Spraying for Success — It Starts With Nozzle Knowledge

Choose the right nozzle for the job and improve the effectiveness of spray applications, reduce the risk of environmental impacts, and save money.

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Although they may seem trivial, nozzles have a dramatic impact on product distribution and the performance of every spray application. As such, there are many styles of nozzles available to choose from, each offering specific traits for specific applications. Diligent course managers use different nozzles depending upon the goal of each application and the product being used. If only one nozzle type is used for all spray applications, reduced performance can be expected with certain products.

Not all products are the same, nor is the intended target of every spray application. Turfgrass leaf blades are the intended target for some applications — e.g., applications of foliar-active products like trinexapac-ethyl. In other situations, such as the application of products to control fairy ring, turfgrass leaf blades are an obstacle because the products must reach the thatch and soil to be effective. Using a nozzle type that is appropriate for the product and its intended target is essential to maximize the performance of every application. Course managers are encouraged to calibrate sprayers with a minimum of three different nozzles designed to deliver products to 1) turf leaves for foliar or contact products, 2) the crown or leaf sheath for systemic products, and 3) the soil for products that target soil-borne pests or must be absorbed by roots.

This article provides valuable information about nozzles and spray volumes that can improve the effectiveness of spray applications, help avoid negative environmental impacts, and potentially save money by reducing labor and product inputs.

NOZZLE BASICS

The nozzles on a sprayer deliver products by uniformly breaking a pressurized, water-based spray solution — i.e., a product(s) dissolved or suspended in water — into a range of droplet sizes and directing the droplets toward a target. Usually, either turfgrass or soil is the target of product applications to golf courses. However, there are other targets such as waste areas or banks adjacent to water hazards that require special considerations. Before spraying, it is important to read and follow relevant product and equipment guidelines regarding sprayer setup, spray volumes, nozzle characteristics, sprayer calibration, and product application directions and restrictions.

KEY COMPONENTS OF SUCCESSFUL SPRAYING

When planning a spray program for optimal performance, it is important to consider spray volume, drift potential, topography, phytotoxicity concerns, potential for nozzle clogging, and, most important, the intended target of each application.

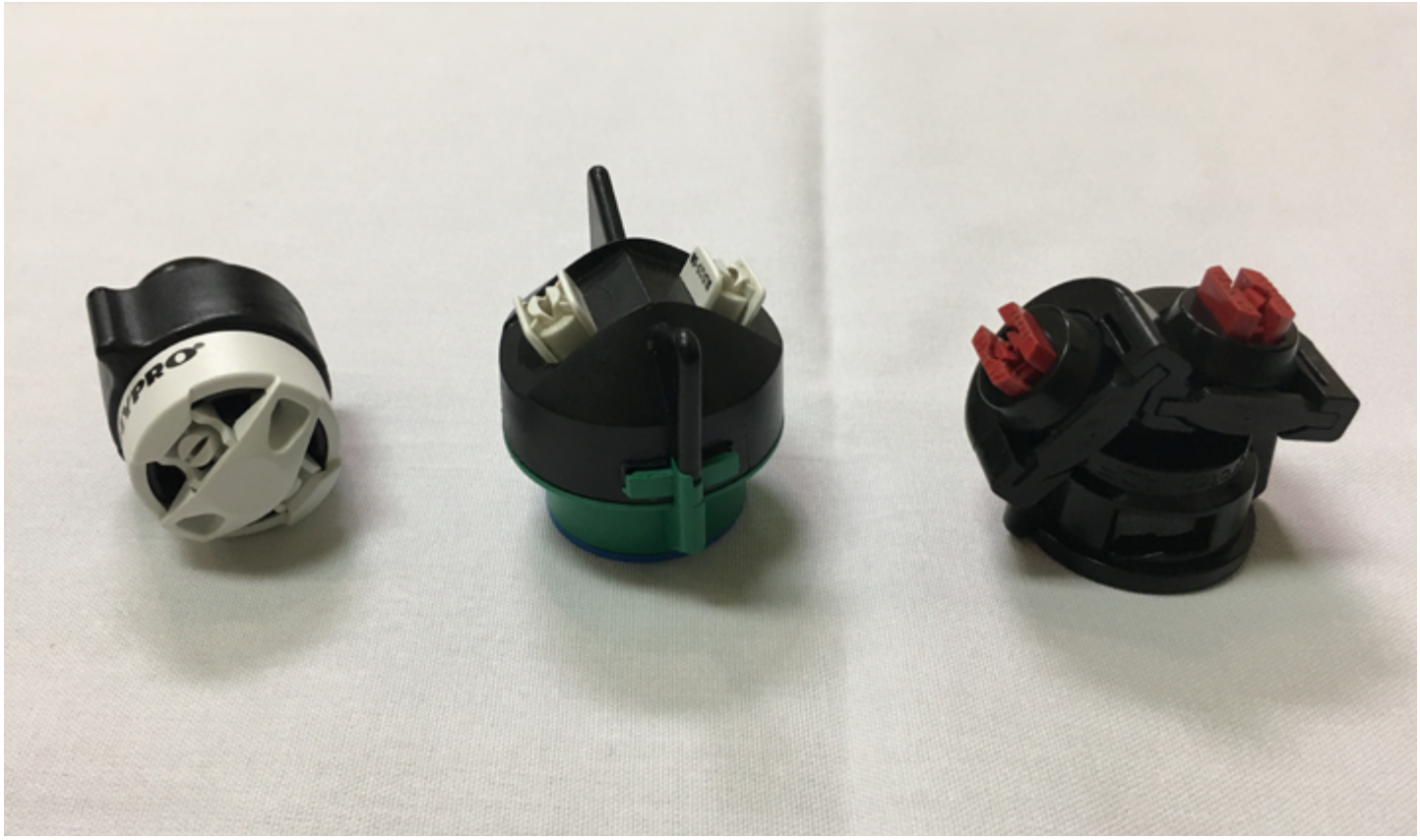
SPRAY VOLUME

Before deciding on a nozzle, it is important to read product labels to discern the recommended spray volume for each application. Labels often specify different spray volumes based on the target or location of the pest. Most products recommend a spray volume between 0.5 and 2 gallons per 1,000 square feet. Low spray volumes may require a nozzle that delivers fine droplets to achieve thorough coverage of turf foliage without running off into the thatch or soil.

However, when the intended target of an application is the soil, recommended spray volumes may reach 4 to 8 gallons per 1,000 square feet. Choosing the correct nozzles can help improve coverage when trying to achieve high spray volumes, but there are limitations. Ultimately, modifying spray volume and nozzle selection at a fixed sprayer speed and pump pressure can ensure precise delivery and maximum efficacy of any product.

Applying irrigation after an application that uses a low spray volume can help move a product further into the turfgrass canopy, thatch layer, or soil. However, irrigating following a spray application cannot match the uniformity and deep coverage achieved by using the appropriate spray volume and nozzles to make the application. Furthermore, irrigation may not effectively move a product to the target location if the product dries after application and does not readily resolubilize. Irrigation may also cause undesirable product movement if the irrigation system has uniformity issues, if too much water is applied, or steep slopes and impermeable soil conditions cause runoff.

Course managers must also consider dew and external leaf moisture before spraying, especially if the target is turf foliage. Data obtained from a study conducted at the University of Maryland found that dew can contribute 100 to 272 gallons of water per acre. The same study found that applications of chlorothalonil, a common turfgrass fungicide, provided significantly better control of dollar spot when dew was not present. Making spray applications



There are many nozzle choices available; choosing the right one for the product and target will improve the effectiveness of spray applications.

to a dry turf canopy can improve product performance and extend the interval between applications.

DRIFT CONSIDERATIONS

For most foliar spray applications, small spray droplets lead to better coverage and product performance. However, small spray droplets are also vulnerable to drift, which can reduce application uniformity and decrease product performance by reducing the concentration of spray solution at the intended target. Drift can also cause offsite movement of spray solution, potentially posing health and environmental concerns. Nozzles that produce large droplets can help minimize drift, but unfortunately large droplets may reduce the performance of foliar applications or products with contact activity.

Drift potential can be reduced by positioning sprayer booms closer to the ground and switching to nozzles with a wider spray angle — e.g., using nozzles with a 110-degree spray angle rather than nozzles with an 80-degree spray angle. As spray angle increases, nozzles can be mounted closer to the ground without changing nozzle spacing. Drift can also be minimized by reducing spray pressure, but adjusting spray pressure may decrease product performance. Dramatically reducing spray pressure should be avoided because there is a minimum pressure required to maintain the correct spray angle and overlap of nozzles. Likewise, excessively raising spray pressure should be avoided because it can increase drift potential. In general, pressure modifications have to be major to significantly affect volume output — e.g., spray pressure must be increased fourfold to double spray volume.

Another way to minimize drift is to equip sprayers with lightweight drift-reduction boom shrouds that shield nozzles and their spray pattern from wind. However, care must be taken to ensure that a boom shroud does not contact the spray pattern or allow spray solution to gather on and run off its edges; either condition reduces application uniformity and could result in overapplications.

TOPOGRAPHY

Another factor that influences the effectiveness of spray applications is topography. The height of spray nozzles in relation to the target must be consistent to achieve proper coverage, but keeping nozzle height consistent across a three-dimensional landscape is much more challenging than it is when spraying a flat surface. It can be difficult to maintain a consistent boom height over irregular terrain such as undulating fairways or green and tee surrounds. To solve this problem, spray booms can be outfitted with an automated system that uses ultrasonic sensors to continually monitor and adjust boom height. The ultrasonic boom-leveling systems can maintain a consistent boom height even as applications are made to irregular, undulating surfaces. Furthermore, the ultrasonic sensors are extremely robust and reliable under most conditions.

PHYTOTOXICITY AND NOZZLE CLOGGING

When making spray applications, caution should always be exercised to minimize the risk of phytotoxicity and turf damage. Increasing the spray volume of an application can decrease the potential for phytotoxicity, but it may also decrease product performance. This can be the case with some postemergence herbicides like MSMA and soil wetting agents. Choosing the appropriate nozzle can be an option, independent of adjusting spray volume, to reduce the potential for phytotoxicity while minimizing the loss of product performance.

Clogged nozzles can also negatively affect spray applications. Some organic-based products, fertilizers, colorants, and chemicals are prone to clogging nozzles when applied at high rates. Mixing several products in the spray tank can also result in nozzle clogging. The risk of clogged nozzles increases if the materials being applied are thick, viscous, incompatible with each other, or do not completely mix into solution or suspension. Nozzles that deliver fine droplets are more vulnerable to clogging because they often have small orifices. In general, large nozzle orifices are less likely than small nozzle orifices to become clogged. For example, many commercial sprayers come equipped with flood-type nozzles that have large orifices and low clogging risks. Flood-type nozzles can be ideal for preemergence herbicides and liquid fertilizers, but they provide poor foliar coverage for contact products.

TARGET DESTINATION CONSIDERATIONS

Turfgrass Leaves: Materials intended for leaf coverage — i.e., foliar application — often are contact products that have little to no soil activity. Many of these products depend on direct contact with a pest or uptake and movement in foliage to be effective. Examples of products in this group include:

- Contact fungicides for foliar diseases like dollar spot or leaf spot — e.g., chlorothalonil, fluazinam, iprodione, and mancozeb
- Biostimulants or hormones such as gibberellic acid and cytokinins
- Foliar fertilizers — e.g., chelated micronutrients — that are specifically formulated for foliar uptake
- Insecticides for foliage feeders such as caterpillars, mites, and aphids — e.g., acephate, chlorpyrifos, and pyrethroids
- Plant growth regulators with little to no root uptake — e.g., trinexapac-ethyl and mefluidide
- Turfgrass pigments and colorants
- Postemergence and non-selective herbicides such as 2,4-D, glyphosate, and sulfonylurea herbicides

In general, products intended for foliar coverage are most effective when applied using a spray volume of 0.5 to 1 gallon per 1,000 square feet. While a spray volume of 1 gallon per 1,000 square feet may provide better foliar coverage than a volume of 0.5 gallon per 1,000 square feet, the concentration of the product on the leaf surface is reduced by 50 percent. The higher spray volume also increases the risk of product running off the leaves and into the thatch or soil, decreasing efficacy or residual control and wasting product.

For foliar applications, course managers are encouraged to use a nozzle with a fine spray pattern rather than an all-purpose nozzle and increased water volume. Flat-fan nozzles with medium to fine spray droplets are recommended for foliar applications. In a fungicide trial at the University of Maryland where contact fungicides were applied to control the foliar disease dollar spot, high spray volumes

Applying turf colorant using twin flat-fan nozzles spaced at 10 inches apart and a boom height of 14 inches helps maximize coverage and color quality.

This rotating nozzle body allows course managers to quickly choose between three nozzles, making it easier to use the best nozzle for a specific application.

resulted in reduced disease control when using the same spray nozzles.[1] In a University of Georgia study of foliar-applied growth regulators on TifSport bermudagrass, researchers observed greater clipping reduction when applying the same product with nozzles that delivered the finest spray particles.[2]

The performance of turf colorants is also dictated by application accuracy. Turf colorants are commonly used as an alternative to overseeding in locations where bermudagrass enters winter dormancy, conserving resources, saving money, and enhancing the playing quality. However, the spray pattern when applying turf colorants must be consistent to achieve a uniform, visually pleasing color. For the best results when applying turf colorants, use fine to very fine spray nozzles with close nozzle spacing and low boom heights. Also, try to apply turf colorants when there is little or no wind. When turf colorants are properly applied, the results are easy to see.

SOIL OR TURF ROOTS

The effectiveness of products that target the soil or turf roots is influenced by 1) soil activity; 2) soil texture; 3) absorption or adsorption by leaves, thatch, and organic matter; 4) sensitivity to UV degradation; 5) root uptake; and 6) high temperatures coupled with high humidity, which can translate to potential phytotoxicity if certain products remain on the foliage for an extended period of time. Examples of products in this group are:

- Algae or cyanobacteria products
- Fairy ring control products
- Non-systemic nematicides
- Preemergence herbicides
- Products that control root-borne diseases such as summer patch, spring dead spot, and take-all patch
- Insecticides that control soil-inhabiting insects such as grubs and mole crickets
- Soil wetting agents

Most products that need to reach the soil to be effective should be applied with a minimum spray volume of 2 gallons per 1,000 square feet. High spray volumes are especially necessary if the ability of a product to reach the soil — even following subsequent rainfall or irrigation — is diminished after it dries on turfgrass leaves or thatch. Products designed to target fairy ring may even specify spray volumes as high as 4 gallons per 1,000 square feet along with subsequent irrigation. While there are nozzles capable of applying upwards of 4 gallons per 1,000 square feet, achieving high spray volumes is difficult. Reduced nozzle spacing and significantly slower operating speeds may be required to reach ultra-high spray volumes.

To help ensure products reach the soil, use nozzles that produce very coarse to extremely coarse spray droplets. Coarse spray droplets are more capable of penetrating the turf canopy than fine spray droplets. Also, nozzles that produce coarse spray droplets have low potential for drift and nozzle clogging, so the likelihood of the spray reaching the soil is greatly increased.

TURF CROWN OR THATCH

Turf crowns and thatch layers are the most challenging targets to effectively reach because they are below most of the foliage but above the soil surface. Examples of products that target these areas include both systemic and contact products, such as:

- Biologicals for soil or crown diseases
- Insecticides for thatch-dwelling insects such as chinch bugs and hunting billbugs
- Materials sensitive to UV degradation
- Pesticides for pathogens that cause crown diseases such as anthracnose,

Pythium blight, brown patch, large patch, and snow mold

A spray volume from 1 to 2 gallons per 1,000 square feet is best when targeting crowns or thatch layers. When using a 1 gallon per 1,000 square feet spray volume, select a nozzle that produces a medium to coarse spray droplet and set the spray pressure on the high side of the manufacturer-specified range for the nozzle being used. When using a 2 gallons per 1,000 square feet spray volume, spray droplets can be coarse to very coarse with lower spray pressures. Ultimately, spray volume should be dictated by turfgrass density. Greater turf density requires higher spray volumes to effectively reach the turf crown or thatch layer. Typically, drift potential for the nozzles used to reach the turf crown or thatch layer is low.

PUTTING IT ALL TOGETHER

As an exercise, ask yourself what three nozzle types could address the majority of your spraying needs. The answer will depend on your priorities, performance goals, the type of products you use, drift potential, spray tank capacity, and the time available for applications. To better understand your specific nozzle requirements, compile a list of all sprayer-applied products utilized at your facility and categorize them by target area: leaf, soil, and crown or thatch layer. Next, equip your sprayer with nozzles that can effectively deliver products to each of these target destinations (Table 1). Work with nozzle and spray system manufacturers and distributors to find the equipment that meets your needs. Calibrate your spray systems for each type of nozzle you will use, making sure to recalibrate your sprayer and replace nozzles every year. Regularly check nozzles during the season to ensure that they are not damaged or worn and that all filters and screens are clean.

Golf course managers who think about course priorities, the products utilized, and the objectives for each spray application will be able to choose the right nozzle for the job. Using the appropriate nozzles will improve the effectiveness of spray applications, reduce the risk of environmental impacts, and save money by reducing labor and chemical inputs.

TABLE 1

Example of a three-nozzle setup on a rotating nozzle body. This setup can easily achieve a range of spraying objectives without removing any nozzles. The appropriate nozzle can be selected by rotating the nozzle body until the desired nozzle is in the correct position.

Fixed Variables:
Boom height: 20 inches
Nozzle spacing: 20 inches
Sprayer speed: 4 miles per hour

Nozzle 1
Flat-fan, fine- to medium-droplet, low-volume nozzle
Target: Foliage
Spray Volume: 0.5 to 1 gallon per 1,000 square feet
Applications: Contact products, systemic products designed for foliar uptake, postemergence herbicides, and turf pigments and colorants

Nozzle 2
Flat-fan, coarse-droplet, medium-volume nozzle
Target: Crown or thatch layer
Spray Volume: 2 gallons per 1,000 square feet
Applications: Products for controlling crown diseases and thatch-dwelling pests

Nozzle 3
Single or dual flat-fan, very coarse-droplet, high-volume nozzle
Target: Soil
Spray Volume: Up to 4 gallons per 1,000 square feet
Applications: Soil-borne pest control products, preemergence herbicides, fairy ring control products, soil wetting agents, nonsystemic nematicides

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