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F Richard Beard

*Utah State University*, [rbeard@cc.usu.edu](mailto:rbeard@cc.usu.edu)

Howard Deer

*Utah State University*, [howardd@ext.usu.edu](mailto:howardd@ext.usu.edu)



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## Calibration of Boom Sprayers Using Charts to Reduce Math Calculations

### Abstract

The calibration of boom sprayers, although not difficult, is often neglected by producers. This article explains procedures for calibrating boom sprayers using charts and techniques rather than math calculations. It provides Extension educators with information they can use to give producers a quick and easy way to regularly calibrate their spray equipment.

### F. Richard Beard

Agricultural Engineering Specialist  
Internet Address: [Rbeard@cc.usu.edu](mailto:Rbeard@cc.usu.edu)

### Howard Deer

Pesticide Specialist  
Internet Address: [howardd@ext.usu.edu](mailto:howardd@ext.usu.edu)

Utah State University  
Logan, Utah

To protect the investment in agricultural pesticides, a boom sprayer should be calibrated at the start of the season and whenever application conditions change. Also, sprayer output should be periodically checked throughout the season to assure proper application rate. Although boom sprayers are calibrated in a variety of ways, each method uses the measurements of nozzle flow rate and equipment travel speed.

The following charts and procedures illustrate how easily the calibration process can be achieved. The charts provided reduce the need for math calculations. They provide Extension educators with information they can use to give producers a quick and easy way to calibrate their boom sprayers.

### Travel Speed: Miles per Hour (MPH)

Speed in MPH is based on the number of seconds required to travel 200 feet. Set up a travel speed test area where markers spaced 200 feet apart can be permanently located. Use Chart 1 to determine the actual travel speed. With the transmission in the correct gear and the throttle set in the appropriate position, drive at a uniform speed past the first marker, and begin the time. Use a stopwatch or second hand on a watch. As you pass the second marker, stop the timer.

Complete at least two trips, and average the times. Adjust travel speed up or down to match the exact time, as shown in Chart 1. Re-check the travel speed after each throttle adjustment or gear change. Calibration should be done with the spray tank 50% full and over terrain similar to field-travel, such as rough terrain, rolling hills, etc.

**Chart 1**  
Determine MPH By Seconds Required To Travel 200 Feet

Seconds per 200 Feet	68.2	54.5	45.5	39.0	34.1	30.3	27.3	24.8	22.7	21.0	19.5
Miles per Hour	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0

To calculate speed:

MPH = 136.36 ÷ Seconds Required to Travel 200 Feet

If a sprayer travels 1 mph faster or slower than required, it will under or over apply pesticides by 5-8 gallons per acre (based on 20 gallons per acre delivery rate, 3.5 MPH travel speed, 24" nozzle spacing). If an operator intends to apply 20 gallons per acre, this could result in an under or over application of 25-40%.

### **Delivery Rate: Gallons per Minute (GPM)**

The number of gallons delivered per minute by a spray nozzle can be determined by collecting the output in ounces during 1 minute. A plastic container with a 60-ounce graduated capacity should be used. Do not add pesticide to the spray tank. Calibrate using only water, and begin with the pressure gauge set at the appropriate pressure for the nozzles. Adjust the pressure to achieve the appropriate delivery rate. The following chart can be used to convert ounces-per-minute to gallons-per-minute. This procedure should be repeated for each nozzle on the boom.

**Chart 2**  
Convert Ounces Per Minute to Gallons Per Minute

Ounces per Minute	14	16	18	20	22	24	26	28	30	32
Gallons per Minute	0.11	0.13	0.14	0.16	0.17	0.19	0.20	0.22	0.23	0.25

To calculate delivery rate:

$$\text{GPM} = \text{Ounces Collected Per Minute} \div 128$$

Each nozzle is designed to deliver a predetermined volume at a given pressure. For the nozzle to provide the appropriate application rate and develop the correct pattern, it must be supplied with an uninterrupted flow of tank liquid at the correct pressure. Identically sized nozzles should provide the same delivery rate. Old or cheap pressure gauges are frequently inaccurate. Rely on the spray pattern and delivery rate rather than the numerical gauge value.

### **Spray Pattern: Type, Size, Pressure, Angle, Overlap, Height, Wear, and Blockage**

If all of the nozzles on a boom sprayer are the same size and type, then the spray pattern and delivery rate should also be the same. When operating at the correct pressure, if a clean nozzle is above or below the correct delivery rate by 10% or more, then it should be replaced. For example, if a worn tip is designed to deliver 0.20 GPM and it delivers at or below 0.18 GPM or at or above 0.22 GPM, then it should be replaced. Also, if brass or plastic nozzles are being used and two or more nozzles show excessive wear, all nozzles of the same age should be replaced.

Determining spray pattern overlap and measuring uniformity of distribution can be difficult. Visual appraisal of the spray patterns while stationary equipment is operating at the correct pressure will frequently reveal problems. A new nozzle can also be installed for comparison. If the patterns are not the same or spray overlap is incorrect, this may be easily observed. Another way to visually appraise the spray pattern requires access to a large concrete or asphalt area such as a parking lot, driveway, or private road.

On a warm, calm, sunny day, while applying only water, spray a hard flat surface for a distance of 20-30 feet. Make sure the boom sprayer is operating at the appropriate pressure and traveling at the correct speed. The sun should be shining evenly on the surface sprayed, and the surface should be free of debris and dirt. As soon as the test strip is sprayed, stop the spray rig and turn off the sprayer. Closely observe the wet area that was just sprayed. If the spray was applied uniformly, it should evaporate uniformly. For broadcast or band spraying, the wet areas should evaporate uniformly from start to finish. The boom may need to be positioned closer to the surface in some situations.

For broadcast spraying, if the moisture appears as stripes while evaporating, then the nozzles could be worn, the flow might be blocked, or the nozzle overlap or boom height might be incorrect. For band spraying, either wide or narrow strips can be caused by similar problems. Under both spraying conditions, this test will make it obvious if one or more nozzles are not operating correctly. Adjusting and/or replacing components will allow the spray evaporation test to result in fairly uniform evaporation. This is a subjective evaluation, with much room for interpretation and error. To achieve best results, the "spray and observe" process should be repeated three to four times, and the pattern carefully evaluated each time.

If problems are apparent, the malfunctioning nozzles should be cleaned or replaced. If worn, blocked, and/or damaged nozzles are used on a spray unit, the resulting outcome will reflect the pattern sprayed. Under-treated and over-treated areas will be obvious, and misapplications of materials such as herbicides can be easily recognized.

### **Application Rate: Gallons per Acre (GPA) and Gallons per Minute (GPM)**

When applying a pesticide, it is important that label directions are followed. An applicator's failure

to follow label directions can result in criminal penalties and/or fines. Do not exceed the application rate specified on the pesticide label. Read and follow the label directions.

Spray operators commonly select a convenient pesticide application rate. Rates such as 10 or 20 gallons of mixture per acre are frequently selected. Higher rates, such as 20 gallons per acre, offer better coverage of the target site, while lower rates, such as 10 gallons per acre, provide greater field coverage per tank-full. For future reference, applicators should keep detailed records of pesticide dilutions, application rates, sprayer travel speed, pressure settings, spray sites, and results.

**Chart 3**

Determining Application Rate In Gallons Per Acre (GPA) And Gallons Per Minute (GPM)

Travel Speed	Nozzle Spacing	Application Rate	
		GPA	GPM
3.5	20	10	0.12
3.5	20	20	0.24
3.5	24	10	0.14
3.5	24	15	0.21
3.5	24	20	0.28
4	20	10	0.13
4	20	20	0.27
4	24	10	0.16
4	24	15	0.24
4	24	20	0.32
4.5	20	10	0.15
4.5	20	20	0.30
4.5	24	10	0.18
4.5	24	15	0.27
4.5	24	20	0.36
5	20	10	0.17
5	20	20	0.34
5	24	10	0.20
5	24	15	0.30
5	24	20	0.40

To calculate application rate:

$$\text{GPA} = \text{GPM} \times 5940 \div \text{MPH} \div \text{Nozzle Spacing in Inches}$$

$$\text{GPM} = \text{GPA} \times \text{MPH} \times \text{Nozzle Spacing in Inches} \div 5940$$

$$\text{GPM} \times 128 = \text{Ounces per Minute}$$

For band spraying, substitute the band width, in inches, for the nozzle spacing.

When adjusting spray calibration equipment for optimum performance, spray pressure is adjusted for small changes in delivery rate; travel speed is increased or decreased for larger adjustments; and tip replacement is the preferred method for major changes in delivery rates.

### Pesticide and Water Mixtures: Quantity of Pesticide per Gallon or Tank

Pesticide labels include information specific to applications rates and target plants or organisms. For agricultural applications, the rates commonly appear as a volume or weight on a per acre basis. Application rates may appear as ounces, gallons, or pounds per acre. Additional information includes the minimum number of gallons of water that should be used to dilute the pesticide. The following chart provides mixing information for commonly used equipment and pesticide formulations.

**Chart 4**

Pesticide And Water Mixtures

Spray Tank Capacity	Application Rate, Water, & Pesticide	Pesticide Label Application Rate		Pesticide Required per Full Tank		
		Gal./Acre	Lb./Acre	Gal./Tank	Oz./Tank	Lb./Tank
Gal.	Gal./Acre	Gal./Acre	Lb./Acre	Gal./Tank	Oz./Tank	Lb./Tank
400	20	0.2		4		
400	15	0.2		5.33		

400	10	0.2		8		
400	10	0.1		4		
200	20	0.2		2		
200	15	0.1		1.33		
200	10		0.25			5
100	15	0.1		0.67	85.3	
100	10	0.1		1	128	
100	10		0.25			2.5
25	10	0.1		0.25	32	
25	10		0.5			1.25
10	10		0.5			0.5

To calculate pesticide and water mixtures:

Acres Sprayed per Full Tank = Tank Capacity in Gallons ÷ Application Rate in GPA

Gallons of Pesticide per Full Tank = Acres Sprayed per Full Tank x Application Rate in GPA

Care should be taken when filling a spray tank so that the water supply is protected from contamination and back siphoning. Individuals mixing pesticides should wear the appropriate personal protective equipment (PPE) as specified by the product label.

### General Guidelines

If agricultural spray equipment is maintained and worn nozzles or components are regularly replaced, then a calibration check will require just a few minutes each time a sprayer is operated, and producers are much more likely to do it.

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