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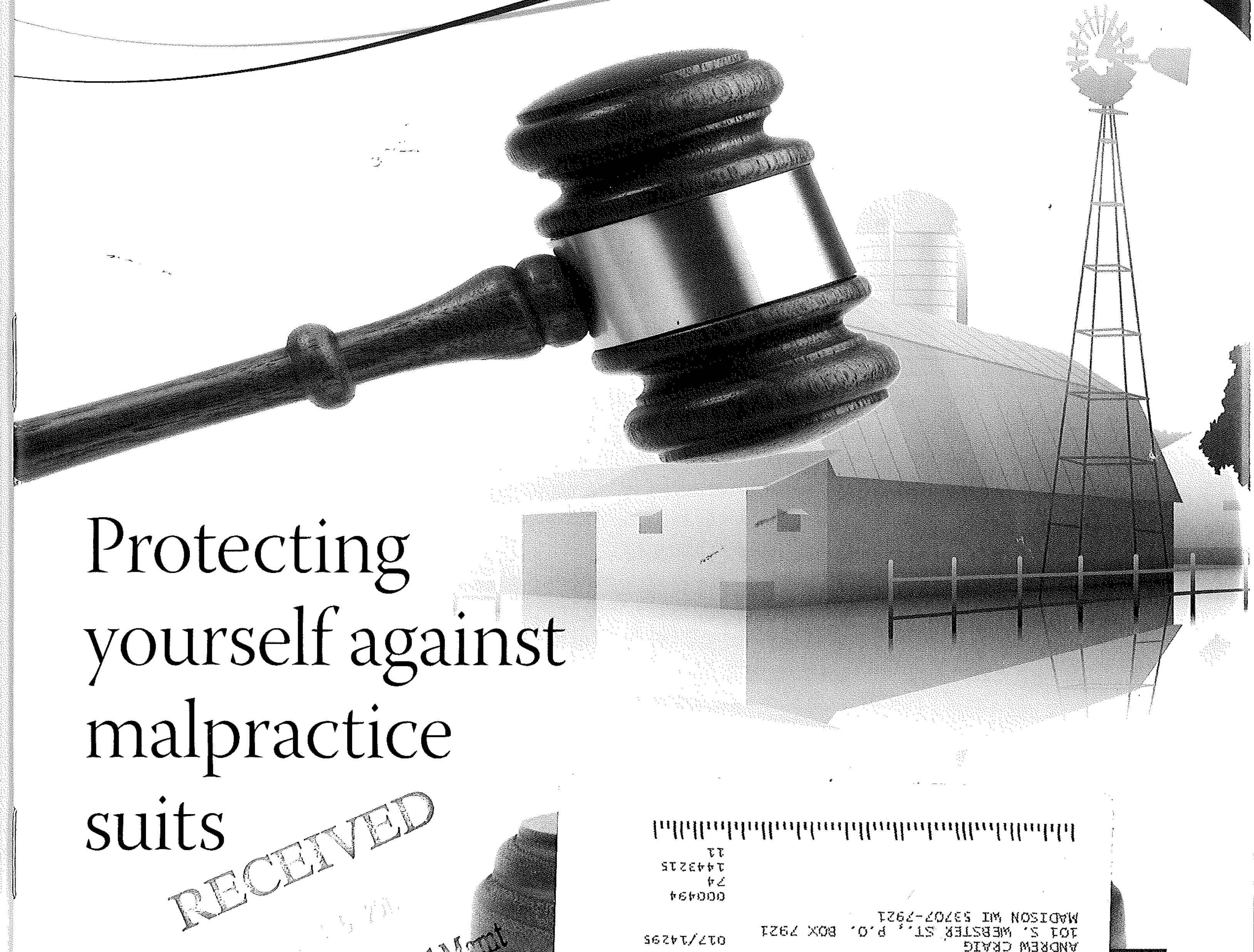

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[Spray] tips for increasing your producer's bottom line

The spray tip may be the least expensive, yet most important component of the precision sprayer. It is a major factor in determining the amount of spray applied to an area, uniformity of application, coverage obtained on the target surface, and amount of potential drift. At the 2011 Farm Show in Raleigh, NC in February, Brian Mathis from TeeJet Technologies reviewed some of the basics of nozzle use and technology to help producers increase their bottom line.

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Spraying isn't what it used to be. Producers used to pick a nozzle, pressure, and speed, do their best to stick to it, and spray. But things have become a little more complicated these days with all of the electronics available such as automatic rate controllers, guidance systems, and sensors. These tools can help increase your client's bottom line and reduce negative environmental impacts, according to Brian Mathis, Southeast Regional Manager for TeeJet Technologies, but without the right spray tips in place, the sprayer will never reach its precision capability.

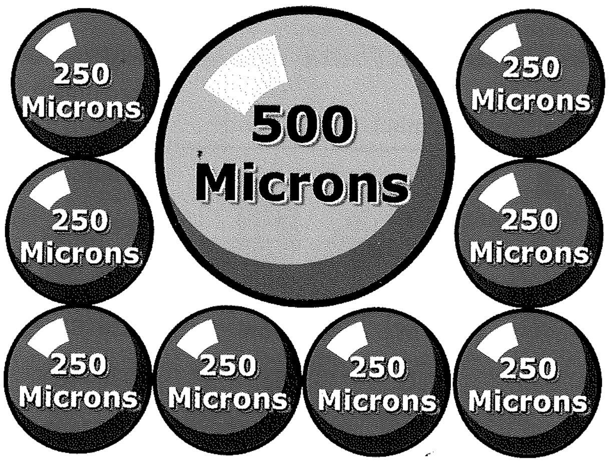
"The spray tip may be the least expensive, yet most important component of the precision sprayer," Mathis said during a talk he gave at the 2011 Southern Farm Show in Raleigh, NC in February. "You can have all those nice electronics, but if you screw up at the nozzle, at the exit point of delivery of that chemical on the ground, you've compromised the whole precision sprayer."

The nozzle is a major factor in determining the amount of spray applied to an area, uniformity of application, coverage obtained on the target surface, and amount of potential drift. It forms the spray pattern and determines the application volume at a given operating pressure, travel speed, and spacing.

The spray nozzle controls the flow rate, which is affected by the speed you drive. If you double your speed, you have to double your flow rate if you want to maintain the same application rate, Mathis explained. Automatic rate controllers can help with this.

"The automatic rate controller can help that system know what a gallon is and what an acre is so that it can properly allocate your gallons to your acres," Mathis said. "The other variable in that formula is the operator. The rate controller can only do the math, but he'd better drive that width. And that's where the guidance systems and the autosteer come into play."

For most conventional spray tips, the flow rate has a square root relationship with pressure. To maintain the same rate per acre, if you double your speed, your flow rate must dou-



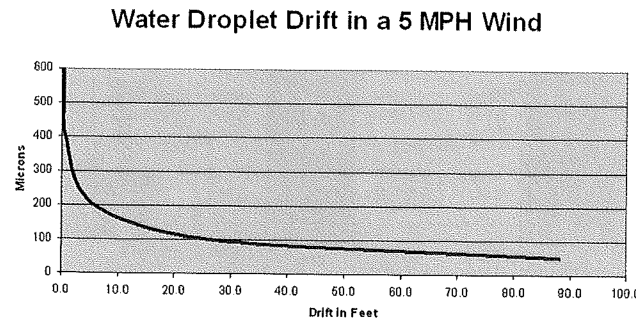


Fig. 1 (left): Cutting the droplet size in half results in eight times the number of droplets. **Fig. 2 (right):** The distance water droplets drift falling 3 ft to the ground in a 5 mph wind as related to droplet size. Source: TeeJet Technologies.

ble, but your pressure quadruples. This wide range of spraying speeds and resulting pressures can lead to drifting problems if spray droplet size is not understood and managed. So if operators plan on spraying at various speeds, they should make sure they have the appropriate size and type of nozzles to match their range of changing flow rates, pressures, and droplet sizes.

Nozzles break the liquid into droplets, which are measured in microns (1/1,000 of a millimeter). A human hair is about 100 microns. A nozzle will spray a wide range of droplet sizes, from real fine to real course. So, not all droplets coming out of a 300-micron nozzle will be 300 microns, but the median value should be 300. Selecting nozzles that produce the largest droplet size, while providing adequate coverage at the intended application rate and pressure, can minimize drift (Fig. 1 and 2).

"You can have your cake and eat it too," Mathis said. "You can have coverage and drift control, but I'll be the first to admit that you can take droplet sizes to one extreme or the other and not achieve the desired coverage or control. In other words, if it's too fine of a droplet for this herbicide or if it's too course of a droplet for that fungicide, you won't get the performance you want. But there is a range, and if you get right where you need to be in that range, you can get both."

There is an international standard for classifying nozzles according to colors and nomenclature. The color can tell you things like the nozzle flow capacity at a reference pressure (Fig. 3 and Table 1) while the nomenclature printed on the nozzle can tell you the brand name, nozzle type and material, flow capacity, and spray angle (Fig. 4).

"So a lot of times if we're talking on the phone, I'll ask what color tip are you using? You might not be able to read the tiny print on that nozzle, but if you tell me it's a red one, I'll at least know whether or not that's the right size flow rate nozzle for the desired speed, pressure, and application rate."

While there are many different types of nozzles (Fig. 5), the most common type used in agriculture is the fan nozzle. It's is widely used for spraying pesticides—both banding (over and between rows) and broadcast applications. The standard flat-fan nozzle normally operates between 30 and 60 psi, with an ideal range of 30–40 psi. The even flat-fan nozzles apply uniform coverage across the entire width of the nozzle's spray pattern. They are used for banding and should not be used for broadcast applications. The bandwidth can be controlled with the nozzle-release height and the spray angle.

The extended-range flat-fan nozzle provides fair drift control when operated at less than 30 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. Because 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.

The special-feature fan nozzles, such as the off-center fan, are used for boom-end nozzles so the swath is uniform end to end vs. tapered at the edges. The twin-orifice fan produces two spray patterns: one angled 30 degrees forward and the other directed 30 degrees backward (Fig. 5). 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 apply-

VisiFlow Color Coding Standard

VisiFlow Color Coding	Liquid Pressure	Capacity of One Nozzle	VisiFlow Color Coding	Liquid Pressure	Capacity of One Nozzle
Orange	40 psi (3 bar)	0.1 GPM (0.4 L/min)	Brown	40 psi (3 bar)	0.5 GPM (1.9 L/min)
Green	40 psi (3 bar)	0.15 GPM (0.55 L/min)	Gray	40 psi (3 bar)	0.6 GPM (2.3 L/min)
Yellow	40 psi (3 bar)	0.2 GPM (0.75 L/min)	White	40 psi (3 bar)	0.8 GPM (3 L/min)
Violet	40 psi (3 bar)	0.25 GPM (0.95 L/min)	Light Blue	40 psi (3 bar)	1 GPM (3.8 L/min)
Blue	40 psi (3 bar)	0.3 GPM (1.15 L/min)	Light Green	40 psi (3 bar)	1.5 GPM (5.7 L/min)
Red	40 psi (3 bar)	0.4 GPM (1.5 L/min)			

Fig. 3. VisiFlow color coding standard for nozzles. Source: TeeJet Technologies.

Table 1. Droplet-size classification chart. Source: Virginia Cooperative Extension Fact Sheet 442-032—"Nozzles: Selection and Sizing."

Droplet category†	Symbol	Color code	Approximate VMD range‡
			microns
Very fine	VF	red	<145
Fine	F	orange	145–225
Medium	M	yellow	226–325
Coarse	C	blue	326–400
Very coarse	VC	green	401–500
Extremely coarse	XC	white	>500

† American Society of Agricultural & Biological Engineers Standard 572.

‡ VMD, volume median diameter. It is a value where 50% of the total volume or mass of liquid sprayed is made up of droplets larger than this value, and 50% is made up of droplets smaller than this value. Reported VMD ranges vary widely, based on the type of laser analyzer used.

ing post-emergence contact herbicides, insecticides, and fungicides. Because of the small spray droplets, drift is a concern. To produce "fine" droplets, the twin-orifice usually operates between 30 and 60 psi.

Special designs such as "air induction" and "pre-orifice" designs are available to reduce drift (Fig. 6). Air induction nozzles have a hole in the side or in the shaft in the bottom, which inducts air into the passageway as the product travels through, helping to form larger droplets. With the pre-orifice design, when the product moves through the small pre-orifice chamber to the larger adjacent chamber, the pressure drops.

"Pressure drop makes my droplets a little bit bigger, and I get a little better drift control that way," Mathis said. "It's kind of neat how these nozzles are built so that we get the droplet size that we want in the nozzle."

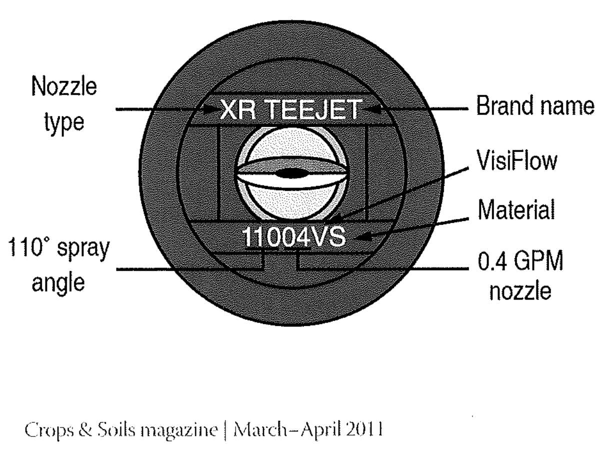


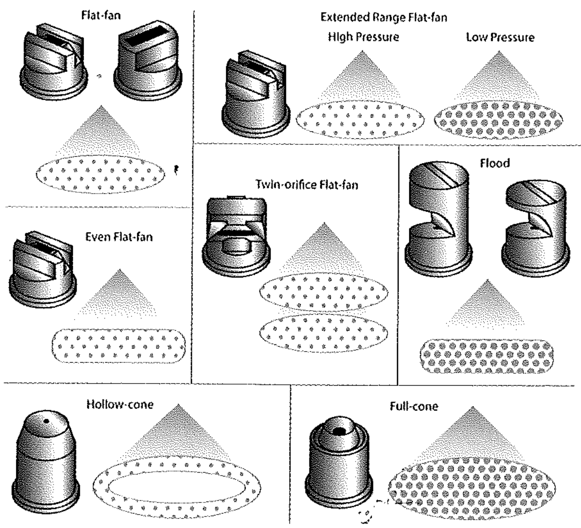
Fig. 4. The nomenclature printed on the nozzle can tell you the brand name, nozzle type and material, flow capacity, and spray angle. Source: TeeJet Technologies.

No one nozzle works for every situation, Mathis explained, because no one chemical does either.

"The chemical mode of action is a major factor in nozzle selection. If it's a contact fungicide, it's going to treat right where it touches—it may not move very far on that foliage. A locally systemic fungicide may move within the leaf. A translocated mode of operation means it will be applied and then translocate into the root and kill the whole plant. We have to know what we are applying to know what nozzle to use."

If you're using a contact chemical, you might want some pretty fine droplets to make sure you have a bunch of those droplets covering a lot of area on the plant, Mathis said. But you might be able to get away with a course droplet with a translocated chemical if it hits the plant, gets sucked in, and travels all the way to the root and kills the plant.

"I've had farmers say to me, 'Man I know it's not working unless I see fog behind me,'" Mathis said. "He's saying he wants real fine droplets everywhere to make that particular chemical work. He would never do that same thing with a herbicide that's going to kill everything and be a driftable problem to his neighbors. It's not one size fits all, and it's go-



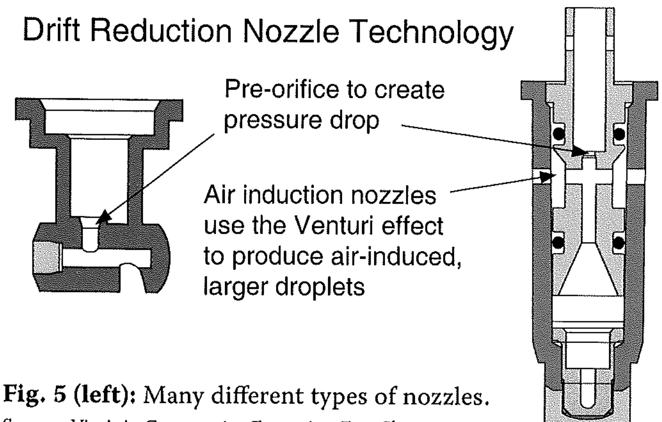


Fig. 5 (left): Many different types of nozzles. Source: Virginia Cooperative Extension Fact Sheet 442-032—"Nozzles: Selection and Sizing." **Fig. 6 (right):** Special designs such as "air induction" and "pre-orifice" are available to reduce drift. Source: TeeJet Technologies.

ing to be a matter of what chemical you're applying and how you're going to make that chemical effective. And droplet size is just as important as the actual flow rate, pressure, target, and pattern. It's a puzzle, and you've got to put all those pieces of the puzzle together."

Another piece of the puzzle is the spray angle on the nozzle. The most common spray angles are 65 degrees, 80 degrees, and 110 degrees. The angle you use depends on the height of the nozzle from the target, which may be the top of the ground, growing canopy, or stubble. Recommended nozzle heights for flat-fan nozzles during broadcast application are given in Table 2. Use 110-degree nozzles when booms are less than 30 inches high with 30-inch nozzle spacing; use 80-degree nozzles when the booms are higher. Although wide-angle nozzles produce smaller droplets, 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% overlap at the target height. Most fan nozzles should not be oriented more than 30 degrees back from vertical.

Nozzles eventually wear down and need to be replaced. Their wear rates depend on the tip material, chemicals used, water quality, operating pressure, and care taken when cleaning them out. Mathis said when measured flow rates are 10% over the nominal flow rate, it's time to replace your tips.

"I always get asked, 'How often do I need to change my nozzles?' There's not a good answer to that," Mathis admitted. "What we suggest is that you get a calibration jug, take a brand new nozzle, and test it at, say, 40 psi to see what your [default output] is that all of the rest of your nozzles should be compared to.... The 10% rule is where you really start noticing uneven wear from tip to tip to tip. It's not a science—it's just a good indicator."

Should a nozzle become clogged, it is best to blow out the dirt with compressed air or use a soft-bristled brush such as a toothbrush. It's important to wear chemical-resistant gloves when handling and cleaning nozzles to reduce pesticide exposure and never use a wire or nail as a cleaner because the orifice can be easily damaged. &

Portions of this report were based on the Virginia Cooperative Extension Fact Sheet 442-032—"Nozzles: Selection and Sizing."

Table 2. Suggested minimum spray heights. Source: Virginia Cooperative Extension Fact Sheet 442-032—"Nozzles: Selection and Sizing."

	Spray height			
	20-inch spacing overlap		30-inch spacing overlap	
Spray angle	50%	100%	50%	100%
	inches			
65	22–24	NR†	NR	NR
80	17–19	26–28	26–28	37–39
100	10-12	15–17	14–18	25–27

† NR, not recommended.