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EC141

Nozzles — Selection and Sizing

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The proper selection of a nozzle type and size is essential for proper pesticide application. The nozzle is a primary factor in determining the amount of spray applied to an area, the uniformity of application, the coverage achieved on the target surface, and the amount of potential drift.

Nozzles break the liquid into droplets, form the spray pattern, and propel the droplets in the proper direction. They determine the amount of spray volume at a given operating pressure, travel speed, and spacing. Drift can be minimized by selecting nozzles that produce the largest droplet size while providing adequate coverage at the intended application rate and pressure.

Spray Particle Size

The size of the spray particle is important because it affects both efficacy and spray drift potential of the pesticide. If the size of the spray particle is doubled (for example 300 to 600 microns) and the application volume stays the same, you have only 1/8 as many spray droplets. For optimum efficacy and 10 to 20 gallon spray volumes, a medium droplet size is suggested for foliar applied non-translocating herbicides and a coarse droplet size for foliar applied translocating herbicides. Concern for drift may cause you to consider larger droplet sizes and higher spray volumes.

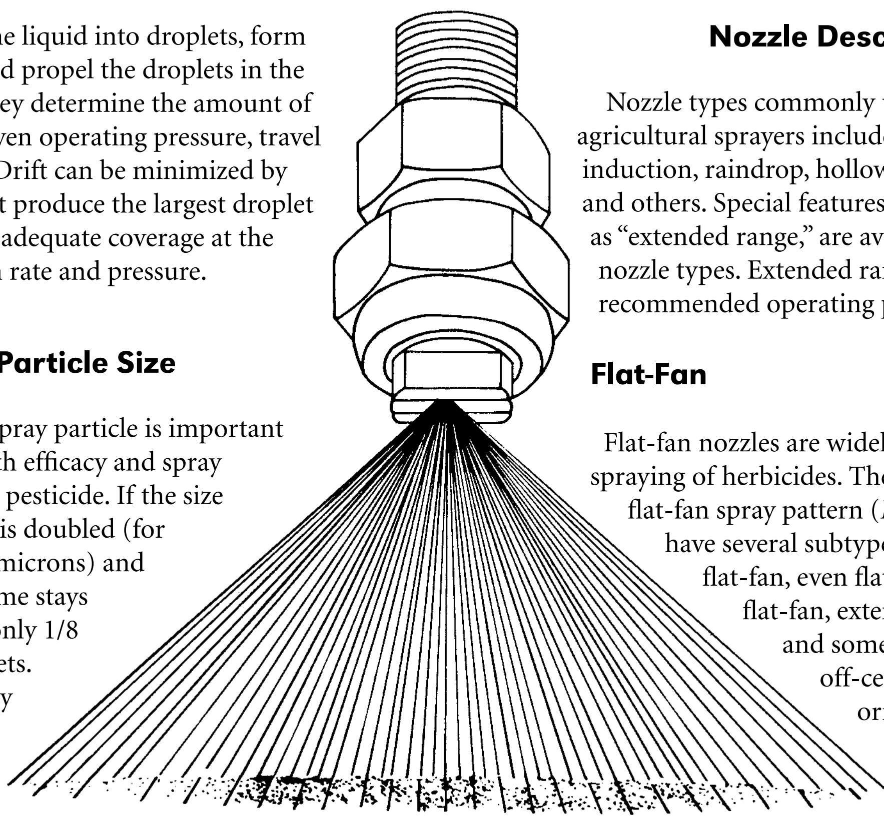

Figure 1. Flat-fan spray nozzle.

Nozzle Description

Nozzle types commonly used in low-pressure agricultural sprayers include: flat, flood, air induction, raindrop, hollow-cone, full-cone, and others. Special features, or subtypes such as "extended range," are available for some nozzle types. Extended range increases the recommended operating pressure range.

Flat-Fan

Flat-fan nozzles are widely used for broadcast spraying of herbicides. These nozzles produce a flat-fan spray pattern (*Figure 1*). These nozzles have several subtypes, such as standard flat-fan, even flat-fan, low pressure flat-fan, extended range flat-fan, and some special types such as off-center flat-fan and twin-orifice flat-fan where each orifice is 1/2 the size of a single nozzle tip.

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Nozzle Nomenclature

Most companies identify their flat-fan nozzles with a four or five digit number (*Figure 2*). The first numbers are the spray angle and the other numbers signify the discharge rate at rated pressure. For example, an 8005 has an 80 degree spray angle and will apply 0.5 gallons per minute (GPM) at rated pressure of 40 psi. An 11002 nozzle has a 110 degree spray angle and will apply 0.2 GPM at rated pressure of 40 psi. Additional designations are "BR," brass material; "SS," stainless steel; "HS," hardened stainless steel; "VP," polymer with color coding; "VK," ceramic with color coding; "VH," hardened stainless steel with color coding; and "VS," stainless steel with color coding.

Some nozzles are identified by "LF" or "LF-R," which reflect the standard and extended range flat-fan nozzles. The first numbers are the spray angle followed by a dash, and then the discharge rate at rated pressure. For example, an LF 80-5R is an extended range nozzle with an 80 degree spray angle that will apply 0.5 GPM at the rated pressure of 40 psi.

Nozzle Type	Spray angle	Nozzle discharge GPM
TT	110	015

Figure 2. Nozzle identification.

Nozzle Materials

Nozzles can be made from several materials, including brass, nylon, stainless steel, hardened stainless steel, and ceramic. Stainless steel nozzles last longer than brass or nylon, and generally produce a more uniform pattern over a longer time. Nylon nozzles with stainless steel or hardened stainless steel inserts offer an alternative to solid stainless steel nozzles at a reduced cost. Ceramic nozzles have the longest life and are usually worth the added cost. Thermoplastic nozzles have good abrasion resistance, but swelling can occur with some chemicals. They are easily damaged when cleaned.

Do not mix nozzles of different materials, types, spray angles, or spray volumes on the same spray boom. A mixture of nozzles produces uneven spray distribution.

110015VS

Figure 3. Example of a standard flat-fan.

Features:

- Tapered edge flat spray pattern for uniform coverage in broadcast spraying.
- 110° spray angle
- GPM at 40 psi
- VS – stainless steel with VisiFlo® color-coding
- Pressure range 30 to 60 psi.
- Best pressure range 35 to 45 psi.
- Drift management – fair at lower psi

Limitations:

- Limited pressure range

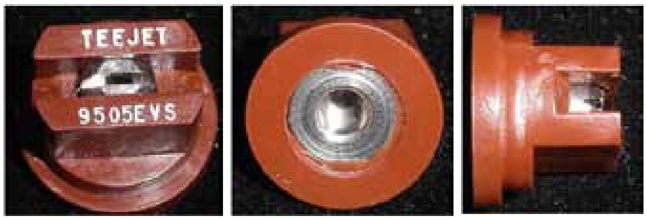
Standard flat-fan nozzles (*Figure 3*) normally operate between 30 and 60 psi, with an ideal range between 35 and 45 psi.

Even Flat-Fan

The ***even*** (E) (*Figures 4* and *5*) flat-fan nozzles apply uniform coverage across the entire width of the spray pattern. They are used for ***banding*** pesticide over the row and should not be used for broadcast applications. The band width can be controlled with the nozzle height, nozzle orientation, and the spray angle.

Even flow nozzle *Broadcast nozzle*

Figure 4. The spray pattern produced by the even flow nozzle tip (E) as compared to the pattern produced by a broadcast nozzle tip.



9505EVS

Figure 5. Example of an even flat-fan.
Applications:
Very good for post-emergence contact herbicides, contact fungicides, and contact insecticides
Features:
Ideal for banding over the row or in row middles.
95º spray angle 0.50 GPM at 40 psi
VS – stainless steel with VisiFlo color-coding
E – even flat spray
Pressure range 20 to 60 psi.
Best use pressure range 25 to 40 psi.
Drift management – fair
Limitations:
Small particle sizes

Extended Range Flat-Fan

The ***extended range*** (XR) (*Figure 6*) flat-fan nozzle provides fair drift control when operated between 15 and 25 psi. This nozzle is ideal for an applicator who likes the uniform distribution of a flat-fan nozzle and wants lower operating pressures for drift control. Since extended range nozzles have an excellent spray distribution over a wide range of pressures (15-60 psi), they can be used on sprayers equipped with flow controllers.

Left: XR11003VS
Right: XR11003VK

Figure 6. Examples of an extended range (XR or LFT).
Applications:
Excellent for post-emergence contact herbicides, contact fungicides, and contact insecticides. For pressure below 30 psi. Very good for post-emergence systemic herbicides, systemic fungicides, and systemic insecticides.
Features:
Excellent spray distribution over a wide range of pressures.
110º spray angle 0.30 GPM at 40 psi
VS – stainless steel with VisiFlo color-coding
VK – ceramic with polypropylene VisiFlo color-coding
Pressure range 15 to 60 psi.
Best use pressure range 20 to 30 psi.
Drift management – good
At pressure under 30 psi – very good
Limitation:
Droplets tend to be small, especially at higher pressures

Off-Center

The special feature flat-fan nozzles, such as the ***off-center*** (LX) (*Figure 7*) flat-fan, are used for boom end nozzles to achieve a wide swath projection.

AIUB8504

Figure 7. Example of an off-center nozzle.
Applications:
Excellent for post-emergence systemic herbicides, systemic fungicides, and systemic insecticides. Good for post-emergence contact herbicides contact, fungicides, and contact insecticides .
Features:
Larger droplets for less drift.
Off-center spray pattern with flat spray characteristics.
Underleaf banding of pesticides or liquid fertilizers.
Used at the end of the spray boom around the perimeter of the field to protect sensitive areas.
Spraying pressure of 30-115 psi.
Limitations:
Due to the pre-orifice design, this tip is incompatible with some check valves.

Twin Orifice Flat-Fan

The ***twin orifice*** (*Figure 8*) flat-fan produces two spray patterns — one angled 30 degrees forward and the other directed 30 degrees backward. The droplets are small due to the atomizing by two smaller orifices. The two spray directions and smaller droplets improve coverage and penetration, a plus when applying post-emergence contact herbicides. Because of the small spray droplets, drift is a concern. To produce fine droplets, the twin-orifice usually operates between 30 and 60 psi.

TJ60 11008VS

Figure 8. Example of a twin orifice.

Applications:

Excellent for post-emergence contact herbicides, contact fungicides, and contact insecticides.

Features:

Penetrates crop residue or dense foliage.
Smaller droplets for thorough coverage.
Better spray distribution along boom than with hollow-cone nozzles.
110° spray angle 0.80 GPM at 40 psi
VS – stainless steel with VisiFlo color-coding
Pressure range 30 to 60 psi.
Best use pressure range 35 to 50 psi.
Drift management – NA

Limitations:

Plug easily.

Nozzle Height

Flat-fan nozzles are available in several spray angles. The most common spray angles are 65, 73, 80, and 110 degrees. Recommended nozzle heights for flat-fan nozzles during broadcast application are given in *Table 1.*

Table 1. Suggested minimum spray heights.

	Spray height (in.)			
	20" Spacing		*30" Spacing*	
Spray angle (degrees)	*30% Overlap*	*100% Overlap*	*30% Overlap*	*100% Overlap*
65	22-24	NR	NR	NR
73	20-22	NR	29-31	NR
80	17-19	26-28	26-28	37-39
110	10-12	15-17	14-18	25-27

NR = Not recommended.

The correct nozzle height is measured from the nozzle to the target, which may be the top of the ground, growing canopy, or stubble. Use 110 degree nozzles when booms are less than 30 inches high with a 30-inch nozzle spacing, and 80 degree nozzles when the booms are higher.

Although wide-angle nozzles produce smaller droplets, which are more prone to drift, the lower boom height reduces the drift potential more than the corresponding decrease in droplet size. The nozzle spacing and orientation should provide for 100 percent overlap at the target height. Nozzles should not be oriented more than 30 degrees back from vertical.

Turbulence Chamber

The ***turbulence chamber nozzle*** (*Figure 9*) is an updated nozzle design that incorporates a pre-orifice (which meters the liquid) concept with an internal turbulence chamber. These design improvements have resulted in larger, less driftable droplets and improved spray pattern uniformity. Turbulence chamber nozzles are available in flood and flat-fan tip designs.

TF-4

Figure 9. Example of a turbulence chamber (a turbo flood nozzle).

Applications:

Excellent for soil applied herbicides. Very good for post-emergence systemic herbicides, systemic fungicides, and systemic insecticides.

Features:

Excellent spray distribution for uniform coverage along the boom.
Nozzle design incorporates a pre-orifice to produce larger droplets for less drift.
0.40 GPM at 10 psi the rated pressure
VS – Stainless steel with VisiFlo color-coding
Pressure range 10 to 40 psi .
Best use pressure range 15 to 30 psi.
Drift management – excellent

Limitations:

Not recommended for contact pesticides.
Note difference in orifice sizes between pre-orifice and exit orifice

Turbo TeeJet

The ***Turbo TeeJet*** (*Figure 10*) has the widest pressure range of the flat-fan nozzles — 15 to 90 psi. It produces larger droplets for less drift and is available only in 110 degrees.

TT11004

Figure 10. Example of a Turbo TeeJet.

Application:

Excellent at pressures below 30 psi for post-emergence systemic herbicides, systemic fungicides, and systemic insecticides. At pressures above 30 psi very good for post-emergence contact and systemic herbicides, contact and systemic fungicides, and contact and systemic insecticides.

Features:

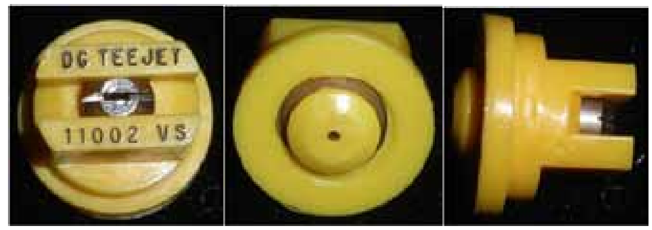
Tapered edge wide angle flat spray pattern for uniform coverage in broadcast spraying.
Large, rounded internal passage to minimize clogging.
110º spray angle 0.40 GPM at 40 psi
VP – polymer with VisiFlo color-coding
Pressure range 15 to 90 psi.
Best use pressure range 30 to 40 psi.
Drift management – very good
At pressures below 30 psi – very good

Limitations:

May be difficult to clean out because of location of pre-orifice.
Note difference in orifice sizes between pre-orifice and exit orifice

Drift Guard

The ***drift guard*** (*Figure 11*) flat-fan has a pre-orifice that controls the flow. The spray tip is approximately one nozzle size larger and therefore produces larger droplets and reduces the small, drift-prone droplets.



DG11002

Figure 11. Example of a drift guard.

Features:

Pre-orifice design produces larger droplets and reduces the small drift-prone droplets, minimizing off-target spray contamination.
110º spray angle 0.20 GPM at 40 psi
VS – stainless steel with VisiFlo color-coding
Pressure range 30 to 60 psi.
Best use pressure range 35 to 45 psi.
Drift management – good at lower end of pressure range

Limitations:

Limited pressure range
Note difference in orifice sizes between pre-orifice and exit orifice

Venturi Type

The ***venturi type*** (*Figure 12*) nozzle produces large air-filled drops through the use of a venturi air aspirator for reducing drift. These include the Delavan Raindrop Ultra, Greenleaf Turbo Drop and Airmix, Lurmark Ultra Lo-Drift, Spraying Systems AI Teejet, ABJ Agri, Air Bubble Jet, and Wilger's Combo-Jet.

AIXR11004

Figure 12. Example of a venturi type.

Applications:

Excellent for post-emergence systemic herbicides, systemic fungicides, and systemic insecticides. Very good for soil applied herbicides.

Features:

110º wide, tapered flat spray angle with air induction technology offers better drift management.
110º spray angle 0.40 GPM at 40 psi

VP – polymer with VisiFlo color-coding
Pressure range 15 to 90 psi.
Best use pressure range 35 to 50 psi.
Drift Management – excellent

Limitations:

May not give the coverage needed for contact pesticides.
Note difference in orifice sizes between pre-orifice and exit orifice

Flood

Flood nozzles (*Figure 13*) are popular for applying suspension fertilizers where clogging is a potential problem. These nozzles produce large droplets at pressures of 10 to 25 psi. The nozzles should be spaced less than 60 inches apart. The nozzle orientation and height should be set for 100 percent overlap.

Nozzle spacing between 30 to 40 inches produces the best spray patterns. Pressure influences spray patterns of flooding nozzles more than flat-fan nozzles. However, the spray pattern is not as uniform as with the flat-fan nozzles, and special attention to nozzle orientation and correct overlap is critical. The turbo flood nozzles (*Figure 9*), which have a pre-orifice and turbulence chamber, have excellent spray patterns. Besides fertilizer suspensions, these nozzles are used with soil incorporated herbicides, preemergence without contact herbicides, and with spray kits mounted on tillage implements.

Flooding nozzles are designated "TK" or "TF" by Spraying Systems and "D" by Delavan. The value following the letters is the flow rate divided by 10 at a rated pressure of 10 psi. For example, TK-SS2 or D-2 are flood nozzles that apply 0.2 GPM at 10 psi.

TKVS-3

Figure 13. Example of a Flood Jet.

Features:

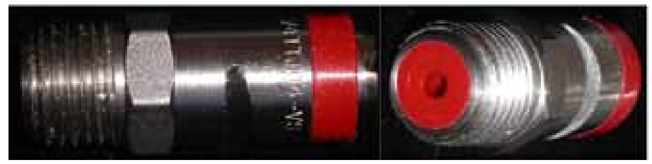
0.30 GPM at 10 psi
VS – stainless steel with VisiFlo color-coding
Pressure range 10 to 40 psi.
Drift management – poor

Limitations:

Changes a lot in particle size depending on pressure.
Not recommended for pesticide application

TurfJet

The **TurfJet®** (*Figure 14*) is a new nozzle designed for the turf industry. It is modeled after the Turbo flood nozzle, which is used extensively in the application of crop protection products for agricultural field crops. The major difference is that the TurfJet nozzle incorporates a larger orifice to accommodate heavier application volumes, which are common in the turf industry.



1/4TTJ04

Figure 14. Example of a TurfJet.

Applications:

Excellent for soil applied herbicides. Very good for post-emergence systemic herbicides, systemic fungicides, and systemic insecticides.

Feature:

Very large droplets
Direct replacement for plastic hollow-cone, low-drift nozzles.
0.40 GPM at 40 psi (This flood nozzle tip is rated at 40 psi.)
VS – stainless steel with VisiFlo color-coding
Pressure range 25 to 75 psi.
Best use pressure range 30 to 50 psi.
Drift management – excellent

Limitations:

Very large particle size.
Need high carrier volume to insure adequate coverage
Note difference in orifice sizes between pre-orifice and exit orifice

Hollow-Cone

Hollow-cone (*Figure* 15) nozzles generally are used to apply insecticides or fungicides to field crops when foliage penetration and complete coverage of the leaf surface is required. These nozzles operate at pressures ranging from 40 to 100 psi. Spray drift potential is higher from hollow-cone nozzles than from other nozzles due to the small droplets produced.

TX-6

Figure 15. Example of a hollow-cone.

Applications:

Excellent for post-emergence contact herbicides, contact fungicides, and contact insecticides.

Features:

For use with defoliants and foliar fertilizers at pressures 40 psi and above.

Finely atomized spray pattern provides thorough coverage.

Limitations:

Small particle size subject to drift.

The wide-angle full-cone (*Figure 16*) nozzles produce large droplets. Full-cone nozzles, which are recommended for soil-incorporated herbicides, operate at pressures between 15 and 40 psi. Optimum uniformity is achieved by angling the nozzles 30 degrees and overlapping the spray coverage by 100 percent.

Full-Cone

FL-10VS

Figure 16. Example of a wide-angle full-cone.

Features:

Large droplets to reduce drift.

Excellent spray distribution over a range of pressures 15-40 psi.

Ideal for use on rigs with sprayer controllers.

Wide spray angle allows use on 40" spacings.

Limitations:

Only available in larger sizes.

Boomless Flat Spray Nozzles

Boomless nozzles are used for a number of pesticide applications. They are used in single-spray left or right depending on nozzles, spray both left and right with left and right nozzles and also used with a conventional nozzle or nozzle tips between them. The advantage of boomless nozzles is one can reach areas not accessible with a boom or where it would be easy to damage a boom (*Figure 17*).

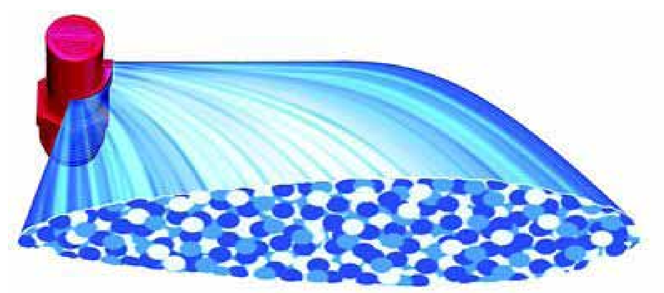


Figure 17. Example of a 1/4 xP20R (2.0 GPM at 40 psi spray to right side).

Applications:

Boomless field spray applications

Roadside and right-of-way applications

End row spraying

Orchard spraying

De-icing applications

Forestry

Features:

Unique orifice geometry produces a wide spray pattern while maintaining superior distribution across entire width.

Extra wide spray pattern – up to 18.5' (5.5 meters) – using a single nozzles.

Recommended spray pressure range: 20-60 psi (1.5-4 bar)

Nozzle Selection

It is important to select a nozzle that develops the desired spray pattern. The specific use of a nozzle, such as broadcast application of herbicides or insecticides on row crops, determines the type of nozzle needed. Examine current and future application requirements and be prepared to have several sets of nozzles for a variety of application needs. In general, do not select a nozzle that requires a nozzle screen smaller than 50 mesh. Nozzles requiring 80-100 mesh screens plug easily.

Follow the steps below to determine the correct nozzle type and capacity needed.

Step 1. Consult the label. The most important source of information is the pesticide label. Not only will the label specify the application rates, controllable pests, and conditions needed to apply the pesticide, it often will provide information concerning the gallons per acre, nozzle type, and spacing. Follow the guidelines outlined on the pesticide label. If nozzle recommendations are not stated on the label, use *Table 2* to select a nozzle type best suited to the application.

Step 2. Select operating conditions. Select or measure ground speeds in miles per hour (mph). Select the desired nozzle spacing and spray volume. For most broadcast applications, a 30-inch spacing is preferred, especially if the row spacing is 30 inches. If the label doesn't recommend nozzle spacing or spray volume, follow university and chemical company recommendations.

Correct selection of a spray volume is important. It will influence several spray characteristics such as drift potential, coverage, droplet size, acres per tank, and pesticide efficacy. Generally the greater the operating pressure or spray angle, the smaller the droplets. Smaller droplets increase drift potential. As the orifice opening becomes larger, the droplets increase in size.

Step 3. Calculate required nozzle discharge. To select a specific orifice size, the spray volume, nozzle spacing, and travel speed are needed for the following calculation:

Nozzle discharge (GPM) =

$$\frac{\text{Travel speed x Nozzle spacing x Spray volume}}{5940}$$

where: Travel speed = miles per hour (mph)
Nozzle spacing = inches (in) for broadcast or band width
Spray volume = gallons per acre (GPA)

Step 4. Consult a nozzle catalog. Once the nozzle discharge (GPM) has been determined, consult a nozzle catalog for a specific nozzle number or size. Using the nozzle type selected from the application guide *(Table 2)*, review the specification of these nozzles in the discharge capacity column. Several consecutive nozzles may meet your needs, but select a nozzle that operates at a low pressure and gives the desired particle size and still gives a range for "fine-tuning." Remember, most nozzles only perform well over a limited pressure range.

A linear relationship does not exist between pressure and flow discharge. If the discharge rate is not found in the catalogs, calculate by using operating pressure and known catalog conditions:

$$\frac{GPM_1}{GPM_2} = \frac{\sqrt{psi_1}}{\sqrt{psi_2}} \qquad [1]$$

Where: subscript "1" is the desired condition and subscript "2" is known catalog condition.

Simply stated, to double the flow through a nozzle, the pressure must be increased four times.

Avoid high pressures for the nozzle used. Higher pressures increase the drift potential and put strain on the sprayer components. Conversely, avoid pressures less than the recommended minimum pressure because spray patterns begin to distort and cause poor spray uniformity.

Step 5. Calibrate the sprayer. Once the nozzles are selected, purchased, installed, and flushed, calibrate the spray system. Nozzle catalogs provide tables to show spray volumes for various nozzles, spacing, pressures, and ground speeds. Use these tables to initially set up the sprayer, and then use the "ounce" calibration method (NebGuide 1756) to evaluate and adjust the sprayer for accurate application.

Nozzle Selection and Sizing Example

Suppose a postemergence herbicide is to be broadcast at 15 GPA at a speed of 5 mph. Using *Table 2* as a guide, an acceptable choice is a Turbo TeeJet. The recommended nozzle spacing is 30 inches. Calculate the required nozzle discharge:

Nozzle discharge = (5 mph x 30 in x 15 GPA)/5940 = 0.38 GPM

Consult a nozzle catalog. The selected nozzle must have a flow discharge of 0.38 GPM when operated within the recommended range for the nozzle. A nozzle performance table shows the discharge rate at various pressures for several nozzle sizes. *Table 3* shows that four nozzles listed in the catalog are possible choices. The TT11003, TT11004, TT11005, or TT11006 nozzles may be purchased for this application, but the TT11004 gives the most flexibility with a wide pressure range for "fine-tuning."

Table 2. Spray nozzle selection guide for broadcast applications.

	Herbicides			*Fungicides*		*Insecticides*			
		Post-emergence							
Nozzle	*Soil Applied*	*Contact*	*Systemic*	*Contact*	*Systemic*	*Contact*	*Systemic*	*Drift Management*	*Liquid Fertilizer*
Turbo TeeJet®		Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	
Turbo TeeJet	Good	Good	Excellent	Good	Excellent	Good	Excellent	Very Good	
Turbo TeeJet® Induction	Excellent		Excellent		Excellent		Excellent	Excellent	Excellent
XR, XRC TeeJet®		Excellent	Good	Excellent	Good	Excellent	Good	Good	
AIRX TeeJet®	Very Good	Good	Excellent	Good	Excellent	Good	Excellent	Excellent	Good
AI, AIC TeeJet®	Very Good	Good	Excellent	Good	Excellent	Good	Excellent	Excellent	Very Good
TwinJet®		Excellent		Excellent		Excellent			
Turbo FloodJet®	Excellent		Very Good		Very Good		Very Good	Excellent	Excellent
TurfJet®	Excellent		Very Good		Very Good		Very Good	Excellent	Excellent

Information unavailable or not applicable in blank cells.
—Adapted from Spraying Systems Catalog.—

Table 3. Example of nozzle data and comparisons of pressure and discharge, for several Turbo TeeJet nozzles.

Nozzle	*psi*	*GPM*	*psi*	*GPM*
TT11003	60	0.37	64	0.38
TT11004	30	0.35	36	0.38
TT11005	20	0.35	24	0.38
TT11006	15	0.37	16	0.38

Nozzle Manufacturers

Several principal spray nozzle manufacturers supply local equipment dealers. Each manufacturer distributes nozzle catalogs. These can be obtained from a local dealer or ordered from the following addresses:

CP Products Co., Inc.
418 S. Price Road
Tempe, AZ 85281
Phone: (866) 303-0600
Web: *www.cpproductsinc.com*

Greenleaf Technologies
P.O. Box 1767
Covington, LA 70434
Phone: (985) 892-3870
Web: *www.greenleaftech.com/*

Hardi Inc.
1500 West 76th St.
Davenport, IA 52806
Phone: (563) 386-1730
Web: www.hardi-US.com

HYPRO
375 Fifth Avenue NW
New Brighton, MN 55112-3288
Phone: (800) 424-9776
Web: *www.hypro-eu.com/en-gb/Our+Products/Spray+Nozzles/*

Spraying Systems Co.
P.O. Box 7900
Wheaton, IL 60189-7900
Phone: (800) 957-7729
Web: *www.spray.com*

Wilger Inc.
255 Seahorse Drive
Lexington, TN 38351-6538
Phone: (877) 968-7695
Web: *www.wilger.net*

Reference

R. Klein. *Fine Tuning a Sprayer with the "Ounce" Calibration Method.* University of Nebraska–Lincoln Extension NebGuide G1756.

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
1 cup = 16 tablespoons = 48 teaspoons = 236.5 ml

Length

3 feet = 1 yard = 91.44 centimeters
16.5 feet = 1 rod
5,280 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 = 0.405 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

GPM = 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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