On Target Sprays ~ Successful Farming

On-Target Sprays

Air-induction nozzles produce fewer driftable fines while maintaining efficacy

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Here's why you need to reduce drift and what you can do to put spray droplets where they need to be.

Trying to get a handle on spray drift is like trying to wrestle an octopus. About the time you get control of one arm of the problem, you realize you're losing control of something else.

Concerns about off-target spray applications seem to have intensified the past few years. Part of the concern, no doubt, has to do with increased use of broad-spectrum, postemergence herbicides such as glyphosate and the potential liability for damage to neighboring crops or rural homeowners' yards and gardens.

While potential property damage is in itself a legitimate reason to pay more attention to the way you spray, there are three other good reasons why you need to be careful: efficacy, the environment, and the EPA.

Since most pesticide rates have a bit of a fudge factor built in to account for variable application, you may not notice a reduction in efficacy due to drift. However, if the spray you are making contains a high enough percentage of small droplets that evaporate, you could notice performance problems if conditions are right.

In a study last summer at Kansas State University, normally reliable Turbo TeeJet nozzles didn't perform as well as venturi-style tips on broadleaves, according to Bob Wolf, Extension ag engineer. The day of the application was 98°F. with very low humidity, and Wolf speculates that control was less because the smaller droplets being produced by the Turbo TeeJets were evaporating.

According to Dennis Gardisser, Extension ag engineer at the University of Arkansas, potato growers have been able to boost the efficacy of fungicide applications by increasing the average droplet size to 350 microns and using tips that produce a minimum of driftable droplets.

Environmental concerns
From a regulatory standpoint, the environment may be the biggest issue with drift. Larger

spray particles seldom fall out more than 5 meters from the spray swath unless you're spraying in winds above 20 mph, says Brian Storozynsky, project manager for sprayer studies at the Alberta Agriculture Technology Centre in Lethbridge. Droplets smaller than 150 microns, on the other hand, tend to remain airborne.

These smaller spray particles either evaporate or are carried up into the atmosphere and are transported long distances. They may not damage your neighbors' crops, but they come down eventually, and that creates concerns for society, says Al Womac, ag engineer at the University of Tennessee.

Then there's the issue of the EPA. In the fall of 2001, the agency proposed new language for pesticide labels aimed at minimizing spray drift (see sidebar on page 35). Among other things, this proposed label language set limits on droplet size, spray boom heights, and maximum wind speeds allowed during spray applications. It also called for buffer zones (for certain pesticides) near sensitive areas.

One of the reasons the EPA cited for proposing the new restrictions is that states receive about 2,500 complaints about drift each year, according to a 1999 survey conducted by the Association of American Pesticide Control Officials.

The survey covered the three years from 1996 to 1998 -- the first three years that Roundup Ready crops were available. According to the survey, drift complaints held steady at about 2,500 per year for the three years.

Complaints do not always represent actual drift problems. Over the three-year period, only one third of the complaints resulted in some kind of enforcement action. On the other hand, no one has a good handle on how many actual drift problems are never reported to state agencies.

While there's still a good amount of jousting about how the final labeling guidelines will read, most experts predict that something will eventually be finalized. And once the drift language is included on pesticide labels, it will have the force of law. Some chemical companies are already changing their labels to include drift-control language before the EPA forces the issue.

How should you go about reducing drift? There are many factors that influence drift potential, and they all seem to interact. Some you can manage, others you can't.

Among the factors you can change are nozzle type, flow rate, pressure, speed, boom height, nozzle spacing, fan angle, boom stability, adjuvants used, timing of application, and, for some products, the formulation.

Focus on droplet size

The most significant thing you can do to reduce drift is manage droplet size and the spectrum of the droplets you produce. The nozzle style, pressure, and flow rate all come into play as you boost droplet size.

The American Society of Agricultural Engineers (ASAE) recently spent five years developing a new system to describe nozzles according to the size and spectrum of droplets they produce at various spray pressures. Nozzle catalogs from the various manufacturers do a good job of highlighting the droplet spectrum their nozzles produce at various sizes and pressure settings.

Until these categories were developed, the drift control focus was on nozzles that produce large droplets. The number used to describe droplet size was the VMD -- the volume median diameter. If a nozzle was listed as having a VMD of 350 microns, that meant that 50% of the spray volume was produced in droplets that are smaller than 350 microns.

Unfortunately, the VMD doesn't tell the whole story. From a drift reduction standpoint, the key issue is how much of the spray is being produced in droplets smaller than 150 or 200 microns because these are the droplets most likely to drift.

The ASAE nozzle classifications are a good first step, says Womac. But ag engineers still hope to refine the categories so they give more weight to drift concerns than the current standards. He says it's possible to have a nozzle with a decent VMD that still produces 15% to 20% of its spray volume in small, driftable droplets.

In selecting nozzles and target droplet sizes, you need to balance drift control and efficacy, Gardisser says. You want bigger droplets for reducing drift and smaller droplets for improving efficacy, particularly with contact-type pesticides.

The critical factor for efficacy seems to be the number of droplets per square inch, says Tom Wolf, research scientist with Agriculture and Agrifood Canada. "If you reduce water volume and increase droplet size, you are going to have fewer droplets per square inch. There comes a point where you have too few."

Over the last several years, nozzle manufacturers have made a series of significant improvements in design to produce nozzles with a minimum of driftable fines. Preorifice-style nozzles, such as the Drift Guard and Turbo TeeJets, produce significantly less fines than XR flat fan nozzles.

The air-induced or venturi-style nozzles have reduced drift even more. These nozzles draw air into a chamber where it's mixed with the spray solution. The Greenleaf TurboDrop was

the first of the venturi-style nozzles, and now there are nearly a dozen different models available.

The Canadians have decided to classify the Venturi nozzles as either low pressure or high pressure. "If you have a low-pressure venturi, it doesn't matter which one you have -- they all behave similarly," says Storozynsky. He says low-pressure venturis (minimum operating pressure down to 20 psi) produce more droplets smaller than 150 microns than the high-pressure venturis (minimum operating pressure around 40 psi).

"There were always subtle differences, but overall they behave the same in terms of drift potential, coverage, and droplet size. The high-pressure venturis behave differently than the low-pressure models -- and it is significant," Storozynsky adds.

Dramatic drift reduction
Tests have shown dramatic reduction in drift potential with the venturi-style tips. "With a low-pressure venturi-style nozzle, there is a 35% to 60% reduction in drift compared to Turbo TeeJets," says Storozynsky. "With a high-pressure venturi, the reduction in drift is 60% to 90% compared with the Turbo TeeJet. That range depends on the manufacturer, the size of nozzle, and the spray pressure used."

Good as they are, the Venturi nozzles don't give you a green light to spray in high winds, Storozynsky says. "Producers, after seeing some of our studies on drift with Venturi nozzles, think that they can go in higher wind speeds," he says. "The truth is that Venturi nozzles have brought drift levels back to what they were 25 years ago -- around and below the 3% level. Going in higher winds is not recommended by the AgTech Centre."

The Venturi nozzles aren't foolproof, however. Several styles are designed to work at high pressure, and some users had performance problems the first couple of years because they didn't use enough pressure.

Keep the pressure up
Applicators were running high-pressure Venturi tips at 40 psi, Storozynsky says, when they were designed to run at a minimum of 40 psi. "If they were running at 40 psi with an automatic rate controller and slowed down, the pressure dropped to 20 to 30 psi and they had problems."

It's difficult to convince applicators to increase pressure with these venturi-style nozzles, says Bob Wolf. That's because ag engineers have spent years trying to convince applicators to use less pressure in order to minimize drift potential.

Tom Wolf says even low-pressure Venturi nozzles need to be operated using at least 30 psi to produce a good spray pattern. Bad patterns and bad overlap are the biggest issues relating to Venturi tips, he says.

Overlap is important with the venturis because the droplet spectrum varies across the fan, Tom Wolf adds. "We're finding that the majority of really big droplets from these nozzles are on the outside edge of the spray fan," he says. "If you don't have sufficient overlap, you get a great amount of variation in droplet size underneath the boom. You'll have finer droplets in the center of the spray fan and coarser droplets in the overlap.

"To minimize that effect, you project the edge of the spray farther into the adjacent pattern, and you equalize the overall droplet size under the boom. That's why we advocate 110° tips for low-drift nozzles," Wolf adds.

As engineers and applicators get more experience with venturi-style nozzles, efficacy issues are fading. Storozynsky says his group recently completed an extensive five-year herbicide and fungicide efficacy study involving six different nozzle systems and a range of droplet sizes from very fine to extremely course droplets.

The tests were designed to represent real-world, field-scale conditions. They included three conventional setups and three air-assisted systems.

The conventional setups included extended-range nozzles that produced fine to medium sprays, a Spraying Systems Turbo TeeJet nozzle that produced medium to coarse sprays, and a Greenleaf TurboDrop venturi-style nozzle that produced very coarse to extremely coarse sprays.

"They all performed about the same. I don't think there was one system that was better than the other, at least in postemerge spraying of cereal and oilseed crops," Storozynsky says.

Bob Wolf has had similar results in his efficacy studies at Kansas State University. He's looked at herbicide performance using different spray volumes and spray pressures using both contact and systemic herbicides. In terms of efficacy, the Venturi nozzles have usually held their own with nozzles making smaller droplets. And last summer, they had better performance than turbo flat fan nozzles under hot, dry spraying conditions.

"If you use the tips correctly, efficacy definitely holds up, so I would not hesitate to recommend an air-induced or low-drift tip to an applicator," adds Tom Wolf in Canada. "But I would attach a couple of conditions."

The first condition, Wolf says, relates to what you're trying to control. If you're trying to control insects or grassy weeds, efficacy may be more sensitive to droplet size than broadleaf weeds or diseases.

The second condition relates to the amount of pressure your sprayer can produce since some of the Venturi tips require higher pressures.

Watch the spray volume

Finally, Tom Wolf says you need to ask what carrier volume you're able to use. If you're limited to a low carrier volume because of water shortages or distance traveled, that can affect the droplet size you produce.

"When you apply low water volumes, you can't go to as coarse a droplet as you can otherwise," Wolf says. "We just finished a study where we compared three water volumes: 12, 8, and 4 gallons per acre.

"Each of these water volumes was tested with five droplet sizes ranging from fine to extremely coarse using Roundup and Liberty. The conclusion of the study is that if you use a low- carrier volume, you cannot go as coarse in spray quality as you could if you were using a high-carrier volume," Wolf says. "If you opt for lower water volume, you don't have as many low-drift choices available to you."

Depending on weather conditions, the effect of lower-carrier volume can be dramatic, says Tom Wolf. In 2001, they had no response to droplet size as long as they sprayed Roundup with at least 8 gallons per acre. When they dropped to 4 gallons of carrier, control dropped to 50% with coarse and very coarse sprays. In 2002, the loss of control with coarse sprays at low-carrier volume was not nearly as great.

Lower the boom

In western Canada, more farmers are buying high-clearance sprayers instead of pull types, says Storozynsky. It's tough to keep the booms low on these rigs.

"Having been a custom applicator for several years, it's very difficult to keep the booms at a certain height for an entire field or an entire day. As the day goes by and the boom dips and hits the ground several times, you always have a tendency to put it up," Storozynsky says. "Before you know it, you may be 12 to 24 inches above your original height setting.

"We don't have that problem with pull-type sprayers. They operate much lower to the ground -- within 20 inches," Storozynsky adds. "To us, that's a good height for reducing drift. Once you get higher than that, your drift starts to increase."

As a result, Storozynsky says they suggest that high-clearance sprayers be fitted with high-pressure venturis. He says the high-pressure Venturi nozzles are more forgiving in terms of drift, but they sacrifice a bit of coverage.

Bob Wolf says he actually recommends a slightly higher boom height when making postemergence applications. That increases the overlap and helps the spray penetrate the canopy.

Legal limits in Arkansas

In Arkansas, you're not allowed to have the boom more than 60 inches above the target, Gardisser says. "If you go higher than 30 inches, the smallest droplet you can use is coarse no matter what speed you drive. A lot of times, coarse is too big for really good efficacy, so that makes them put the boom at 30 inches or closer and makes them drive at speeds of 10 mph or less. Those are the only two combinations that will allow a medium or smaller droplet."

Gardisser says the intent of that regulation was drift control. "When they do inspections, the applicators they have trouble with are the ones driving at higher speeds, so they've imposed tighter restrictions."

Since the only way to increase flow rate from a given spray tip is to increase pressure, driving faster requires a higher pressure to maintain the application rate.

"If you're using a rate controller and you double the speed, you need to double the flow rate to get the same dosage in the field," Gardisser explains. "But to double the flow rate, you have to increase the pressure by a factor of four. So if you're spraying at 4 mph using 20 psi and increase your speed to 8 mph, the pressure needs to increase to 80 psi. In a lot of cases, that would put the nozzle into the very fine category."

Controlling physical drift may be a matter of using larger spray droplets around sensitive areas. If your sprayer is fitted with multiple-nozzle turrets, one way to do that is to change to a nozzle with a coarser droplet spectrum on the outside of the field.

"I tell producers at meetings that they should have more than one nozzle at their disposal," says Tom Wolf. "You have to make judgments about the conditions -- the weather conditions, for example. You have to make a judgment about your location. How near are you to a sensitive area? You have to make a judgment about the kind of pest you're controlling and the product you're using to control it. And that will determine which spray quality, which droplet size, and which water volume you need to apply."