G88-865 Fine Tuning a Sprayer wih the "Ounce" Calibration Method

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Fine Tuning a Sprayer with the "Ounce" Calibration Method

This NebGuide discusses guidelines to quickly evaluate the performance of a sprayer. Sprayer calibration, nozzle discharge and speed checks are evaluated with minimal calculations.

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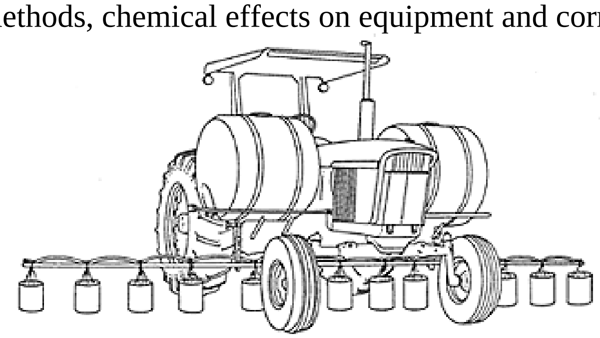
Tractor-mounted, pull-type, pick-up mounted and self-propelled pesticide application equipment are available from numerous sources. pesticide costs, potential crop damage, unsatisfactory control and environmental concerns make correct application important.

Proper calibration to ensure accurate application must be a primary management consideration for both farmers and custom applicators. Application equipment users also should know proper application methods, chemical effects on equipment and correct cleaning and storage procedures of liquid sprayers.



pesticide application depends on the combination of six basic factors, which are sprayer design, nozzle type, boom height, boom pressure, agitation and ground speed. pesticides are applied correctly when pesticides have been mixed properly.

Properly applied pesticides are expected to return a profit. Improper application can result in wasted chemical, marginal weed, insect or disease control, excessive carry-over, water contamination and/or crop damage. Inaccurate application can be expensive.

Pre-season visual checks of application equipment are not adequate for accurate application, nor is the fact that the equipment and nozzle tips are new. A recent Nebraska survey found only one of three sprayer operators applying pesticides within five percent of their estimated rate. This survey illustrates that sprayers must be checked to ensure that all nozzles have the correct discharge rate, and are applying pesticides uniformly and at the correct pesticide rate. Manufacturer's catalogs are guidelines, but fine-tuning a sprayer is the operator's responsibility.

Sprayers should be calibrated every time a different pesticide is applied. In addition, a sprayer should be checked at least every other day when in continuous use. Since these six factors are used in the right combination and when the these checks may have to be performed often, evaluating a sprayer quickly and without excessive investment in equipment or calculation is important.

Table 1. Calibration Distances and Speeds for Varying Nozzle or Row Spacing

Nozzle or Row Spacing (in)	*Calibration Distance (ft)*	*Time in Seconds for Various Ground Speeds (MPH)**							
		3.0	*3.5*	*4.0*	*4.5*	*5.0*	*6.0*	*7.0*	*8.0*
40	102	23.2	19.9	17.4	15.5	14.0	12.6	9.9	8.7
38	107	24.3	20.8	18.2	16.2	14.6	12.2	10.4	9.1
36	113	25.7	22.0	19.3	17.1	15.4	12.8	11.0	9.6
34	120	27.3	23.4	20.5	18.2	16.4	13.6	11.7	10.2
32	127	28.9	24.7	21.6	19.2	17.3	14.4	12.4	10.8
30	136	30.9	26.5	23.2	20.6	18.5	15.5	13.2	11.6
28	146	33.2	28.4	24.9	22.1	19.9	16.6	14.2	12.4
24	170	38.6	33.1	29.0	25.8	23.2	19.3	16.6	14.5
22	185	42.0	36.0	31.5	28.0	25.2	21.0	18.0	15.8
20	204	46.4	39.7	34.8	30.9	27.8	23.2	19.9	17.4
18	227	51.6	44.2	38.7	34.4	31.0	25.8	22.1	19.3 +
16	255	58.0	49.7	43.5	38.6	34.8	29.0	24.8	21.7
14	291	66.1	56.7	49.6	44.1	39.7	33.1	28.3	24.8

*1 MPH = 88 feet per minute
+ Note: for times less than 20 seconds, improved accuracy can be attained by doubling the collection time (Step 3), and dividing the output collected by two.

There are a number of calibration techniques. The following outlines a method for quick sprayer calibration.

Calibration--Determining Gallons Per Acre

The purpose of any calibration method is to determine the number of gallons of spray solution (both pesticide and carrier) being applied per acre. Subsequently, the solution volume applied per acre can be used to determine the quantity of pesticide to be added in the spray tank.

The following method has four steps. **No calculations are required.** Calibration equipment needed includes: a stopwatch, a container to collect nozzle discharge, a tape measure, marking flags, and a

container graduated in ounces. The procedure is as follows:

Step 1. Select the travel distance according to the nozzle spacing on the sprayer using *Table 1*. Measure the travel distance in a level field. The travel area should be typical of the surface and soil conditions of the area to be sprayed. Many tractors and sprayers will gain or lose in excess of 10 percent of desired travel speed while moving up and down slopes.

If field variations exist, several speed check areas may be needed. Remember, the time required to drive the travel distance will give the speed of the sprayer, so the measured distance and timing must be exact.

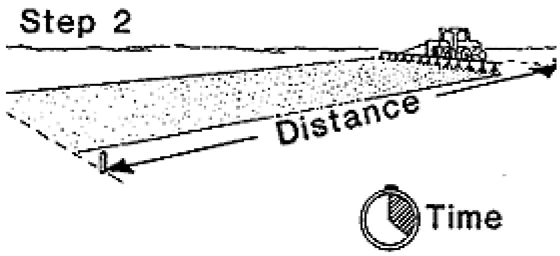


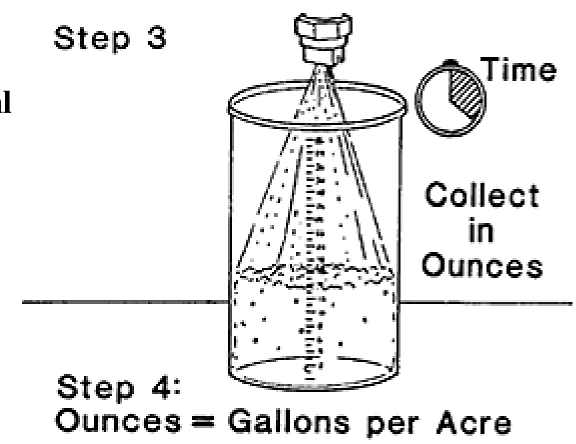
Figure 1. Measure the appropriate length for the nozzle spacing, then measure the time to run the course.

Step 2. Drive and time the sprayer in seconds (*Figure 1*) at the throttle setting, pressure setting and load used during spraying (spray tank should be 1/2 to 2/3 full). Engage incorporation equipment (disks, planter, etc.) or other devices used while spraying. Repeat at least three times and average the results. Do not change the gear or throttle setting after you have chosen a spraying speed. A change in ground speed will change the sprayer application rate and will require recalibration.

Step 3. While in a stationary position, bring the power unit to the proper throttle setting and sprayer to the boom pressure used in Step 2. Catch the nozzle discharge for the time recorded in Step 2. Measure the discharge in ounces (*Figure 2*) with a graduated container. For an accurate assessment of the sprayer, measure all nozzles and average the results.

Remember, from a safety point of view, the collection of discharge should be done *using water only!* Even while collecting water use the proper personal safety clothing and protection.

Figure 2. In stationary position and proper boom pressure, measure the output over the same time period to made the run. The number of ounces collected is equal to the gallons per acre.



Step 4. The measured ounces from a nozzle are equal to gallons per acre that will be applied Since this calibration was based on water, conversion factors (*Table 2*) must be used when spraying solutions heavier or lighter than water. Multiply the observed rates of water by the conversion factors to attain the rate of other spray solutions.

Table 2. Conversion Factors for Solutions with Densities Different than Water.		
Density of Solution (lbs/gallon		*Conversion Factors*
7.0		1.092
8.0		1.021
8.34	Water	1.000
9.0		.963
10.0		.913
10.65	28% nitrogen solution	.885
11.0	7-27-7 fertilizer	.871
11.06	32% nitrogen solution	.868
11.40	10-34-0 fertilizer	.855
11.50	12-0-0-26 fertilizer	.852
11.60	11-37-0 fertilizer	.848
12.0		.834
14.0		.772

Nozzle Discharge and Uniformity Check

Nozzle condition influences the uniformity of application. Observe the spray pattern from each nozzle. If the spray pattern is not uniform from visual observations, large output variations exist. Often poor spray patterns are due to clogged nozzle and strainer components. To clean a metal nozzle or strainer use an old toothbrush or a wooden toothpick. For plastic tip nozzles use only a toothbrush (special nozzle cleaning brushes are available). Always recalibrate after cleaning and never use a metal object when cleaning a nozzle or strainer.

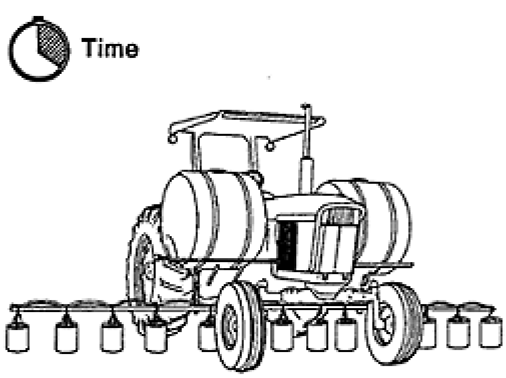


Figure 3. Check the discharge from each nozzle across the boom.

Check nozzle discharge uniformity (*Figure 3*) by repeating Steps 3 and 4 for all nozzles. If a single nozzle has a discharge output that is not within 10 percent of the average output of all the nozzles, then replace the nozzle. If more than one nozzle is not satisfactory, replace all the nozzles. After adjustment or correction, recalibrate.

Example of "Ounce Calibration"

Suppose a sprayer was set up with 30 inch nozzle spacing.

Step 1. Using *Table 1*, 136 feet was marked off and the sprayer was driven through the course three times; the time was recorded and the pressure checked.

Step 2. The average time recorded was 21 seconds and the pressure was 30 PSI. According to *Table 1*, the travel speed was about 4.5 mph.

Step 3. In a stationary position, the sprayer was brought to the proper pressure of 30 PSI. Nozzle outputs were collected for 21 seconds as measured in Step 2. The discharge was measured as:

Nozzles	Output in Ounces for 21 Seconds
1.	14.5
2.	13.0 *****
3.	15.5
4.	15.0
5.	15.5
6.	15.0
7.	14.5
8.	15.5
9.	16.0
10.	15.5
	Average = 15.0 ounces +10% = 16.5 ounces -10% = 13.5 ounces

Step 4. The average of all nozzles was 15.0 ounces, so the calibration of the sprayer was 15 gallons per acre. Notice that nozzle number two is outside the 10 percent satisfactory range; this nozzle should be cleaned or replaced and rechecked.

Suppose the actual carrier will be 28 percent fertilizer and not water. The spray volume must be adjusted. Using *Table 2*, the actual spray volume would be: [15 CPA x .885 (*Table 2*)] = 13.3 CPA for a 28 percent fertilizer solution. This would be the value used to determine the proper amount of pesticide to add in the spray tank.

Band Sprayer Calibration

The same calibration method used for broadcast spraying can be used to calibrate band applicators. The only difference is the amount of area being covered.

A broadcast application means the total area or the entire acreage in the field was sprayed. A band application refers to the method that sprays strips or only a portion of the field. A treated acre then refers only to the treated area in the band.

When calibrating a band sprayer, consider the row spacing and the nozzle spacing are the same. But

when banding, the total acres sprayed by a given volume will be greater than broadcasting. A conversion is necessary to determine the amount of pesticide to be added in the tank. After performing **Steps 1** through **4** of the "ounce" calibration method, multiply the answer (broadcast spray volume) by the appropriate conversion factor (*Table 3*) to attain the band rate.

Table 3. Conversion factor to convert broadcast spray volume (gallons per total acre) to band spray volume (gallons per treated acre)

Band width (in.)	*Row spacing (inches)*			
	20	*30*	*36*	*40*
8	2.5	3.8	4.5	5.0
10	2.0	3.0	3.6	4.0
11	1.8	2.7	3.3	3.6
12	1.6	2.5	3.0	3.3
13	1.5	2.3	2.8	3.1
14	1.4	2.1	2.6	2.9
15	1.3	2.0	2.4	2.7
16	1.2	1.9	2.3	2.5

Unless otherwise specified, chemical application rates are given on a broadcast basis. For band applications, the rate per treated area is the same as the broadcast label rate, but the total amount of pesticide used on a field is less because only a portion of the field is treated.

Ground Speed Check

A survey of spray application equipment indicated 65 percent of the operators had errors of greater than five percent in estimated field travel speed. **Step 2** of the described sprayer calibration method provides the actual speed the sprayer was going under field conditions. Because of wheel slippage and rough surface conditions, the actual speed often is lower than the tachometer or speedometer readings. For a more accurate measurement of travel speeds, mark off a distance of 220 feet. Drive and time the operation as in **Step 2**. The speed is calculated as:

$$\text{MPH} = \frac{150}{\text{Seconds timed to travel 220 ft}}$$

Conclusions

Calibrate frequently. The "Ounce" calibration method describes a procedure with minimal calculations in order to evaluate a liquid sprayer. Wallet size plastic cards (EC 87-726) outlining this particular method of sprayer calibration are available through the Nebraska Cooperative Extension Service.

Most farmers use the "Known Area" calibration method. This method requires the operator to know a given area, then observe the number of gallons of liquid applied on that area by the sprayer. The gallons per acre can be calculated by dividing the number of gallons applied by the known acres covered.

The method is a useful field check but should not be-the primary method because a misapplication error can occur before it can be detected. Use the "Ounce" calibration method; it does not require cumbersome equations or calculations, and is simple to use.

Spray equipment in good condition will apply chemicals properly if frequently calibrated and correctly operated. Manufacturer's manuals include tables to show spray volumes (GPA) for various nozzles, pressures and ground speeds. Use this information to initially set up the sprayer, then use the "Ounce" calibration method to evaluate and fine tune the sprayer for accurate application.

Weight and Measures Conversions

Weight
- 16 ounces = 1 pound = 453.6 grams
- 1 gallon water = 8.34 pounds = 3.78 liters

Liquid Measure
- 1 fluid ounce = 2 tablespoons = 29.57 milliliters
- 16 fluid ounces = 1 pint = 2 cups
- 8 pints = 4 quarts = 1 gallon

Length
- 3 feet = 1 yard = 91.44 centimeters
- 16.5 feet = 1 rod
- 5280 feet = 1 mile = 1.61 kilometers
- 320 rods = 1 mile

Area
- 9 square feet = 1 square yard
- 43,560 square feet = 1 acre = 160 square rods
- 1 acre = 405 hectare
- 640 acres = 1 square mile

Speed
- 88 feet per minute = 1 MPH
- 1 MPH = 1.61 km/h

Volume
- 27 cubic feet = 1 cubic yard
- 1 cubic foot = 1,728 cubic inches = 7.48 gallons
- 1 gallon = 231 cubic inches
- 1 cubic foot = 0.028 cubic meters

Common abbreviations and terms used:
GAM = gallons per minute
GPA = gallons per acre
PSI = pounds per square inch
MPH = miles per hour
RPM = revolutions per minute
GPH = gallons per hour
FPM = feet per minute

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