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Nozzle Selection for Fungicide Application

How one applies fungicides is just as important as the selection of a fungicide that will control a disease. Spray nozzles help control the rate, uniformity, distribution and safety of product application. Factors that influence nozzle selection include the target area, wind speed, the type of product to be applied, operating pressures, ground speed, desired water volume and application rate. Due to these variables, one nozzle does not work for all applications.

There are several nozzle types that deliver either a "flat fan" or a "hollow cone" spray pattern. Examples of nozzles that deliver a flat fan distribution pattern include XR TeeJet®, Turbo TeeJet®, AI TeeJet® and TurfJet™, and the nozzles that deliver a hollow cone distribution pattern are ConeJet® and raindrop nozzles. Depending upon the nozzle type and pressure, droplet sizes can range from very fine to extremely coarse.

The flat fan spray pattern generally produces the most uniform distribution within a sprayed area with a minimum of a 30% overlap. There is a large selection of nozzle types that produce the flat fan pattern with optimum coverage under a variety of conditions.

The hollow cone nozzle also produces a uniform application, but the particle sizes are smaller than the flat fan spray nozzle. The hollow cone nozzles are used to assure a finely atomized spray droplet. The hollow cone nozzle is commonly used on hand-held sprayers.

The raindrop nozzle or whirl chamber nozzle produces a much larger droplet size in a hollow cone pattern. Applications with this nozzle type are generally less uniform and spray coverage may be incomplete. The raindrop nozzle was developed to minimize clogging and reduce spray drift.

When selecting a flat fan nozzle, choose a nozzle that provides the right size of droplet to achieve the desired result. Spray droplets are measured in microns (1/1,000 mm or 1/25,000 inch). Most nozzle manufacturers produce charts that follow the American Society of Agricultural Engineers' droplet size classification standard that indicate a given nozzle at various pressures (Table 1). If applying a fungicide at 0.5 gallons per 1,000 square feet from a nozzle that puts out a 400-micron droplet, there will be about 360 droplets per square inch. Whereas, a nozzle that produces a 200-micron-size droplet will output eight times more droplets or about 2,900 droplets per square inch. Keep in mind that the potential for drift increases as droplet size decreases. Match nozzles to achieve the droplet size and water volume that is needed.

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Table 1.
Droplet Size Categories

Category (Microns)	Symbol	Color Code	Approximate VMD* (0.5)
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	XC	White	>550

*VMD (volume mean diameter) = droplet size where half of volume has droplets > the VMD, and half the volume in droplets smaller than the VMD.

For fungicides, it is best to select a nozzle that delivers a fine-to-coarse droplet size. This allows for uniform coverage, especially when water volumes approach 1.0 gallon per 1,000 square feet and light winds (less than 3 mph) are anticipated. For example, an XR TeeJet extended-range flat-spray tip XR11008, when applied at 40 psi and a ground speed of 5 mph, will deliver 1.1 gallons of water per 1,000 square feet and a droplet size that is coarse. Changing to a XR11006 extended-range flat-spray tip at 40 psi and a ground speed of 4 mph will deliver 1.0 gallons of water per 1,000 square feet, but the droplet size is reduced to a medium droplet, thereby increasing the number of droplets per square inch. If using a TurfJet wide-angle flat-spray tip 1/4TTJ08 applied at 40 psi and a ground speed of 5 mph, expect 1.1 gallons of water per 1,000 square feet and an extremely coarse droplet size. While the extended-range flat-spray tips are good for both contacts and upward-systemic fungicides, the 1/4TTJ08 is definitely a poor choice for fungicides as the droplet coverage is not enough under low-water-volume conditions. When wind conditions are greater than 3 mph, it is best to choose a nozzle that makes a larger droplet size. For proper coverage, make applications at a lower ground speed, increase water volume up to 2 gallons per 1,000 square feet and opt for a nozzle that produces a very coarse droplet. The Turbo TeeJet wide-angle spray tip TT11008, when applied at 40 psi and a ground speed of 3 mph, will deliver 1.8 gallons of water per 1,000 square feet and a droplet size that is very coarse and less susceptible to spray drift. Sprayers used by golf courses should be equipped with a minimum of three spray nozzles. This can easily be achieved by using a multiple-body nozzle that holds between three and five nozzles (Figure 1). Table 2 contains a list of nozzles that are suggested for fungicide applications.

Table 2.
Suggested nozzles for fungicide applications.

Nozzle Type	Suggested Use	Desired Droplet Size Ranges
XR and XRC	Contacts and Systemic	Medium to Coarse
Turbo TeeJet	Contacts and Systemic Drift reduction	Medium to Coarse
AI TeeJet	Contacts and Systemic Drift reduction	Coarse to Very Coarse
TurfJet	Systemic only Drift reduction High water volume applications	Extremely Coarse

Fungicide efficacy is dependent upon getting the fungicide to the right location and concentration on the turfgrass plant. When applying a contact fungicide, it is important to coat the foliage to prevent the pathogen from entering the plant. When applying an upward-systemic fungicide, it is important to penetrate into the plant canopy to the plant

crown, achieving a uniform application to ensure best plant uptake of the fungicide. In a dense stand of turfgrass, this is easier said than done. For this reason, the flat-fan spray nozzle is the obvious choice for either of these applications.

In 2004, a field trial was initiated to determine which droplet sizes were best for applications of Banner® MAXX®, Daconil Ultrex® and the combination of both. While the trial is in preliminary stages, the photos taken of spray patterns and the actual droplets provide dramatic evidence that droplet size is one of the determining factors for fungicide efficacy. Figures 3 and 4 are close-up photos of the spray droplets for the XRC11003 nozzle and the 1/4TTJ04 nozzle that were applied at 0.95 gallons per 1,000 square feet at a nozzle pressure of 40 psi. The XRC11003 is a fine droplet size and the 1/4TTJ04 is an extremely coarse droplet size. Figures 5 and 6 are photos of the actual spray pattern during the application for the XRC11003 nozzle and the 1/4TTJ04 nozzle. The fine droplet provided excellent coverage, however the droplet drift potential was high. The extremely coarse droplet did not drift but failed to provide adequate spray coverage. One alternative is to use an air induction nozzle. These nozzles produce a very coarse droplet size, lower drift potential with very good coverage. The spray pattern for this nozzle is displayed in Figure 2.

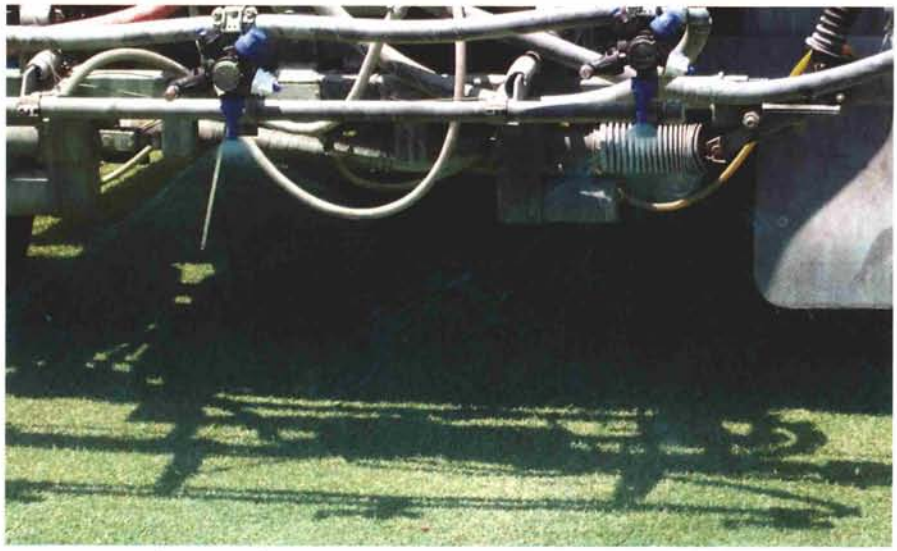

Figure 2. The AI11003 Air Induction Spray Tip produces very coarse droplets, lower drift potential and good coverage.

Figure 1. Multiple-nozzle body with five different nozzles.

Figure 3. Droplets from XRC11003 Extended Range Flat Spray Tip.

Figure 4. Droplets from 1/4TTJ04 Wide Angle Flat Spray Tip.

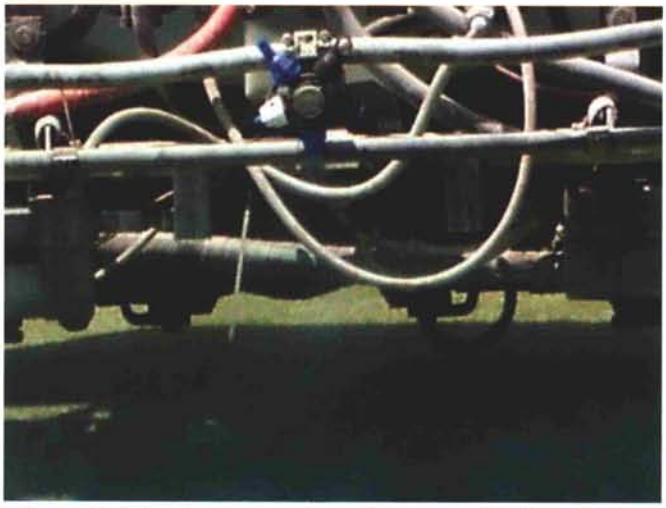

Figure 5. Actual spray pattern during application of the XRC11003 Extended Range Flat Spray Tip.

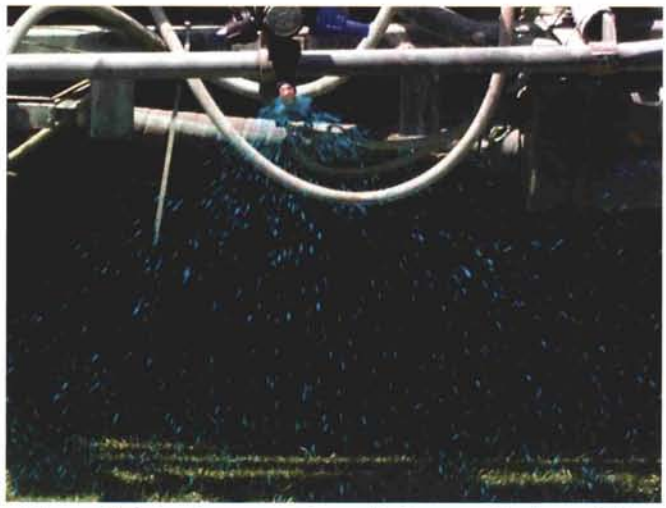

Figure 6. Actual spray pattern during application of the 1/4TTJ04 Wide Angle Flat Spray Tip.