Improving Sprayer Accuracy

Simple Methods for Correct Calibration

by Tom Karsky

Accurate sprayer application is important for good farm management. Improper calibration is not only expensive, resulting in the overuse of materials, but it can be damaging to crops as well. Proper sprayer application is also necessary for human and environmental safety. The following methods will help you determine correct calibration.

Suppose you intend to apply an herbicide at a rate of 3/4-pound active ingredient (a.i.) per acre at a cost of $25 per pound a.i. The cost of material is $18.75 per acre. If you make an application error and over apply by 30 percent, for example, you'll waste $5.75 an acre (30% of .75 lbs = .23 lb; .23 lbs @ $25/lb = $5.75). If this application covers 200 acres, you are wasting $1,150 in excess material.

It takes approximately one hour to calibrate a spray rig. In that time you can earn $1,150 for yourself.

The other possibility is under application. It has been estimated that a 20 percent under application of an herbicide can reduce control by 50-60 percent. This may require a repeat application and a doubling of cost.

Methods for Correct Calibration

To get the most efficient use out of your sprayer and avoid unnecessary costs, correct calibration is important. Before you calibrate your sprayer, however, make sure that it is working properly and that all the nozzles are cleaned and the system flushed out. The general formula for calibration is:

$$GPA \text{ (gallons per acre)} = \frac{5940 \times GPM \text{ (gallons per minute) per nozzle}}{MPH \text{ (speed)} \times W \text{ (nozzle spacing in inches)}}$$

The first thing you want to check is the ***sprayer speed*** (MPH). Even if you are using a speedometer to gauge speed, slippage on the ground surface can cause speedometer errors of as much as 30 percent. You need to mark a course and time how long it takes to travel that distance. The minimum distance should be 100 feet. The longer the distance, the more accurate your speed determination will be. Use the following table to determine the actual speed. This formula will help you determine proper calibration, of the amount of material to apply in gallons per acre (GPA). You can also rewrite this formula to calculate sprayer speed in MPH. That is, if you want to know what speed is required to apply a certain amount of material in gallons per acre, then use

$$MPH = \frac{5940 \times GPM^{*}}{GPA \times W}$$

* Abreviations:
GPA = Gallons Per Acre
GPM = Gallons Per Minute Per Nozzle
MPH = Miles Per Hour
W = Nozzle Spacing in Inches
5940 = A constant to convert gallons per minute, miles per hour, and inches to gallons per acre.

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Speed in MPH	Time required in SECONDS to travel a distance of:		
(miles per hour)	100 feet	200 feet	300 feet
3.0	23	45	68
3.5	20	39	58
4.0	17	34	51
4.5	15	30	45
5.0	14	27	41
5.5	12	25	37
6.0	—	23	34
6.5	—	21	31
7.0	—	19	29
7.5	—	18	27
8.0	—	17	26
8.5	—	16	24
9.0	—	15	23

The next step is to determine the ***nozzle output****. To do this, you need a calibrated catch container. This can be any container that has markings on it for ounces, such as a measuring cup or baby bottle. Make sure that the difference between markings is small. For example, do not use a container that has markings every four ounces. Ideally, it should have markings every one or two ounces. Spray equipment suppliers should have calibrated containers available.

An easy way to determine the output of the nozzle is to use the ***47 second catch*** method where the ounces you collect in 47 seconds divided by 100 equals the GPM (gallons per minute) output of the nozzles. You need to check all the nozzles to determine if any or all are worn.

The 47 Second Catch Method

$$GPM = \frac{\text{ounces collected in 47 seconds}}{100}$$

To determine the gallons per acre, use one of these formulas:

For 20" spacing GPA = $\frac{300 \times GPM}{MPH}$ *or* $\frac{3 \times ozs^*}{MPH}$

For 30" spacing GPA = $\frac{225 \times GPM}{MPH}$ *or* $\frac{2.25 \times ozs^*}{MPH}$

For 40" spacing GPA = $\frac{150\ GPM}{MPH}$ *or* $\frac{1.5 \times ozs^*}{MPH}$

**Ounces collected in 47 seconds*

***** *Once the GPM has been determined then select the proper nozzle size from spray nozzle catalog charts.* ***Note****: These charts are calibrated for water, if the solution is heavier or lighter than water use the conversion charts in the catalog. Charts are also available in catalogs to determine pressure drop in the system due to hoses.*

Record the amounts and average them. If any vary more than 10 percent from the average, replace them. If several fall into that category, replace the whole set. With the ***47 second catch*** method you can simplify the math by using the following formulas:

If you have a ground-driven sprayer, or choose to collect output from the sprayer as it is traveling, you may want to use the ***ounce method*** to determine sprayer output. When using this method, ***the ounces that you collect are equal to gallons per acre output*** of the sprayer. Use the following chart to determine the distance you need to collect spray. Make sure you flush the system and that the sprayer is operating fully for some time at the proper speed before you collect spray. Collect from several nozzles and average them.

Ounce Collected Method

Calibration Distances

Row or Nozzle Spacing (inches)	Calibration Distances (feet)*
40	102
38	107
36	113
34	120
32	127
30	136
28	146
26	157
24	170
22	185
20	204
18	227

* Number of feet to collect output so that ounces collected per nozzle = Gallons Per Acre

Adding Tank Material

After you have determined that your sprayer is delivering the amount of spray that it should, you need to add the correct ***amount of material to the tank.*** Always follow label directions for adding material to the tank. See the *Useful Formulas and Equivalents* section for conversion of ounces to pints on the back of this publication.

Suppose that you have a liquid material recommendation that calls for .5 lb/a.i. per acre and it

comes in a 4 lb/a.i. per gallon formulation. Your sprayer has a 300 gallon tank and it is calibrated for 10 GPA(gallons per acre). How much material do you add to the tank? You first need to determine how many acres the sprayer will cover per tankful. Then multiply that number times the amount of material per acre needed. For example, a 300 gallon tank divided by 10 gallons per acre output equals 30 acres covered per tank; .5 lb/a.i. per acre recommended divided by 4 lb/a.i. per gallon formulation equals .125 gallon per acre needed, which equals one pint. Therefore, you need 30 pints or 3.75 gallons of material, as the following illustrates.

$$\frac{\text{300 gallon tank}}{\text{10 GPA}} = \text{30 acres per tankful}$$

$$\frac{\text{0.5 lb. a.i. (spray recommendation)}}{\text{4 lb a.i./gal (formulation)}} = .125 \text{ gal/acre} = 1 \text{ pint}$$

(128 oz (1 gal) x .125 = 16 oz or 1 pint)

30 acres/tankful x 1 pt/acre = 30 pts = 3.75 gal/tank to add to tank

If you have a dry material recommendation of 2 lb/a.i. per acre and the material is an 80 percent wettable powder formulation, how much material do you add? Using the same sprayer, you know that you can cover 30 acres per tankful. To determine the amount of material needed per acre, divide the percentage of active ingredient (80%) into the total (100%) and multiply this times the active ingredient needed per acre (2 lb). In this case, we need 2.5 lb per acre or 75 lbs per tankful, as the following illustrates.

$$\frac{100\%}{80\%} \times 2 \text{ lb a.i.} = 2.5 \text{ lb of product/acre}$$

2.5 lb x 30 acres/tankful = 75 lb/tankful

Field Calibration Measured Course

To verify whether or not a sprayer is calibrated correctly, a field test can be performed. Measuring the material used over a known acreage can help determine application rates. However, use the following procedure to determine and/or verify the actual application rate, since only a small area is treated.

1. Measure off a distance of $^1/_8$-mile (660 feet or 40 rods). It is best to run the test in the field that will be sprayed, since sinkage in a soft field can change travel speed.
2. Start with a full spray tank. Be sure to eliminate air pockets in the pump, lines, and tank. Water (or the usual carrier) will usually do for calibration, but if you are using a chemical that changes the viscosity of the carrier, you should use the chemical as it will be sprayed.
3. Spray the $^1/_8$-mile strip, using the gear and throttle setting that you will use while spraying. You should run the engine well into the governed rpm range so that the governor can hold the speed constant.
4. Measure carefully the amount of water needed to refill the tank. Again, be careful to eliminate air pockets in the tank.
5. Calculate the application rate as follows:

   Broadcast:

   $$\frac{\text{Gallons used x 66}}{\text{Swath width in ft.}} = \text{Gallons per treated acre}$$

   Banding:

   $$\frac{\text{Gallons used x 66}}{\text{Band width in ft. x number of bands}} = \text{Gallons per treated acre}$$

6. Divide tank capacity by gallons per acre determined in step 5. This gives the number of acres covered by one tankful of spray.
7. To determine the amount of chemical to add to each tank, multiply the recommended application rate by the number of acres covered per tankful.

More information on sprayer calibration and spray equipment can be obtained from *Spray Equipment and Calibration* (BUL 658), available for $2 from Agricultural Publications, University of Idaho, Moscow, Idaho 83844-2240, TEL & FAX 208-885-7982; email cking@uidaho.edu. Add 50¢ postage and handling plus 5% Idaho tax in Idaho.

About the Author–

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See the **Useful Formulas and Equivalents** section for conversion of ounces to pints on the back of this publication.

Useful Formulas and Equivalents

1 acre = 43,560 square feet
1 gallon = 128 fluid ounces
1 pint = 16 fluid ounces
1 pound = 16 ounce of weight.
(16 fluid ounces of water at
39 degrees Fahrenheit
weighs 1 pound)

$$GPA = \frac{5940 \times GPM}{MPH \times W}$$

$$GPM = \frac{GPA \times MPH \times W}{5940}$$

$$\text{Ounces per minute} = \frac{GPA \times MPH \times W \times 32}{1485}$$

MPH = distance traveled (ft) / (88 x minutes)
= distance traveled (ft) / (.47 x seconds)

Rate per Acre	
Oz/Acre	Pints/Acre
4.0	1/4
5.3	1/3
8.0	1/2
10.7	3/4
16.0	1
20.0	1 1/4
24.0	1 1/2
28.0	1 3/4
32.0	2

GPA = Gallons Per Acre
GPM = Gallons Per Minute Per Nozzle
MPH = Miles Per Hour
W = Nozzle Spacing in Inches

Gallons Sprayed per Tankful

Gallons per Acre	Acres per Tankful for Various Capacities in Gallons						
	30	50	100	150	200	300	500
5	6.0	10	20	30	40	60	100
6	5.0	8.3	16.7	25	33.3	50	83.3
7	4.3	7.1	14.3	21.4	28.6	42	71.4
8	3.8	6.3	12.5	18.8	25.0	37.5	62.5
9	3.3	5.6	11.1	16.7	22.2	33.3	55.6
10	3.0	5.0	10.0	15.0	20.0	30.0	50.0
15	2.0	3.3	6.7	10.0	13.3	20.0	33.3
20	1.5	2.5	5.0	7.5	10.0	15.0	25.0

To determine acreage actually covered when band spraying, apply the following formula:

$$\textit{Crop acres band sprayed} = \frac{\textit{Acres per tankful x row width (inches)}}{\textit{Width of band (inches)}}$$

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