.1)
= 60 / 4
= 15 minutes

5. Calculate sprayer output per hectare

= spray output (L/min) x time to spray l ha (min)
= 18 x 15
= 270 L / Ha

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6. Calculate product dilution rate

Product dilution rate (L/ tank)
= label rate (L/ha) x tank volume (L)
sprayer output (L /ha)
= 2 x 2000 = 270
= 14.81 litres of insecticide per full tank

Product dilution rate (ml/L)
= product rate (L/ tank) x 1000
tank volume (L)
= 14.81 x 1000 / 2000
= 7.41 ml of insecticide per litre of water

Example 2

- A grower using a boom sprayer mounted on a four-wheel-bike intends to spray 10 hectares of olives with Roundup along the tree rows.
- The Roundup label rate is 6 litres of Roundup per sprayed hectare for the target weed species.
- The label also recommends applying the product in 75 to 200 litres of water per sprayed hectare when using boom equipment.
- The recommended speed for the bike sprayer is 8km/hr.
- The sprayer has 5 nozzles that have an output of 0.42 litres per minute when operated at 2.5 Bar.
- The tank capacity is 100 litres.

1. Measure nozzle output
= 5 nozzles x 0.42 litres
= 2.1 litres / minute

2. Check Travel Speed
8 km/hr

3. Measure spray width/ coverage
The spray boom covers 1.2 metres

4. Calculate time required to spray 1 hectare (min)
= 60 / (spray width (m) x speed (km/hr) x 0.1)
= 60 / (1.2 x 8 x 0.1)
= 60 / 0.96
= 62.5 minutes

5. Calculate sprayer output per hectare
= spray output (L/min) x time to spray 1 ha (min)
= 2.1 x 62.5
= 131.3 litres / Ha

6. Calculate product dilution rate
Product dilution rate (L/ tank)
= label rate (L/ha) x tank volume (L)
sprayer output (L /ha)
= 6x 100 / 131.3
= 4.6 Litres of Roundup per full tank

Product dilution rate (ml/L)
= product rate (L/ tank) x 1000
tank volume (L)
= 4.6 x 1000 / 100
= 46 ml of Roundup per litre of water

For further information on calibration, contact your local agricultural department or rural equipment supplier.

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