attended meetings of their association and other turf conferences and 25 Clubs avail themselves of the USGA Green Section Visiting Service.

Seeing a scientific approach to grass growing problems begin to creep into maintainance procedures throughout the country, appeals to a professional man such as myself. I hope that more clubs, through their greens superintendents, avail themselves of this truly exhilarating experience.

Distributing information on how to avoid compaction with new green and tee construction is an example of the splendid work that Dr. Marvin Ferguson and his group have done and are doing to help us help ourselves.

How Much Did You Put On?

By DR. MARVIN H. FERGUSON
Mid-Continent Director, National Research Coordinator, USGA Green Section

The Green Section agronomist visiting with a golf course superintendent asked, "How much fungicide did you put on this green?" The answer came immediately, "Two ounces per 1000 square feet." The agronomist expressed surprise because the fungicide in question is normally used at lighter rates and the amount mentioned would almost surely have produced burn. The superintendent, however, could not be shaken. He had measured the material accurately, he had applied it carefully, he had not watered it afterward. The agronomist had almost decided that there could have been no mistake when he asked the question, "How much area is in this putting green?" The answer was, "I don't know." Obviously, careful measurement and careful application are wasted if the size of the area is unknown.

If he is to know "how much was put on," he must measure the material to be applied, measure the area to be treated, and then treat the "measured area" with the "measured material."

Measure Material to Be Applied

The sellers of golf course supplies are doing a good job of packaging materials in convenient sizes for use without measuring; however, some materials must be measured. The first rule is to use standard measurements. For solids, such as powdered or crystalline materials, use ounces and pounds. For liquids use liquid ounces, pints, quarts and gallons.

The cost of graduates and scales is not prohibitive. These enable the use of measurements and quantities as stated by the manufacturer. When Coke bottles, bar glasses, beer cans or other such containers are used, a chance for error is permitted that is not necessary. Occasionally we are told something like this, "Well, I use a ginger ale bottle full of crabgrass control material to each tankful of water and three tankfuls on 18 greens." How many ounces in the ginger ale bottle? "About 32 ounces, but I don't fill it up completely." Are all the greens the same size? "No, there is some variation. We put a little more on the larger ones and a little less on the small ones."

It is fortunate that grasses tolerate some error and that manufacturers of turf chemicals usually allow for some deviation from their printed instructions. It is amazing that hit or miss methods do not cause more trouble than they do.

The foregoing comments should not be construed to suggest that sloppy handling of chemicals is common among golf course superintendents. The competent men are conscientious about proper measurements and they carefully control the amount of material applied.

One problem in the measurement of pesticide or fertilizer arises from using different concentrations. How much

40% liquid sodium arsenite must be used if the recommendation calls for 3 lbs. of sodium arsenite per acre? Because 1 gallon of 40% liquid sodium arsenite weighs approximately 10 lbs., we can determine easily that there are 4 lbs. of active material per gallon, or 1 lb. of active material per quart. Therefore 3 quarts of solution per acre will provide the desired amount. This is a relatively simple example; however, some problems become considerably more complicated. Usually liquid formulations are prescribed in terms of liquid measure. When this is not the case, the weight of the liquid, the percentage of active ingredient calculated in terms of weight per gallon must be determined, and the measurement made accordingly. In the example above, 1 gallon weighs 10 lbs. and the concentration is 40%. Therefore .40 x 10 = 4 lbs. active ingredient.

Some manufacturers show the weight of the active ingredient per gallon. The container will carry a label saying "Contains two pounds per gallon of Product A."

Fertilizer rates also require some calculation. Such calculations are not difficult using this brief formula: Desired rate of nutrient x 100 ÷ % concentration = Rate of application. The formula may be written:

$$\frac{R \times 100}{\%\ \text{nutrient}} = \text{rate of application}$$

Assume that 60 lbs. of nitrogen per acre is to be applied using a 12-12-12 fertilizer, then substitute figures in the formula as follows:

Desired rate (60 lbs.) x 100 ÷ percent N (12) = rate of application

$$\frac{5 \times 100}{1} = 500 \text{ lbs. of 12-12-12 per acre}$$

This formula may be applied to any particular nutrient. In the above example, it may be readily seen that equivalent amounts of phosporus and potash were applied.

Measurements of area on a golf course are usually expressed in terms of acres (43,560 square feet) or in 1000 sq. ft. units. These convenient units can be converted from acres to 1000 sq. ft. by multiplying by the factor 43.56.

There are several acceptable methods of measuring areas. Aerial photos, made to a known scale can be quickly measured at any well-equipped civil engineer's office. Accurate approximations may be obtained by laying a clear plastic grid over the area to be measured, provided the area covered by each square in the grid is known. Another method using a map or photo is to divide irregular areas into more or less regularly shaped parts, measure the parts with a scale ruler and add them up to provide a total for the area.

On the ground, measurements may be made with a tape or a measuring wheel. If irregularly-shaped areas are to be measured, it may be necessary to divide the area into more regularly shaped parts.

If the course superintendent has an inclination to estimate the size of areas, he may be wise to check himself frequently. Estimates can sometimes miss the mark by virtue of faulty reasoning. The following is one example:

Superintendent A has a green that is oval shaped, 110 feet long and 75 feet wide. He multiplies 110 x 75 and finds that this is 8,250 square feet. He estimates that the rounded off corners probably amount to about 500 square feet and he considers the green to be 7,750 square feet (See Fig. 1.)

When the green is measured, it is divided so that part B is a rectangle with the dimensions 35′ x 75′. Its area then is 2,625 square feet. Parts A and C, if placed together, would form a circle with a diameter of 75′. The formula for finding the area of a circle is pi (3.1416) times ½ the diameter, squared. It is written:

$3.1416 \times (37.5)^2 = 4{,}417+$ square feet. Adding these values we find that 4,417 + 2,625 = 7,042 square feet. Thus the estimate is off by more than 700 square feet or 10%.

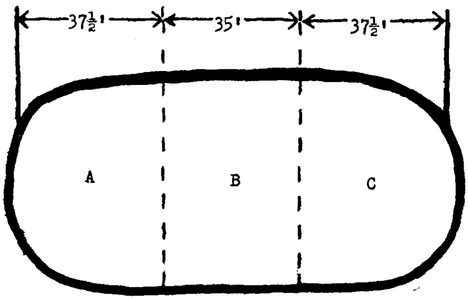

Fig. 1

One of the most common occurrences of faulty estimates comes from treating fringes of greens. The green may be circular and 80 feet in diameter. The superintendent wishes to apply 3 ounces of fungicide per 1000 square feet. We may calculate the area by the formula pi (3.1416) x ½ diameter squared:

3.1416 x 40 x 40 = 5,026 square feet
Therefore 15 ounces of fungicide will be required. But because the superintendent wishes to spray a strip about 10′ wide around the collar of the green he decides to put in a little additional fungicide, so he allows enough for another 1000 square feet (3 ounces more). How much fungicide is he applying?

The radius of the area to be treated is now 50′ instead of 40′.

3.1416 x 50 x 50 = 7,854 square feet
Now we have applied 18 ounces to 7,854 square feet. This amounts to a little more than 2¼ ounces per 100 square feet. Thus, the estimate was seriously in error.

Calibration of spreaders or sprayers is one of the most important steps in the application of any material. In the case of sprayers, the rate of output will remain constant so long as pressures and orifice sizes are constant. Therefore the procedure is to measure the rate of discharge and from this information together with the known width of the swath covered by the sprayer, calculate the distance to be traveled in order to apply the given amount of material.

Treat the "Measured Area" with the "Measured Material"

Consider one example. Fifty gallons of a spray material per acre are to be applied. The sprayer discharges 2 gallons of solution per minute. Thus 1/25 of the required amount is discharged in one minute. Another way of saying this is that 1/25 of an acre must be covered in one minute. One twenty-fifth of an acre is 1,742 square feet (43,560 ÷25). If we know that the spray covers a strip 12 feet wide, the rig must travel 145 feet (1,742 ÷ 12) in order to cover this area. By converting feet per minute to miles per hour, the correct tractor speed can be determined. (A speed indicator on the tractor is a very useful "extra" in turf maintenance work.) A rate of 145 feet per minute is equivalent to 8,700 feet per hour or 1.65 miles per hour (8,700 ÷ 5,280).

A fertilizer distributor must be handled differently. The conventional distributor will vary in its discharge rate with variations in speed, fullness of the hopper, and roughness of the terrain. Usually the best way to measure rate of discharge is to fasten a pan to the underside of the distributor, operate the machine over a measured

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Gainesville, Fla.

September 10-11
Midwest Field Days
Purdue University
Lafayette, Indiana

September 26-27-28
Northwest Turf Association Conference
Washington State University
Pullman, Washington

area and weigh the fertilizer discharged into the pan. Openings in the spreader may be adjusted to provide the desired rate of output.

One pitfall in the application of spray materials suspended in water rather than dissolved is the danger of settling out. Unless thorough and constant agitation accompanies the spraying operation, the concentration of the solution may vary. There have been cases in which excellent fungicides failed to provide disease control. Subsequent examination of the sprayer disclosed a "paste" of fungicide material in the bottom of the tank.

Use Clean Equipment

The last step in any operation involving sprayers or spreaders is to thoroughly clean the equipment, service it, and store it in such condition that it is ready for use. However, it is always a good idea to check over equipment again just prior to use. These precautions are not only a part of good housekeeping and a way to forestall rust and corrosion of metal parts, but they may prevent disaster. There is one case on record where a club killed nine bluegrass fairways by failure to use clean equipment. The club borrowed a large sprayer, placed 2,4-D solution in it and sprayed the fairways; the workman failed to check the tank prior to filling. Had he done so, he would have found that it was partially filled with a solution of a powerful soil sterilant. The previous user had failed to empty the tank.

Few soils in the world have enough plant nutrients naturally to support themselves efficiently for more than a few years at best, thus one of the reasons for fertilizers. As a nation, we are using about five times as much fertilizer as we did in 1935.

England had commercial phosphatic fertilizers by 1850. Later they were made in the United States. They improved only gradually, and the concentrated sorts were relatively scarce until about 1933.

The use of potash fertilizer came along with the use of nitrogen and phosphorus. As all three increased, we learned to use the secondary nutrients—magnesium, boron, zinc and others. Few of us, on reasonably good soils, now need to let soil fertility be a limiting factor. Knowledge of how the soils respond and chemical tests for current nutrient status are generally well established as the basis for recommendations.

The chemical materials which have become an important part of turfgrass management have had a revolutionary effect upon the profession. The superintendent would be hard pressed to maintain turf without them. Because of their effectiveness and their costs, they must be used in accordance with thoroughly tested procedures and rates. The superintendent who uses them is obliged to be ever alert to make certain that he is using the correct material and the correct amount on the known area to be treated. Accorded this attention, turfgrass chemicals can be a tremendously effective maintenance tool.

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