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Food, Agricultural and Biological Engineering

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Boom Sprayer Calibration

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Calibrating a boom sprayer is not as difficult as it sounds. Although there are many methods to use, the method described here is simple and requires few calculations.

It's based on spraying 1/128 of an acre per nozzle and collecting the spray that would be released during the time it takes to spray the area. Because there are 128 ounces of liquid in 1 gallon, this convenient relationship results in ounces of liquid caught from one nozzle being directly equal to the application rate in gallons per acre, or GPA.

For example: If you catch an average of 15 ounces from a set of nozzles, the actual application rate of the sprayer is equal to 15 GPA. With this method, make sure that the time used to catch output from nozzles is the same as the time it takes to cover 1/128 acre. Table 1 shows the distance you must travel to cover 1/128 acre for different nozzle spacings and row spacings. For broadcast applications, use the nozzle spacing to determine the calibration distance. For band or directed applications, use the row spacing.

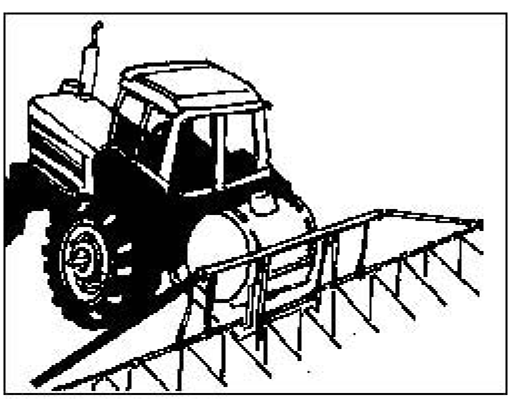

Figure 1. Broadcast spraying.

Table 1. Calibration distance for each nozzle to spray 1/128 acre.			
Nozzle/row spacing (in.)	**Travel distance (ft.)**	**Nozzle/row spacing (in.)**	**Travel distance (ft.)**
18	227	30	136
20	204	32	127
22	185	34	120
24	170	36	113
26	157	38	107
28	146	40	102

To calibrate your sprayer, you need a measuring tape, a watch capable of indicating seconds, and a measuring jar graduated in ounces. A pocket calculator also will be handy.

Calibrating for Broadcast Application

Follow these steps when calibrating boom sprayers for broadcast applications:

1. Fill the sprayer tank with water.
2. Run the sprayer, inspect it for leaks, and make sure all vital parts function properly.
3. Measure the distance in inches between the nozzles. Then measure an appropriate distance in the field based on this nozzle spacing, as shown in Table 1.
4. Drive through the measured distance in the field at your normal spraying speed, and record the travel time in seconds. Repeat this procedure and average the two measurements.
5. With the sprayer parked, run the sprayer at the same pressure level and catch the output from each nozzle in a measuring jar for the travel time required in Step 4.
6. Calculate the average nozzle output by adding the individual outputs and then dividing by the number of nozzles tested. If an individual sample collected is more than 10 percent higher or lower than the average nozzle output rate, check for clogs and clean the tip, or replace the nozzle.
7. Repeat steps 5 and 6 until the variation in discharge rate for all nozzles is within 10 percent of the average.
8. Then, the final average output in ounces is equal to the application rate in gallons per acre: Average output (ounces) = Application rate (GPA).
9. Compare the actual application rate with the recommended or intended rate. If the actual rate is more than 5 percent higher or lower than the recommended or intended rate, you must make adjustments.
10. You can start the adjustments by changing the pressure. Lowering the spray pressure will reduce the spray delivered; higher pressure means more spray is delivered. Don't vary from the pressure range recommended for the nozzles that you use. (Look to "Useful Formulas" on the back page to determine the new pressure rate.)
11. You also can correct the application error by changing the actual travel speed. Slower speeds mean more

spray is delivered; faster speeds mean less spray is delivered. (Look to "Useful Formulas" on the back page to determine the new pressure rate.)

12. If these changes don't bring the application rate to the desired rate, then you may have to select a new set of nozzles with smaller or larger orifices.

13. Recalibrate the sprayer (repeat steps 5 through 12) after any adjustment.

Calibrating for Band Spraying

Pesticides sometimes are applied in bands centered on the crop row (Figure 2). The application rate on the treated band must be the same as the broadcast rate for band application to be effective. But the total amount of pesticide used on a field is less, because only a portion of it is treated with chemicals.

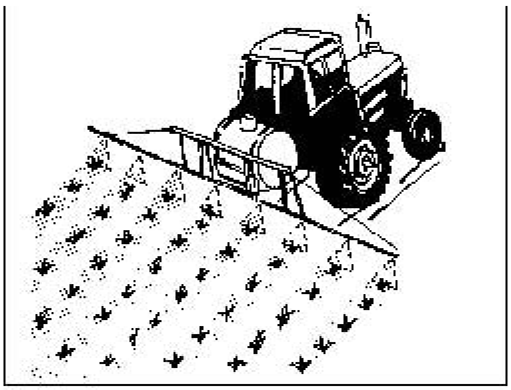

Figure 2. Band spraying.

Calibrating a sprayer for banding applications is similar to the procedure outlined for broadcast sprayers. The only difference is to choose the travel distance from Table 1 based on row spacing, not nozzle spacing. Drive the distance shown in the table at your spraying speed and catch the output from each nozzle for the length of time it takes to travel the indicated distance.

The average nozzle output again is directly equal to the application rate in gallons per acre. This application rate is less than the broadcast rate, because only a portion of the field is treated with chemicals. For example: If the broadcast rate recommended is 15 GPA and you're spraying 10-inch bands on 30-inch rows, you will need only 5 GPA, one-third of the broadcast rate. Therefore, at the end of your calibration, the average number of ounces caught from all the nozzles should equal 5 ounces, which represents an application rate of 5 GPA. At this rate you will treat bands at the recommended 15 GPA rate but the entire field at 5 GPA.

Herbicide recommendations are usually given on a broadcast basis. Therefore, convert the recommended broadcast rate to the band rate before comparing it with the measured rate to determine the application error. To convert a broadcast application rate to a band rate, use this formula:

Band rate = Band Width (in)/Row Spacing (in) X Broadcast rate

Then, compare this converted band rate to the measured rate. Make some adjustments and recalibrate the sprayer if the difference between the two rates is greater than □5 percent of the recommended rate.

Example

Recommended broadcast rate: 15 GPA
Rate measured with calibration: 6 GPA
Row spacing: 30 inches

Band width: 10 inches

Determine the sprayer application error:

First, convert the recommended broadcast rate of 15 GPA to the band rate:

10-in. band width/30-in row spacing X 15 GPA = 5 GPA

Application error = 6 GPA - 5 GPA = 1 GPA (off by 20%)

Because the application error is more than 5 percent of the recommended rate, adjustments must be made and the sprayer must be recalibrated.

Calibrating for Directed Spraying

Calibrating a row crop sprayer with two or three nozzles per row (Figure 3) is similar to calibrating a band sprayer. With broadcast or band applications, GPA is equal to the output from one nozzle. When more than one nozzle is used per row, the combined amount collected from all nozzles directed at one row is equal to the GPA. Again, this application rate is not the same as the broadcast rate. You must convert the recommended broadcast rate to the band rate before comparing it with the actual rate you obtained with calibration.

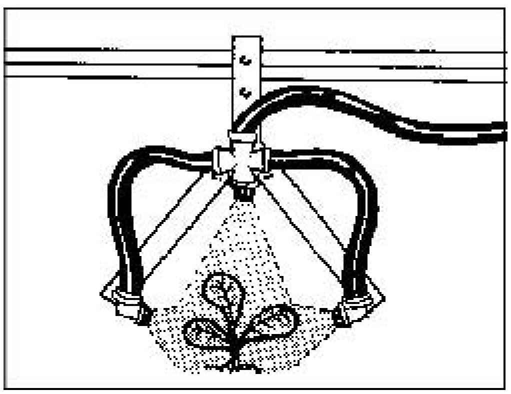

Figure 3. Directed spraying.

Example

You want to spray a 30-inch row using three nozzles per row. The steps:

1. Select a travel distance from Table 1 based on row spacing. The distance to travel for a 30 inch row is 136 feet.
2. Drive 136 feet and measure the time in seconds.
3. If it took 15 seconds, catch the output from each of the three nozzles for 15 seconds. If each tip delivers 5 ounces, the total ounces collected per row is 15 ounces. This represents the sprayer application rate of 15 GPA. (5 ounces/nozzle X three nozzle/row = 15 ounces/row).
4. Repeat Step 3 for each set of nozzles on the boom to make sure the application rate is uniform across the boom.

Adding the Chemical to the Tank

You can spend hours in the field to achieve the accuracy desired from your sprayer through proper calibration, but it won't do any good if you don't know how much chemical to put in the tank. A survey conducted by agricultural engineers at the University of Nebraska revealed that of the applicators surveyed, 38 percent failed to add the correct amount of chemical to the tank.

The amount of chemical needed per tankful depends on the recommended rate and the number of acres you can treat per tank of spray.

- To find the acres treated per tank, divide the tank capacity by the GPA application rate.
- To find the amount of pesticide needed per tank, multiply the number of acres treated by the amount of actual chemical to be applied per acre.

Example 1 (broadcast application)

A sprayer has a 300 gallon tank, and it has been calibrated to apply 15 gallons per acre. The pesticide label recommends 2 pints of commercial product per acre for broadcast application. Determine the quantity of pesticide to add to the tank:

- First, find the acres each tank will spray: 300 gal. per tank/15 gal. per A. = 20 A./tank
- Next, calculate the number of pints to be added to the tank:
  20 A./tank X 2 pts./A. = 40 pts./tank
- The final mix consists of 40 pints (5 gallons) of pesticide formulation and 295 gallons of water per 300 gallons of tankful.

NOTE: If the tank is not completely empty when refilling, use the amount of water required to refill the tank, not the capacity of the tank itself when determining acres treated per tank. For example: If you have a 300 gallon tank but you have 75 gallons of spray left in it when you refill, you will use 225 gallons in your calculations instead of the total tank capacity.

225 gal. refill/15 gal./A. = 15 A./refill

15 A./refill x 2 pts/A. = 30 pts./refill

You must add 30 pints of chemical to the tank.

Sometimes, chemical manufacturers give recommended rates in terms of active ingredient (A.I.) to be used per acre rather than the amount of total product per acre. In these cases, calculate the amount of material to be applied as shown in examples 2 and 3 for dry chemicals and liquid chemicals, respectively.

Example 2

The application rate of the chemical is 2 pounds A.I. applied per acre. The material to be used is a wettable powder containing 50 percent A.I. Determine the quantity of chemical to add to the tank:

Lbs. of material per A. = 2 lbs X 100/50 = 4 lbs./A.

4 lbs/A. x 20 A./tank = 80 lbs./tank

Example 3

The chemical you are using is liquid. The recommendation calls for 1 pound A.I. per acre. You have purchased a formulation that contains 4 pounds A.I. per gallon. Determine the amount of product needed per acre.

Gal.of product needed per A.= 1 lb.A.I./A. /4 lb.A.I.gal = 0.25gal./A.

Next, calculate the amount of chemical to add to each tankful:
0.25 gal./A. X 20 A./tank = 5 gal./tank

Example 4

(Band Spraying) You want to apply a herbicide on a 12-inch band on rows spaced 36 inches apart. The herbicide label recommends 3 pounds of material per acre on a broadcast basis. The sprayer has a 300 gallon tank, and the application rate measured with the calibration method explained previously for band application is 5 GPA. Determine the amount of chemical needed per tank:

- First, determine how much chemical will be used when applied on 12-inch bands.

  12-in. band/36-in row X 3 lbs./A. = 1 lb./A.

- The rest of the procedure to determine the chemical required per tank is the same as explained earlier for broadcast applications.

300 gal. per tank/ 5 gal. per tank = 60 A./tank

60 A./tank X 1 lb./A. = 60 lbs./tank

Thus, you will need to add 60 pounds of chemical product to the 300 gallon tank.

Mixing Chemicals

Mixing the pesticide thoroughly and carefully is an important step in good sprayer operation. Incomplete mixing results in varied application rates - too heavy at times, too low otherwise. Some chemicals, when mixed improperly with others, form a thick, mayonnaise-like mixture that will not spray properly and is difficult to clean out of the sprayer. Always read the label for proper mixing sequence and test the compatibility of chemicals in a small container before mixing.

Generally, when preparing the spray mixture, fill the tank more than half full of water and pour in the correct amount of chemical while the pump is running. Then, finish filling the tank. When using wettable powders, make a slurry in a separate container and then add the slurry to the tank to ensure good mixing.

Other Considerations

Here are some other considerations for calibrating your sprayer:

- Getting the right amount of chemicals on the ground is not enough to achieve effective pest control. How the chemical is deposited on the spray target is as important as the amount deposited. Make sure that all nozzle tips are properly aligned. Some nozzles require overlapping adjacent spray patterns. Check the nozzle catalog to determine the overlap required for a given type of nozzle.

- A common cause of non-uniform coverage is clogged nozzles. Watch the nozzles periodically while spraying to detect clogging. Always carry extra nozzles in your tool box, and replace bad nozzles with good ones immediately.

- In most cases, the pressure gauges on sprayers do not represent the actual pressure at the nozzle tip. Therefore, check the pressure at the nozzle tip when calibrating your sprayer.
- Safety is extremely important when working with chemicals. Always wear gloves and protective clothing when handling chemicals and calibrating sprayers. For safety reasons, use water instead of actual chemical mixtures when calibrating.

However, some carriers, such as liquid fertilizers, are much denser than water and may cause the nozzle flow rate to vary from the rate obtained with water. In this case, determine the average nozzle output using the actual chemical mix in the field, away from the farmstead.

Useful Formulas

- To determine the actual travel speed in the field:
  Distance (feet)/ Travel (seconds) X 0.68 = Travel speed (mph)
- To determine the appropriate travel speed (MPH) for a desired application rate (GPA):
  a. GPA_2 X MPH_2 = GPA_1 X MPH_1

  b. MPH_2 = GPA_1 X MPH_1 / GPA_2
- To determine the appropriate pressure (PSI) for a desired application rate (GPA):
  a. GPA_2/GPA_1 = (sq.rt. PSI_2)/sq.rt.PSI_1

  b. $PSI_2 = PSI_1$ X $(GPA_2/GPA_1)^2$

GPA_2, GPA_1: Desired and measured application rate, respectively (gal./A.).

MPH_2, MPH_1: Desired and measured travel speed, respectively (miles/hour).

PSI_2, PSI_1: Desired and measured spraying pressures, respectively (lb./in.2).

Acknowledgment

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