

Chapter 13

Chemical Application and Calibration

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Chemical applications play an important role in Arkansas soybean production. The proper application of chemical products, both plant nutrients and pesticides, will provide the best economic return. Proper application of chemicals also includes care to ensure that materials do not drift away from the target site. In some cases, chemicals may be placed in a band to conserve input costs. It is imperative that all chemical applications be done with precision!

There are several ways to calibrate a sprayer. You should use the one that you feel most comfortable with. The method that will be described here is universal. It may be used to calibrate for almost any type of known row crop situation which may arise.



Management Tip

Nozzle manufacturer catalogs should always be consulted for sprayer component and tip selection, setup and operation guidelines. These catalogs are also an excellent source of other technical information that will help applicators make more efficient applications.

Nozzle Selection

Selecting the correct nozzle is very important to obtain the desired droplet size and coverage. No one nozzle will do every job. Almost all of the major nozzle manufacturers provide guidance in their nozzle catalogs to assist with the selection of the correct tip. In many cases there may be more than one tip that will work, but some may be more desirable than others.

Chemical labels should be carefully read to see if they require a specific droplet size or size classification. A new U.S. standard has set up six standard

categories: very fine, fine, medium, coarse, very coarse and extremely coarse. The categories denote the average size as well as the number of fines one might expect. Tables are being provided in almost all the manufacturer catalogs to illustrate what droplet category can be expected for each size and pressure configuration.

Broadcast Tips – Broadcast tips are generally of a flat fan or simple fan or cone-shaped design. The application rate from broadcast tips tapers down from the center of the tip output to the outer edges. This tapering effect allows overlapping to occur for uniform coverage across the boom.

Drift Reduction Tips – Nozzle manufacturers have made major strides in the development of spray tips that will cut down on the number of fines developed during spray operations. Small droplets, or fines, are generally considered one of the major causes of high drift potential. Nozzles that produce very few droplets less than 200 μ m will help keep materials on target.

Droplet sizes are generally referred to as VMD (volumetric median diameter). VMDs from 250-500 are desirable for almost all spray applications. Droplets smaller than this may drift or evaporate, and larger droplets will generally result in poor coverage.

Drift-reducing tips of many styles are now available. These have some design characteristics that will help avoid making small droplets. Operators should study the information in their operator's manual carefully when spraying drift-sensitive products. Almost all of these use a chamber design where the metering function is separated from the pattern development phase of the nozzle outlet. A popular design concept that uses a venturi built between these two functions also helps reduce fines. These are typically referred to as air induction nozzles.

Banding – Banding applications require different tips also. Band applications that are sprayed on the soil surface should use flat fan, even style tips. The deposition rate does not taper off near the end of the spray pattern, thus allowing an even application all the way across the band with only one tip. Over-the-top band applications may be done with flat fan even tips or a combination of cone-type tips if the spray is being directed onto the plant surfaces of an individual row (example: three nozzles over the top, sometimes referred to as a *Basagran rig*).

Calibration

Calibrations should be done often enough to ensure that the dosage is correct.

Step 1

Determine that the correct tip has been selected and that all tips are the same size and flow rate. Flow rate test each tip across the boom to make sure the flow rates do not fluctuate more than 10 percent. This is easily done by catching the flow from each nozzle for approximately 30 seconds and comparing the values. If they vary by more than 10 percent, clean, replace or adjust as appropriate.

Step 2

Determine the sprayer operating speed. This needs to be done precisely – do not rely on the tractor/sprayer speedometer unless it is GPS driven. Speed should also be measured on a soil surface similar to what is going to be sprayed. If a tillage tool or planter is going to be pulled by the spray unit, the speed check should be done with that unit attached and operating normally.

Speed Equation

$$\text{Speed (MPH)} = \frac{\text{Distance (ft)} \times 60}{\text{Time (Seconds)} \times 88}$$

Any distance may be used, but longer distances will be more accurate. A minimum of 100 feet for each 5 MPH of travel speed is recommended.

General Calibration Equation

$$\text{GPA} = \frac{5,940 \times \text{GPM (per nozzle)}}{\text{MPH} \times \text{W (inches)}}$$

where:

MPH = miles per hour

W = width that the nozzle(s) are responsible for

GPM = flow rate

These values are all rather straightforward, except the W term:

- For broadcast spraying, this is the nozzle spacing.
- For single nozzle band spraying, this is the band width.
- For multiple nozzle band spraying, this is the band width divided by the number of nozzles.
- For directed spraying, when no band is being used, this is the row width divided by the number of nozzles per row.
- This works well if all the nozzles spraying a band or row are all the same size. If there are different sizes being used on a band or row, the sum may be treated as a single nozzle, and the total GPM would be entered in along with the total width of the nozzle group application.

The General Calibration Equation may be manipulated to solve for other variables as well.

Nozzle Size Equation

$$\text{GPM (per nozzle)} = \frac{\text{GPA} \times \text{MPH} \times \text{W}}{5,940}$$

The Nozzle Size Equation is used to determine the nozzle size needed if the application rate desired (GPA), travel speed (MPH) and nozzle spacing (W)

are known. One will generally be able to find one to three nozzles of the style desired that may produce the desired flow rate. Spray pressure has a direct influence on droplet size. If smaller droplets are desirable, select a high pressure. If larger droplets are needed to control drift, select a nozzle with lower pressure. If droplet size is not a factor that plays into the selection, choosing a nozzle size that will allow lower operating pressure will result in longer wearing tips.

Useful Conversion

One gallon = 128 fluid ounces

Step 3.

Nozzle Flow Rate Check – Set the sprayer at a pressure that you think will provide the desired application rate. Catch the flow rate from one nozzle and determine the GPM flow rate. Use the following equation to convert ounces collected to GPM.

$$\text{GPM} = .469 \times \frac{\text{number of ounces collected}}{\text{number of seconds during collection}}$$

Example: 28 ounces were collected in 30 seconds

$$\text{GPM} = .469 \times 28/30 = 0.44 \text{ GPM}$$

Another method would be to catch the discharge from one nozzle for 60 seconds and divide by 128 to obtain GPM.

Step 4.

Determine GPA – Once the speed, nozzle flow rate and nozzle spacing are known, the GPA is easily determined by plugging these values into the general calibration equation.

Example: 5.2 MPH, 0.44 GPM, 20-inch spacing

$$\text{GPA} = \frac{5,940 \times .44}{5.2 \times 20} = 25.1 \text{ GPA}$$

Adjustments – Adjustments to the application rate may be accomplished by changing the following variables: travel speed, nozzle spacing and size, and spray pressure.

Changing spray pressure is the hardest to manipulate. The spray pressure must be changed by four times to get twice the flow rate. If the pressure is changed, the droplet size will follow inversely. Small droplets result from higher pressures.

Nozzle spacing is also hard to manipulate. If the nozzles have not been purchased, this is probably the best way to change the desired application rate. If large changes are needed, this may be the only way.

Travel speed may be changed sometimes. There is a direct and linear relationship between travel speed and application rate. If the speed is cut in half, the rate doubles, simply because you would be in one location twice as long. If the speed is doubled, one-half the original rate will be applied for the same reasons.

All nozzles have a preset recommended operating pressure range. The maximum and minimum allowable travel speeds needed to stay within these parameters may be determined by manipulating the general application equation and solving for speed at the lowest and highest flow rates that correspond to the lowest and highest pressures.

$$\text{MPH} = \frac{5,940 \times \text{GPM (per nozzle)}}{\text{GPA} \times \text{W (inches)}}$$

Spray patterns are almost always deformed if sprayers are operated below the recommended minimum pressure range. Operating above the recommended range increases wear and creates excessive fine droplets.

This technique may be used to help one determine the minimum and maximum operating speeds that must be observed when a spray controller is being used. The spray controller will automatically lower the flow and/or pressure as the unit slows down and increase as the speed increases to apply the correct rate. The controller will do this even though the pattern may be distorted at the low and high positions.

Look for additional sprayer setup and calibration information in other Cooperative Extension Service publications such as the MP-44 and MP-144, which are available from your county Extension office.