

SPRAYER APPLICATION AND CALIBRATION - (*Sumner*)

Nozzle section is one of the most important decisions to be made related to pesticide applications for soybeans. The type of nozzle determines not only the amount of spray applied, but also the uniformity of the applied spray, the coverage obtained on the sprayed surfaces, and the amount of drift that can occur. Each nozzle type has specific characteristics and capabilities and is designed for use under certain application conditions. The types which are commonly used for ground application of agricultural chemicals for soybeans are the fan and cone nozzles.

Herbicide Application

The type of nozzle used for soil incorporation and applying herbicides is one that develops a large droplet and has no drift. The nozzles used for broadcast applications include the regular flat fan, extended range flat fan, drift reduction flat fan, turbo flat fan, twin flat fan, air-assist flat fan, flood and wide angle cone nozzles. Operating pressures should be 20 to 30 psi for the flat fan, turbo flat fan and twin flat fan. The flood and wide angle cone nozzles should be operated at 18 to 20 psi. Pressure more than 40 psi create significant drift. Air assist or air induction nozzles should be operated above 40 psi. All of the flat fan type nozzles will achieve uniform application of the chemical if they are placed properly along the boom. For the flat fan nozzles overlap should be 50 to 60 percent. Wide angle cone and flood nozzles should have 100 percent overlap. The table below presents suggested boom heights for flat fan nozzles with different angles. Also the orientation of each along the boom should place such they are angled 5 degrees from the center line of the boom.

Various Nozzle Heights for a 20-Inch Spacing.

Spray Angle (degrees)	Nozzle height (inches)
65	22-24
80	17-19
110	15-18

Even flat-fan nozzles are used for banding herbicides over the row to apply uniform coverage across the entire width of the spray pattern. The width of the band produced is determined by nozzle height (table below).

Nozzle Height for 80 and 95 Degree Even Flat Fan Nozzles in Inches.

Band Width (inches)	80 degree	95 degree
8	5	4
10	6	5
12	7	6
14	8	7

Insecticide Applications

Hollow cone nozzles are used primarily when plant foliage penetration is essential for effective insect or disease control, and **when drift is not a major concern**. At pressures of 60 to 120 psi, these nozzles produce small droplets that readily penetrate plant canopies and cover the underside of the leaves more effectively than any other nozzle type. The hollow-cone nozzles produce a cone-shaped pattern with the spray concentrated in a ring around the outer edge of the pattern. Even fan and hollow cone nozzles can be used for banding insecticide and fungicides over the row.

Fungicide Applications

Coverage of the plant at bloom stage is critical for prevention and control of Asian Rust on soybeans. Rust is first established on the lower plant surfaces so good fungicide coverage is needed on the lower leaves and stems. Therefore, fungicide must get on the lower plant to protect it. The fungicides that are available for treatment of Asian Rust need surface coverage to be effective and this is achieved best by smaller droplets. The two types of the chemistries currently available for Asian Rust are contact and locally systemic. The contact fungicides remain on the surface and will only protect the area that is covered. The locally systemic material is absorbed into the plant tissue. However, this is not the same type of systemic movement normally seen in systemic-based herbicides. The fungicide will not move throughout the plant, only within a small absorption zone (within a single leaf, for example).

Droplet Size, Spray Volume and Boom Height

In order to get the maximum plant surface coverage one should use a nozzle that develops medium to fine droplets (225 – 325 microns). Some fine droplets are acceptable but fine droplets drift easily and may blow over a dense canopy, while coarse sprays drift less but make fewer droplets available for coverage. The extended range and low drift fan nozzles can achieve good coverage when operated at pressures above 50 psi. At this pressure spray is forced down into the canopy. Care should be taken not to operate sprayer above 75 psi with these nozzles, a large amount of fine droplets will be generated. Consult nozzle manufactures catalogues for droplet classification at the various pressure settings and nozzle sizes.

Total spray volume applied should be 15-20 GPA for ground application. This will give sufficient droplets to cover the target area. Ground speed of 5–7 mph is desirable.

The boom height should provide 50 percent overlap. Keep as low as possible giving you better penetration, coverage and lessening drift potential.

Aerial Application

Growers may elect to use aerial application. Aerial applicators should also use a nozzle that will produce a medium droplet size (285 – 235 microns). Spray volume applied should be 3 – 5 GPA.

REOURCES

The two excellent publications on sprayer setup have been developed specifically for Asian Rust.

- Spraying Recommendations for Soybean Rust, Ohio State University Extension – <http://www.tifton.uga.edu/spray/ohio0526.pdf>
- Aerial Application: Tips for Rust Control, University of Arkansas - <http://www.tifton.uga.edu/spray/Rust%20Arkansas.pdf>

Nozzle Material

Various types of nozzle bodies and caps, including color coded versions, and multiple nozzle bodies are available with threads as well as quick-attaching adapters. Nozzle tips are interchangeable in the nozzle cap and are available in a wide variety of materials, including hardened stainless steel, stainless steel, brass, ceramic, and various types of plastic. Hardened stainless steel and ceramic are the most wear-resistant materials but are also the most expensive. Stainless steel tips, with corrosive or abrasive materials, have excellent wear resistance. Plastic tips are resistant to corrosion and abrasion and are proving to be very economical for applying pesticides. Brass tips have been common but wear rapidly when used to apply abrasive materials such as wettable powders and are corroded by some liquid fertilizers. Brass tips are economical for limited use, but other types should be considered for more extensive use.

The following chart can be used as a guide for selecting the proper nozzle type for most soybean spraying applications.

Suggested Application for Various Spray Nozzles Used in Soybeans. 1 - Excellent, 2 - Very Good, and 3 - Good.

Type	Pre-Emerge Herbicide			Post-Emerge Herbicide				Insecticides - Fungicides		
	Soil Incorp	Band	Broadcast	Contact Band	Contact Broadcast	Systemic Band	Systemic Broadcast	Soil Incorp	Band	Broadcast
Regular Flat Fan (8003)*	2		2		2		2	2		2
Ext. Range Flat Fan (XR8004 and 80-4R)	1		2		1			2		
Drift Control Flat Fan (DG8002 and RF2)	1		1		2		1	1		
Turbo Flat Fan (TT11002)	1		1		2		1	1		
Air-Assist Fan (TDXL-11003, AI11003, Raindrop Ultra 3)	1		1		1		1	1		
Flood (TK-2 and D 2)	2	3	2				2	2		
Turbo Flood (TF-VS4)	1		1				1	1		
Wide Angle Full Cone (FL - 8 and RA-8)	3		2				2	3		
Even Fan (8004E)		1		2		1			2	
Twin Flat Fan (TJ60-8003)		1		1					1	
Hollow Cone (TX-6 and HC 6)									1	1
Hollow Disc-Core									1	1

(D 4-23 and DC 4-23))										
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*** Example of nomenclature for nozzles.**

Selecting the Proper Size Nozzle Tip

The correct nozzle tip size will depend upon application rate in gallons per acre (GPA), ground speed (MPH), effective spray width of each nozzle (W). The best method for choosing the correct nozzle tip size is to determine the gallons per minute (GPM) of nozzle output required and then select a nozzle tip size that, when operated within the recommended pressure range, will provide this flow rate. Avoid relying on the "gallons per acre" rating which some manufacturers give their nozzles as means of selecting nozzle tip size. This rating is correct only for standard conditions (usually 30 psi, 4 MPH, and 20-inch nozzle spacings). The gallons-per-acre rating is useless if any conditions vary from the standard. By following the steps described below, the proper nozzle tip size can be selected well ahead of the spraying season.

1. *Determine "GPA "* - First select the application rate in gallons per acre (GPA) used. The application rate consists of the gallons of carrier (water, fertilizer, etc.) plus chemical applied per treated acre. The best guides for this decision are the recommended ranges listed on the label, the recommendation of a chemical dealer or county agricultural agent, and experience with that particular chemical.
2. *Determine "MPH"* - Select an appropriate ground speed in miles per hour (MPH) for the field to be sprayed. Experience is the best guide here. Generally, speeds between 3 to 7 MPH are considered appropriate for low pressure ground sprayers depending upon field conditions. Do not rely solely on speedometers as an accurate measure of ground speed, especially on older tractors. Slippage and variation in tire sizes can result in speedometer

$$MPH = \frac{Distance(ft) \times 60}{Time(sec) \times 88}$$

errors of 30 percent or more. Ground speed can be determined by the following equation:

3. *Determine "W"* - Determine the effective sprayed width per nozzle (W) in inches. For broadcast spraying, W = nozzle spacing, For band spraying, W = band width, For row-crop application, W = row spacing (or band width).
4. *Determine Tip Size* - Once the application rate, ground speed, and spray width per nozzle have been determined, the flow rate required for each nozzle in gallons per minute (GPM) can be determined by using a nozzle catalog, tables or the following equation:

$$GPM = \frac{GPA \times MPH \times W}{5,940}$$

The constant, 5,940, is used to convert gallons per minute, miles per hour, and inches to gallons per acre. The use of 6,000 instead of 5,940 will make the calculation easier and result in an error of only 1 percent.

Example: A herbicide is to be broadcast at 20 GPA at a speed of 5 MPH, using flat fan nozzles

spaced 20 inches apart on the boom. What size nozzle tip should be selected?

$$GPM = \frac{GPA \times MPH \times W}{5,940}$$

$$GPM = \frac{20 \times 5 \times 20}{5,940} = \frac{2,000}{5,940} = 0.34$$

The required flow rate for each nozzle is as follows:

The nozzle selected must have a flow rate of 0.34 GPM when operated within the recommended pressure range of a flat-fan nozzle (20 to 30 psi). By checking nozzle catalogs, you will find a number of different brands of flooding flat fan nozzles which will provide this flow rate. For example, the Spraying Systems XR8004 and Delavan LFR80-4R nozzles have a rated output of 0.35 GPM at 30 psi. Either of these nozzles will be sufficient for this application.

Example: A foliar fungicide is to be applied at 15 GPA at a speed of 7 MPH, using hollow cone nozzles. The row spacing is 36 inches with three nozzles directed toward each row. What size tip should be selected?

$$GPM = \frac{GPA \times MPH \times W}{5,940}$$

The required flow rate for each row is as follows:

$$GPM_{row} = \frac{15 \times 7 \times 36}{5,940} = \frac{3,780}{5,940} = 0.64$$

The flow rate for each nozzle is the row (GPM) divided by the number of tips per row.

$$GPM_{nozzle} = \frac{0.64}{3 \text{ nozzles/row}} = 0.21$$

The nozzle selected must have a flow rate of 0.21 GPM operating between 40 to 80 psi. Checking nozzle catalogs, the Spray Systems TX-10 and Delavan HC-10 cone spray nozzles have a rated output of 0.20 GPM at 60 psi. Or the Spray System D 4-23 and Delavan DC 4-23 disc-core nozzles have a rated output of 0.21 GPM at 80 psi. Either one of the nozzles chosen would deliver the proper amount per acre.

Water Rates (GPA)

The grower who plans to use spray materials at the low water rates should follow all recommendations carefully. Use product label recommendations on water rates to achieve optimal performance. Plant size and condition influence the water rate applied per acre. Examination of the crop behind the sprayer before the spray dries will give a good indication of coverage.

Agitation

Most materials applied by a sprayer are in a mixture or suspension. Uniform application requires a homogeneous solution provided by proper agitation (mixing). The agitation may be produced by jet agitators, volume boosters (sometimes referred to as hydraulic agitators), and mechanical agitators. These can be purchased separately and installed on sprayers. Continuous agitation is needed when applying pesticides that tend to settle out, even when moving from field to field or when stopping for a few minutes.

Calibration

The procedure below is based on spraying $\frac{1}{128}$ of an acre per nozzle or row spacing 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 collected being directly equal to the application rate in gallons per acre.

Calibrate with clean water when applying toxic pesticides mixed with large volumes of water. Check uniformity of nozzle output across the boom. Collect from each for a known time period. Each nozzle should be within 10 percent of the average output. Replace with new nozzles if necessary. When applying materials that are appreciably different from water in weight or flow characteristics, such as fertilizer solutions, etc., calibrate with the material to be applied. Exercise extreme care and use protective equipment when active ingredient is involved.

1. Use the table on page 55 to determine the distance to drive in the field (two or more runs suggested). For broadcast spraying, measure the distance between nozzles. For band spraying, use band width. For over the row or directed, use row spacing.
2. Measure the time (seconds) to drive the required distance, with all equipment attached and operating. Maintain this throttle setting!
3. With sprayer sitting still and operating at same throttle setting or engine RPM as used in Step 2, adjust pressure to the desired setting. Machine must be operated at same pressure used for calibration.

- For broadcast application, collect spray from one nozzle or outlet for the number of seconds required to travel the calibration distance.

For band application, collect spray from all nozzles or outlets used on one band width for the number of seconds required to travel the calibration distance.

For row application, collect spray from all outlets (nozzles, etc.) used for one row for the number of seconds required to travel the calibration distance.

- Measure the amount of liquid collected in fluid ounces. The number of ounces collected is the gallons per acre rate on the coverage basis indicated. For example, if you collect 18 ounces, the sprayer will apply 18 gallons per acre. Adjust applicator speed, pressure, nozzle size, etc. to obtain recommended rate. If speed is adjusted, start at Step 2 and recalibrate. If pressure or nozzles are changed, start at Step 3 and recalibrate.

Distance to Measure to Spray $\frac{1}{128}$ Acre. One Ounce Discharged Equals One Gallon per Acre.

Nozzle Spacing (inches)	Distance (feet)	Nozzle Spacing (inches)	Distance (feet)
6	681	20	204
8	510	22	186
10	408	24	170
12	340	30	136
14	292	36	113
16	255	38	107
18	227	40	102

To determine a calibration distance for an unlisted spacing, divide the spacing expressed in feet into 340. Example: Calibration distance for a 13" band = $340 \div 13 = 26.15$ feet.