Strategies to Reduce Spray Drift

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How Pesticides Drift

Vapor and particles

Weeds, insects, and diseases are not the only enemies you face when applying pesticides. Drift is another one. Drift results in a waste of product, reduces the effectiveness of your application, and can damage crops that are economically or aesthetically important. Pesticide that drifts off-target also can hurt wildlife and contaminate water supplies. There are two basic ways in which pesticides move downwind:

Vapor drift. When pesticide molecules volatilize (evaporate into the air), they can move downwind as a vapor. This form of drift is related to the product, not to the type of application method used.

Particle drift. This is the movement of spray particles, or droplets, formed during application. Several key factors determine if a spray droplet will hit its target or drift downwind: (1) the droplet size; (2) the equipment and method of application; and (3) the wind speed and other climatic conditions.

Droplet Size

Small droplets increase drift

"Atomizing" the spray solution into very small droplets will increase the coverage possible, but you must also consider the potential for evaporation, drift, canopy penetration, and deposition of the spray particles. The droplet, the greater the risk of drift.

Decreasing the droplet size from 200 to 20 microns will increase relative coverage tenfold, as shown in the table, "The effect of droplet size on coverage" (see page 2). But keep in mind that a 20 micron droplet will travel less than 1 inch in less than one second before the water droplet evaporates (see the table, "Spray droplets: evaporation and distance traveled").

Droplets less than 100 microns in size reach a horizontal trajectory in a very short time and evaporate rapidly. Rather than reaching the target, the pesticide contained in these water droplets become very small aerosols, which remain in the air until picked up in falling rain.

Droplets over 150 microns in size resist evaporation much more than smaller droplets because of their large surface area. Therefore, the potential for drift rapidly decreases when the diameter of droplets is increased to about 150 microns.

A range of sizes

In reality, you want a range of droplet sizes to effectively deposit pesticide on the wide variety of plant types, sizes, and shapes that you encounter. For instance, here is how different size droplets vary in their effectiveness.

Very fine droplets (median size less than 120 microns). These droplets are collected efficiently by insects or by needles on coniferous plants, but they tend to remain in the air stream and are carried around the stems and leaves of weeds.

Fine and medium size droplets (median size between 120 and 350 microns). If these droplets are applied when there is some air movement, they will deposit more efficiently on sterns and narrow vertical leaves such as grasses.

Coarse and very coarse droplets (median size over 350 microns). These droplets will deposit most efficiently on large flat surfaces such as broad-leaved weeds.

To effectively control pests, the actual range of droplet sizes will depend on the specific pesticide being used, the kind and size of the target plant, and weather conditions. A few nozzles are specifically designed to reduce drift by reducing the amount of small, driftable droplets in the spray pattern.

Insecticides and fungicides generally require smaller droplets than herbicide applications to obtain adequate coverage of the target. For foliar herbicides, however, experimental results suggest that droplet sizes in the range of 100 to 400 microns do not significantly differ in weed control, unless application volumes are extremely high or very low. Exceptions to this guideline may exist for specific herbicides.

Equipment and Application Methods

Application parameters

The equipment you choose and the way you use it makes a difference. For example…

Lower spray height. You can reduce drift by mounting the spray boom closer to the ground (without sacrificing the uniformity of the spray pattern). That is because wind speed increases with height. The correct spray height for each nozzle is determined by the nozzle spacing and the spray angle. Wide-angle nozzles can be placed closer to the ground than narrow-angle nozzles. However, wide-angle nozzles also produce smaller droplets, offsetting the advantages of a lower boom height to some extent.

Use the lower end of the pressure range. Higher pressures generate many more small droplets (less than 100 microns). For this reason, refrain from using pressures that exceed 40 to 45 psi.

Increase nozzle size. Larger nozzle sizes create larger droplets, which are less likely to move off-target. If you use nozzles that put out 10 to 15 gallons per acre (GPA), increase to nozzles that put out 15 to 20 GPA.

For more details on how equipment can affect drift, see the companion Cutting Edge fact sheet, Equipment to Reduce Spray Drift (MF-2445). That publication discusses nozzle selection, air-assisted sprayers, and electrostatic sprayers.

Spray volume and pressure for foliar herbicides

Many applicators are reducing the spray volume of foliar herbicides from the commonly used 10 to 20 GPA to 5 to 10 GPA. When you reduce spray volume, the herbicide concentration will increase to maintain the same dose of active ingredient. But as spray volume is reduced, the droplet size will decrease, and this means greater drift potential.

Research has also shown that control of some broadleaf weeds with contact herbicides is reduced when you cut back on spray volume. However, reduced volumes have little effect on weed control with most translocated herbicides, as long as the chemical is applied properly.

To compensate for the reduced spray volume, some applicators will increase spray pressure from a normal 30 to 40 pounds per square inch (psi) to 60 to 120 psi. They believe they can "drive" small droplets into the crop canopy to increase coverage. But as mentioned earlier, a large number of the droplets will quickly evaporate before they reach the plant. In addition, the small droplets have low momentum and insufficient energy to be driven into a plant canopy.

Therefore, increasing pressure should not be used as a substitute for spray volume. We recommend maintaining pressure below 45 psi, and if you need increased coverage, increase spray volume.

Wind speed

Wind speed and direction, temperature, relative humidity, and atmospheric stability all affect spray drift. Wind speed, however, is usually the most critical meteorological condition. The greater the wind speed, the farther off-target small droplets will be carried. Although there is no maximum wind speed to serve as a guideline in all situations, try to spray when the wind speed is less than 10.1 miles per hour.

To minimize the damage done by drift, it is also important to determine the wind direction relative to sensitive crops (something that is often overlooked). To greatly reduce damage to sensitive plants, leave a buffer zone at the downwind edge of the spray area. After the wind has died down or changed direction, you can then safely spray the buffer zone.

Temperature and inversions

Temperature and humidity affect the amount of drift that occurs through evaporation of spray particles. Although some spray is lost through evaporation under all atmospheric conditions, the losses are less likely in cool, damp conditions.

Temperature also influences atmospheric stability, as well as the presence of air turbulence and "inversions." An inversion can occur when the air is very calm with very little air mixing. This condition makes it easier for spray to move slowly downwind. In other words, extremely calm conditions can also pose the risk of drift; it doesn't necessarily have to be excessively windy. Inversions generally occur in early morning or near bodies of water. You can recognize an inversion by observing a column of smoke. If the smoke does not dissipate, or if it moves downwind without mixing vertically, conditions are not good for spraying.

The best way to avoid the kind of drift associated with atmospheric conditions is to eliminate the formation of very small droplets in the spray. Once you do this, you can essentially ignore weather stability factors.

Increasing droplet size

An excellent way to minimize drift is to use spray additives that increase spray droplet size. Tests indicate that, in some cases, drift control additives can reduce downwind drift deposits by 50 to 80 percent.

Drift control additives are a specific class of chemical adjuvants and should not be confused with such products as surfactants, wetting agents, spreaders, and stickers.

A number of drift control additives are commercially available. But many of these products are very rate sensitive, so follow the mixing directions closely. Increased rates may further reduce drift, but can also cause nozzle distribution patterns to become nonuniform.

Drift control additives vary in cost, depending on the rate and formulation, but they are comparatively inexpensive for the amount of control they provide. They do not eliminate drift, however. Common sense is still required.

The effect of droplet size on coverage*

Droplet diameter (microns)	**Type of droplet**	**Droplets per square inch**	**Coverage** (relative to a 1,000 micron drop)
5	Dry fog	9,220,000	200
10	Dry fog	1,150,000	100
20	Wet fog	144,000	50
50	Wet fog	9,222	20
100	Misty rain	1,150	10
150	Misty rain	342	7
200	Light rain	144	5
500	Light rain	9	2
1,000	Heavy rain	1	1

***Application rate:** • 1 gallon per acre

Spray droplets: evaporation and distance traveled*

Droplet diameter (microns)	**Terminal velocity** (feet per second)	**Drop diameter after water evaporates** (microns)	**Time to evaporate** (seconds)	**Distance traveled from nozzle** (inches)
20	0.04	7	0.30	Less than 1
50	0.25	17	1.80	3
100	0.91	33	7.00	9
150	1.70	50	16.0	16
200	2.40	67	29.0	25

***Conditions assumed:** • Temperature: 90 °F • Relative humidity: 36%
• Spray pressure: 25 pounds per square inch
• Pesticide solution: 3.75%

Eight Ways to Reduce Drift

1) Select a nozzle that produces coarser droplets

Use droplets that are as coarse as practical to provide necessary coverage.
Nozzle examples: Turbo flood, turbo flat-fan, Raindrop®.

2) Use the lower end of the pressure range

Higher pressures generate many more small droplets (less than 100 microns). Under most conditions, do not exceed 40 to 45 psi.

3) Lower boom height

Wind speed increases with height. If boom height is a few inches lower, off-target drift is reduced.

4) Increase nozzle size

Larger capacity nozzles reduce drift. If you use nozzles that put out 10 to 15 gallons per acre (GPA), increase to nozzles that put out 15 to 20 GPA.

5) Spray when wind speeds are less than 10 m.p.h.

More spray will move off-target as wind increases.

6) Spray when wind is moving away from sensitive crops

Leave a buffer zone if sensitive plants are downwind. Spray the buffer zone when the wind changes direction.

7) Do not spray when the air is very calm

Calm air, or an inversion, reduces air mixing, which means spray can move slowly downwind. Inversions generally occur in early morning or near bodies of water.

8) Use a drift control additive when needed

Drift control additives increase the average droplet size produced by nozzles.

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