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CALIBRATION OF HERBICIDE APPLICATION EQUIPMENT

T. N. Jordan, M. A. Ross and T. T. Bauman, Extension Weed Specialists

Safe, effective use of herbicides to control weeds in crops requires precise calibration of spray equipment. Accurate calibration ensures the correct dosage to control weeds, eliminates damage to crops caused by over-application of chemicals, and avoids the extra cost of excessive rates. An underdose does not control the weeds, and an overdose is wasteful and may injure or kill your crop or cause toxic herbicide residues in the soil. Applicators of restricted use herbicides must, by law, properly calibrate their equipment.

There are several ways to calibrate herbicide application equipment; all are correct. The particular method selected depends upon individual preference. All calibration procedures for liquid herbicide equipment involve selection of the right combination of nozzle type, nozzle orifice size, number of nozzles, nozzle placement, spraying pressure, and sprayer speed for the volume rate desired. The methods described in this publication are intended to help in calibrating herbicide application equipment in accordance with the need and understanding of the individual applicator.

Before any herbicide equipment can be calibrated, several pre-calibration operations need to be checked.

1. Operating parts of your sprayer should be checked for proper functioning. Repair or replace malfunctioning parts.
2. Clean nozzle tips and screens.
3. Select and install correct nozzles and screens (size and shape) for the particular spraying job.
4. Check each nozzle for delivery and spray pattern. Replace worn or defective nozzles.

Calibration Methods

Full Tank Method - (broadcast)

The full tank method is where you fill the spray tank with water and, maintaining desired operating speed, spray until the tank is empty. Then calculate the area covered.

a. Fill sprayer tank with a normal load of water (determine gallons in the tank).

b. Set desired pressure (normally 25-35 psi).

c. Spray at operating speed until tank is empty.

d. Measure the area covered.

e. Calculate delivery rate.

\[
\text{Gallons/acre} = \frac{\text{gallons in full tank}}{\text{No. of acres sprayed}}
\]

Example: 100 gallons in tank; 5 acres sprayed; thus gallons per acre = \(\frac{100}{5}\) or 20.
f. Determine the herbicide rate per acre needed from state recommendations or herbicide label.

g. Multiply rate per acre needed times acres covered by 1 tankful. This equals the amount needed in the spray tank.

In the above example one tank load covered 5 acres. If the recommended rate of a herbicide was 3 pints per acre then multiply 3 pints per acre times 5 acres per tank. This equals 15 pints per tank needed.

One-Fourth Acre Method (broadcast)

a. Fill tank with water.

b. Adjust spray pressure and ground speed to be used in spraying.

c. Spray 1/4 acre (10,890 square feet). Distance traveled will vary with boom width. Example: If boom width is 22 feet then the distance needed to travel to cover 1/4 acre equals 10,890 sq. ft. / 22 ft. = 495 ft. (distance needed to travel).

d. Measure amount of water needed to refill tank.

e. Multiply gallons needed to refill tank by 4 to determine gallons per acre.

f. Divide gallons in the tank by gallons per acre for acres covered per tank.

g. Determine the amount of herbicide needed per acre from state recommendations and/or herbicide label. Multiply this rate by acres covered per tank to determine the amount of herbicide needed per tankful. Gallonage per acre can be adjusted by varying the tractor speed or changing the nozzle size. Recalibrate after making each adjustment.

One-fourth Acre Method (band)

This method is used when drop nozzles are mounted behind the planter.

a. Fill tank with water.

b. Adjust spray pressure and ground speed to be used in spraying.

c. Set nozzles to spray the desired band width over each row.

d. Spray 1/4 acre (10,890 square feet).

The distance traveled will vary with the number of rows on the planter and the row width. Example: Band spraying over 4 rows spaced 40 inches requires 817 feet to cover 1/4 acre:

\[
\text{distance traveled} = \frac{10,890 \text{ sq. ft.}}{4 \times 40 \text{ inches}} = 3,33 \text{ ft.}
\]

\[
= 817 \text{ feet (distance traveled)}.
\]

e. Measure water needed to refill tank.

f. Multiply gallons needed to refill tank times 4 to determine gallons per total field acre.

g. Determine the amount of herbicide needed per acre broadcast from state recommendations or herbicide labels. Calculate rate of herbicide needed for band application by:

\[
\frac{\text{band width (inches)}}{\text{row width (inches)}} \times \text{rate for per acre broadcast}
\]

= amount needed for band treatment

Example: You are applying Lasso on a 20-inch band on a 40-inch row. Using the 1/4 acre method for 4-row boom you determined that you need 5 gallons of water in 817 feet. Five gallons times 4 (for 1 acre) equals 20 gallons per acre. Your equipment is delivering 20 gallons per field acre broadcast. The Lasso label states 2 quarts per acre broadcast. How much is needed for a 20-inch band on a 40-inch row?

\[
\frac{20 \text{ inches}}{40 \text{ inches}} \times 2 \text{ quarts} = 1 \text{ quart needed.}
\]

Thus, you will need 1 quart for every 20 gallons of water.

1/128 Acre Method (broadcast)

This method is based on the fact that the spray volume in ounces delivered by a nozzle while spraying an area equal to 1/128 acre is equal to the application rate in gallons per acre because there are 128 ounces in a gallon.

a. The distance traveled to spray 1/128 acre (broadcast) depends upon the swath width of each nozzle. There are 340 square feet in 1/128 acre, thus the distance traveled
can be calibrated by distance traveled (feet)
\[
= \frac{340 \, ft^2}{\text{nozzle swath width (ft)}}
\]

<table>
<thead>
<tr>
<th>Nozzle swath width (inches)</th>
<th>Distance traveled to equal 1/128 acre (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>408</td>
</tr>
<tr>
<td>12</td>
<td>340</td>
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<td>60</td>
<td>68</td>
</tr>
<tr>
<td>80</td>
<td>51</td>
</tr>
</tbody>
</table>

Example: If you wish to apply 11 gallons per acre and your nozzles are spaced 22 inches apart on a sprayer that travels 4.2 mph, how many seconds will it take to catch 1 quart from 1 nozzle?

\[
\text{Time needed} = \frac{89,100}{(22 \times (11) \times (4.2))} = 87.66 \text{ seconds}
\]

Catch 1 quart from one nozzle in 88 seconds to spray 11 gallons per acre. Adjust pressure until this rate is delivered. The same formula can be used for one or more nozzles per row by substituting row spacing for nozzle spacing and catching 1 quart from all nozzles directed to one row in the calculated number of seconds.

The number 89,100 is a constant which takes into account all factors needed to allow this formula to be used for any calibration of row spacing, tractor speed, and/or gallons per acre desired.

The 13,068 Row Feet Method (for a band of any width)

There are two procedures that serve almost any calibration need of the farmer. The first is suggested for your initial calibration, while the second is suggested for your regular daily checks throughout the spraying season. These procedures apply for preplant, preemergence, or postemergence applications which are made either broadcast or on bands of any desired width on a row of any width. The calibration is based on a specific volume per 13,068 linear feet of row, rather than on a per acre basis.

<table>
<thead>
<tr>
<th>Row Width</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-inch</td>
<td>1.05</td>
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<tr>
<td>40-inch</td>
<td>1.00</td>
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<tr>
<td>38-inch</td>
<td>0.95</td>
</tr>
<tr>
<td>36-inch</td>
<td>0.90</td>
</tr>
<tr>
<td>30-inch</td>
<td>0.75</td>
</tr>
<tr>
<td>12-inch</td>
<td>13,068 feet long should receive the same amount of chemicals regardless of the row width. The same holds true for any other band width.</td>
</tr>
</tbody>
</table>
a. Procedure 1 (for initial calibration)

1. Mount planting and spray equipment. Fill spray tank with water and check to make certain that planting and spraying equipment is operating properly.

2. Measure off 300 feet in the field and time tractor over the course at the desired throttle setting and gear. Timing more than once will give greater accuracy.

3. Refer to Table 3 (second to travel 300 feet) to determine miles per hour. Example: If it took 49 seconds to travel 300 feet then your tractor is traveling 4.2 mph.

4. Decide the per acre volume you want to use. Opposite the appropriate miles per hour or seconds to travel 300 feet you will find columns headed from 6 to 20 gallons per acre. Select the column that corresponds with the gallons per acre you want to use.

5. Start pump at same throttle setting used to determine speed and check time to fill one quart from all nozzles directed to each row. The correct time in seconds is shown across from the speed and below the gallons per acre. Adjust pressure up and down to catch a quart at the correct number of seconds. Example: To apply 12 gallons per acre (broadcast or on a band of any width) at 5 mph the required number of seconds to catch a quart is shown under 12 gallons and across from 5 mph on the calibration table. This is 37 seconds.

b. Procedure 2 (for daily checks)

1. Stake off the number of feet which corresponds to your row width in Table 2.

2. Drive the spray equipment over the distance at the throttle and gear setting the equipment will be operating in the field. Record the time in seconds required to travel this distance. The average time of two or more runs is more accurate.

3. Using the same nozzle setting—tractor in neutral and spray pressure at the approximate desired pressure—spray water through the nozzles. Collect the spray from all nozzles that are directed to one row in the number of seconds it took to travel the measured distance.

4. Measure the volume of water collected in ounces. Ounces collected are equal to gallons of spray applied per planted acre when applied at the previously described throttle, gear, and pressure setting.

5. To increase the gallons per acre output of the sprayer, increase the pressure. To decrease the output, decrease the pressure. Sometimes tractor speed and spray tip sizes must be changed to calibrate the sprayer at the desired gallons per acre.

6. Regardless of whether the spray is being applied with one or more nozzles per row or the spray is being applied on a band or the spray is applied preplant, preemergence, or postemergence, the ounces collected equals the amount of spray applied per planted acre.

**Hand Sprayer Method**

1. Add measured quantity of water to sprayer (1 gallon).

2. Spray area with the measured quantity of water until sprayer is empty.

   a. Walk at rate to be used when actually applying herbicide.

   b. Hold nozzle at level to be used when applying herbicide.

3. Determine area covered: width of spray band x length of sprayed area.

4. Determine how much water sprayer is delivering on an acre basis.

   Example: Spray width of 1.5 feet x length sprayed 400 feet = 600 square feet covered with 1 gallon of water.

   Divide area of 1 acre by square feet
Table 3. Calibration table for all weed control herbicides

<table>
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<tr>
<th>MPH per 300 ft.</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<td>79</td>
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<td>86</td>
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<td>2.8</td>
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<td>114</td>
<td>99</td>
<td>88</td>
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<td>19</td>
<td>16</td>
<td>14</td>
<td>12</td>
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</table>

* Applicable to preplant, preemergence, postemergence and layby. Number of seconds required for delivery of 1 quart from all nozzles directed to 1 row when a sprayer at a specified speed is applying a specified volume per 13,068 row feet of a band of any width.

43,560 (sq. ft./acre) = 72.5 gal./A

600 (sq. ft. covered by 1 gal.)

5. Determine amount of herbicide needed per acre.

Example: Recommended rate of diphenamid is 4 pounds per acre. Using Enide 50 W the amount would be 8 pounds of material per acre.

6. Determine amount of herbicide needed in each gallon of water when using the sprayer that has just been calibrated.

Example: Sprayer delivers 72.5 gallons per acre, 8 pounds of Enide 50 W needed per acre. Divide the amount of water into pounds of herbicide needed.

8 lbs. = 0.11 lbs./gal.

72.5 gal.

To convert to ounces per gallon, multiply by 16.
16 \times 0.11 = 1.76 \text{ or } 1 \frac{3}{4} \text{ oz./gal.}

It is absolutely essential that the sprayer be calibrated accurately so that the delivery rate of water can be determined. The amount of water used is the only variable in the calculations and it is important that this variable be determined accurately.

**DETERMINING HERBICIDE RATES**

Herbicide rates are generally given on a broadcast basis. Banding saves herbicide, reduces soil residues, and is more economical especially when the fields are to be cultivated. If you are to apply herbicides broadcast and have calibrated your sprayer equipment by procedures 1 or 2, then add the appropriate amount of herbicide for your tank to spray at the rate recommended by the label.

To determine the rate per acre herbicide for a band application, use the following formula,

\[
\text{Band width (inches)} \times \frac{\text{Row width (inches)}}{x \text{ rate per acre for broadcast applications}} = \text{Amount needed per acre band treatment}
\]

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