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herbicides. A common misconception is that preemergence herbicides act by preventing weed seeds from germinating. These herbicides actually prevent germinating seedlings from developing into mature plants. For preemergence herbicides to work properly, they must be applied before seed germination and need approximately 0.5 inch of rainfall or overhead irrigation within 24-48 hours after application in order to be activated.

Large and smooth crabgrass seed germinates in the spring when soil temperatures exceed 55 F for 4 consecutive days and nights. Initial applications of preemergence herbicides for crabgrass control should be made before these temperatures occur in your region. In the transition zone applications are normally made in late February through early April.

The blooming of the forsythia plant, also known as golden bells (Figure 3), is a visual indicator that soil temperatures are increasing to a level conducive for crabgrass seed germination. Using this visual indicator, the first preemergence herbicide application of the season should be made before the last forsythia bloom falls from the tree.

Preemergence herbicides will generally provide crabgrass control for 12-16 weeks after application depending on application rate. However, the level of control provided will dissipate over time. Using a split application strategy where an herbicide is applied twice at a lower rate can extend the length of residual control provided by that application. Additionally, a split application strategy will offer improved preemergence goosegrass control.

Preemergence crabgrass herbicides

THERE ARE SEVERAL PREEMERGENCE HERBICIDES marketed for crabgrass control on athletic fields. The following information is provided as a guide for herbicide selection. Always refer to the product label for specific information on proper product use, tank-mix compatibility, and turfgrass tolerance.

Trade Name: Dimension
Chemical Name: dithiopyr
Family: Pyridine
Use Areas: Golf course (except putting greens), athletic fields, sod farms, residential and non-residential areas.
Turf Safety: All major established turfgrass species.
Rate: Dimension EC - 2 qt/a (0.5 lb ai/a)
Application Type: Sprayable and Granular

Trade Name: Echelon
Chemical Name: prodiamine + sulfentrazone
Family: Dinitroaniline + protox-inhibitor
Use Areas: Golf course (except putting greens), athletic fields, sod farms, residential and non-residential areas.
Turf Safety: All major established turfgrass species
Rate: Echelon 4SC – 18-36 oz/a (0.57-1.125 lb ai/a)
Application Type: Sprayable

Trade Name: Ronstar
Chemical Name: oxadiazon
Family: Oxadiazole
Use Areas: Golf course (Except tees and putting greens), athletic fields, sod farms, and non-residential areas [Not labeled for residential lawn use].
Turf Safety: All major established turfgrass species.
Rate: Ronstar G - 100 to 200 lb/a (2 to 4 lb ai/a)
Application Type: Granular or Sprayable to Dormant Turf Only

Trade Name: Pendulum Aquacap
Chemical Name: pendimethalin
Family: Dinitroaniline
Use Areas: Golf course (except tees and greens), athletic fields, sod farms, residential and non-residential areas.
Turf Safety: All major established turfgrass species.
Rate: Pendulum Aquacap - 1.5-3 qt/a (1.5 to 3 lb ai/a)
Application Type: Sprayable and Granular

Trade Name: Barricade 4FL and 65 WG
Chemical Name: prodiamine
Family: Dinitroaniline
Use Areas: Golf course, athletic fields, sod farms, residential and non-residential areas.
Turf Safety: All major established turfgrass species.
Rate: Barricade 4 FL- 10 to 48 oz/a (0.5 to 1 lb ai/a)
Application Type: Sprayable and Granular

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Preemergence herbicides must be applied before seed germination and need approximately 0.5-inch of rainfall or overhead irrigation within 24-48 hours

RESEARCH

Each year the University of Tennessee evaluates numerous preemergence crabgrass herbicides in different locations and environmental conditions. In most years, labeled rates of prodiamine (Barricade), dithiopyr (Dimension), pendimethalin (Pendulum Aquacap), oxadiazon (Ronstar), and prodiamine + sulfentrazone (Echelon) all provide effective crabgrass control (> 90%) throughout the season when applied properly.

Some preemergence herbicides do provide activity against crabgrass plants that have emerged from the soil seedbank. Early postemergence applications of Dimension (1 tiller or less) and Echelon (1-3 leaf) have been found to provide a level of smooth crabgrass control similar to applications of the same herbicides at recommended preemergence timings. While these are the only two preemergence crabgrass herbicides that exhibit postemergence activity, control from these applications has been reported to be inconsistent in other locations. In general, preemergence herbicides should be applied before crabgrass seed germination. Any postemergence activity should be considered an added bonus when these herbicides are made at later than optimal timings

DEVELOPING A PREEMERGENCE PROGRAM

Step 1. Choosing a preemergence herbicide. While many athletic field managers hold strong opinions as to which preemergence herbicides work better than others, research data collected at the University of Tennessee has found all of these products to perform similarly when applied properly. Therefore, be sure to select a product that is available in a formulation that is compatible with your application equipment. In many cases granular products may be better suited than sprayable formulations for some turf managers.

Step 2. Apply in a timely manner. After choosing a preemergence herbicide make sure it is applied in a timely manner. Keep in mind

Establishment of grassy weeds, like crabgrass, can often be prevented with a timely preemergence herbicide application in the spring of the year.

that all preemergence herbicides need rainfall or irrigation to be activated. The optimal time to apply preemergence herbicides for crabgrass control varies greatly from region to region. Contact your local Extension office for more information regarding crabgrass seed germination timing in your area. For extended residual activity make a second application 6-8 weeks after the initial application.

Establishment of grassy weeds, like crabgrass, can often be prevented with a timely preemergence herbicide application in the spring of the year. Research has found that these herbicides perform similarly when applied correctly at the proper timing. Using a split application strategy can extend the length of residual control provided by a single preemergence herbicide. With the forthcoming loss of an effective, economical postemergence herbicide like MSMA, preemergence control of crabgrass will become increasingly important.

Always refer to the product label for specific information on proper product use, tank-mix compatibility, and turfgrass tolerance. For more information on turfgrass weed control, visit the University of Tennessee's turfgrass weed science website, http://tennesseeturfgrassweeds.org. ■

Greg Breeden is weed science extension assistant and Dr. James T. Brosnan is assistant professor-turfgrass weed science at the University of Tennessee.

Sprayer calibration in a pinch

SPORTS FIELD MANAGERS, particularly those working in a K-12 setting, do not always have access to state-of-the-art spray application equipment. In these settings, the application of liquid materials is frequently contracted out or the sports field manager must often work with available equipment.

The sports fields and grounds at Overbrook High School (Pine Hill Public Schools, Pine Hill, NJ) are overseen by Rich Watson, grounds supervisor and sports turf manager, and Bill Loftus, sports turf manager. The school owned a simple, functional, 30 year-old sprayer that could be used for the application of liquid materials. The sprayer consisted of a 100-gallon tank mounted on a tractor three-point hitch and a pump powered by the PTO. The boom was equipped with nine flat flan nozzles commonly used in turfgrass applications.

Rich Watson's goal was to properly calibrate this sprayer, with little or no modification to its existing set-up, to correctly apply a selective, systemic broadleaf weed herbicide.

What we knew about the sprayer and what we needed to determine. While there are various methods and techniques that can be used to calibrate a sprayer, we used the following formula to sort-out which variables we knew and which variable(s) needed to be determined to accurately deliver the broadleaf herbicide: GPM = [GPA x MPH x W] / 5940, where GPM = gallons per minute (per nozzle); GPA = gallons per acre (spray volume); MPH = miles per hour (tractor operating speed); and W = width (inches) between nozzles. The value of 5940 is a constant needed to convert units and is not derived in this article.

Figure 1. Using a calibration formula

The formula:	Variables:
$GPM = \frac{GPA \times MPH \times W}{5940}$	GPM = 0.4 GPA = 40 W = 20 MPH = ?
GPM = gallons per minute (per nozzle)	**Our calculations:**
GPA = gallons per acre (from label)	$MPH = \frac{5940 \times GPM}{W \times GPA}$
MPH = miles per hour	$MPH = \frac{5940 \times 0.4}{20 \times 40}$
W = nozzle spacing (inches)	MPH = 3.0

» THE GOAL was to calibrate an existing 30-year-old sprayer (with minimal equipment modification) to properly apply a systemic broadleaf herbicide.

The sprayer was equipped with nine (9) XR TeeJet 8004VS nozzles positioned on 20-inch spacings across the boom. Per manufacturer specifications (TeeJet Technologies, Spraying Systems Co., Wheaton, IL), the nozzle output is designed to be 0.4 GPM and each nozzle will produce an 80-degree spray angle at an operating pressure of 40 pounds per square inch (psi).

Note that this calibration formula, nozzle nomenclature, and other technical information can be accessed at the TeeJet Technologies website (www.teejet.com).

The label of the broadleaf herbicide chosen for this application states that the product should be applied in 20 to 220 gallons of water per acre. While this is obviously a wide range, the product being used was a systemic broadleaf herbicide. The goal of applying a systemic herbicide is to simply deliver the product onto the leaf of the plant (as opposed to uniformly covering turfgrass leaves in the case of a contact pesticide). Thus, a target application rate of 40 GPA (approximately 1.0 gallon per 1000 sq ft) was appropriate for the systemic herbicide. Also, applying the product at this spray volume (as opposed to 80 GPA or greater) would require fewer tank refills to spray large acreages.

(All photos by Brad Park, Rutgers University).

Thus, with the existing sprayer components in mind (XR 8004 nozzles positioned on 20-inch spacings), it becomes clear upon examining the calibration formula that operating speed is the variable that needed to be determined to calibrate the sprayer to deliver 40 GPA of spray solution. Inputting our known variables into the equation, we determined that the sprayer required an operating speed of 3.0 mph (Figure 1).

CALIBRATING THE SPRAYER

A 100-foot course was measured, the spray tank was filled halfway with clean water, and the tractor was operated numerous times over the course at varying ranges and forward gears at an engine rpm of 2100 (rpm necessary to maximize PTO performance) until the course was completed in 23 seconds. A speed chart was used to determine that 23 seconds were required to complete the 100-foot course at 3.0 mph; however, a calculation and unit conversions could have been performed to obtain the same information. Through trial and error, we determined that the tractor had to be operated in 3rd range and 2nd gear at 2100 rpm to complete the course in 23 seconds.

All nozzles, screens, and seat gaskets were removed from the boom the day before and soaked in an ammonia solution for 24 hours. Once cleaned, nozzle assembly components were then reassembled on the boom. This was an important step because clogged nozzles and screens will often produce an uneven appearance of the spray, which will affect spray volume and the uniformity of the application.

With the tractor engine rpm set to 2100 in an idle position and the PTO engaged, the sprayer was operated with clean water with the pressure regulator set to 40 psi. This allowed us to observe the operating appearance of the "fan" pattern produced by each nozzle, which we determined to be satisfactory.

Next, a graduated cylinder was used to confirm that each nozzle

» **Left:** A 100-FT COURSE was set-up to determine the tractor's range and forward gear necessary to achieve an operating speed of 3.0 mph.
» **Right:** EXISTING nozzles and components were allowed to soak in an ammonia solution for 24 hours before being reassembled on the sprayer boom.

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» A graduated cylinder (ml) was used to check each nozzle for a calculated spray volume equivalent to 0.4 GPM (i.e. 380 ml in 15 seconds).

was delivering 0.4 GPM (Figure 2). At 0.4 GPM, each nozzle delivers 380 ml (~13 fluid oz) of water over 15 seconds. An acceptable margin of error is + 5%; hence, the acceptable amount of water to be collected ranged from 361 to 399 ml. Actual quantities collected ranged from 340 to 360 ml. The spray pressure was adjusted to 50 psi to increase spray output. An upward adjustment in pressure was not unexpected since the pressure gauge was mounted to the pressure regulator and the operating pressure at the nozzles was likely less due to friction associated with the spray solution moving though the hose lines. Spray output was increased to the acceptable range after the pressure adjustment.

Figure 2. Calculating how much water to collect per nozzle

Steps we took:

Our goal was to collect a quantity of clean water equal to 0.4 GPM per nozzle.
We had a graduated cylinder (ml).
We recognized that 15 sec is an appropriate amount of time to perform a spray volume check.

Calculations

$$\frac{0.4 \text{ gallons}}{1.0 \text{ minute}} \times \frac{3785 \text{ ml}}{1.0 \text{ gallon}} \times \frac{1.0 \text{ minute}}{60 \text{ seconds}} \times 15 \text{ seconds} = 380 \text{ ml (~13.0 oz)}$$

2) We needed to collect 380 ml (±5%) per nozzle in a 15 second period.
3) The pressure regulator was set to 40 psi (per manufacturer specifications).
4) Our collected volume ranged between 340 and 360 ml (outside 5%).
5) We increased the pressure regulator to 50 psi to reach desired input.

FINAL STEPS

Per manufacturer specifications, the XR TeeJet 8004VS nozzles positioned on 20-inch spacings should be set at 17 to 19 inches above the intended target. Thus, the boom height was adjusted to set the nozzles at 20 inches above the paved surface; this height is approximately 18 inches above the 2-inch high turfgrass canopy (the intended target).

We then operated the sprayer (filled with clean water) across a dry, paved surface at the calibrated speed and pump pressure to