Managing Aerial Spray Drift

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Spray drift is the movement of droplets outside the target area occurring at (or soon after) application.

Off-target spray movement at any other time is NOT drift!
This guide discusses the conditions that cause particle drift and the methods aerial applicators may employ to reduced the drift potential from pesticide spray applications.

Spray drift of pesticides away from the target is an important and costly problem facing aerial applicators. Drift causes many problems including: 1) damage to susceptible off target sites, 2) a lower rate than intended which can reduce the effectiveness of the pesticide, wasting pesticide and money, and 3) environmental contamination, such as water pollution and illegal pesticide residues.

Drift occurs by two methods; vapor drift and particle drift. This guide will mainly focus on conditions that cause particle drift and methods to reduce the drift potential from spraying pesticides.

**Drift Dynamics**

A solution sprayed through a nozzle divides into droplets that are spherical or nearly spherical in shape. A recognized measurement for indicating the size of these droplets is microns.

Droplets smaller than 100 microns are considered highly "driftable" and are so small that they cannot be readily seen unless in high concentrations such as fog. By comparison, a dime is about 1,270 microns thick. As a result of the small size, drift is more dependent on the irregular movement of turbulent air than on gravity.

Particle drift is the actual movement of spray particles away from the target area. Many factors affect this type of drift, but the most important is the initial size of the droplet. Small droplets fall through the air slowly, and are carried farther by air movement.

Table 1 shows the effect of droplet size on the rate of fall. The longer the droplet is airborne, the greater the potential for drift.

When leaving the nozzle, the solution may have a velocity of 60 feet per second (41 mph) or more. Unless the spray particles are electrostatically charged, there are two forces acting upon the emerging droplets. These forces are gravity and air resistance. These forces greatly influence the speed and movement of spray droplets.

The droplet speed is reduced by air resistance which breaks up the droplets. After their initial speed slows, the droplets continue to fall under the gravitational pull.
Table 1. Effect of droplet size on drift potential (Ross and Lembi, 1985).

<table>
<thead>
<tr>
<th>Diameter (microns)</th>
<th>Time to fall 10 feet in still air</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Fog)</td>
<td>28 hours</td>
</tr>
<tr>
<td>10 (Fog)</td>
<td>17 minutes</td>
</tr>
<tr>
<td>100 (Mist)</td>
<td>11 seconds</td>
</tr>
<tr>
<td>200 (Fine Spray)</td>
<td>4 seconds</td>
</tr>
<tr>
<td>400 (Coarse Spray)</td>
<td>2 seconds</td>
</tr>
<tr>
<td>1,000 (Coarse Spray)</td>
<td>1 second</td>
</tr>
</tbody>
</table>

Large droplets maintain a downward velocity longer than smaller ones. Small droplets also evaporate quickly, leaving minute quantities of the pesticide in the air (Figure 1). Larger droplets are more likely to be deposited on the intended target.

Figure 1. Lateral movement of water droplets. (Hofman, et al., 1986)

Ideally, most of the volume should be contained in larger droplets. When the pressure is increased, a higher percentage of the droplets are smaller droplets. With a greater proportion of the total spray volume in smaller droplets, the potential drift onto off target sites increases.

Altering Droplet Size
Many components of a sprayer can be adjusted to alter droplet size. Of these, nozzle type selection is one of the most critical.

Nozzle Type: Spray droplets are produced from nozzles in different ways. A fan nozzle forces the liquid under pressure through an elliptical orifice and the liquid spreads out into a thin sheet that breaks up into different-sized droplets. A flood nozzle deflects a liquid stream off a plate that causes droplets to form. A whirl chamber nozzle swirls the liquid out an orifice with a circular motion and aids the, droplet formation with a spinning force.

Droplet sizes are influenced by various nozzle types and different spray pressures. Volume median diameter (VMD) is a term used to describe the droplet size produced from a nozzle tip. VMD is the droplet size at which one-half the spray volume consists of large droplets and one-half consists of smaller droplets. Since it takes many more small droplets to make up one-half the spray volume, there always will be more small droplets present in a typical spray pattern.

Remember, nozzles produce a wide range of droplet sizes. A nozzle that can produce only one size of droplet is not available at the current time. Therefore, the goal in the proper application of pesticides is to achieve a uniform spray distribution while retaining the spray droplets within the, intended target area.

The nozzle must provide adequate coverage and pest control while minimizing small, drift prone droplets. Request a droplet spectrum sheet from the manufacturer that gives information about the percentage of droplets that are smaller than 200 microns. Use a nozzle with 10 percent or lower of this size. Table 2 list some of the more typical nozzles used in aerial application.

Spray Pressure: Spray pressure influences the formation of the droplets. The spray solution emerges from the nozzle in a thin sheet, and droplets form at the edge of the sheet. Higher pressures cause the sheet to be thinner, and the sheet breaks up into smaller droplets.

Large orifice nozzles with higher carrier volumes produce larger drops. Small droplets are carried farther downwind than larger drops formed at lower pressures (Figure 1). The relationship between flow rate (G.P.M.) and pressure (PSI) is not linear. For example, to double the flow rate would require the pressure to be increased by four times. This action would greatly contribute to the drift potential and is not an acceptable method to increase carrier volumes. If the carrier volume needs to be changed, select a different nozzle tip that meets the spraying requirements.
Table 2  Droplet Size Distribution for Various Nozzles, water in 115 to 120 MPH airstream and parallel to airflow (Bouse, 1991, 1994).

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Psi</th>
<th>Gpm</th>
<th>VMD (microns)</th>
<th>% &lt;100 microns</th>
<th>% &lt;200 microns</th>
</tr>
</thead>
<tbody>
<tr>
<td>D6</td>
<td>40</td>
<td>1.05</td>
<td>697</td>
<td>0.05</td>
<td>0.60</td>
</tr>
<tr>
<td>ACCU-FLO; 32 tubes</td>
<td>40</td>
<td>1.90</td>
<td>409</td>
<td>0.14</td>
<td>1.95</td>
</tr>
<tr>
<td>M.L. Tips No.6 Plastic</td>
<td>40</td>
<td>1.08</td>
<td>718</td>
<td>0.11</td>
<td>1.49</td>
</tr>
<tr>
<td>6510</td>
<td>40</td>
<td>0.93</td>
<td>397</td>
<td>0.08</td>
<td>2.58</td>
</tr>
<tr>
<td>D6-46</td>
<td>40</td>
<td>0.96</td>
<td>423</td>
<td>0.06</td>
<td>1.59</td>
</tr>
<tr>
<td>(\frac{1}{6}) B5-5 Whirjet</td>
<td>40</td>
<td>0.84</td>
<td>325</td>
<td>0.29</td>
<td>5.30</td>
</tr>
<tr>
<td>TK5 Floodjet</td>
<td>40</td>
<td>0.91</td>
<td>339</td>
<td>0.18</td>
<td>5.26</td>
</tr>
<tr>
<td>Nylon CP 0.078 30° Deflection</td>
<td>40</td>
<td>0.97</td>
<td>403</td>
<td>0.09</td>
<td>2.07</td>
</tr>
<tr>
<td>Nylon CP 0.078 60° Deflection</td>
<td>40</td>
<td>0.97</td>
<td>321</td>
<td>0.37</td>
<td>7.64</td>
</tr>
<tr>
<td>Nylon CP 0.078 90° Deflection</td>
<td>40</td>
<td>0.97</td>
<td>273</td>
<td>1.11</td>
<td>13.15</td>
</tr>
<tr>
<td>REGLOJET 0.078 - 45°</td>
<td>40</td>
<td>0.98</td>
<td>348</td>
<td>0.31</td>
<td>7.20</td>
</tr>
<tr>
<td>A&amp;C Roto - D7 - 80 Mesh Screen</td>
<td>40</td>
<td>1.12</td>
<td>319</td>
<td>1.19</td>
<td>7.94</td>
</tr>
</tbody>
</table>

**Spray Volume:** The size or capacity of the nozzle also influences droplet size. The larger orifice will increase the droplet size at a common pressure. It will also increase the number of refills, but the added carrier improves coverage and in some cases increased pesticide effectiveness.

**Other Drift Factors**

**Nozzle Orientation and Location:** Orient the nozzles straight back to minimize small droplet formation due to wind shear. Utilize 4 inch drops on each nozzle to put the nozzle in clean less turbulent air.

**Boom Length:** Limit the boom length to 75% or less of the wingspan of the air-
craft in order to prevent small droplets from becoming entrained in the wing tip vortices and contributing to drift problems.

**Speed:** Limit aircraft speed when applying chemicals that crops in neighboring nontarget fields are particularly sensitive to. Modern turbine powered aircraft capable of flying in the 150 to 160 mph range will create more small drift-prone droplets at these speeds.

**Buffer Zone:** Leave a buffer of approximately 300 feet between the treated field and any particular sensitive areas. Buffer zones will avoid contamination of neighboring areas by displacement of relatively large droplets. However, buffer zones will not effectively eliminate low level contamination of distant areas by the small droplets formed by all nozzles.

**Field:** Dress the ends of a field with a couple of passes, so that the spray does not have to be turned on before the aircraft is level at the beginning of a pass or left on after pulling up at the end of a pass.

**Wind Speed:** The amount of pesticide lost from the target area and the distance it moves both increase as wind velocity increases (Figure 3). However, severe drift injury can also occur with low wind velocities, especially under temperature inversion situations. Recommendations are to stop spraying if the wind speeds exceed 8 mph.

![Droplet Drift vs Wind Speed](image)

**Figure 2.** Effect of wind speed on drift in a 10 foot fall.
**Wind Direction:** Pesticides should not be applied when the wind is blowing toward a nearby susceptible crop or a crop in a vulnerable stage of growth. Select a time when there is little wind or the wind blows away from susceptible crops. If these conditions do not exist, consider another method of control or time of application.

**Air Stability:** Air movement largely determines the distribution of spray droplets. Wind is generally recognized as an important factor, but vertical air movement is often overlooked. Temperature inversion is a condition where cool air near the soil surface is trapped under a layer of warmer air. A strong inversion potential occurs when ground air is 2 to 5 degrees F. cooler than the air above.

Under inversion conditions, little vertical mixing of air occurs, even with a breeze. Spray drift can be severe under inversion conditions. Small spray droplets may fall slowly or may be suspended and move several miles with a gentle breeze to susceptible areas.

![Normal Temperature Profile](image1.png)

*Figure 3. Definition of a temperature inversion.*

Avoid applying pesticides near susceptible crops during temperature inversion conditions. Inversions can be identified by observing smoke from a smoke bomb or fire. Smoke moving horizontally close to the ground would indicate a temperature inversion.

Usually less material will drift from the target field during an inversion, but the material that does leave the target field remains in a more concentrated cloud and the level of residue that settles onto nontarget areas will be higher than usual. Even though the amount of chemical that drifts from the target area during an inversion is often less, the potential for a drift problem can be greater because the small droplets are not lofted into the upper atmosphere, diluted and spread over a large area.

**Relative Humidity and Temperature:** Low relative humidity and/or high
temperature conditions cause faster evaporation of spray droplets and thus, a higher potential for drift. During evaporation, the droplets become smaller.

The quantity of spray that evaporates is related to the quantity of the spray deposit. Evaporation is greater from the same deposit in small droplets than in larger drops because the small droplets have greater surface area relative to their volume. Thus, less pesticide gets to the target (Figure 1).

Evaporation increases the drift potential, so spray during lower temperature and higher humidity conditions. Pesticides differ in their evaporation rate. Use formulations and adjuvants that reduce evaporation.

As a rule of thumb, if the relative humidity is above 70%, the conditions are ideal for spraying. However, a relative humidity below 50% is critical enough to warrant special attention.

*Spray Thickeners:* Some spray adjuvants act as spray thickeners when added to a spray tank. These materials increase the number of larger droplets and decrease the number of fine droplets. They tend to give water-based sprays a "stringy" quality and reduce drift potential.

Droplets formed from an *oil carrier* tend to drift further than those formed from a water carrier. Oil droplets are usually smaller, lighter and remain airborne for longer periods but don't evaporate quickly.

All nozzles produce a range of droplet sizes. The smaller drift-prone particles cannot be eliminated but they can be reduced and kept within reasonable limits.