UNDERSTANDING SPRAY NOZZLE PERFORMANCE

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Spray drift is not a new concept. The offsite movement of pesticides during application has been occurring since we began spraying pesticides some 50 years ago. Today's heightened concern over spray drift is a culmination of several factors. Infringing housing development, contamination of neighboring crops with illegal pesticide residues, increased use of "non-selective" herbicides on gmo crops, and a more litigious society have all placed increased demands for caution and safety on today's pesticide applicators.

Weather conditions at the time of application are the primary factor affecting the movement of spray droplets. Wind speed and direction, temperature, humidity and air stability can all play a significant role. But since we have little hope in controlling the weather, our reaction to the weather will determine our success or failure in controlling spray drift.

The movement of spray droplets is a function of spray droplet size. Spray droplets are measured by their diameter which is measured in microns (µm). One micron is approximately 1/25,000 of an inch. For comparison purposes, a human hair is about 100 microns in diameter. Larger spray droplets have greater mass, fall quicker, and therefore have a decreased risk of drift. From Table 1 you can see that while it takes 11 seconds for a 100 micron spray droplet to travel 10 vertical feet, it only takes 2 seconds for a 400 micron droplet to travel the same distance. In general, droplet sizes smaller than 150 microns are considered to pose the greatest drift hazard and should be avoided for most applications.

Table 1. Spray droplet fall rates.

Droplet diameter	20 microns	100 microns	240 microns	400 microns
Time to fall 10 feet	4.2 min	11 sec	6 sec	2 sec

Source: Akesson andYates, 1964.

If small droplets are the problem, then spraying with very large and course droplets must be the answer, right? Not necessarily. The type of pesticide being applied will

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determine the desired spray droplet size. Generally, smaller droplets are more desirable for insecticide and fungicide applications where very thorough coverage may be necessary to maximize crop protection effectiveness. Very large droplet sizes are most suited to soil applied preemergence or preplant incorporated applications where the pesticide is further dispersed by rainfall or mechanical incorporation, therefore requiring less thorough spray coverage. The effectiveness of postemergence applied herbicides can be affected significantly by spray droplet size. Contact herbicides, such as Gramoxone Extra and Liberty which are not translocated well through the plant will require thorough coverage for effective control. Consider spraying droplet sizes from 200-350 microns when applying contact herbicides to minimize drift while maximizing weed control. Translocated herbicides such as Roundup and 2,4-D are moved throughout the plant and therefore do not require as thorough of spray coverage. Larger droplet sizes in the 350-450 micron range can be safely used when applying translocated herbicides without sacrificing control. Because each pesticide has its own limitations, always consult the label for complete guidance on application recommendations.

Because spray nozzles produce a range of droplet sizes, nozzles are classified based on the percentages of the droplet sizes they produce. The term volume median diameter, or VMD is often used to measure a nozzles range of droplet sizes. The VMD represents the droplet size where half of the spray volume is contained in droplets larger than the VMD and half of the spray volume is in droplets smaller than the VMD (Table 2). Nozzle manufacturers use this classification system to indicate the droplet size of their nozzles for different size and pressure combinations. In addition, pesticide labels sometimes use this system to recommend appropriate droplet sizes to be used with their products.

Table 2. Spray droplet classification.

Category	Symbol	Color code	VMD (μm)
Very fine	VF	Red	< 150
Fine	F	Orange	150-250
Medium	M	Yellow	250-350
Coarse	C	Blue	350-450
Very coarse	VC	Green	450-550
Extremely coarse	EC	White	>550

Source: ASAE Standard S-572.

Adjusting spray pressure is perhaps the quickest and simplest way to affect droplet size. Operating any given nozzle at a lower pressure increases the VMD output from that nozzle. Additionally, spray output will be reduced at the lower pressure, potentially requiring a change to larger orifice size to maintain equivalent output. Always operate a nozzle within its manufacturer suggested pressure range. Failure to do so can result in less than optimal spray pattern and ultimately loss of pest control. The aspect of pressure is particularly important with today's pressure compensating spray controllers. If possible, always keep the pressure readout active on your display so that you can verify if you are within the acceptable range for the nozzle you are using. Any increases in speed will require an increase in pressure to compensate output. Just because your spray rig can spray at 18 mph, doesn't mean you should be doing so.

Several new drift reducing nozzle types have been developed to increase droplet size, including:

Pre-orifice Flat Fan Nozzles

Example includes the Driftguard nozzles. These nozzles use a pre-orifice prior to the discharge orifice that ultimately reduces spray pressure, resulting in larger droplets at a given operating pressure. The acceptable pressure range for this nozzle type is generally between 30 and 60 psi, with an optimum operating pressure of 40 psi. The amount of fine droplets are reduced substantially compared to a standard extended range flat fan nozzle. This nozzle type has been a popular choice for soil-applied herbicides.

Turbulence Chamber Nozzles

Examples include the Turbo Teejet and Turbo Floodjet nozzles. These nozzles use a pressure reducing turbulence chamber prior to the orifice that absorbs spray energy within the spray tip, increasing droplet size. These nozzles maintain droplet size and acceptable spray pattern over a very wide range of pressures, making them particularly useful in combination with pressure compensating spray controllers. Optimum operating pressure for these nozzles is about 40 psi.

Air Induction Nozzles

These nozzles contain two orifices, one to control liquid flow into the nozzle and one to form the spray pattern. In between the two orifices a jet is used to draw air into the nozzle body. This air mixes with the liquid and becomes trapped in the liquid droplets, resulting in a course spray of air filled droplets and very few fine droplets. These air filled droplets are intended to shatter on impact with the plant, thereby resulting in improved coverage from the otherwise much larger droplet size. Most air induction nozzles are designed to be operated at higher operating pressures, with optimum performance often in the 60-80 psi range.

Correct nozzle selection is your easiest and quickest tool in preventing spray drift. Remember that no nozzle is meant for all conditions and sometimes the only correct decision is to turn off the key and wait. But knowing the correct uses and limitations of both your nozzles and spray rig are critical when determining the best nozzle for the job.

Reference

Akesson and Yates. 1964. Annual Review of Entomology.