Nozzle Types and Drift Reduction

Drift reduction is the practice of reducing or eliminating small droplets in a spray system that can move “off-target” and onto another field. Main causes for drift are droplet size, volatilization of the chemical, or the chemical washing off plants and into a stream. Chemical companies are tasked with making the chemical more safe and providing guidance when to spray and not spray, but farmers are left with the task of selecting the proper nozzle sizes to reduce driftable fines, where driftable fines are defined as those droplets less than 150 micrometers which can become buoyant and travel large distances from the application site (> ½ mile). Choosing the correct nozzles type can greatly reduce driftable fines and create a safer spraying system. Proper nozzle selection is given below:

Proper Nozzle Selection

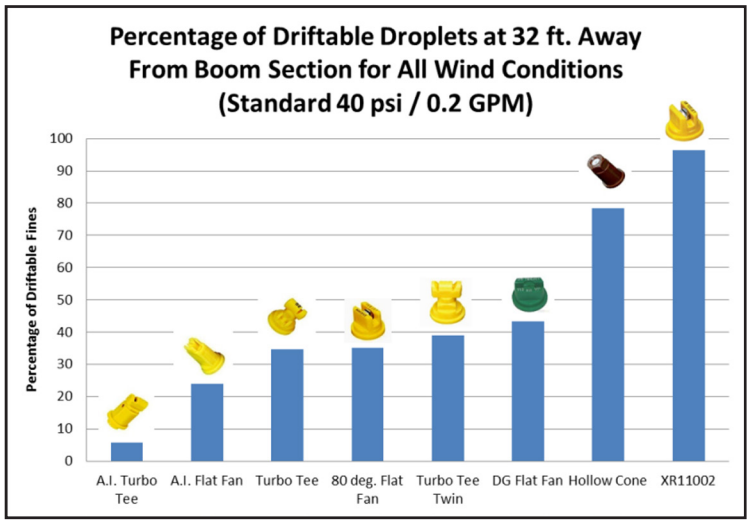

Figure 1. Percentage drift associated with each nozzle type operated in similar conditions.

Figure 1 shows the main types of spray nozzles and the percentage of driftable fines from each one. Air induction (A.I.) nozzles have the best drift reduction qualities of all nozzle types and are recommended for most spraying conditions (note that in pulsed width modulated systems, such as the Capstan or AIM command, you may need to use a flat fan to operate properly). A.I. turbo tees produced the least amount of driftable fines of all nozzles, but also has a very coarse droplet size (500 to 700 um) which maybe too coarse for some applications (note that some chemical labels do require this tip for application of that chemical). For this reason, A.I. flat fans are recommended for most general spraying operations. They have a medium to coarse droplet (300 to 500 um) and very large pressure ranges that allow “safer” operation in many spray systems. XR and Cone Jets produce the most drift able fines, but also may be used in some applications where small droplets and high area contact are needed for good efficacy such as in fungicide and insecticide treatments. All other types of nozzles - Turbo Tees, 80-degree Flat Fans, D.G. - drift guard Flat Fans, and Turbo Tee Twin - fall in-between these sets of nozzles for drift reduction qualities. Picking a nozzle with a slightly “larger than needed” orifice size (to reduce pressure) can also help reduce driftable fines.

Equipment Settings

Equipment settings can vary greatly and affect the amount of driftable fines in a spray system. The following guidelines should be used to create a “safer”, more drift resistant system:

1. **Lower Boom Pressures:** Lowering the boom pressure and/or using a slightly larger nozzle orifice size can greatly help reduce the number of driftable fines in a spray system. Research has shown that a large XR flat fan nozzle combined with a lower boom pressure (< 40 psi) had nearly the same effect on drift reduction qualities as an A.I. Flat Fan type nozzle. Sizing nozzles for drift reduction should include using slightly larger nozzle size with lower boom pressures in drift producing nozzles, or A.I. type nozzles.
2. **Travel speed:** Research has shown (Figure 2) that increased travel speed (and/or wind speeds across a boom) can greatly increase the number of driftable fines in a spray pattern. The number of driftable fines emitted by XR and Cone Jets increased by 6.5 times for each additional 1 mph of wind or travel speed across the boom. A.I. type nozzles only increased by a factor of 0.8 (or less) per MPH of increased wind or travel speed. For this reason, lower travel speeds are always recommended or reducing drift.

3. **Boom height:** Keep boom heights as low as possible. Nozzles are typically placed on booms at set distances to operate 18 to 20 inches above crop surface. Overly high booms allow more time for wind to affect the spray pattern and cause more inconsistent spray patterns.
4. **Sprayer shields:** Spray shields can greatly decrease the number of driftable fines emitted into the open environment by a sprayer system. These shields essentially block the wind and allow the smaller droplets to either collect on the crop or the hood surface (creating a larger droplet that falls in the field). Sprayer shields should be kept tight on the crop surface or high-speed winds can move through the opening and increasing drift - flexible skirts may be needed in this case but can damage crops.

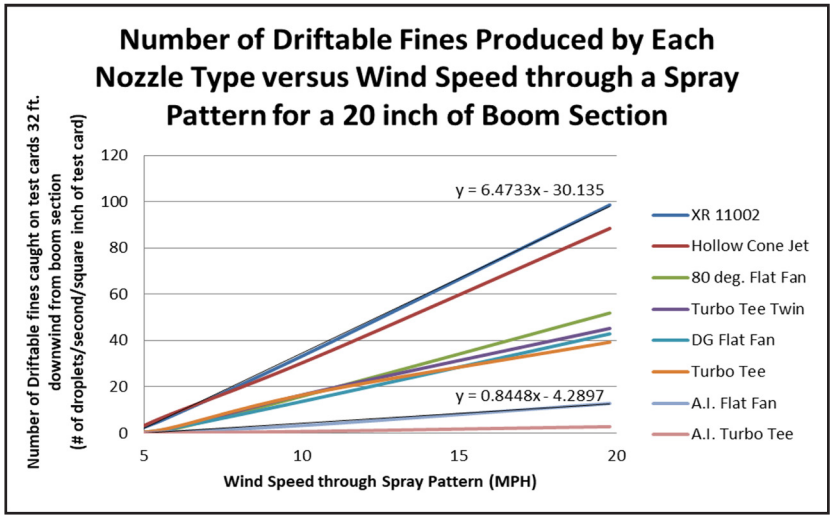

Figure 2. Graph of the amount of driftable fines released into the atmosphere versus wind or travel speed (5 to 20 MPH) across a boom for several different nozzles types.

Environmental Conditions

Environmental factors can play a large role in the amount of driftable fines released into the atmosphere. Note the following:

1. **Inversion layers:** Inversion layers trap driftable fines emitted from the sprayer and concentrate them into a dense layer. This layer can then move off the field and deposits 0 to 50 miles away from that field. Inversion layers most often occur when air temperatures are warmer above the ground than on the ground surface but can also exist in low wind/humidity conditions. To prevent thermal layers from occurring, spraying should not be performed early in the morning or too late in the afternoon. Some states recommend to not start spraying until the morning temperature rises 3 degrees above the morning low, and to cease spraying when the air temperature falls more than 3 degrees from the daily high. Also, spraying when winds are greater than 2 mph will help ensure that inversion layers do not exist.
2. **Wind conditions:** Spray when winds are between 2 and 10 mph.
3. **Relative humidity:** Spraying in lower humidity (R.H.) situations can greatly reduce the number of driftable fines as some research has shown that driftable fines may not evaporate and greatly increase in higher humidity conditions.

Additives

Additives are a good way to reduce drift and, in most cases (Figures 3 and 4), driftable fines were reduced by 60 percent over using pure water in most nozzles. The biggest reductions were seen in nozzles that created the most driftable fines, such as XR and Cone Jets, while the least effects were seen in A.I. type nozzles (only because they had very few driftable fines to begin with). Note that no negative effects were seen in any additives except in very cold or low humidity conditions (where small droplets did not evaporate and were carried further into the air stream).

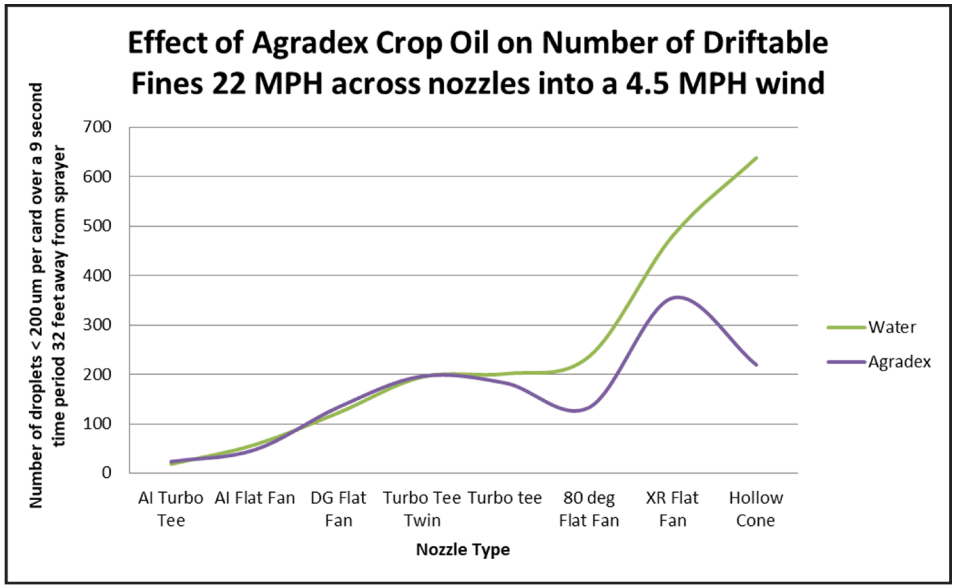

Figure 3. Graphs of the effect of Agradex Crop Oil additive on spray drift for different nozzle types. Most other additives had similar responses.

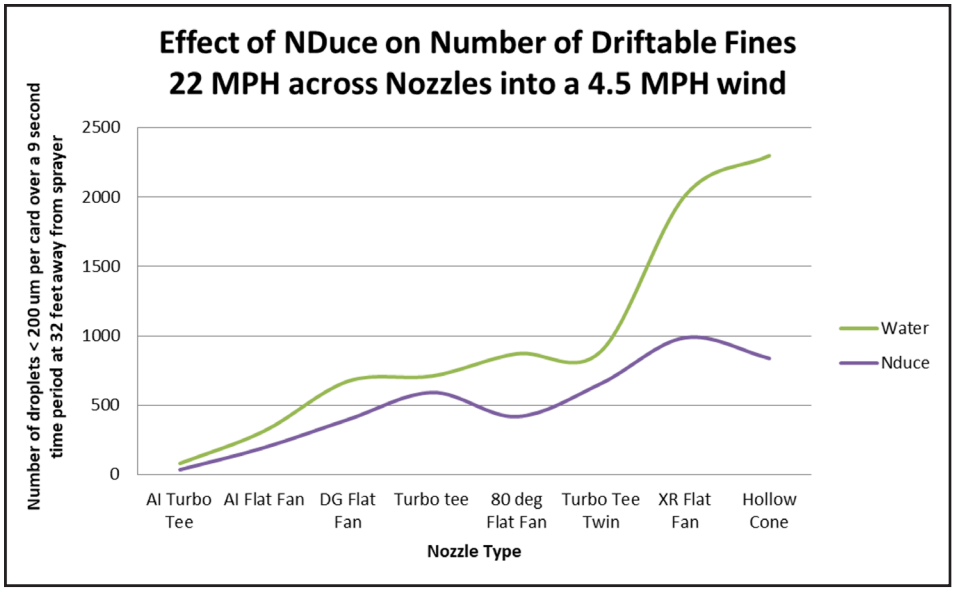

Figure 4. Graphs of the effect of NDuce additive on spray drift for different nozzle types. Most other additives had similar responses.

Using these techniques, the number of driftable fines in a spray system can be reduced to create a safer spray system and less drift. A table of recommended nozzles per type of spray application and recommended spraying practices is given below:

Pesticide and Mode of Action	Nozzle of Tip Selection
Most Herbicides with Systemic Type Attributes – Coarse to Medium Droplets	A.I. (Air Induction) Flat Fan or Turbo Tee
Herbicides and Pesticides with Contact and/or Partially Systemic Attributes –Medium Droplet Size	Turbo Tee, DR, and DG (Drift Reduction and Drift Guard), 80-degree Flat Fans
Fungicides – Medium to Fine Droplet Sizes; Insecticides – Fine Droplet Size	Fungicide and Insecticides – DR/ DG (Drift Reduction/Guard) and Hollow Cones or Equivalent

Recommended Practices

- **Use higher flow rates to ensure good coverage (although higher flow rates are not always necessary to attain good results).**
  - Spray when environmental conditions are optimum.
  - Make sure a low-level inversion layer is not present (fog, heavy air, etc.).
  - Make sure winds are between 2 and 10 mph (some winds are needed to insure a stable, non-inversion layer environment).
- **Monitor back of sprayer for excessive drift.**
  - If you see a large amount misting behind sprayer, check system for over-pressurization or wrong tip selection and flow rate.
- **Keep boom height at recommended distance from canopy (typically 18-20 inches from canopy surface).**
- **Use hooded sprayers to further aid in drift reduction.**
  - Make sure to run hood on or near the crop surface to prevent a wind stream between the crop and hood surface.