TURF MANAGEMENT CALCULATIONS

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THE golf course superintendent is a man who can do many things. He is a plant growth practitioner, an accountant and he serves as a personnel and public relations man. He may also be a construction man and a chemist. Besides these things the superintendent still has to rely upon some mathematics to perform his duties to the best effect. Figures must be used in expressing golf course measurements, in calculating the application of fertilizer and pest control materials, and in reporting expenditures. This is not to say that a superintendent must be a mathematical wizard, but there are a few fundamental calculations that must be made.

Golf course measurements are important to the superintendent. He is not so much interested in the length of golf holes but he must know the areas involved in the various golf course parts. It is essential that his knowledge of areas be accurate. Otherwise he may make some rather serious errors in the application of materials.

As an example, superintendent "A" has a green 70 feet in diameter and he intends to apply 2 ounces of fungicide to 1000 square feet. He knows that to find the area of a circular green he uses the formula: area=pi (3.1416) x radius squared. Substituting, he finds that $3.1416 \times 35^2 = 3847$ square feet. Therefore, 8 ounces of fungicide will provide just a little more than the amount required to treat at the 2 ounce rate. Superintendent "A" also believes that he should treat the collar of his green to a width of about 10 feet all the way around. To provide for this he decides to add a little extra fungicide, so he puts in 2 more ounces making a total of 10 ounces. If he distributes this evenly, how much has he *really* applied to each 1000 square feet? Let's see. His circle is now 90 feet in diameter, so the radius is 45 feet. Using the same formula, the area $= 3.1416 \times 45^2 = 6359$ square feet. He has applied 10 ounces of fungicide to 6359 square feet or 1.57 ounces to 1000 square feet. Therefore superintendent "A" has applied only ¾ as much material as he intended even though he has "allowed" for the additional area.

Guess work such as this has, at times, been responsible for a fungicide's failure to give the desired results. This little example is not an exaggeration. It has happened. It does serve to indicate a need for accurate measurements.

Some golf course superintendents have provided themselves with a chart on which each hole is listed together with the areas involved in teeing grounds, fairways, greens, collars, and bunkers. Such a chart provides a source of information for ready reference and it helps to insure accuracy.

Calibration of Equipment

The calibration of distribution equipment to apply any given material at a prescribed rate is a necessary operation and one that can, at times, be quite difficult. The difficulty may arise from several sources. Among them are clogged, or partially clogged, nozzles on spray equipment; slipping of adjustments after they are fixed in the case of distributors of dry materials; and human error.

Human error can be reduced to some extent by making sure that the equipment operator is well-informed about the job he is expected to do. If the operator of a fertilizer distributor does not understand the importance of checking his output of fertilizer at frequent intervals, he may neglect to do so. He is also likely to guess at his output rather than to measure and calibrate carefully.

The operator should be acquainted with the material he is to apply; he should know what the results of a properly applied treatment will be; he should know the consequences of improper application; and he should know whether or not there is an element of danger in the material he is handling. With a knowledge of these matters, an operator may proceed with confidence to do his job.

Distribution machinery or spray equipment should be kept in good condition. All parts should be clean, well-lubricated, and working properly. When these things have been checked, then the machinery must be adjusted to spread the right amount of fertilizer, lime, or other material. With spray equipment the correct amount of solution per unit of area must be applied.

Mechanics of Calibration

Let us examine the mechanics of calibrating a fertilizer spreader. Determination of the output must be done while the distribution machinery is moving over an area at the same speed that is maintained during actual application. This is necessary because rate of output is affected by the roughness of the ground surface and the speed of forward movement. Usually the speed of application will be that of a tractor in second gear. As an example a Ford tractor in second gear with the tachometer registering 1500 r.p.m. moves at a speed suitable for fertilizer distribution.

A tray or pan must be carried below the fertilizer outlets to catch the material being discharged. This tray may be a piece of metal "eaves trough" or "rain gutter," or it may be a piece of sheet metal crimped to a "V" shape. It is better to use two trays and to fasten one beneath each side of the spreader.

The circumference of the wheels of a distributor should be determined and a string or other marker should be fastened to a point on the wheel to enable the operator to count the turns made by the wheel. The hopper should be filled about half full of fertilizer.

You are now ready for the actual calibration test run. The operator can turn the control lever on and off but it is advisable to have an extra person to operate the lever. Regardless of who may operate the lever, be sure an accurate count is made as the wheel turns. At the end of ten turns of the wheel cut the lever off as close as possible to the position of the marker on the wheel when you pulled or pushed the lever to "on" position. Take the trays off and weigh the material in each tray separately. This will permit the synchronization of both sides of the distributor. Usually a scale graduate in ounces will be accurate enough for the determination of fertilizer rates.

The wheel circumference will have to be known as well as the width of the distributor hopper. These figures permit the determination of the area covered. Example: the wheel is 7 feet, 2 inches in circumference and the hopper is 8 feet wide. The 7-foot, 2-inch wheel will have covered in ten turns of the wheel 70 feet plus 20 inches, or 71 feet, 8 inches. Convert 71 feet 8 inches into 71-2/3 feet. The distance of travel, 71-2/3 feet, multiplied by the width, 8 feet, gives 573-1/3 square

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feet. This is the number of square feet covered when you count ten turns of the wheel marked.

If the amount of fertilizer to be applied per acre is compared with that applied to this part of an acre, in ratio, we can arrive at the amount needed to be caught in the trays. For example, if you wish to apply one pound of nitrogen per 1000 square feet, then you would have to apply 43.56 pounds of nitrogen per acre. There are 43.56 one thousand square feet units in one acre. (43,560 square feet equals one acre.) If your nitrogen is derived from ammonium nitrate you should apply 132 pounds per acre provided the material is 33% nitrogen. (43.56 divided by .33 equals 132 pounds.) Since we want 132 pounds of fertilizer per acre we can set up our ratio and determine the amount of fertilizer that should have been spread on the area covered in our calibration run.

We want to apply 132 pounds to 43,560 square feet. At this rate, how much would be applied to the 573-1/3 feet in our calibration run? A rather simple mathematical procedure will give us the proportionate amount needed.

In this procedure, let Q (or any other symbol) represent the unknown quantity. Then

132 pounds is to 43,560 square feet
as Q pounds is to 573-1/3 square feet
(573.33)

The proportion may be written like this,

$$132 : 43{,}560 :: Q : 573.33$$

To solve this proportion and find the value of Q, one rule must be remembered. Multiply the two middle figures and the two on the extremes. The products will be equal.

$$43{,}560 \times Q = 573.33 \times 132$$
$$43{,}560 \times Q = 75{,}678.56$$

Continuing to solve for Q, we may divide 75,678.56 by 43,560

$$Q = \frac{75{,}678.56}{43{,}560}$$
$$Q = 1.73$$

Therefore, 1.73 pounds of fertilizer should be caught in the pans. This amounts to about 14 ounces in each of the two pans.

After the correct amount is obtained on the trial run, it is advisable that the procedure be repeated at least three times to insure consistent accuracy. After your accuracy has been checked, tighten the adjusting devices so no slippage will be experienced. It is amazing how often these adjusting devices will come loose and cause a variation in your distribution.

Because of the fact that adjustments sometimes slip or work loose, it is advisable to check fertilizer output at frequent intervals. It is fairly simple to do this and very little time is lost in making the check. On a humid day, output may change following the exposure of fertilizer to the air. Nitrogenous materials have a tendency to absorb moisture and this causes the flow characteristics of the fertilizer to be changed appreciably.

Calibrating Spray Equipment

Since World War II spray equipment has been improved remarkably and is far superior to that of pre-war days. Most herbicides and other pest control materials are applied to turf in liquid form. Therefore calculations involving liquid solutions are important.

Water is the most commonly used liquid solvent used for spraying herbicides or other types of chemicals. Unless the addition of the spray chemical changes the viscosity of the water solution, one may use plain water during calibration.

The factors involved in application of solutions with a boom sprayer are:

1. Amount of chemical applied per acre or per 1,000 square feet.
2. Amount of solution applied per acre or per 1,000 square feet, usally in terms of gallons.
3. Concentration of solution.
4. Output of sprayer, usually in gallons per minute.
5. Width of boom.
6. Rate of travel of sprayer.

Most companies that handle spray equipment have tables that give the nozzle number, recommended liquid pressure in pounds per square inch, capacity of nozzle in gallons per minute at given pressures, and the gallons per acre applied when traveling at a given rate of speed, whether it be two, three, or four miles per hour.

Calculating the output of a sprayer involves a procedure similar to that in calibrating a fertilizer distributor. The difference is that the output of a given nozzle is rather difficult to change with any degree of accuracy. Therefore, adjustments must be made in the speed of travel or in the amount of liquid used in dilution of the active material.

As an example let us suppose that we wish to apply 10 pounds per acre of disodium methyl arsonate. We plan to use 100 gallons of solution per acre. Our sprayer has a boom that covers a ten foot swath.

100 gallons will cover 43,560 square feet

10 gallons will cover 4,356 square feet

Because the sprayer boom is 10 feet wide, 435.6 linear feet will have to be covered to put out 10 gallons. It is not difficult to calculate the time required to drive 435.6 feet at 4 miles per hour, but it is simpler to drive the tractor at any given speed 435.6 linear feet, a distance which will have been measured previously, and to measure the time required. If the tractor moves at 4 miles per hour, we find that the 435.6 feet is covered in one minute and 14 seconds.

Now, turn on the sprayer and catch the solution sprayed in one minute and 14 seconds. Again a piece of "eaves trough" or guttering may be used to lead the solution into a suitable container. The equipment may sit still while the spraying is being done. Unlike a fertilizer distributor, the spray output rate is not affected by movement. If 4 miles per hour is the correct speed, 10 gallons of solution should have been sprayed. If a smaller output is measured, speed should be reduced accordingly. If a larger amount is distributed, drive the tractor faster. Of course, where the amount of dilution is unimportant, one may keep the tractor speed constant and alter the amount of water (or other diluent) added.

Another point to be considered in sprayer operation is whether nozzles are discharging solution uniformly. This may be checked rather easily by placing the spray boom over a piece of corrugated metal roofing, spraying a small amount of solution, and catching the run-off from each valley of the corrugation in a separate container.

Active Ingredients in Commercial Formulations

How many times have you heard pest control authorities say "Follow the directions on the package"? This is good advice because manufacturers of such materials package them in various formulations and concentrations. The manufacturers have good reasons for doing this. We need not examine their reasons but it is recognized that such practice does lead to confusion when one tries to figure rates of application.

Chlordane is an example. It is packaged as a 5% dust, a 10% dust, a 25% wettable powder, a 50% wettable powder, a 48% emulsifiable concentrate, and a 75% emulsifiable concentrate. There may be even more formulations of this material. One of the standard recommendations for chlordane is 10 pounds of "actual" per acre.

COMING EVENTS

March 3-4-5
Midwest Regional Turf Conference
Purdue University, Lafayette, Ind.
Dr. Wm. H. Daniel

March 5-6-7
Minnesota Turf Conference
Leamington Hotel, Minneapolis, Minn.
Minneapolis, Minn.
Roy Nelson, Supt. Ravisloe Country Club—Homewood, Ill.

March 6-7
The University of Massachusetts
Annual Fine Turf Conference
University of Massachusetts, Amherst, Mass.
Dr. Eliot C. Roberts

March 10-12
Iowa Turfgrass Short Course
Iowa State College
Ames, Iowa
Prof. Harvey L. Lantz

March 13-14
Michigan Turfgrass Conference
Michigan State College, East Lansing, Mich.
Prof. James Tyson

Two hundred pounds of a 5% dust are required for this amount. But only 13.3 pounds of a 75% emulsifiable concentrate are needed.

Usually calculations such as those in the foregoing paragraph may be done "in the head" without resorting to formula. However, some more complicated ratios may be a little difficult. For example let us suppose that we want to apply 10 pounds of "actual" chlordane per acre. How much 5% dust do we need?

Let Q=quantity needed.

Since 5% actually means 5 parts to 100, we can set up this proportion, 5 is to 100 as 10 is to Q, expressed as follows,

$5 : 100 :: 10 : Q$

Then the product of the end figures, multiplied together, is equal to the product of the two middle figures, multiplied together. Therefore,

$$5 \times Q = 10 \times 100$$
$$5\,Q = 1000$$
$$Q = \frac{1000}{5}$$
$$Q = 200$$

Two hundred pounds of 5% dust delivers 10 pounds of actual chlordane. Now let's apply this formula to our other example, in which we have a 75% emulsifiable concentrate. In that case

75 is to 100 as 10 is to Q

$$75 : 100 :: 10 : Q$$
$$75\,Q = 1000$$
$$Q = \frac{1000}{75}$$
$$Q = 13.33$$

Therefore 13.33 pounds of concentrate are needed.

Fertilizer rates may be calculated in the same way. One may wish to apply 120 pounds of nitrogen per acre, using a 12-6-6 fertilizer. The proportion is as follows,

Let Q equal the quantity of fertilizer needed.

Then, $12 : 100 :: 120 : Q$

$$12\,Q = 12000$$
$$Q = 1000$$

Therefore 1000 pounds of fertilizer will be required.

Another calculation that must be made frequently is that of interpreting acre rates in terms of 1,000 square foot units and vice versa. This is a fairly easy conversion. There are 43,560 square feet in an acre or 43.56 one thousand square foot units. Therefore, if rates are given in pounds per 1000 square feet, one may convert by multiplying the figure by 43.56. Example: 5 pounds per 1000 square feet is equivalent to 217.8 pounds per acre. (5 x 43.56=217.8) For rapid calculations, round off the 43.56 and use 40 as a conversion factor. (5 x 40=200) This is not a precise conversion factor but it is useful for rapid mental calculations.

Conversely, one may convert acre rates to 1000 square feet rates by dividing the rate by 43.56 or by 40 in the case of rapid approximations.

To use arithmetic efficiently requires practice. If you are a little "rusty" along these lines, why not try brushing up a little bit by working out a few extra problems during the season when you aren't too busy. It may save you some time when you need it most. Calibrations and the figuring of rates will come much easier.