Field Sprayer Calibration

Field sprayer calibration is an important component of Integrated Pest Management (IPM) within wild blueberry production. Field sprayer calibration has two important goals, to make sure the proper amount of active ingredient is applied to an area of land and to ensure the product is applied evenly across the entire length of the spray boom. Calibration ensures the pest control product is properly applied and it is also essential to ensure food safety. Sprayer calibration is a wise investment for the blueberry producer for it can prevent improper use of costly products and help improve the effectiveness of the pest control measure.

Pre-Calibration Check

Before calibrating your sprayer you should complete the following steps:

- Repair and replace any faulty hoses.
- Clean your screen and nozzles using a soft brush.
- Set your pressure gauge at the pressure you intend to spray at in the field.
- Make sure you have the same type and size of nozzles over the entire boom.
- Check to make sure the distance between nozzles is the same over the boom.
- Make sure all the nozzles on the boom are delivering the same water volume (within 10%) over a given time.
- Check the nozzles to ensure the spray pattern is even and consistent.
- Adjust the boom so it is level along its entire length and determine the proper height of the nozzles above the target (soil or plant) which provides a uniform application. To do this, check the manufacturer's directions or operate the sprayer slowly over a dry, level surface, checking the spray pattern is uniform as observed on the surface.

Determining Application Rates in Litres per Hectare

Sprayer calibration means determining the sprayer output applied over a given area of land. Online tools, like this website, can also assist with the calibration process. Various calibration bottles and kits are available from a number of suppliers. These tools can be very helpful when used properly. There are many methods to calibrate sprayers but the following two methods are straight-forward, with relatively simple calculations.

Method One – Recommended Method

Step 1: Measure a track length of 50 meters (164 feet) and mark it with stakes. Do not use any other distance, as the formula to be used is based upon 50 m. The track should be staked out in an area similar to that being sprayed, in order to account for wheel slippage. Avoid setting out the track on hard gravel surfaces or pavement.

Step 2: Fill your tank approximately half-full of water. Select the gear and throttle setting that you wish to use to spray the field.

Step 3: Determine the length of time to travel the measured track length. Start travelling at your spraying speed well before you reach the first stake. Start your timer as you pass by the first stake and stop it as you pass by the second. Maintain a constant throttle setting while travelling between the stakes. Repeat this a few times, being careful not to travel over the same wheel tracks. Determine the average time it took you to travel the 50 meters.

Step 4: In a stationary position, operate the sprayer at the same throttle setting (r.p.m.) used during the test run. Adjust the pressure gauge to the pressure that you wish to spray at in the field. Using a measuring device graduated in millilitres (mL) (i.e. graduated cylinder), collect the spray from each nozzle for the same number of seconds it took to travel the 50 m during the test run. If the measuring device overflows before the time is up, cut the time in half and multiply the spray output collected by two. If a helper is available to do the timing, you can put a measuring device in each hand, doing two nozzles at once. Average the output per nozzle (in mL) over the entire boom.

NOTE: If the nozzle outputs were checked as recommended in the "Pre-Calibration Check", It will not be necessary to check each nozzle again in Step 4. Just choose the nozzle that was closest to the average, and measure its output over the number of seconds it took to travel the 50 m during the test run. By following this procedure, Step 5 may also be omitted.

Step 5: Clean or replace any nozzles that vary more than 10% from each other. Take new outputs from these nozzles and determine the new average output per nozzle over the boom.

Step 6: Determine the distance between the nozzles in meters. (100 cm = 1 m; 50 cm = 0.5 m)

Step 7: Determine your application rate in litres per hectare (L/ha) using the following formula:

$$L/ha = \frac{\text{average spray output per nozzle – mL (Step 4)}}{\text{distance separating nozzles – m (Step 6)}} \times 0.2$$

Example for Calibration Method #1	
Step 3:	Average time to travel 50 m = 29 sec
Step 4:	Average Nozzle Output over 29 sec

Nozzle	Output
1	530 mL
2	525 mL
3	528 mL
4	535 mL
5	531 mL
6	529 mL
7	530 mL
8	529 mL
9	531 mL
10	528 mL
Total	5296 mL

Output per nozzle $\dfrac{5296 \text{ mL}}{10 \text{ nozzles}}$ = 529.6 mL

Step 6: Distance between nozzles = 0.5 m

Step 7: $\dfrac{529.6 \text{ mL}}{0.5 \text{ m}}$ x 0.2 = 212 L/ha

Method 2 – Quick Method

Although this method calculates the total spray output per hectare, it does not give a true indication of how evenly distributed the output is over the entire boom. Some nozzles could be worn, or nozzles at the end of the boom could be putting out less spray than other parts of the boom. The nozzles should be individually checked to ensure that each nozzle is spraying a uniform quantity over the entire length of the boom before starting this calibration procedure.

Step 1: Measure a track length of 200 meters (656 ft) and mark it with stakes. Do not use any other distance, as the calibration formula is based upon 200 m. The track should be staked out in an area similar to that being sprayed, in order that wheel slippage can be accounted for. Avoid setting out the track on hard gravel surfaces or pavement.

Step 2: Park the tractor and sprayer on a level surface and fill the sprayer with water to a point that can be easily and accurately marked. The quantity can be marked visually by sighting a mark on the tank, or preferably by using a measuring stick.

Step 3: Select the gear, throttle setting (r.p.m.) and pressure that you wish to use to spray the field. Spray between the two stakes, turning the boom on as you pass the first stake and off as you pass the second. Record the gear, throttle setting and pressure selected.

Step 4: Return the tractor and sprayer to the exact same spot where the sprayer was originally filled with water. Refill the tank to the original level marked earlier, being careful to accurately record the number of litres (L) of water required to do so. This measured amount will be used in Step 6.

Step 5: Determine the swath width for broadcast spraying by measuring the distance between nozzles, in meters, and multiplying by the number of nozzles on the boom. (100 cm = 1 m; 50 cm = 0.5 m)

Step 6: Using the following formula, calculate the application rate in L/ha:

$$L/ha = \frac{\text{volume of water added – L (Step 4)}}{\text{swath width – m (Step 5)}} \times 50$$

Example for Calibration Method #2		
Step 4:	15 L water needed to refill tank	
Step 5:	13 nozzles, spaced 0.5 m apart	
	Swath width = 13 x 0.5 m = 6.5 m	
Step 6:	$\dfrac{15\ L}{6.5\ m} \times 50 = 115\ L/ha$	

How to Adjust Sprayer Output

After calibrating your sprayer, you may find that the application rate is not what you desire. Different pesticides have different recommendations for the proper water volume to use during application. Using the correct water volume will help to ensure pesticide efficacy. As a result, some adjustments to the sprayer output may have to be made. To change the application rate (or water volume) there are basically three things which can be adjusted - nozzle tip size, tractor speed, and pressure:

Nozzle Tip Size

Each nozzle tip is designed to spray a specified range of water volumes. If desired water volumes cannot be obtained by slight adjustments in spraying pressure and/or tractor speeds, a new set of nozzle tips should be purchased. Nozzle manufacturers typically supply charts to help determine water volumes at certain pressures of application, which can help when purchasing nozzles. In addition, producers may want to purchase certain nozzle types for application of certain pesticides.

The correct water volume, and therefore nozzle choice, will depend on the pesticide product being applied. If it is important to have more pest control product spead across the target plant, choose a nozzle which will deliver a higher water volume.

Tractor Speed

Tractor speed can be adjusted to affect sprayer output. By slowing speeds down, higher application rates will result. By speeding up, application rates can be decreased, but the risk of drift also increases with higher speeds. Tractor speed will also be determined by the field situation. Lower tractor speeds will be required for rough, unleveled blueberry ground in order to avoid damaging equipment.

To accurately measure ground speed, the following formula can be used:

$$\text{Ground Speed (km/hr)} = \frac{\text{Distance (m)}}{\text{Time (sec)}} \times 3.6$$

For example, if it takes 28 seconds to travel 50 metres then:

$$\text{Ground Speed (km/hr)} = \frac{50 \text{ m}}{28 \text{ sec}} \times 3.6 = 6.4 \text{ km/hr}$$

The following formula indicates how application rates can be changed by adjusting the tractor speeds.

$$\text{New tractor Speed} = \frac{\text{Calibrated Application Rate (L/ha)}}{\text{Desired Application Rate (L/ha)}} \times \text{original calibration speed}$$

For example, after calibrating a sprayer, the application rate was determined to be 100 L/ha at a speed of 8 km/hr. However, the desired application rate was 175 L/ha. What tractor speed would be needed to achieve this application rate?

$$\text{New tractor Speed} = \frac{100 \text{ L/ha}}{175 \text{ L/ha}} \times 8 \text{ km/hr} = 4.6 \text{ km/hr}$$

Pressure

Of the three adjustments, pressure should be changed the least. In order to double the spray output, the pressure would have to be increased 4 times. Increases in pressure reduce droplet size and increase the chance of drift. Pressure should therefore not be changed to any great degree. In addition, most application equipment has a recommended pressure range and these guidelines should be followed.

For small changes in sprayer output, pressure can be slightly adjusted. The following formula determines the pressure change required to deliver the spray output desired. It is very important to remember that each nozzle is designed to operate within a specified pressure range and the adjustments must not go outside this range.

$$\text{New Pressure} = \frac{\text{Desired Water Volume (L/ha)}}{\text{Actual Water Volume (L/ha)}} \times \frac{\text{Desired Water Volume (L/ha)}}{\text{Actual Water Volume (L/ha)}} \times 40 \text{ psi}$$

For example, a sprayer is applying 175 L/ha at 40 psi. What is the new pressure required to change this rate to 150 L/ha?

$$\text{New Pressure} = \frac{150 \text{ L/ha}}{175 \text{ L/ha}} \times \frac{150 \text{ L/ha}}{175 \text{ L/ha}} \times 40 \text{ psi} = 0.857 \times 0.857 \times 40 \text{ psi} = 29.4 \text{ psi}$$

Conversions

Units	Volume per Area
kPa x 0.14 = pounds per square inch	kg per ha x 0.89 = pounds per ac
hectares x 2.47 = acres	kg per ha x 0.40 = kilograms per ac
kilograms x 2.2 = pounds	g per ha x 0.015 = ounces per ac
1000 grams (g) = 1 kilogram (kg)	tonnes per ha x 0.45 = tons per ac
millilitres x 0.035 = fluid ounces	L per ha x 0.40 = litres per ac
litres x 35 = fluid ounces	L per ha x 0.09 = gallons per ac
litres x 0.22 = imperial gallons	L per ha x 14.17 = fluid ounces per ac
1000 millilitres (mL) = 1 Litre (L)	L per ha x 0.71 = pints per acre
°F = (°C x 9/5) + 32	mL per ha x 0.015 = fl. ounces per ac
°C = (°F-32) x 5/9	L per ha x 0.11 = US gallons per ac
miles per hour x 1.61 = km per hour	L per ha x 0.86 = US pints per ac
5 mL = 1 tsp	