Equipment to Reduce Spray Drift

K-STATE Research and Extension

Application Technology Series

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Nozzles

The next generation of equipment

"The bigger they are, the harder they fall" is a bit of wisdom that has been around for a long time. But when it comes to pesticide application, the line should read, "The bigger they are, the closer they fall." Large droplets are not as likely to drift off-target as smaller droplets. This basic principle ties behind many innovations to reduce drift when spraying herbicides.

Nozzle manufacturers have been especially interested in reducing drift in recent years, as evidenced by the new products entering the market. The following are three techniques that equipment manufacturers use in designing nozzles to reduce drift.

Nozzles that operate at low pressures (extended range nozzles)

For many years, equipment manufacturers attempted to control drift with nozzles that could be operated at lower pressures. Lower pressures typically produce larger droplets, which mean less drift.

For example, the extended range flat-fan nozzles, available from several manufacturers, provide uniform spray patterns at pressures down to 15 pounds per square inch (psi), reducing the number of small, driftable spray droplets as compared to operating the nozzle at 30 to 40 psi.

Nozzles with a pre-orifice design

Several years ago, Delavan-Delta, Inc. developed a low-drift nozzle, the Raindrop® nozzle. It was designed to reduce internal pressure, resulting in larger, drift-resistant spray droplets. The designs using that concept today incorporate a "pre-orifice," located on the entrance side of the nozzle (see photo and illustration on page 3). The pre-orifice restricts the flow from the nozzle. This, in turn, reduces the exit pressure and reduces the number of small droplets in the spray pattern.

These nozzle designs are usually called "drift reduction flat-fan nozzles."

Nozzles with pre-orifice, turbulence chamber

The most recent nozzle designs combine the pre-orifice concept with an internal turbulence chamber. The turbulence chamber absorbs energy, once again reducing the exit pressure from the nozzle. This not only creates larger droplets, but also improves the uniformity of the spray pattern.

Turbulence chamber nozzles are available in a turbo flood tip and now in the turbo flat-fan design. The turbo flat-fan design shows great improvements in pattern uniformity when compared to the extended range flat-fan and other drift reduction flat-fan designs.

In addition, the turbo flat-fan has significantly reduced the percentage of driftable droplets under a wide range of pressures. Both of the turbo designs are adapted for use on the boom to spray straight down with a 50 percent overlap.

Air-Assisted Sprayers and Nozzles

Staying on-target

An increasing number of applicators are turning to air-assisted sprayers as a way to reduce drift and to obtain better coverage on the target.

Air-assist technology uses pneumatic energy to improve the atomization, transportation, penetration, and deposition of spray products. There are two basic styles of air-assist systems — a type that uses an air-curtain or air-shield boom, and a type that uses air-atomizing nozzles.

The air-curtain or air-shield boom

Air-curtain or air-shield booms are designed with an external blower fan system. The blower creates a high velocity of air that will "entrain" or direct the spray solution toward the target. Some sprayers provide a shield in front of or behind the conventional spray pattern, protecting the spray from being blown off-target.

The concept of this approach is to increase the effectiveness of pest-control substances, provide better coverage to the underside of leaves, promote deeper penetration into the crop canopy, make it easier for small droplets to deposit on the target, cover more acres per load, and reduce drift.

Studies conducted by the USDA Agricultural Research Service in Stoneville, Mississippi, have shown that conventional sprayers provided adequate control in the top of the crop canopy, while the air-assisted sprayers tended to show improved control in the mid- to lower canopies. The air stream tended to open the canopy and help spray particles penetrate to a deeper level.

Mid- to lower-canopy penetration and coverage is important when working with insecticides and fungicides, but may not be as critical when applying herbicides.

Another finding in the USDA-ARS study (and supported by a Canadian study), was that air-assisted boom sprayers can decrease drift when there is a crop canopy, but can increase drift when applying to bare ground. When there is a crop canopy, the plants absorb the extra energy created by the blower's air stream, but when the ground is bare, the increased air velocity can cause more drift.

Air-Induction/venturi nozzles

With this design, the air supply is not external, as with the air-curtain or air-shield boom. The air is introduced into the nozzle internally.

Several different designs of air-induction/venturi nozzles are currently being developed. The idea is to "entrap" the air in the spray solution at some point within the nozzle. The introduction of the air is through small openings in the nozzle as a result of a venturi effect. The reduced pressure or vacuum created within the nozzle will draw the air into the spray solution forming air bubbles. The air and liquid exit the nozzle as a larger spray droplet with the potential to get more pesticide product to the target and reduce drift.

Air-induction/venturi nozzle systems appear to be very promising for improved application efficiency and reduced drift, but more research is needed to verify this concept.

Drift-control nozzle development

Nozzles have offered increasing drift control since the mid-1980s. First, there were nozzles that could operate under low pressures, such as the flat-fan nozzle pictured to the right. The next refinement was the pre-orifice design. The latest trend has been toward nozzles with a pre-orifice and turbulence chamber. These nozzles have improved drop size control and create an extremely uniform spray pattern (see chart on page 2).

Drop size comparisons

Data provided by the Spraying Systems Company, 1996

Nozzle Type*	Drop Size (in microns) at different spray volumes and pressures			% of spray volume under 200 microns
Nozzles that operate at low pressures (extended range nozzles)	40 psi 0.2 gpm	40 psi 0.5 gpm	60 psi 0.5 gpm	40 psi 0.5 gpm
• XR flat-fan 80	270	370	300	11
• XR flat-fan 11	224	310	250	22
Pre-orifice nozzles				
• Drift Guard flat-fan 80	340	410	330	8
• Drift Guard flat-fan 110	330	390	320	11
Pre-orifice, turbulence chamber				
• Turbo flat-fan	340	450	400	6
• Turbo flood flat-fan	--	710	650	Less than 1
Other Nozzles				
• Flat-fan 80	270	370	300	11
• Flood flat-fan	--	450	410	3

* All nozzles are Spraying Systems nozzles.

gpm = gallons per minute **psi** = pounds per square inch

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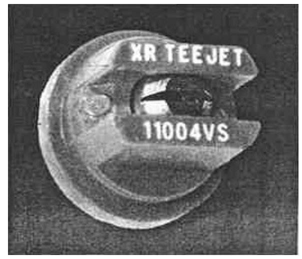
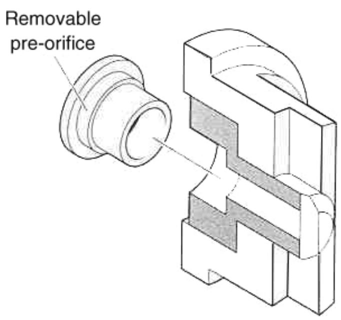
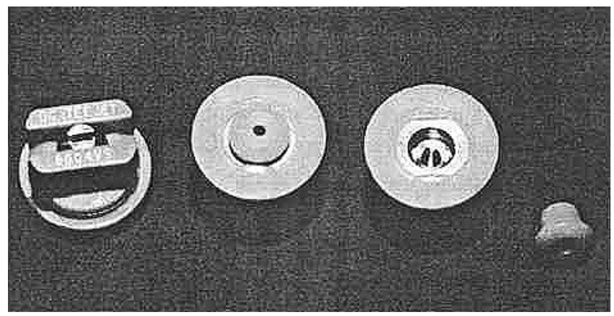
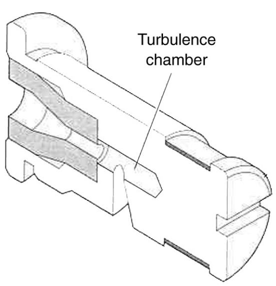


Nozzle that operates at low pressure (extended range nozzle)

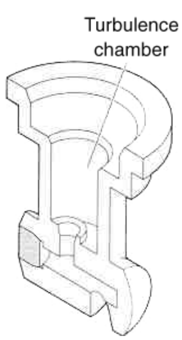




Pre-orifice nozzle



Pre-orifice flood nozzle with turbulence chamber



Pre-orifice turbo flat-fan nozzle

Making a comeback

Electrostatic spraying is an old idea that has been improved and is making a comeback for pesticide application. A new process, the Energized Spray Process (ESP), is being field-tested to determine whether this technology can improve spray efficiency and reduce drift.

With the ESP system, the entire liquid solution receives an electrical charge. By giving the pesticide solution a high electrical charge, the droplets become attracted to the plants. As a result, this high-intensity, electrostatic field helps the droplets deposit on the plant surface.

This approach, known as "contact charging," differs from earlier electrostatic systems, which used "induction charging" of the spray solution. With induction charging, the solution was charged at the nozzle. But, with contact charging, 40,000 volts are added to the liquid spray solution in a charging chamber; then the charged solution moves to the boom and nozzles.

The electrostatic spray process shows promise in increasing the coverage to both the upper and lower sides of the target leaves. But its impact on drift reduction is not clear.

Reviewed June 2014 by John W. Slocombe, professor, ag and forage machinery safety, K-State Department of Biological and Agricultural Engineering. Contact him at *slocombe@ksu.edu* with any questions.

Grateful acknowledgment to the original author, Robert E. Wolf, professor emeritus, K-State Department of Biological and Agricultural Engineering.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF-2445 March 2000