Maximizing Sprayer Performance for Boom Sprayers

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Boom sprayers are an integral part of the equipment inventory used in turfgrass production in Ontario. Over the years sprayer have changed, sprayer operators have become more educated in the operation and use of their sprayers and the spectrum of products applied with the sprayers is constantly changing. Because of these changes, increasing chemical costs, and a heightened concern for the environment, everyone involved in turfgrass production is striving to maximize the performance of the spray chemicals used. This not only involves applying the appropriate product at the correct time but also ensuring that the sprayer is being operated such that the spray solution gets to the target and controls the problem. You, as the sprayer operator, can make adjustments to your sprayer which can result in a more effective spray program.

The hydraulic sprayer which has a tank, pump, boom and nozzles has been around for many years. It has performed a useful function in the application of a wide variety of spray products. Looking to the horizon, it appears that this type of sprayer will be with us for some time.

How nozzles work

Let's look at the basics of how nozzles work. Nozzles come in a range of types, sizes and spray angles, but they are all designed to do one thing. The nozzles are manufactured in such a way that the spray liquid is squeezed through an orifice and deposited to the target in a predetermined pattern. As the liquid is forced through the nozzle the orifice squeezes the liquid into a sheet, this sheet becomes thinner and tears into ribbons and finally the ribbons become thinner still and form droplets. The droplets produced by this process are not all uniform in size. Rather they range in size from very fine droplets to very course droplets. All nozzles produce this wide range in droplet sizes. In order to quantify the droplet size, a number of different techniques have been used. The one which is possibly most useful to you is Volume Median Diameter or VMD. The VMD is merely a means of expressing droplet size in terms of the volume of the liquid sprayed. Thus 50% of the volume of spray is contained in spray drops greater than VMD and 50% of the volume is contained in droplets less than the VMD. This droplet diameter is usually described in microns. To give you some idea of micron size, a human hair is approximately 70 microns in diameter. As we make changes to the orifice such as size or spray angle, a change is evident in the VMD. Very simply here is how the VMD is affected by certain changes to the nozzle.

1. A large orifice will have a higher VMD (produce more larger droplets) than a small orifice nozzle.
2. A narrow spray angle will have a higher VMD (produce more larger droplets) than a wide angle nozzle.
3. A low operating pressure will result in a higher VMD (produce more large droplets) than a higher operating pressure.

Calibration

Calibration of the sprayer is important because it is the only way of knowing exactly how much spray you are applying per unit area. There are many calibration methods which can be used to determine your application rate. Not only do you need to know how much area you can cover with a full load of spray, but you should also measure what the output is for each and every nozzle. If individual nozzles are not checked you are only doing half a calibration job. By checking each nozzle you will see how the output compares to the other nozzles on the boom. Wide variations can be found due to a variety of reasons such as:

- mismatched nozzles
- uneven nozzle wear
- plumbing problems
- plugged or partially plugged screens
- damaged nozzles.

Don't assume that because the nozzles are all the same age they are all delivering the same amount of liquid. Catching the liquid from each tip is the only way to know what the nozzle is delivering. Even when a new set of tips is installed they should all be checked. The liquid output from any one nozzle should not vary more than $\pm$ 5% from the average output of all nozzles on the boom. If a nozzle falls outside this range, it should be replaced and its replacement nozzle should also be checked. Please note that you visually cannot see a difference in flow rate of 20, 30 or even 50%. Using a graduate cylinder is the only way. One limitation of calibration is that it will not show you what the distribution pattern is like. The only true means of evaluating spray distribution is with a patternator. A patternator consists of a boom mounted over a series of Vee shaped channels which drain into individual graduated cylinders.

Nearly all calibration methods require some means of determining sprayer travel speed. If you spray over rugged terrain on golf courses or parks, your travel speed may change as the machine travels up or down these slopes. Variations of travel speed of up to 5% are still acceptable. If speed variations are greater than 5% you should make some adjustments. These adjustments could be; changing gears thereby reducing the lugging on the engine, taking part loads which reduces the weight of the machine and work required to move it up slopes, or spraying across the slopes if possible. Changes in spraying speed will change your rate of application. As you travel up a slope, if the speed drops, the application rate will increase. As you travel down the slope and your speed increases, the application rate will decrease. Both of these conditions could result in problems with reduced control or possible damage to the turf from improper rate of application of product.

Nozzle wear and tear

Let's look at nozzle wear. Nozzles wear with use. The rate at which they will wear depends on these factors:

- nozzle materials
- nozzle type

- nozzle size
- materials sprayed - abrasion, corrosion
- carriers sprayed - abrasion, corrosion
- area sprayed
- boom plumbing layout

Choose the nozzle material for your application based on its performance with the materials you will be spraying. As a nozzle tip wears it not only delivers more spray material but its distribution pattern changes as well. In general terms as a nozzle wears its distribution pattern becomes poorer. A good rule of thumb is to replace nozzle tips when the flow rate is more than 10% greater than its rated flow when the nozzle is new. These nozzle flow rates can be found in the manufacturers' catalogues.

Looking strictly at abrasive wear, here is how the nozzle materials stack up:

Hardened Stainless Steel	SLOW WEAR
Thermo plastic	
Stainless Steel	
Nylon	
Brass	RAPID WEAR

Know your nozzle pressure range

All nozzles are designed to work within a pressure range. When a nozzle is operated within its designed pressure range it will deliver a given quantity of liquid and distribute this liquid in a predetermined spray pattern. When you operate a nozzle outside its designed pressure range the flow will change to a point, but also the spray pattern will not be as designed.

To eliminate the possibility of operating a nozzle outside its working range, you should sense the pressure at the boom with a good quality liquid-filled gauge. Second, the nozzle size should be selected so that it can deliver the flow rate required. Adjusting sprayer speed or operating pressure only offers flexibility in adjusting the application rate. To make large adjustments you have to change the tip size.

This simple formula can be used to determine the size of the nozzle required. By entering your values into this formula you can quickly determine the nozzle size required for the job.

$$GPM\ per\ nozzle = \frac{gal/1000ft^2 \times mph \times w}{136}$$

where; GPM = gallons per minute
gal/1000 ft^2 = gallons per 1000 square feet
mph = spraying speed in miles per hour
w = nozzle spacing on the boom in inches

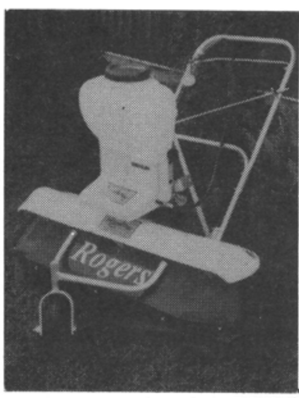
Having calculated the gallons per minute you wish to apply, consulting the nozzle manufacturers' catalogues will show you which nozzle size is required. When you install these nozzles into your prayer remember to calibrate. The values should result in the same application rate as you entered into the previous formula. This calibration is a way of double checking your calculations.

Nozzle-to-target distance

In addition to sizing the nozzles for the job you also need to determine the correct height. This is accurately called the nozzle-to-target distance which for spraying turfgrass is the same as the boom height. Three factors affect the nozzle-to-target distance;

1. nozzle spray angle
2. nozzle spacing on the boom
3. nozzle type

Operating the nozzles too close to the turf will result in a non-uniform distribution of spray material. You will have bands of high concentration alternating with bands of no spray. The problem with this is that the chemicals used will only work in bands. On the other hand, if the boom is operated higher than required these bands of overspray and underspray do not occur. You do, however, cause the spray material to be more prone to drift.



The further spray droplets have to travel to reach the target, the more chance there is that drift can occur. Again nozzle manufacturers' catalogues provide good charts or tables on nozzle-to-target heights for various nozzle configurations.

New technology

New technology is coming in turf sprayers. A number of systems are now available that can maintain the rate of application even with variations in spraying speed. These rate controllers use existing micro processor technology. The sprayer operator programs the rate controller by merely entering his operating parameters into the machine. True ground speed is measured from a non-driven wheel or by means of radar. Flow of liquid to the boom is also measured by means of a flow meter. All this information is then used by the rate controller to deliver your programmed application rate. As spraying speed changes, the rate controller adjusts the liquid flow to the boom to maintain your set rate. This adjustment is accomplished by varying the pressure. Keep in mind what we said earlier about pressure and droplet size.

As you travel faster the pressure will increase to maintain your set rate. To stay within nozzle operating pressure ranges you should not vary from your calibrated spraying speed by more than ± 10%. Put in other words if you programmed the controller with a spraying speed of 3.0 mph you should keep your travel speed between 2.7 and 3.3 mph. In doing so, the operating pressure on the nozzles should remain within acceptable limits. You can see from this discussion that even with rate controllers the operator has some operating limitations.

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GRASS CLIPPINGS

Rhizotomous turfgrasses spread by below-ground, lateral shoots, called rhizomes. New plants can emerge on the rhizome at some distance from the parent plant, closing in bare spaces and forming a dense turf. With good management recovery from winter injury may be achieved without overseeding.

Stoloniferous turfgrasses spread by above-ground, lateral shoots, called stolons. Shoots tend to grow horizontally resulting in a grainy turf. This feature is found among some warm season species and some cultivars of creeping bentgrass.

There are 13 elements required for turf growth which are taken up by the root system. They are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulphur (S), iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), molybdenum (Mo), boron (B), and chlorine (Cl). The first six are called macro nutrients whereas the remaining seven are termed micro nutrients because they are required in very small or trace amounts.

Water is used by turf for growth, transpiration from the stomata and evaporation from the leaves and soil surface. The latter two are grouped together in a term called evapotranspiration. The rate of water use may vary from near zero on a cool, calm and foggy day to 7.5 mm on a hot, sunny and windy day where the relative humidity is less than 30%.