Practical Math for the Turfgrass Professional

UofA
UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE
Cooperative Extension Service

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This publication was prepared by **Dr. Aaron Patton**, assistant professor - turfgrass specialist with the University of Arkansas Division of Agriculture, Cooperative Extension Service, Fayetteville.

Section

1

Turf Mathematics

Math is not as scary as it may seem.

This manual covers some math problems common to the turfgrass industry. Using common sense and careful calculating, you will be able to solve different problems common to the turfgrass industry. Additionally, this manual will provide you with the basic knowledge necessary to solve other problems not discussed. The first lesson today is that turfgrass mathematics is not as scary as it may seem.

STOICHIOMETRY

There are a couple of good textbooks on turfgrass mathematics. The most popular text is by Drs. Nick Christians and Michael Agnew (see references section). This text provides a thorough explanation of how to use cross-multiplication to solve all types of turfgrass math problems. However, today we will learn how to use stoichiometry (chemistry math) in order to solve turfgrass math problems. Stoichiometry is a process used by chemists to convert from one unit to another. The advantage to this method is that it always works if you properly label units.

Here is how it works:

Problem 1: Let's say that you were the 1 trillionth customer to shop at Wal-Mart and, as a gift, they decided to fly you to Scotland. While packing for your trip, you decided to take all your quarters you had saved up in your piggy bank and cash them in at the airport for pounds sterling silver (Scottish currency). You know that 1 United States dollar is equal to about 0.53 pounds sterling silver. If you have 1,250 quarters in your piggy bank, then how many pounds sterling silver will you get at the currency exchange?

Step 1. List what you know.

- 1,250 quarters
- 4 quarters in one U.S. dollar
- 1 United States dollar is equal to about 0.53 pounds sterling silver

1,250 quarters	1 U.S. dollar	0.53 pounds sterling silver
	4 quarters	1 U.S. dollar

Step 2. Arrange them so that the units for your final answer are always on top.

1,250 ~~quarters~~	1 ~~U.S. dollar~~	0.53 pounds sterling silver
	4 ~~quarters~~	1 ~~U.S. dollar~~

Step 3. Make sure that all your units (except your final answer) cancel each other.

Step 4. Multiply all the numbers on top by each other and then divide by the numbers on the bottom. This is easy on a calculator. For example, in this problem enter into your calculator in the following order: 1,250 × 1 × 0.53 ÷ 4 ÷ 1 =

Answer = 165.63 pounds sterling silver

Review

PERCENTS

The word percent comes from the Latin *per centum* meaning "out of one hundred." So, 25% is "25 out of 100." The percent symbol represents a ratio of the part (25 in this case) to the whole (always 100). A percent must be changed to a decimal before we can use it in our calculations. Hence 25% is the ratio 25:100, which equals 0.25 (25 ÷ 100) (Table 1.1). The mechanics of changing a percent to a decimal number involves moving the decimal point two places to the left.

Figure 1.1 The percent symbol can help us remember to move the decimal two places left.

Table 1.1. Percentages.

Percent notation	Decimal notation
90%	0.90
45.5%	0.455
25%	0.25
12½%	0.125
5%	0.05
1%	0.01
0.1%	0.001

Section

2

Area Calculations

Accurate area calculations can save money and time as well as prevent misapplications.

Area measurements are the first calculations that any turfgrass manager should learn. It is important for turf managers to be able to calculate areas accurately, whether it is to topdress, fertilize, overseed or apply any pesticide. Accurate area calculations can save money and time as well as help prevent over or under application of pesticides. Area is defined in terms of square measures. The most commonly used area measurements are square feet (ft^2) and acres (A). Home lawns, greens and tees are commonly measured in units of 1,000 ft^2, and athletic fields, fairways and roughs are often measured in acres. Calculating area can be accomplished using several methods, including geometric figure calculations, offset determination and a variety of other methods.

Figure 2.1 Calculating area is the first step in proper fertilizer and pesticide application to lawns and other turf areas.

Geometic Figures

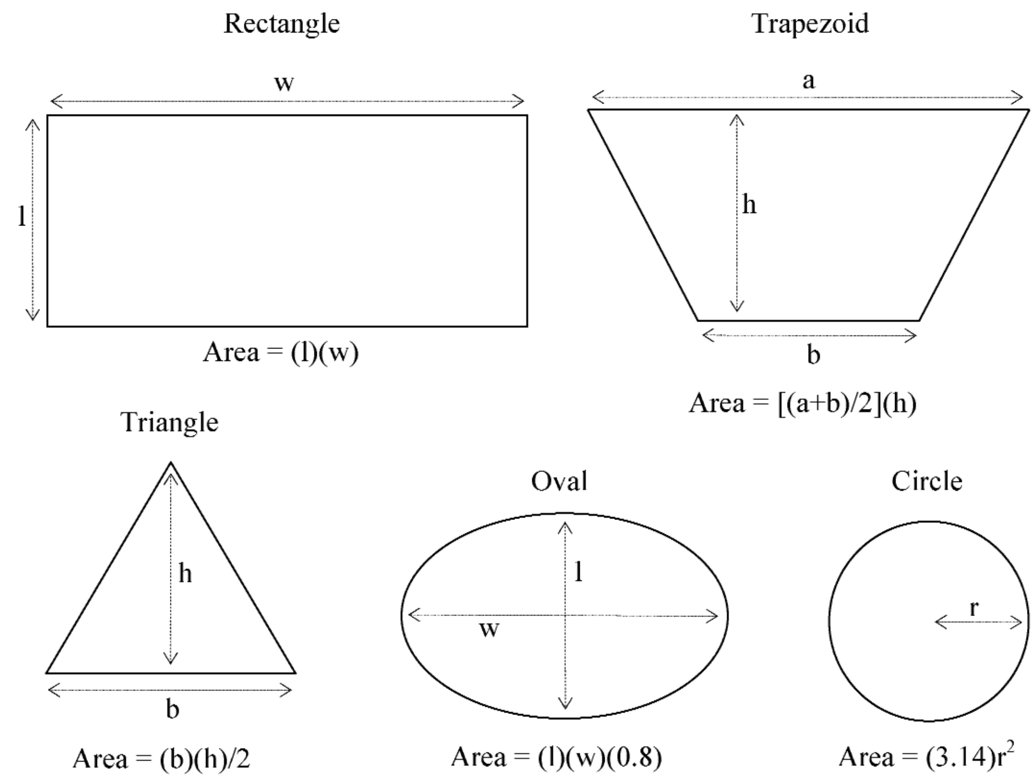


Figure 2.2 Common geometric figures and the formulae used to calculate their areas.

Golf Course Practice Problem

Calculate the area of bermudagrass, zoysiagrass and creeping bentgrass on this golf hole (Fig. 2.3).

Creeping bentgrass greens and zoysiagrass fairway and tee shaded in light green.

Bermudagrass rough shaded in dark green.

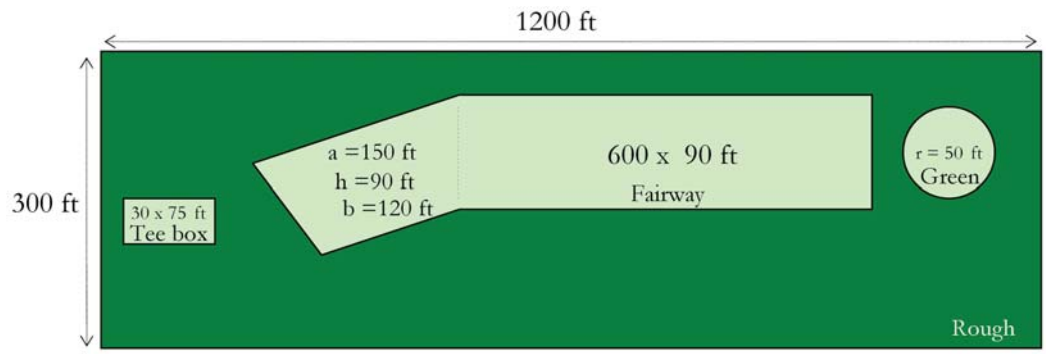


Figure 2.3 Example golf hole layout including rough, tee, fairway and green.

What is the area of the zoysiagrass tee box? (Answer = 2,250 ft^2)

What is the area of the zoysiagrass fairway? (Answer = 66,150 ft^2)

What is the area of the creeping bentgrass green? (Answer = 7,854 ft^2)

What is the area of the bermudagrass rough? (area of rough = total area - tee - fairway - green) (Answer = 283,746 ft^2 or 6.5 acres)

Home Lawn Practice Problem

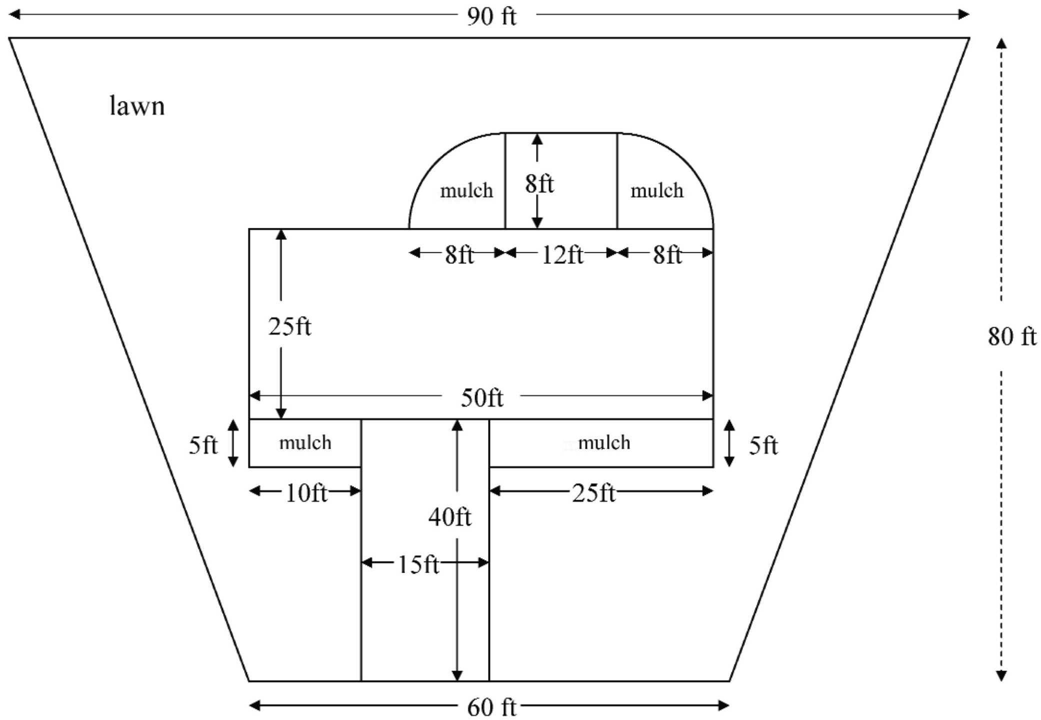


Figure 2.4 Sample home lawn diagram with accompanying measurements.

Calculate the area of bermudagrass turf in this home lawn (Fig. 2.4).

Section	Area	ft^2
Total land ((90 ft + 60 ft)/2) × 80 ft	6,000	ft^2

Section	Area	ft^2
House (50 ft × 25 ft)	1,250	ft^2
Driveway (15 ft × 40 ft)	600	ft^2
Porch (8 ft × 12 ft)	96	ft^2
Mulch 1 (10 ft × 5 ft)	50	ft^2
Mulch 2 (25 × 5 ft)	125	ft^2
Mulch 3 ($0.25 \times 3.14 \times 8^2$)	50	ft^2
Mulch 4 ($0.25 \times 3.14 \times 8^2$)	50	ft^2
Total objects	2,221	ft^2

Total turfgrass (6,000 ft^2 - 2,221 ft^2) 3,779 ft^2

If you do this correctly, you should calculate that there are 3,779 ft^2 of turfgrass.

The Offset Method

The offset method is used to measure irregularly shaped figures. It reduces large figures to a series of smaller trapezoids equally spaced along a measured line. This method will approximate the area to within 5 percent.

The steps in determining area by the offset method are as follows:

Step 1: Determine the length line. This is the longest axis of the object. Its endpoints are points A and B.

Step 2: Mark the offset lines at right angles (90^{o}) to the length line (Fig. 2.5). Choose how many offset lines to create so that the offset lines divide line A-B into equal segments and define separate regions. For example, if the length line was 60 feet, a logical distance between offset lines would be 10 feet, since 60 divided by 10 equals 6, a whole number. If the length line is 300 feet or more, intervals of 10 to 30 feet should be used. If the shape of the area is uniform, then fewer offset lines are needed. However, if the shape of the area is irregular, more offset lines are needed. To ensure accuracy, use as many offset lines as possible.

Step 3: Measure the length of each offset line. These are measured from one edge of the area to the other.

Step 4: Add up the lengths of all offset lines and multiply this total by the distance between offset lines.

The offset method can be used to determine the area of a sand bunker.

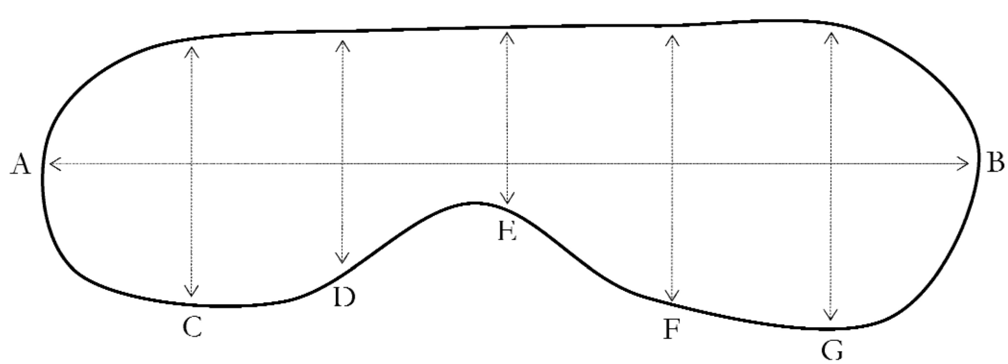


Figure 2.5 Sample diagram of sand bunker with length and offset segments needed to calculate areas using the offset method. Length is the distance from A to B. Letters C-G are labels for the offset lines.

Step 1: Determine the length line.

The distance between points A and B is **60 ft.**

Step 2: Offset lines will be set every **10 ft.**

Step 3: The lengths of the offset lines are as follows:

C = 17 ft	D = 15 ft	E = 13 ft
F = 19 ft	G = 21 ft	

Step 4: The total length of the combined offset lines is **85 ft.**

The distance between offset lines is **10 ft.**

Area = 85 ft × 10 ft
Area = 850 ft^2

The Modified Offset Method

Some areas such as ponds and lakes cannot be calculated with the offset method but can be calculated using the modified offset method.

Step 1. Construct a rectangle around the area to be measured (Fig. 2.6). Label the corners A, B, C and D and determine the length and width.

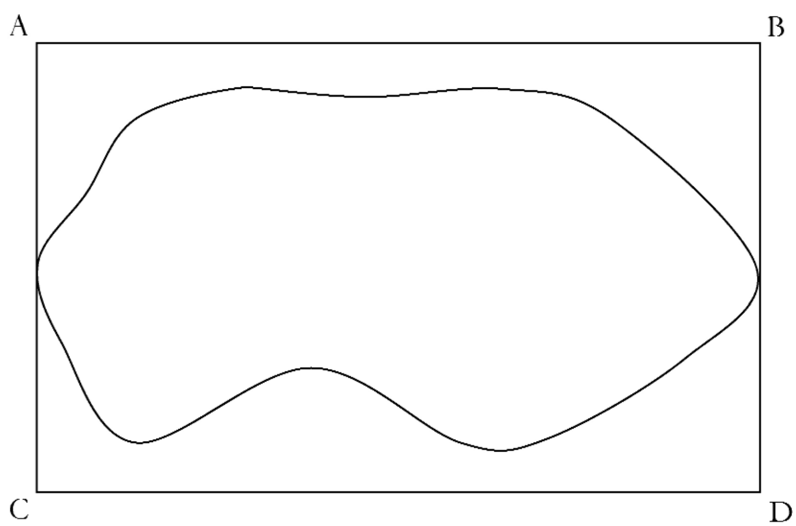


Figure 2.6 Sample diagram of a pond outline.

Length (A to B; C to D) = 60 ft

Width (A to C; B to D) = 40 ft

Step 2. Mark pairs (E1 + E2, F1 + F2, etc.) of offset lines (10 feet apart) along each length line to the nearest perimeter of the object (Fig 2.7).

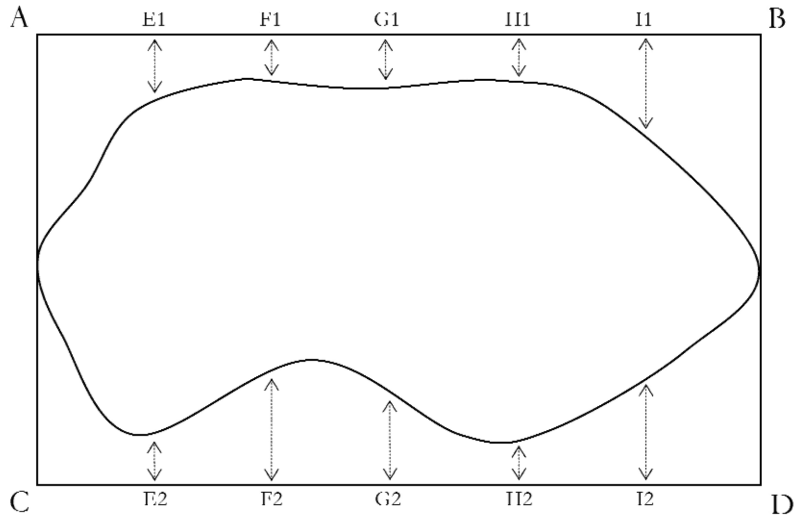


Figure 2.7 Sample diagram of a pond outline with paired offset lines drawn.

Step 3. Determine the length of the pairs of offset lines by measuring from the outside edge to the edge of the pond.

E1 = 10 ft	F1 = 6 ft	G1 = 8 ft	H1 = 6 ft	I1 = 14 ft
E2 = 8 ft	F2 = 16 ft	G2 = 12 ft	H2 = 4 ft	I2 = 14 ft
E = 18 ft	F = 22 ft	G = 20 ft	H = 10 ft	I = 28 ft

Step 4. Subtract the value of each pair of offset lines from the width (40 ft) and then total.

E	40 – 18 =	22 ft
F	40 – 22 =	18 ft
G	40 – 20 =	20 ft
H	40 – 10 =	30 ft
I	40 – 28 =	12 ft
Total		= 102 ft

Step 5. Multiply the total by the distance between the offset lines.

(102 ft)(10 ft) = 1,020 ft^2

The Average Radius Method

Measuring small, irregular, circular-like areas, such as golf course putting greens, can also be determined by using another method. This method simply converts an irregular area into a circle by determining an average radius and calculating that area. This method is only an “estimate” of area and should be within 5 to 10 percent of the actual area.

Step 1. Construct a template out of 2 ft by 2 ft plywood. Mark the center with two lines at right angles (90^o). Next, mark a line from the center-point to the edge every 10^o (total of 360^o in a circle) (Fig. 2.8).

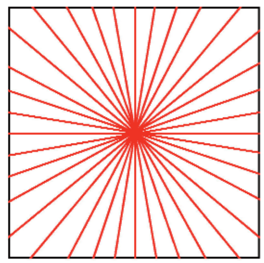


Figure 2.8 Template for determining the average radius should look something like this.

Step 2. Locate a central point within the area to be measured. Place the template on this location and measure the distance from the central point to the edge of the area (Fig. 2.9). Make 18 (every 20^o) to 36 (every 10^o) measurements. The greater the number of measurements, the more accurate the estimate will be.

Step 3. Total all the measurements and divide by the number of measurements. This will equal the average radius for the area. For example, if 36 measurements totaled 1,800 ft, you would divide 1,800 by 36 for an average radius of 50 ft.

Step 4. Calculate the area of the circle using the formula for a circle.

$A = (3.14)(r)^2$

$A = (3.14)(50\text{ ft})^2 = 7{,}850\text{ ft}^2$

Average Radius Example

Determine the area of the putting green and collar in the following diagram.

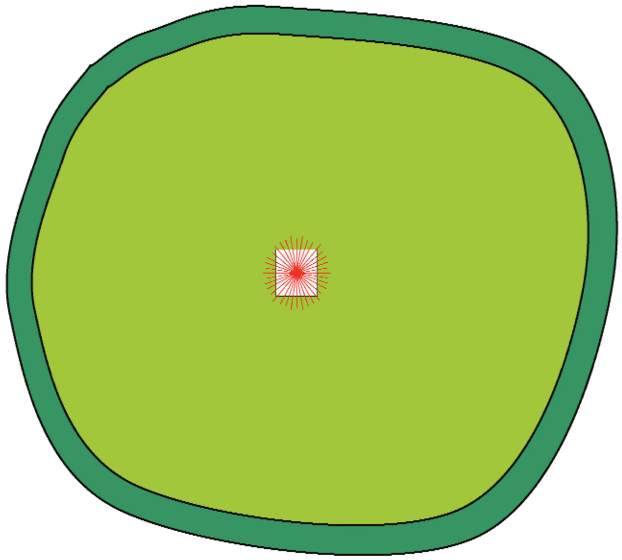


Figure 2.9 Place the template in the center of the putting green.

Step 1. Make 36 measurements every 10° and record the measurements both to the edge of the putting green and to the collar.

Step 2. Total the measurements

Total for collar and green = 1,875 ft
Putting green only = 1,680 ft

Step 3. Divide totals by 36 to determine the average radius.

Collar and green = 52.1 ft
Putting green only = 46.7 ft

Step 4. Determine the area of a circle for each portion.

Collar and green = $3.14(52.1)^2 = 8{,}528\ ft^2$
Putting green only = $3.14(46.7)^2 = 6{,}851\ ft^2$

Step 5. Determine the area of the collar by subtracting the putting surface area from the putting surface + collar area.

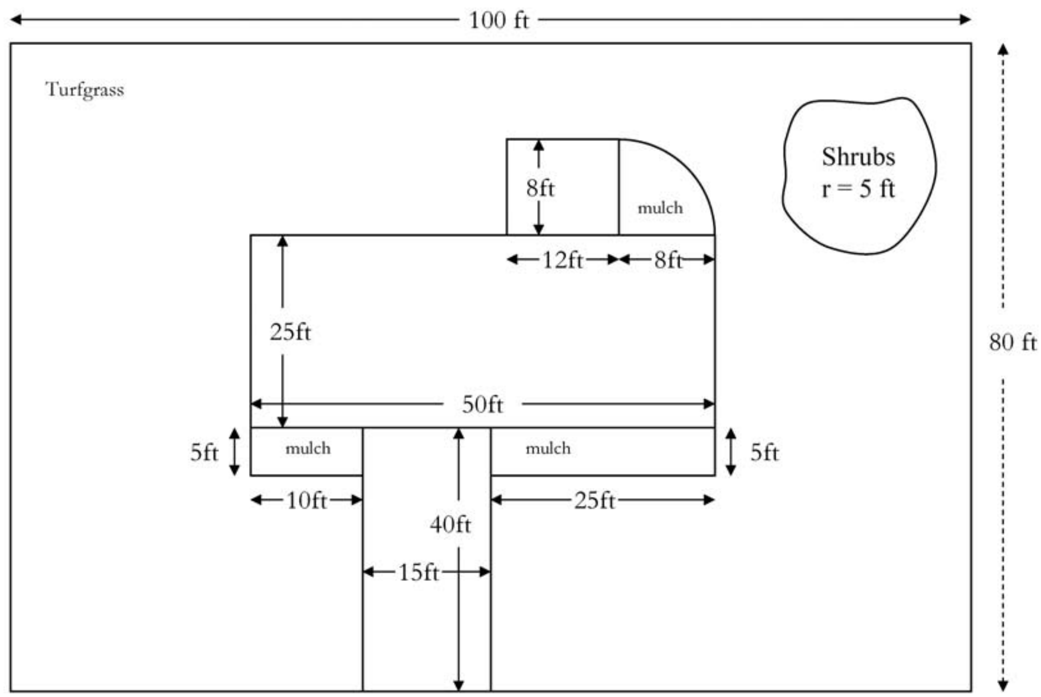
Collar and putting green	$8{,}528\ ft^2$
Putting surface	$- 6{,}851\ ft^2$
Collar	$1{,}677\ ft^2$

GPS

Global position systems (GPS) are a modern method to determine the area of turf using technology to your advantage. Global positioning can be used to create a series of marked points to measure area. Hand-held devices are available to calculate area and can be purchased for a few hundred dollars. These devices are relatively simple to operate and have other uses such as navigation. Garmin, Magellan and other manufacturers produce these devices. Some devices are capable of transferring marked points and areas to a PC where they can be used to generate a map of turfgrass areas. Turfgrass managers must use caution when calculating area with these devices since their accuracy varies by product and is based on satellite signal strength.

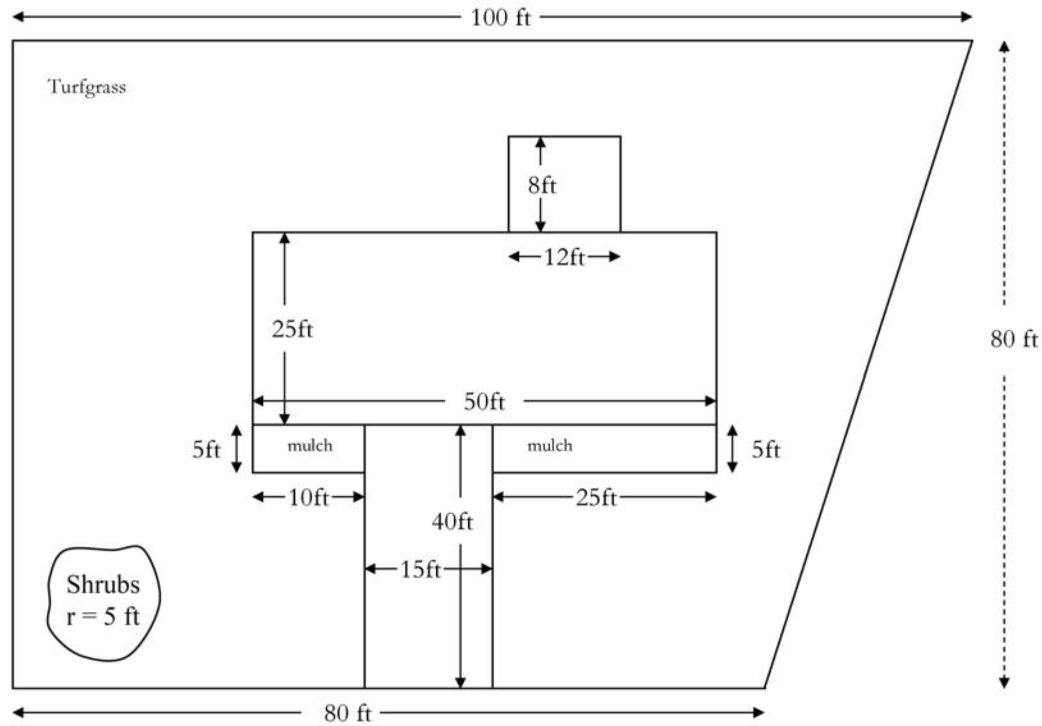
Problems (see page 103 for answers)

1. Calculate the area of turfgrass in this home lawn.

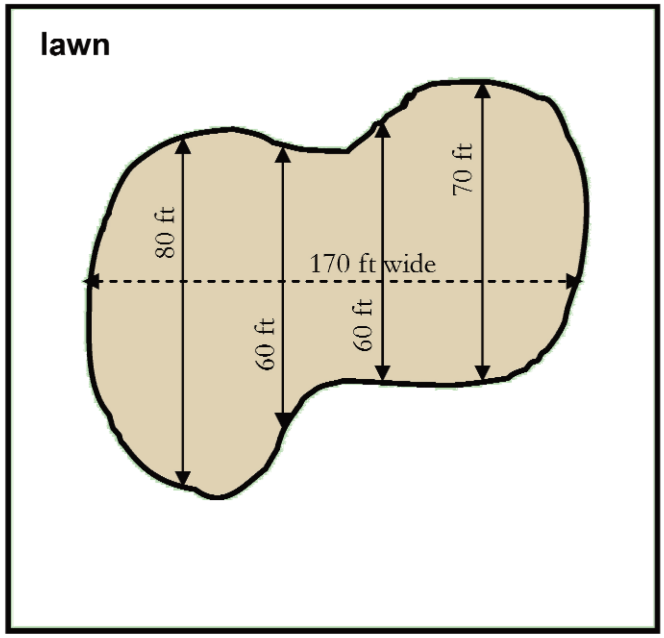


Extra Problems

2. Calculate the area of turfgrass in this home lawn.



3. A client has a plot of land 30,000 ft^2 in size with an irregularly shaped landscape bed in the middle (see image below). Calculate the amount of turf and the surface area of the landscape bed. The landscape bed is 170 feet wide and its cross segments are 80, 60, 60 and 70 feet in length.



4. What is the approximate area of a golf course green, if it has the following radius measurements?

   a = 45 ft
   b = 53 ft
   c = 39 ft
   d = 41 ft

Section

3

Volume Calculations

Knowing how to calculate volume can reduce costs caused by ordering too much product.

It is important for turf managers to be able to calculate volumes accurately, whether they are topdressing a putting green, mulching a perennial bed or calculating the amount of soil needed to fill in a depression. Accurate calculations can save money and time. Volume is a cubic measurement and first requires that surface area (area is defined in terms of square measures) is calculated correctly. Once the surface area is known, you simply need to multiply by depth to accurately calculate volume.

Figure 3.1 Knowing how to calculate volume will help you to order the right amount of sand for topdressing.

Topdressing Calculations

There are 27 ft^3 in a cubic yard (yd^3), or 0.037 yd^3 in a cubic foot (ft^3). To convert ft^3 into yd^3, it is necessary to divide by 27 (Fig. 3.2).

27 ft^3 = 1 yd^3

There are 27 1 ft^3 boxes in 1 yd^3

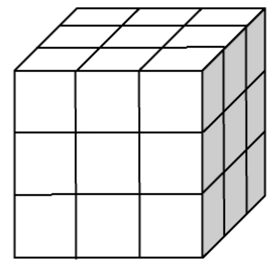


Figure 3.2 One cubic yard contains 27 cubic feet.

Topdressing depths are typically measured in inches rather than feet. A typical amount of topdressing on a putting green may be 1/16 to 1/32 of an inch, whereas tees and fairways may be topdressed with 1/8 to 1/4 of an inch. Since topdressing is measured in inches, it is necessary to convert inches to feet during your calculation to solve for the amount of sand or soil needed.

Example 1. You wish to topdress your greens with 1/16 inch of topdressing material. You have 148,000 ft^2 of golf course greens. How many cubic yards of topdressing material will you need?

148,000 ft^2	1 ft	1 in.	1 yd^3
	12 in.	16	27 ft^3

This should be computed as 148,000 ft^2 × 1 ft × 1 in × 1 yd^3 ÷ 12 in ÷ 16 ÷ 27 ft^3 = ______

Answer = 28.55 yd^3

Example 2. You wish to topdress your football field with an 1/8 inch of topdressing material <u>six</u> times during the season. You have 57,600 ft^2 of turf. How many cubic yards of topdressing material will you need for the entire year?

57,600 ft^2	1 ft	1 in.	1 yd^3	6
	12 in.	8	27 ft^3	

This should be computed as 57,600 ft^2 × 1 ft × 1 in × 1 yd^3 × 6 ÷ 12 in ÷ 8 ÷ 27 ft^3 = ______

Answer = 133.33 yd^3

Aerification Calculations

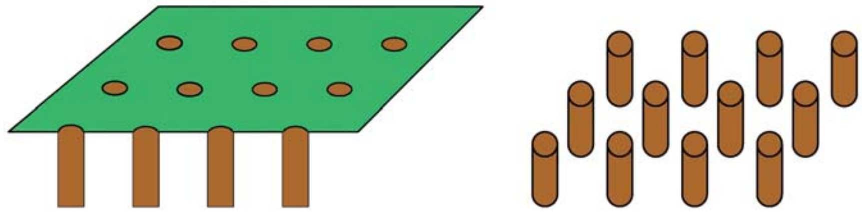


Figure 3.3 Soil removed by aerification tines are called cores.

When aerifying with hollow-tines, soil and plant material (cores) will be removed from the turf/soil (Fig. 3.3). If you are planning on filling these aerification holes with a topdressing material like sand, it is important to be able to estimate how much material you will need in order to fill the holes you have created.

Step 1. The first step is to determine the number of holes per square foot.

The simplest way to do this is to draw a diagram. Let's assume that we are using a 3×3-inch tine spacing. In one square foot of turf, we will have a total of 16 aerification holes per square foot with a 3×3-inch spacing. This can be calculated as 9 whole circles + 12 half circles + 4 quarter circles, for a total of 16 holes per square foot.

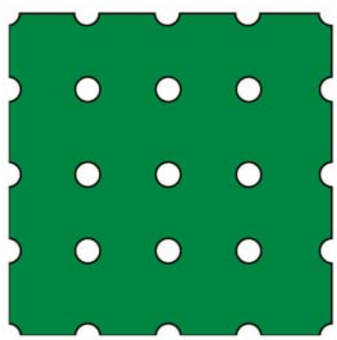


Figure 3.4 Sixteen cores are removed per square foot when aerifying with a 3- by 3-inch spacing.

Alternatively, we can calculate the number of holes per square foot using the formula below.

General formula

12 in.	12 in.
spacing (x)	spacing (y)

Example

12 in.	12 in.
3 in.	3 in.

Answer = 16 holes

We can then calculate the area of turf impacted by an aerification by using the internal diameter of the tine and the number of holes per square foot.

Equation for calculating percent area affected by aerification.

π (r)^2 where r is radius	Number of holes	1 ft^2
	1 ft^2	144 in^2

Table 3.1 The influence of tine size and spacing on the area of turf impacted is shown below.

Internal tine diameter (in.)	Tine spacing	Number of holes/ft^2	Percent surface area affected
0.50	3" x 3"	16	2.2
0.50	2" x 2"	36	4.9
0.75	3" x 3"	16	4.9
0.75	2" x 2"	36	11.0
1.00	3" x 3"	16	8.7
1.00	2" x 2"	36	19.6

Example 1. You have just aerified your 20,000 ft^2 nursery putting green with 0.5 inch (internal diameter) tines spaced 2 inches apart, and penetrated the soil to a depth of 2.5 inches. How much sand will you need (in yd^3) to fill the aerification holes (assuming that all the sand applied goes into the aerification holes)?

How to set up the equation.

π (r)^2 (h) where r is radius of tine and h is depth	Number of holes	size of area	1 ft^3	1 yd^3
	1 ft^2		1,728 in^3	27 ft^3

Example 1:

π (0.25)^2 (2.5) in^3	36	20,000 ft^2	1 ft^3	1 yd^3
	1 ft^2		1,728 in^3	27 ft^3

This should be computed as 3.14 × 0.25 × 0.25 × 2.5 in^3 × 36 × 20,000 ft^2 × 1 ft^3 × 1 yd^3 ÷ 1 ft^2 ÷ 1,728 in^3 ÷ 27 ft^3 = _______

Answer = 7.6 yd^3

It is practically impossible to apply the material only to fill the aerification holes. Therefore, combine the amount of material needed to fill the aerification holes with the amount needed to topdress 1/16 of an inch deep to calculate the total volume of sand needed for the aerification.

Order by the Ton

Soil is ordered not always by the cubic yard but sometimes by weight. It is possible to estimate the amount of material you need in tons using the following equation.

Example 2. Bulk density for sand typically is near 1.7 g/cm^3. Using this number, we can estimate how many tons are in 1 yd^3. NOTE: 1 lb = 454 grams (g); 1 yd^3 = 0.765 m^3.

1.7 g	1,000,000 cm^3	0.765 m^3	1 lb	1 ton
1 cm^3	1 m^3	1 yd^3	454 g	2,000 lb

This should be computed as 1.7 g × 1,000,000 cm^3 × 0.765 m^3 × 1 lb × 1 ton ÷ 1 cm^3 ÷ 1 m^3 ÷ 1 yd^3 ÷ 454 g ÷ 2,000 lb = ______

Answer: 1.43 tons per 1 yd^3 sand

NOTE: This only works for dry sand. Wet or moist sand will weigh more than 1.7 g/cm^3.

Example 3. You topdress 100,000 ft^2 of golf course greens with 1/16 inch of topdressing material. Sand typically costs $25 per ton. You also have access to a scale, and you find out that 50 cm^3 (NOTE: 1 cm^3 = 1 mL) of dry sand weights 84 grams. Calculate how much this application costs using the information provided.

84 g	1,000,000 cm^3	0.765 m^3	1 lb	1 ton	$25	100,000 ft^2	1 ft	1 in	1 yd^3
50 cm^3	1 m^3	1 yd^3	454 g	2,000 lb	1 ton		12 in	16	27 ft^3

This should be computed as 84 g × 1,000,000 cm^3 × 0.765 m^3 × 1 lb × 1 ton × $25 × 100,000 ft^2 × 1 ft × 1 in × 1 yd^3 ÷ 50 cm^3 ÷ 1 m^3 ÷ 1 yd^3 ÷ 454 g ÷ 2000 lb ÷ 1 ton ÷ 12 in ÷ 16 ÷ 27 ft^3 = ______

Answer: $682.59 to topdress 100,000 ft^2 of golf course greens with 1/16 inch of topdressing

Mulching Calculations

Figure 3.5 How much mulch is needed for those landscape beds?

Knowing how to calculate volume can help you order an accurate amount of mulch (Fig. 3.5). Mulch is typically measured in cubic yards rather than in cubic feet. A typical amount of mulch added to a new bed may be 3 to 4 inches (depth) where only 1 to 2 inches (depth) may be needed to touch up an existing bed. Since mulch is measured in inches, it is necessary to convert inches to feet during your calculation to solve for the amount of mulch needed.

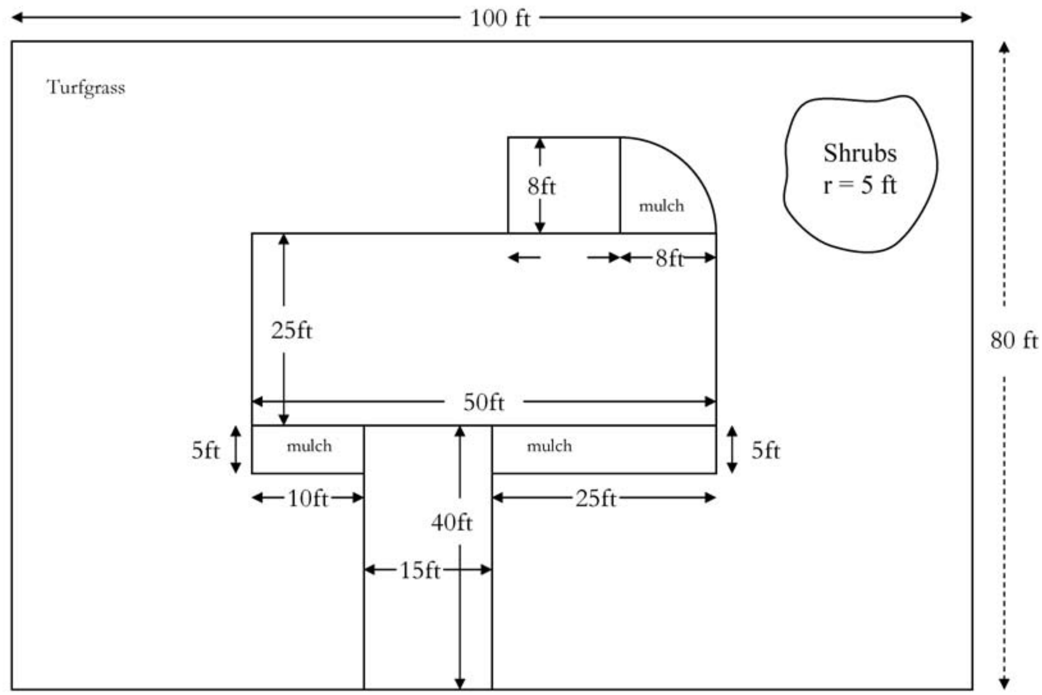
Example 3. You wish to mulch your existing flower beds with 2 inches of material. You have 1,250 ft^2 of flower beds on your property. How many cubic yards of mulch will you need?

1,250 ft^2	1 ft	2 in	1 yd^3
	12 in		27 ft^3

This should be computed as 1,250 $ft^2 \times$ 1 ft $\times$ 2 in $\times$ 1 $yd^3 \div$ 12 in $\div$ 27 ft^3 = _______

Answer = 7.7 yd^3

Problems (see page 103 for answers)



5. You wish to touchup the beds for this home with 1 inch of mulch. How many cubic yards of mulch will you need (not including shrubs)?

6. You wish to mulch an existing bed for a client that measures 500 ft^2 with 1 inch of mulch and also add 4 inches of mulch to a new bed measuring 700 ft^2. How many cubic yards of mulch will you need?

7. After removing an in-ground swimming pool measuring 20 ft × 10 ft × 6 ft, how many cubic yards of soil will be needed to fill in this hole (disregard settling)?

8. You wish to topdress your greens with 1/32 inch of topdressing material. You have 138,000 ft^2 of golf course greens. How many cubic yards of topdressing material will you need?

9. You have just aerified your 20,000 ft^2 nursery green with 0.5 inch (internal diameter) tines spaced 2 inches apart, and penetrated the soil to a depth of 3.0 inches. How much sand will you need (in yd^3) to fill the aerification holes and also apply 1/16 inch of topdressing material over the green to help smooth out the surface?

10. The greens on your golf course measure 131,000 ft^2. They are to be topdressed eight times during the next season with 1/32 inch of material per application. How many cubic yards of topdressing material will be needed for next season?

11. During your internship, you help topdress the 100,000 ft^2 of golf course greens with 1/16 inch of topdressing sand. The superintendent tells you that sand typically costs about \$32 per ton. You also have access to a scale, and you find out that 50 cm^3 of dry sand weighs 79 grams. Calculate how much this application costs using the information provided.

Section

4

Irrigation Calculations

Knowing how to calculate volume can help with certain irrigation applications.

Irrigation is a key component of turfgrass growth and health. Volume is the major mathematical component to calculating how much irrigation needs to be applied, the cost of irrigation and other important components such as how large irrigation ponds need to be constructed to supply needed water. Other important irrigation calculations include irrigation efficiency calculations. This chapter does not cover information about calculating pipe size, irrigation pressure, flow rate or other irrigation system calculations. Your local irrigation salesperson will be able to supply support for calculating these components of irrigation design.

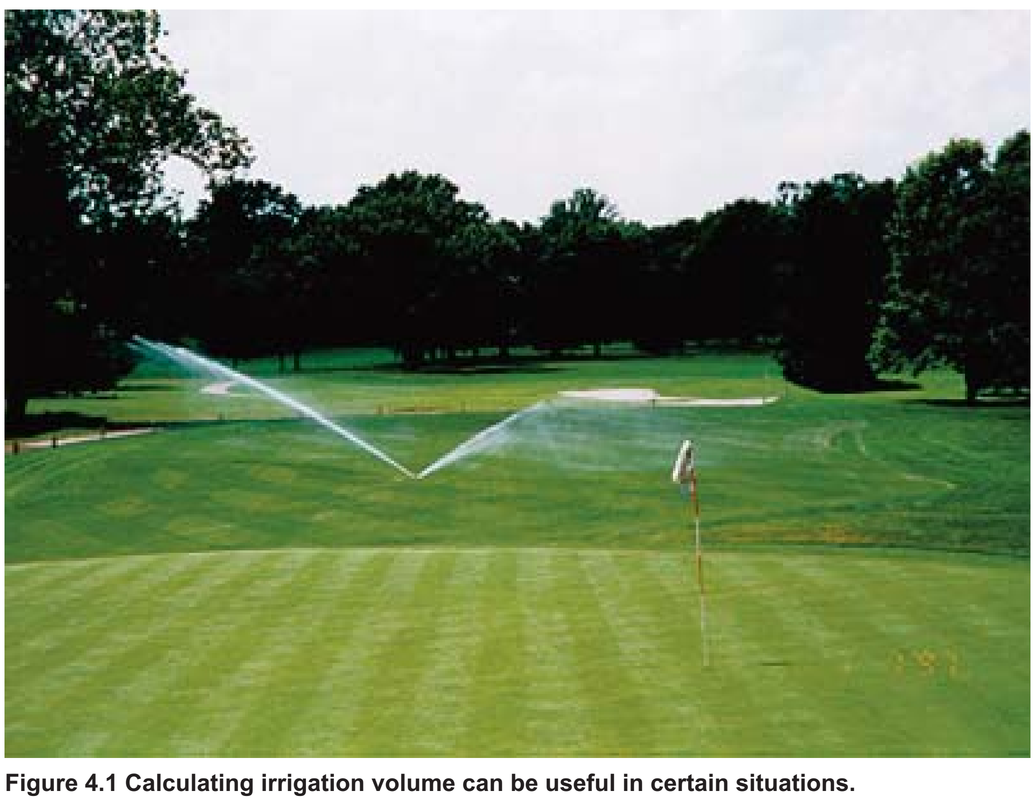


Figure 4.1 Calculating irrigation volume can be useful in certain situations.

Irrigation Calculations

Important irrigation standards of measurement.

- 1 ft^3 of water is equal to 7.48 gallons of water
- 325,829 gallons of water in 1 acre-foot
- 27,152 gallons of water in 1 acre-inch

Example 1. You irrigate 0.7 inch per week on your golf course. If your golf course has 41 acres of irrigated turf and if you irrigate 17 weeks of the year, how many gallons will you use each year?

0.7 inch	17 weeks	41 acres	27,152 gallons
1 week			1 acre-inch

This should be computed as 0.7 inch × 17 weeks × 41 acres × 27,152 gallons ÷ 1 week ÷ 1 acre-inch = ______

Answer = 13,247,460 gallons

Example 2. Twelve thousand square feet of turf are to be irrigated with 1.3 inches of water per week for 12 weeks of the season. The water is to be purchased from the city for 5 cents per cubic foot. How much money needs to be budgeted to purchase the water?

12,000 ft^2	1.3 inches	12 weeks	1 ft	$0.05
	1 week		12 in	1 ft^3

This should be computed as 12,000 ft^2 × 1.3 inches × 12 weeks × 1 ft × $0.05 ÷ 1 week ÷ 12 in ÷ 1 ft^3 = ______

Answer = $780

Example 3. A storage lake is being constructed with a surface area of 254,000 ft^2 and an average depth of 19 feet. Disregarding evaporation, how many inches of water could be applied to 42 acres of turf if all of the water in the lake were to be used for irrigation?

254,000 ft^2	19 ft		1 acre	12 in
		42 acres	43,560 ft^2	1 ft

This should be computed as 254,000 ft^2 × 19 feet × 1 acre × 12 in ÷ 42 acres ÷ 43,560ft^2 ÷ 1 ft = ______

Answer = 31.7 inches

How to Determine Irrigation Efficiency (Coefficient of Uniformity)

Two types of uniformity are typically calculated with irrigation systems: coefficient of uniformity and the distribution uniformity. Both calculations provide important information about the efficiency of the irrigation system. Compared to the coefficient of uniformity (CU), distribution uniformity (DU) typically weighs under-watering as a bigger problem than over-watering.

Coefficient of Uniformity (CU)

$$CU = 100 \times \left(1 - \frac{d}{\mu}\right)$$

Where:

d = average deviation from the mean
μ = average (mean) of the collections

Disadvantages of using CU:

- Averages collections over entire measured area and does not highlight problem areas (areas over-watered or under-watered)
- Weighs over-watering the same as under-watering

Use CU to determine if your irrigation system needs repair or if it is currently operating efficiently.

Step 1. Place eight or more (n) cups around a sprinkler head and collect water. Collect irrigation for at least 10 minutes. Uniformity is greatly influenced by wind. Collect samples at night or in the early morning under calm conditions.

Step 2. Calculate the average deviation.

Calculate the average deviation (d) using this formula:
$[|y_1 - \mu| + |y_2 - \mu| \ldots\ldots |y_n - \mu|] / (n)$, where y_1 = the collection from the first cup, μ = the average collection and $|y_1 - \mu|$= the absolute value of the difference between the collection cup and the average collection.

y_1 = the collection from the first cup
$|y_1 - \mu|$ = absolute value of the difference between collection cup and μ
μ = average (mean) of the collections

Step 3. Plug your calculated values into the formula.

$$CU = 100 \times \left(1 - \frac{d}{\mu}\right)$$

Step 4. If the % uniformity is less than 80%, then it is necessary to repair (adjust arc/radius, change nozzle, etc.) the irrigation system.

Distribution Uniformity (DU_{LQ})

The lower quarter distribution uniformity (DU) is the average water applied in the 25% of the area receiving the least amount of water, regardless of location within the irrigation pattern, divided by the average collection applied over the total area. The lower quarter distribution uniformity helps to determine how much additional irrigation should be applied to ensure the turf receives the desired amount. Most landscape irrigation systems have average DU between 55% and 75%, but many systems can be found with averages that are lower. Lower values indicate less uniform distribution and that areas are being under-watered.

$$DU = \left(\frac{\mu_{min}}{\mu}\right) \times 100$$

Where:

DU = Lower quarter distribution uniformity

$\mu_{(min)}$ = average of lower 25% of collections

μ = average (mean) of the collections

Use DU to determine if your irrigation system needs repair or if it is currently operating efficiently. More specifically, DU can be used to make sure areas are not being under-watered.

Step 1. Place eight or more (n) cups around a sprinkler head and collect water. Collect irrigation for at least 10 minutes. Uniformity is greatly influenced by wind. Collect samples at night or in the early morning under calm conditions.

Step 2. Calculate the average (μ).

Step 3. Calculate the average for the 25% of the total collections with the lowest volume ($\mu_{(min)}$). Multiply the total number of collection cups by 0.25 in order to determine how many cups represent 25% of the sample. For example, 8 cups multiplied by 0.25 = 2. Therefore, calculate the average for the 2 collection cups with the lowest volume.

Step 4. Plug your calculated values into the formula.

$$DU = \left(\frac{\mu_{min}}{\mu}\right) \times 100$$

Step 5. If the % uniformity is less than 55%, then it is necessary to adjust (adjust arc/radius, change nozzle, increase cycle time, etc.) the irrigation system.

Example 4. While evaluating the irrigation distribution of an area on a sports field, a manager collected water in 8 cups.

Step 1. The measurements he collected were:

90, 75, 100, 95, 100, 80, 75 and 105 mL in each, respectively.

Step 2. Calculate the average deviation.

Calculate the average deviation using this formula:
$[|y_1 - \mu| + |y_2 - \mu| \ldots\ldots |y_n - \mu|] / (n)$, where y_1 = the collection from the first cup, μ = the average collection, and $|y_1 - \mu|$ = the absolute value of the difference between the collection cup and the average collection.

The mean (μ, average) of the samples is 90.0, therefore

$$d = [|90\text{-}90| + |75\text{-}90| + |100\text{-}90| + |95\text{-}90| + |100\text{-}90| + |80\text{-}90| + |75\text{-}90| + |105\text{-}90|] / (8)$$

$$d = [0 + 15 + 10 + 5 + 10 + 10 + 15 + 15] / (8)$$

$$d = [80] / (8)$$

$$d = 10.0$$

Step 3. Plug your calculated values into the formula.

$$CU = 100 \times \left(1 - \frac{d}{\mu}\right)$$

$$CU = 100 \times \left(1 - \frac{10}{90}\right)$$

$$CU = 88.9\%$$

Step 4. Irrigation is uniform and efficient since CU is greater than 80%; therefore, no adjustment is needed.

Example 5. While evaluating the irrigation distribution of a lawn, a technician collected water in 8 cups.

Step 1. The measurements he collected were:

20, 60, 120, 40, 160, 80, 100, and 140 mL in each, respectively.
Step 2. Calculate the average (μ).

$\mu = [y_1 + y_2 + y_3 + y_4 + y_5 + y_6 + y_7 + y_8] / (n)$

$\mu = [20 + 60 + 120 + 40 + 160 + 80 + 100 + 140] / (8)$

$\mu = [720] / (8)$

$\mu = 90$

Step 3. Calculate the average for the 25% of the total collections with the lowest volume ($\mu_{(min)}$).

$\mu_{(min)} = [y_1 + y_2] / (n)$

$\mu_{(min)} = [20 + 40] / (2)$

$\mu_{(min)} = [60] / (2)$

$\mu_{(min)} = 30$

Step 4. Plug your calculated values into the formula.

$$DU = \left(\frac{\mu_{min}}{\mu}\right) \times 100$$

$$DU = \left(\frac{30}{90}\right) \times 100$$

$DU_{(LQ)} = 33.3\%$

Step 5. Since the $DU_{(LQ)}$ is less than 55%, then it is necessary to adjust (adjust arc/radius, change nozzle, increase cycle time, etc.) the irrigation system.

Problems (see page 103 for answers)

1 ft^3 of water is equal to 7.48 gallons of water

325,829 gallons of water in 1 acre-foot

27,152 gallons of water in 1 acre-inch

12. Twenty acres of turf are to be irrigated with 1.3 inches of water per week for 10 weeks of the season. The water is to be purchased from the city for 4 cents per cubic foot. How much money needs to be budgeted to purchase the water?

13. A storage lake has a surface area of 166,000 ft^2 and an average depth of 17 feet. Disregarding evaporation, how many inches of water could be applied to 14 acres of turf if all of the water in the lake were to be used for irrigation?

14. You irrigate 1.1 inches per week on your golf course. If your golf course has 62 acres of irrigated turf and if you irrigate 24 weeks of the year, how many gallons will you use each year?

15. Calculate the CU and $DU_{(LQ)}$ for the following example.

Step 1. While evaluating the irrigation distribution of an area of turfgrass, you collected water in 8 cups. The measurements you collected were:

225, 275, 150, 295, 210, 305, 100 and 280 mL in each, respectively.

$$CU = 100 \times \left(1 - \frac{d}{\mu}\right)$$

$$DU = \left(\frac{\mu_{min}}{\mu}\right) \times 100$$

Section

5

Seed Calculations

Learn how to interpret a seed label and calculate establishment problems.

S seed labels contain a great deal of information that is useful to the end user and can help in making important business decisions. Of the popular Arkansas lawn grasses, Kentucky bluegrass, tall fescue, bermudagrass, zoysiagrass and centipedegrass can all be established by seed. This chapter will teach you much more about seed labels, calculating pure live seed, establishment costs, seed counts and seed costs.

Figure 5.1 Unhulled bermudagrass seed.

The Seed Label

When purchasing turfgrass seed, it is important to read the label to determine the kind, amount and quality of seed in the package. All seed sold in Arkansas and most other states is required by law to bear a tag or label indicating basic information about the quality of the seed. The basic information that should appear on the label is as follows:

1. Name and address of labeler
2. Lot number
3. Kind and variety/cultivar of turfgrass seed listed in order of predominance
4. Percent by weight of pure seed of each species and variety (percent purity)
5. Germination percentage (percent viable seed)
6. Percent by weight of other crop seed
7. Percent by weight of weed seed
8. Percent undesirable grass seed
9. Percent by weight of inert matter
10. Date on which the germination test was conducted

Arkansas Premium Sunny Lawn Mixture
Ozark Seed Co.

Pure Seed	Germ.	Origin
22.82 % **L'Anguille Tall Fescue**	85 %	Oregon
32.10 % **Strawberry Tall Fescue**	83 %	Iowa
31.09 % **Buffalo Tall Fescue**	85 %	Montana
10.94 % **King Kentucky bluegrass**	90 %	Oregon

Other Ingredients
0.02 % Crop Seed
0.20 % Weed Seed — Noxious Weeds: None
2.01 % Inert Matter

Test Date: February 2005
Lot # 22-OR-661

Figure 5.2 Sample seed label.

Table 5.1. Suggested minimum standards for a quality turfgrass seed label.

Label Property	Preferred Range
Purity	> 90%
Germination	> 80%
Other crop	< 0.5%
Weed seed	< 0.3%
Noxious weeds	None
Inert matter	< 8%
Date tested	Within the last 9 months

Table 5.2. Suggested minimum standards for a percent purity[1] and percent germination of several major turfgrass species.

Turfgrass species	% Purity[1]	% Germination
Kentucky bluegrass	90	80
Perennial ryegrass	95	85
Tall fescue	95	80
Fine fescues[2]	95	80
Creeping bentgrass[3]	99	85
Bermudagrass[3]	98	85
Zoysiagrass[3]	98	85
Centipedegrass[3]	98	85

[1] Percent purity is based on one variety of the designated species in the container. Often, more than one species and/or variety will be included in the seed container. In this case, the % purity will reflect the proportion of each species and/or variety in the mixture or blend. The total should be equal to or greater than 95%.

[2] Fine fescues include creeping red fescue, Chewings fescue, hard fescue and sheep fescue.

[3] These seeds may have a seed coating containing fertilizer, fungicide or other products to improve handling, germination and establishment. This coating decreases the number of pure live seeds per pound by dramatically lowering purity to 40% or more.

Table 5.3. Seed count and rate information

Turfgrass species	Seeds per pound	Recommended seeding rate (lb/1,000 ft^2)[1]
Annual ryegrass	200,000	7-10
Tall fescue	200,000	7-9
Perennial ryegrass	250,000	6-8
Fine fescues	500,000	4-5
Kentucky bluegrass	1,500,000	1-2
Rough bluegrass	3,000,000	1-2
Creeping bentgrass	6,500,000	0.5-1.0
Bermudagrass (hulled)	2,900,000	0.5-1.0
Bermudagrass (unhulled)	1,700,000	0.5-1.0
Bermudagrass (coated)	725,000	1.0-2.0
Centipedegrass	650,000	0.25-0.5
Zoysiagrass	1,250,000	1-2

[1] Seeding rate is based on seed size, seed number per square foot, plant size and plant growth habit.

Seed Calculations

Calculating seed is important whether you are establishing an area for the first time, renovating an existing area or even overseeding a warm-season species for winter color and play. Determining the percentage of pure live seed (PLS) in a seed sample is one of the more useful seed calculations. PLS is defined as the pure seed in the lot that can be expected to germinate under strict laboratory germination test conditions. It is calculated simply by multiplying the purity listed on the label by the percent germination.

Ouachita Seed Co.
Pencil Bluff, Ark.

Kind: Pennlinks Bentgrass
Lot#: D2AA

Purity: 99.10%
Other crop: 0.00%
Inert matter: 0.90%
Weed seed: 0.00%
Noxious weed seed: 0.00%
Germination 87%
Tested 7/01
Cost: $8.90/lb

Figure 5.3 Sample seed label for Ouachita Seed Co.

Example 1: A seed lot (Fig 5.3) with 99.1% pure seed and 87% germination would have a PLS percentage of:

$$(0.991) \times (0.87) = 0.862$$

This seed lot contains 86.2% PLS.

If this seed lot contains 86.2% PLS and the lot weighs 50 lb, the actual weight of PLS in the 50-lb bag is:

$$(50 \text{ lb}) \times (0.862) = 43.1 \text{ lb PLS}$$

Sometimes a seed lot may have more than one species (mixture), each with a different purity and germination.

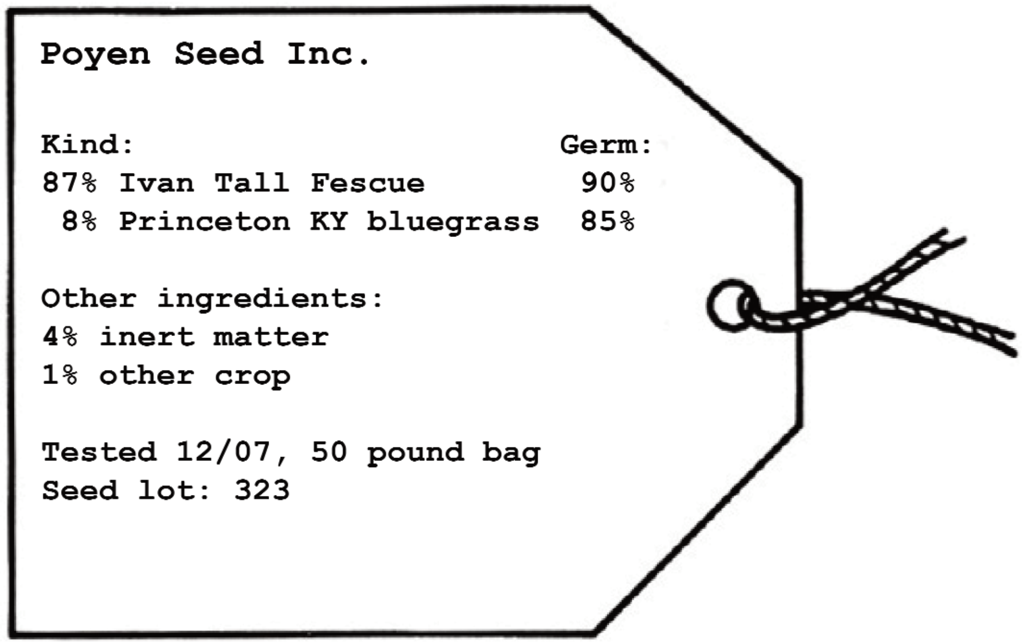


Figure 5.4 Sample seed label for Poyen Seed Inc.

Example 2: Calculating the PLS of a seed mixture (Fig. 5.4).

First, determine the PLS for tall fescue:

(0.87) × (0.90) = 78.3 % pure 'Ivan' Tall fescue

(0.783) × 50 lb bag = 39.15 lb of pure live 'Ivan' tall fescue seed in this 50-lb bag

Second, determine the PLS for Kentucky bluegrass:

(0.08) × (0.85) = 6.8% pure 'Princeton' Kentucky bluegrass

(0.068) × 50 lb bag = 3.4 lb of pure live 'Princeton' Kentucky bluegrass seed in this 50-lb bag

Lastly, add the two together for the total pure live seed in the 50-lb bag:

39.15 lb + 3.4 lb = 42.55 lb of pure live seed in this 50-lb bag

A seed lot may have more than one variety (blend), each with a different purity and germination.

Arkansas Premium Sunny Lawn Mixture
Ozark Seed Co.

Pure Seed	Germ.	Origin
22.82 % **L'Anguille Tall Fescue**	85 %	Oregon
32.10 % **Strawberry Tall Fescue**	83 %	Iowa
31.09 % **Buffalo Tall Fescue**	85 %	Montana
10.94 % **Piney Tall Fescue**	90 %	Oregon

Other Ingredients
0.02 % Crop Seed
0.20 % Weed Seed — Noxious Weeds: None
2.01 % Inert Matter

Test Date: February 2005
Lot # 22-OR-661 — 50 pound bag

Figure 5.5 Sample seed label for Ozark Seed Co.

Example 3. To calculate the PLS in this seed lot (Fig. 5.5), use the same procedure as in example 2. *Show your work below.* Answer = PLS = 82.3%.

Cost Calculations

Example 4. Calculate the PLS.

(0.97) × (0.87) = 84.4% pure live 'Zealot' zoysiagrass seed (Fig. 5.6)

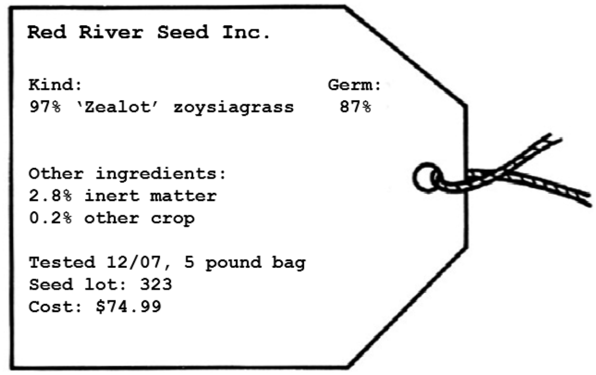


Figure 5.6 Sample seed label for Red River Seed Inc.

Example 5. Calculating the cost per pound of seed.

\$74.99	1 lb seed
5 lb seed	

This should be computed as \$74.99 × 1 lb ÷ 5 lb = ______

Answer = \$15.00

Example 6. Calculate the cost per pound of pure live seed.

\$74.99	1 lb seed
5 lb seed	0.844 lb PLS

This should be computed as \$74.99 × 1 lb ÷ 5 lb ÷ 0.844 lb PLS = ______

Answer = \$17.77 / lb PLS

Example 7. Calculate the amount of seed needed to seed 2.0 lb PLS/1,000 ft^2?

General formula

Seeding rate	1 lb seed	Area
1,000 ft^2	PLS	

2.0 lb PLS	1 lb seed	1,000 ft^2
1,000 ft^2	0.844 lb PLS	

This should be computed as 2.0 lb PLS × 1 lb × 1,000 ft^2 ÷ 1,000 ft^2 ÷ 0.844 lb PLS = ______

Answer = 2.37 lb seed

Example 8. Calculate the cost to seed a 4,000 ft^2 lawn with 1.0 lb PLS/1,000 ft^2 using the information from the above seed lot.

General formula

Seeding rate	1 lb seed	Area	\$ Cost
1,000 ft^2	PLS		lb seed

1.0 lb PLS	1 lb seed	4,000 ft^2	\$74.99
1,000 ft^2	0.844 lb PLS		5 lb seed

This should be computed as 1.0 lb PLS × 1 lb seed × 4,000 ft^2 × \$74.99 ÷ 1,000 ft^2 ÷ 0.844 lb PLS ÷ 5 lb seed = ______

Answer = \$71.08

Seeds Per Pound in a Mixture

Turfgrass seeds vary considerably in size and weight. A pound of ryegrass contains about 250,000 seeds per pound, whereas a pound of Penncross creeping bentgrass contains more than 6.5 million seeds. Therefore, a more accurate description of a seed package could be given by listing turfgrass seeds by seed count rather than weight. As a buyer, it is always helpful to consider seed count when analyzing a seed label. This hypothetical example illustrates this point.

Example 9. A seed mixture contains 65% Kentucky bluegrass, 22% fine fescue and 10% creeping bentgrass by weight. Since the bentgrass is in such a small proportion, this would seem to be a reasonably good mixture for a shady site. However, by calculating actual seed count, a pound of this mixture would contain 981,150 Kentucky bluegrass seeds, 682,500 creeping bentgrass seeds and 111,150 fine fescue seeds. In other words, the creeping bentgrass actually comprises more than 1/3 of the mixture and will probably be a substantial component of the resultant mature stand.

Step 1. Read and decipher the label:

```
              Sample Seed Mixture
                                              Germ.
Purity
65.41 % Common Kentucky bluegrass             85 %
22.23 % Chewings fescue                       80 %
10.50 % Bentgrass                             80 %

Other Ingredients
0.24 % Crop Seed
0.17 % Weed Seed
       (1,000 Poa annua seeds/lb.)
1.45 % Inert Matter
```

Figure 5.7 Sample seed label.

Step 2. Multiply purity percentages by the number of seeds per pound of each variety to find the number of seeds per pound in the mixture.

Turfgrass Species	Purity		Total Seeds per Pound		Seeds per Pound in Mixture
Kentucky bluegrass	0.6541	×	1,500,000	=	981,150
Chewings fescue	0.2223	×	500,000	=	111,150
Creeping bentgrass	0.1050	×	6,500,000	=	682,500

Step 3. Add all seeds of each species to find the total number of seeds per pound in the mixture.

Turfgrass Species	Seeds per Pound in Mixture
Kentucky bluegrass	981,150
Chewings fescue	111,150
Creeping bentgrass	682,500
Total number of seeds per pound	1,774,800

Step 4. Determine the actual percentage of the seeds in the mixture.

Turfgrass Species	Number of Seeds		Total Seeds per Pound		Percentage Seeds per Pound by Count*
Kentucky bluegrass	981,150	/	1,774,800	=	55.28%
Chewings fescue	111,150	/	1,774,800	=	6.26%
Creeping bentgrass	682,500	/	1,774,800	=	38.46%

* Be sure to multiply your answer by 100 to get the actual % and not a decimal.

Example 10. Cost Comparisons

Often, seed that is low in purity and germination is sold at a reduced price. One way of determining if the reduced price is really a bargain is to use PLS. A comparison of two seed lots is provided as an example.

Seedlot A
(sold at 'reduced' price of $0.99 per lb):

PLS = [(Purity) × (Germination)] × 100

PLS = [(0.85) × (0.60)] × 100 = 51%

Cost per pound/pounds PLS in one pound of seed

Cost per pound of PLS = $0.99 / 0.51 = $1.94

Seedlot B
(sold at regular price of $1.65 per lb):

PLS = [(Purity) × (Germination)] × 100

PLS = [(0.99) × (0.90)] × 100 = 89.1%

Cost per pound/pounds PLS in one pound of seed

Cost per pound of PLS = $1.65 / 0.891 = $1.85

A comparison of actual cost per pound of pure, viable seed reveals that the seed that appeared to be a bargain was actually more expensive.

Problems (see page 103 for answers)

16. Calculate the PLS of the seed label.

Figure 5.8 Hog Seed Co. sample seed label.

17. You want to seed 50,000 ft^2 of lawn using this seed lot at a rate of 2.0 lb of PLS/1,000 ft^2. How much seed should you purchase?

18. How much does 1 lb of PLS cost?

19. How much will it cost to seed the lawn described in Practice Problem 17 (previous page)?

20. Using the Hog Seed Co. label, calculate the percentage of seeds per pound by seed count for each species. It is known that there are approximately 500,000 seeds of creeping red fescue per pound, 250,000 seeds of perennial ryegrass per pound and 1,500,000 seeds of Kentucky bluegrass per pound, respectively.

21. Determine which of the two seed lots (ASU Seed Co. and Razorback Seed, Inc.) below would be the best buy.

Figure 5.9 ASU and Razorback sample seed labels.

Section

6

Fertilizer Calculations

Calculate fertilizer quantities and cost.

The calculations involved in the application of fertilizers are a necessary part of any turf manager's job. They are a critical part of the budgeting process and play an important role in everyday management practices. The first step in comprehending fertilizer calculations is to understand some of the terminology associated with fertilizer materials.

Figure 6.1 Application of fertilizer using a ride-on spreader/sprayer.

Acre or 1,000 ft^2

Fertilizer and pesticide calculations are often expressed as the amount needed per acre or per 1,000 ft^2. It is important to keep in mind which area we are dealing with when calculating our fertilizer or pesticide needs.

1 acre = 43,560 ft^2

For example: 20,000 ft^2 is equivalent to 0.46 acres (20,000 ft^2 / 43,560 ft^2)

or

0.79 acres is equivalent to 34,412 ft^2 (0.79 × 43,560 ft^2)

N, P_2O_5, K_2O

Remember that the analysis on a fertilizer bag expresses the nutrients as total N, available P_2O_5 and soluble K_2O. However, a soil test might ask for 200 pounds of P to be applied per acre, rather than asking for a quantity of P_2O_5. Therefore, it is important to understand how to convert from P_2O_5 to P, K_2O to K, or vice versa. NOTE: Turfgrass soil samples tested at the University of Arkansas will provide recommendations on the amount of N, P_2O_5 and K_2O recommended per 1,000 ft^2.

P_2O_5 contains 44% P (molecular weight of P/molecular weight of P_2O_5)

K_2O contains 83% K (molecular weight of K/molecular weight of K_2O)

For example: A fertilizer with a 12-12-12 analysis contains

12% total nitrogen

12% available P_2O_5 = 5.3% available P (12% × 0.44 = 5.3%)

12% soluble K_2O = 10% soluble K (12% × 0.83 = 10%)

Fertilizer Applications

How much fertilizer is needed to fertilize an area at a given rate?

General formula

Rate	1 lb fertilizer	Area to be treated
1,000 ft^2	Analysis	

Example 1. How much 20-4-12 is needed to apply 1.0 lb N/1,000 ft^2 to a 1,000 ft^2 lawn?

1.0 lb N	1 lb fertilizer	1,000 ft^2
1,000 ft^2	0.2 lb N	

This should be computed as 1.0 lb N × 1 lb fertilizer × 1,000 ft^2 ÷ 1,000 ft^2 ÷ 0.2 lb N = ________

Answer = 5.0 lb 20-4-12 fertilizer

Example 2. How much 46-0-0 is needed to apply 0.75 lb N/1,000 ft^2 to a 5,000 ft^2 lawn?

0.75 lb N	1 lb fertilizer	5,000 ft^2
1,000 ft^2	0.46 lb N	

This should be computed as 0.75 lb N × 1 lb fertilizer × 5,000 ft^2 ÷ 1,000 ft^2 ÷ 0.46 lb N = ________

Answer = 8.2 lb 46-0-0 fertilizer

Example 3. How much 8-22-10 is needed to apply 1.0 lb P_2O_5/1,000 ft^2 to a 5,000 ft^2 lawn?

1.0 lb P_2O_5	1 lb fertilizer	5,000 ft^2
1,000 ft^2	0.22 lb P_2O_5	

This should be computed as 1.0 lb P_2O_5 × 1 lb fertilizer × 5,000 ft^2 ÷ 1,000 ft^2 ÷ 0.22 lb P_2O_5 = ________

Answer = 22.7 lb 8-22-10 fertilizer is needed to apply 1.0 lb P_2O_5/1,000 ft^2

Example 4. How much 8-22-10 is needed to apply 1.0 lb P/1,000 ft^2 to a 5,000 ft^2 lawn?

1.0 lb P	1 lb fertilizer	1.0 lb P_2O_5	5,000 ft^2
1,000 ft^2	0.22 lb P_2O_5	0.44 lb P	

This should be computed as 1.0 lb P × 1 lb fertilizer × 1.0 lb P_2O_5 × 5,000 ft^2 ÷ 1,000 ft^2 ÷ 0.22 lb P_2O_5 ÷ 0.44 lb P = ________

Answer = 51.7 lb 8-22-10 fertilizer is needed to apply 1.0 lb P/1,000 ft^2

Example 5. How much 32-4-5 is needed to apply 0.8 lb N/1,000 ft^2 to a 4.3-acre lawn?

0.8 lb N	1 lb fertilizer	4.3 acres	43,560 ft^2
1,000 ft^2	0.32 lb N		1 acre

This should be computed as 0.8 lb N × 1 lb fertilizer × 4.3 acres × 43,560 ft^2 ÷ 1,000 ft^2 ÷ 0.32 lb N ÷ 1 acre = ________

Answer = 468 lb 32-4-5 fertilizer

How Much of Each Nutrient Was Applied?

Let's say that you were sent out by the superintendent to apply 0.5 pounds of N/1,000 ft^2 to the fifth green, which is 7,000 ft^2, using a 12-4-5 fertilizer. Let's say that after you finished fertilizing the green, you determined that you had used up 42 pounds of the 12-4-5 fertilizer. How much did you actually apply?

General formula

lb fertilizer applied	Analysis	1,000 ft^2
Total area (ft^2)	1 lb fertilizer	

Example 6. At what rate did you actually apply the 12-4-5 in the illustration above?

42 lb fertilizer	0.12 lb N	1,000 ft^2
7,000 ft^2	1 lb fertilizer	

This should be computed as 42 lb fertilizer × 0.12 lb N × 1,000 ft^2 ÷ 7,000 ft^2 ÷ 1 lb fertilizer = _________

Answer = 0.72 lb N/1,000 ft^2

Cost of Application in Price Per Pound of Nutrient

General formula

Cost	1 lb fertilizer
Amount	Analysis

Example 7. What is the cost per pound of N for a 50-pound bag of urea (46-0-0) that costs $16.99?

$16.99	1 lb fertilizer
50 lb fertilizer	0.46 lb N

This should be computed as $16.99 × 1 lb fertilizer ÷ 50 lb fertilizer ÷ 0.46 lb N = _________

Answer = $0.74 per pound of nitrogen

Example 8. Two fertilizers are available at Wal-Mart. Calculate which fertilizer is the best buy according to its price per pound of nitrogen.

Fertilizer 1: Scotts Turf Builder (48-pound bag of 29-3-4)

$27.50	1 lb fertilizer
48 lb fertilizer	0.29 lb N

This should be computed as $27.50 × 1 lb fertilizer ÷ 48 lb fertilizer ÷ 0.29 lb N =

____

Answer = $1.98 per pound of nitrogen

Fertilizer 2: Sam's Choice Lawn (46-pound bag of 29-3-4)

$19.50	1 lb fertilizer
46 lb fertilizer	0.29 lb N

This should be computed as $19.50 × 1 lb fertilizer ÷ 46 lb fertilizer ÷ 0.29 lb N =

____

Answer = $1.46 per pound of nitrogen

Fertilizer 2: Sam's Choice Lawn is the best buy per pound of nitrogen

Liquid Fertilizers

The analysis on a liquid fertilizer has the same meaning as the analysis on a dry fertilizer. However, one extra step is necessary in order to determine the amount of fertilizer needed. Liquid fertilizers are usually sold in gallons. Each gallon of liquid fertilizer may have a different weight, and the weight is always over 8.3 pounds, which is the weight of one gallon of water. Liquid fertilizer weighs more than water because it has minerals (fertilizer) dissolved in it. To determine how many pounds of N, P_2O_5 and K_2O are in one gallon of fertilizer, we must multiply the weight of the fertilizer times its analysis. To illustrate this point, let us look at a common over-the-counter liquid fertilizer.

How much fertilizer is needed to fertilize an area at a given rate?

General formula – liquid

Step 1. Determine how many pounds of nitrogen are in each gallon of fertilizer.

fertilizer weight	N analysis
1 gallon	1 lb fertilizer

Step 2. Determine how much fertilizer is needed to fertilize an area at a given rate.

Rate	1 gallon fertilizer	Area to be treated
1,000 ft^2	Analysis	

Example 9. Progressive Turf, Turf Foundation liquid fertilizer

Analysis: 10-3-5

Size: 128 fluid ounces (1 gallon)

Weight: 12.00 pounds

12 lb fertilizer	0.10 lb N
1 gallon	1 lb fertilizer

This should be computed as 12.0 lb fertilizer × 0.1 lb N ÷ 1 gallon ÷ 1 lb fertilizer = ________

Answer = 1.2 lb N/gallon

Figure 6.2 Liquid fertilizer with 10-3-5 analysis.

Using similar math, we can determine that in one gallon of this same liquid fertilizer there are 0.36 lb P_2O_5/gallon and 0.60 lb K_2O/gallon.

Example 10. Using this liquid fertilizer, how many gallons would be required to fertilize 6,000 ft^2 of creeping bentgrass at a rate of 0.3 lb/1,000 ft^2?

0.3 lb N	1 gallon	6,000 ft^2
1,000 ft^2	1.2 lb N	

This should be computed as 0.3 lb N × 1 gallon × 6,000 ft^2 ÷ 1,000 ft^2 ÷ 1.2 lb N = ________

Answer = 1.5 gallons of 10-3-5 liquid fertilizer

Using a Spreadsheet to Calculate Fertilizer Needs

In addition to calculating fertilizer math problems by hand, computer spreadsheets can also be a useful tool for calculating your fertilizer needs. Using spreadsheet software programs such as Microsoft Excel will allow managers to more rapidly calculate various problems. Figure 6.3 provides step-by-step instructions for calculating

- the amount of fertilizer needed per acre (depending on rate)
- the cost per pound of nitrogen
- the cost to fertilize an acre

This spreadsheet can be used to compare products and make purchasing decisions. It is possible to compare a couple of products or hundreds of products using spreadsheets.

When creating these spreadsheets, always check your spreadsheet answers with hand calculated answers.

This is just one example of how a spreadsheet can be used to help make purchasing decisions. Spreadsheets like this can be customized in order to calculate specific fertilizer problems relevant to your company's needs.

Step 1. Enter fertilizer information

	A	B	C	D	E	F	G	H	I
1	***FERTILIZERS***	**WIN**	**N**	**lb N/1000**	**lbs/bag**	**lbs/Acre**	**Cost/bag**	**Cost/lb N**	**Cost/Acre**
2	Urea - Plant Food	0.00	0.46	1	50		$9.00		
3	Scotts Turf Builder	0.27	0.29	1	48		$27.50		

Step 2. Calculate lbs of fertilizer needed per acre to deliver 1 pound N per 1000 square feet

	A	B	C	D	E	F	G	H	I
1	***FERTILIZERS***	**WIN**	**N**	**lb N/1000**	**lbs/bag**	**lbs/Acre**	**Cost/bag**	**Cost/lb N**	**Cost/Acre**
2	Urea - Plant Food	0.00	0.46	1	50		$9.00		
3	Scotts Turf Builder	0.27	0.29	1	48		$27.50		

Type "=D2/C2*43.56" in this box. Multiplying by 43.56 changes area to Acres

Drag formula down by clicking on cell **F2** and then selecting the lower right edge of the cell (+) and dragging downwards.

Step 3. Calculate cost per pound of nitrogen for each fertilizer

	A	B	C	D	E	F	G	H	I
1	***FERTILIZERS***	**WIN**	**N**	**lb N/1000**	**lbs/bag**	**lbs/Acre**	**Cost/bag**	**Cost/lb N**	**Cost/Acre**
2	Urea - Plant Food	0.00	0.46	1	50	95	$9.00		
3	Scotts Turf Builder	0.27	0.29	1	48	150	$27.50		

Type "=G2/(E2*C2)" in this box

Drag formula as described above.

Step 4. Calculate cost per acre for an application at the rate of 1 pound of N per 1000 square feet

	A	B	C	D	E	F	G	H	I
1	***FERTILIZERS***	**WIN**	**N**	**lb N/1000**	**lbs/bag**	**lbs/Acre**	**Cost/bag**	**Cost/lb N**	**Cost/Acre**
2	Urea - Plant Food	0.00	0.46	1	50	95	$9.00	$0.39	
3	Scotts Turf Builder	0.27	0.29	1	48	150	$27.50	$1.98	

Type "=F2/E2*G2" in this box

Drag formula as described above.

Step 5. Choose product based on cost per acre

	A	B	C	D	E	F	G	H	I
1	***FERTILIZERS***	**WIN**	**N**	**lb N/1000**	**lbs/bag**	**lbs/Acre**	**Cost/bag**	**Cost/lb N**	**Cost/Acre**
2	Urea - Plant Food	0.00	0.46	1	50	95	$9.00	$0.39	$17.05
3	Scotts Turf Builder	0.27	0.29	1	48	150	$27.50	$1.98	$86.06

Figure 6.3 How to create a fertilizer price list with Microsoft Excel.

Problems (see page 103 for answers)

2 pints	=	1 quart	1 pound	=	454 g
4 quarts	=	1 gallon	1 yard	=	3 ft
1 gallon	=	128 ounces	1 mile	=	5,280 ft
1 gallon	=	3,785 ml	1 acre	=	43,560 ft^2
1 gallon	=	8 pounds	P_2O_5	is	44% P
1 pound	=	16 ounces	K_2O	is	83% K
1 ton	=	2,000 pounds	1 gallon	=	3.785 liters

22. How many ft^2 are there in 0.7 acres?

23. How many acres are there in 88,000 ft^2?

24. How much actual N, P_2O_5 and K_2O is in a 50-lb bag of 16-0-0?

25. How much 12-24-6 is needed to apply 1.0 lb P/1,000 ft^2?

26. How much 31-0-0 is needed to apply 0.5 lb N/1,000 ft^2?

27. How much 12-12-12 is needed to apply 1.0 lb P_2O_5/1,000 ft^2?

28. Apply a 24-8-12 fertilizer at 1.0 lb N/1,000 ft^2 to a 9,200 ft^2 lawn. How much fertilizer do you need?

29. Apply an 18-4-24 fertilizer at 0.7 lb N/1,000 ft^2 to 23 acres at the local Electrical Co-op. How much fertilizer do you need?

30. Apply a 8-22-14 starter fertilizer at 1.0 lb P_2O_5/1,000 ft^2 to 1.3 acres of newly seeded lawn. How much fertilizer do you need?

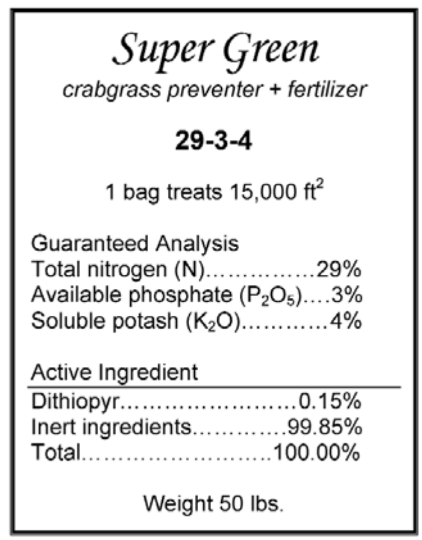
31. A 50-lb bag of 22-0-22 fertilizer costs \$28, whereas a 40-lb bag of 20-0-20 costs \$18.99. Assuming both fertilizers meet your need, which is the better buy?

32. A ton of 20-4-10 fertilizer plus micronutrients costs \$899. What is the cost per lb N?

33. A 20-4-10 liquid fertilizer weighs 10.8 lb per gallon. How much N, P_2O_5 and K_2O are in one gallon?

34. Using the 20-4-10 liquid fertilizer from the question above, how many gallons of fertilizer would be needed to apply 0.2 lb N/1,000 ft^2 to 97,000 ft^2 of turf on a baseball field?

35. You wish to fertilize your one-acre home lawn with Super Green crabgrass preventer + fertilizer. Using the information on the bag, calculate how much nitrogen would be applied per 1,000 ft^2 using this product?


Super Green
crabgrass preventer + fertilizer

29-3-4

1 bag treats 15,000 ft^2

Guaranteed Analysis
Total nitrogen (N)……………29%
Available phosphate (P_2O_5)….3%
Soluble potash (K_2O)…………4%

Active Ingredient
Dithiopyr……………………0.15%
Inert ingredients…………99.85%
Total……………………….100.00%

Weight 50 lbs.

36. After fertilizing your lawn, you determine that you applied 76 lb of fertilizer to 12,000 ft^2. If you were using a 22-8-12 fertilizer, how many pounds of N did you apply per 1,000 ft^2?

Section

7

Pesticide Calculations

Calculating pesticide quantities and cost

Proper application of pesticides is crucial to turfgrass health and environmental stewardship. Pesticides are also a critical part of the budgeting process and much of the overall budget of a golf course. Before we discuss calculations, we first need to discuss pesticide labels and the different formulations and units of pesticides.

Figure 7.1 Pesticides being applied to a golf course green.

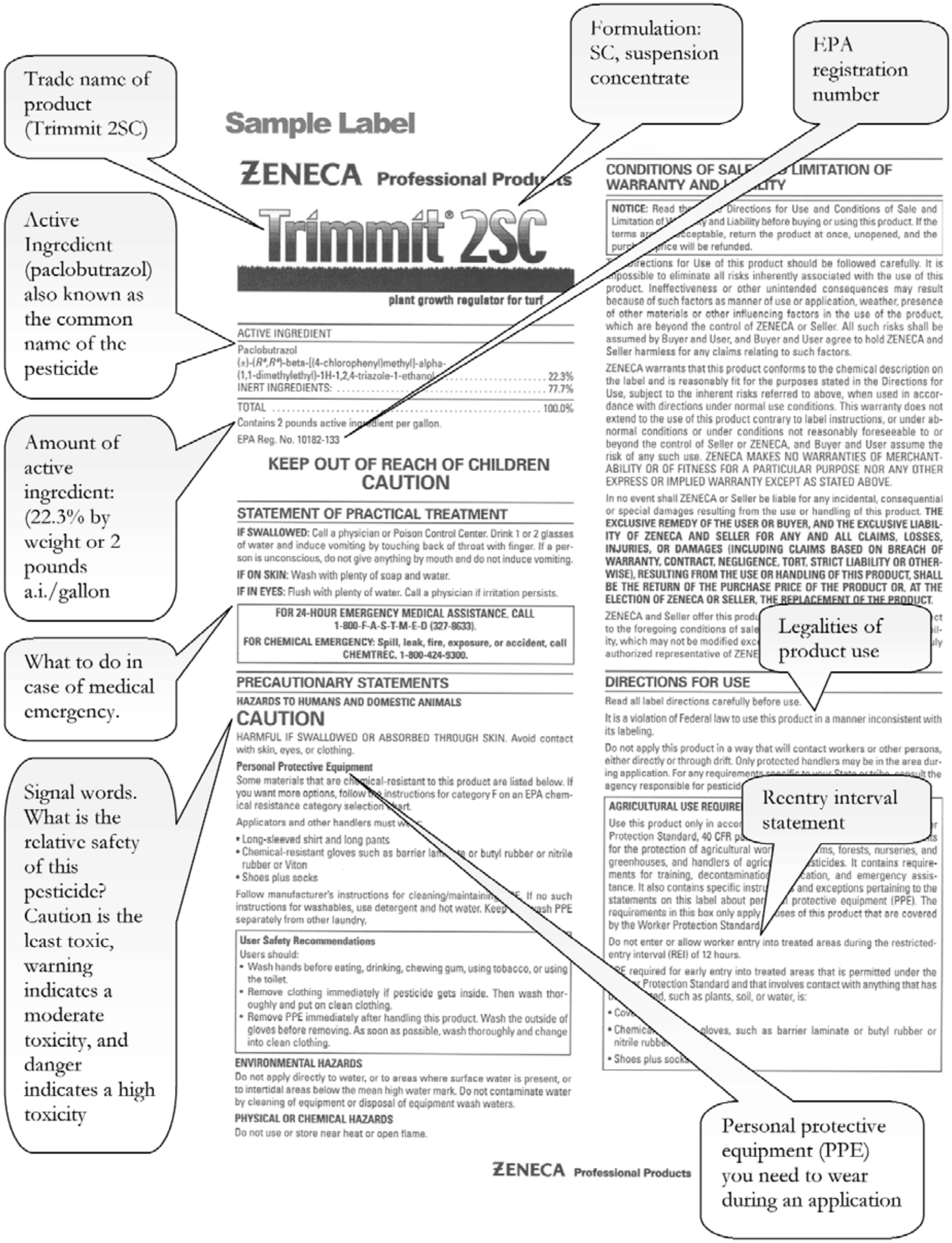
What's on a Pesticide Label?

By federal law, specific information must appear on a pesticide label. The Environmental Protection Agency (EPA) in the United States requires manufacturers to provide specific information on the pesticide label.

The information includes:

1. Brand name or trade name of the product
2. Ingredient statement
3. Percentage or amount of active ingredient(s) by weight
4. Net contents of the container
5. Name and address of the manufacturer
6, Registration and establishment numbers
7. Signal words and symbol
8. Precautionary statements
9. Statement of practical treatment
10. General information
11. Directions for use
12. Reentry statement as necessary
13. Storage and disposal statement

Sample Label



Sample Label

ZENECA Professional Products

Trimmit® 2SC

plant growth regulator for turf

ACTIVE INGREDIENT

Paclobutrazol
(±)-(R*,R*)-beta-[(4-chlorophenyl)methyl]-alpha-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol 22.3%
INERT INGREDIENTS: 77.7%
TOTAL 100.0%

Contains 2 pounds active ingredient per gallon.

EPA Reg. No. 10182-133

KEEP OUT OF REACH OF CHILDREN
CAUTION

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED: Call a physician or Poison Control Center. Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. If a person is unconscious, do not give anything by mouth and do not induce vomiting.

IF ON SKIN: Wash with plenty of soap and water.

IF IN EYES: Flush with plenty of water. Call a physician if irritation persists.

FOR 24-HOUR EMERGENCY MEDICAL ASSISTANCE, CALL 1-800-F-A-S-T-M-E-D (327-8633).

FOR CHEMICAL EMERGENCY: Spill, leak, fire, exposure, or accident, call CHEMTREC, 1-800-424-9300.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION

HARMFUL IF SWALLOWED OR ABSORBED THROUGH SKIN. Avoid contact with skin, eyes, or clothing.

Personal Protective Equipment

Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category F on an EPA chemical resistance category selection chart.

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves such as barrier laminate or butyl rubber or nitrile rubber or Viton
- Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water by cleaning of equipment or disposal of equipment wash waters.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame.

CONDITIONS OF SALE AND LIMITATION OF WARRANTY AND LIABILITY

NOTICE: Read the entire Directions for Use and Conditions of Sale and Limitation of Warranty and Liability before buying or using this product. If the terms are not acceptable, return the product at once, unopened, and the purchase price will be refunded.

The Directions for Use of this product should be followed carefully. It is impossible to eliminate all risks inherently associated with the use of this product. Ineffectiveness or other unintended consequences may result because of such factors as manner of use or application, weather, presence of other materials or other influencing factors in the use of the product, which are beyond the control of ZENECA or Seller. All such risks shall be assumed by Buyer and User, and Buyer and User agree to hold ZENECA and Seller harmless for any claims relating to such factors.

ZENECA warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated in the Directions for Use, subject to the inherent risks referred to above, when used in accordance with directions under normal use conditions. This warranty does not extend to the use of this product contrary to label instructions, or under abnormal conditions or under conditions not reasonably foreseeable to or beyond the control of Seller or ZENECA, and Buyer and User assume the risk of any such use. ZENECA MAKES NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESS OR IMPLIED WARRANTY EXCEPT AS STATED ABOVE.

In no event shall ZENECA or Seller be liable for any incidental, consequential or special damages resulting from the use or handling of this product. **THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE EXCLUSIVE LIABILITY OF ZENECA AND SELLER FOR ANY AND ALL CLAIMS, LOSSES, INJURIES, OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OF WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE), RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, SHALL BE THE RETURN OF THE PURCHASE PRICE OF THE PRODUCT OR, AT THE ELECTION OF ZENECA OR SELLER, THE REPLACEMENT OF THE PRODUCT.**

ZENECA and Seller offer this produ... ct to the foregoing conditions of sale ... bility, which may not be modified exc... uly authorized representative of ZENE...

DIRECTIONS FOR USE

Read all label directions carefully before use.

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements ... consult the agency responsible for pesticid...

AGRICULTURAL USE REQUIRE...

Use this product only in accor... Protection Standard, 40 CFR pa... for the protection of agricultural wor... ms, forests, nurseries, and greenhouses, and handlers of agric... sticides. It contains requirements for training, decontaminatio... cation, and emergency assistance. It also contains specific instru... and exceptions pertaining to the statements on this label about per... protective equipment (PPE). The requirements in this box only apply ... uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 12 hours.

...E required for early entry into treated areas that is permitted under the ... Protection Standard and that involves contact with anything that has ...ed, such as plants, soil, or water, is:

- Cove...
- Chemica... gloves, such as barrier laminate or butyl rubber or nitrile rubbe...
- Shoes plus socks

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Figure 7.2 Sample pesticide label – Part 1.

Directions for proper storage and disposal of product

STORAGE AND DISPOSAL

PROHIBITIONS: Do not contaminate water, food, or feed by storage and disposal. Open dumping is prohibited. Do not reuse empty container.

STORAGE: Keep container closed when not in use. Do not store near food or feed. Protect from freezing. In case of spill or leak on floor or paved surfaces, soak up with sand, earth, or synthetic absorbent. Remove to chemical waste area.

PESTICIDE DISPOSAL: Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL: Triple rinse (or equivalent); then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

GENERAL INFORMATION

TRIMMIT® 2SC is a plant growth regulator for turfgrass that slows grass growth for up to 2 months after application. The frequency of mowing can be reduced by up to 50% during the period of effective retardation. Used alone, TRIMMIT 2SC will not prevent seedhead production, and tank mixture for a spray program using an appropriate seedhead control agent (Embark®) is required in situations where seedhead visibility is a problem. Use of TRIMMIT 2SC on fine turf should be accompanied by moderate-to-high fertility to maintain turfgrass appearance and reduce discoloration. Some grasses (e.g., *Poa annua*) can be more retarded than others leading to selective control after prolonged use.

What Applications of TRIMMIT 2SC to Turfgrasses Provide:

- Slowed vertical growth and reduced mowing for 6 to 8 weeks on established hybrid bermudagrass, bentgrass and perennial ryegrass fairways, tees and roughs, and on St. Augustinegrass and Kentucky bluegrass/perennial ryegrass turf areas (use reduced rates on bentgrass and overseeded bermudagrass greens).
- Improved and extended fertilizer performance for up to 12 weeks when combined with a nitrogen fertilizer while improving turfgrass quality versus fertilizer alone.
- Reduced potential for scalping of all turfgrass areas.
- Better ball playability on hybrid bermudagrass due to increased turf density and tighter-knit turf areas.
- Suppression of *Poa annua* by reducing its growth and competitive ability.

When to Use for Growth Suppression of Warm Season Grasses:

Use anytime when established hybrid bermudagrass and St. Augustinegrass are green, actively growing, and have recovered from dormancy (filled in fully following winter).

When to Use for Growth Suppression of Cool Season Grasses and *Poa annua*:

Apply in spring after green-up and after turf has been mowed once or twice. Apply at least 1 month before onset of high air temperatures. In late summer/early fall, apply at least 1 month before anticipated first killing frost.

When to Use for Color and Quality Enhancement of Winter Overseeded Turf:

Apply anytime after overseeded turf has successfully established itself. Do not apply after March 15th to avoid delay in bermudagrass green-up. Moderate soil moisture conditions should be present before and after application to achieve best regulating effect.

Directions for use, including application rates for different species and cultivars

USE DIRECTIONS

Apply treatment solution uniformly to turf. For best results, apply 0.25 inch of water within 24 hours after application to remove product from foliage and onto soil surface.

Apply with standard pressurized application equipment with by-pass or mechanical agitation using strainer screens of 50 (or coarser) mesh. Product should be added during filling of applicator tank. When tank is allowed to stand, vigorous agitation should be used to assure material suspension before application.

Apply TRIMMIT 2SC to turf in sufficient amount of water (minimum 1 gallon treatment solution per 1,000 square feet = 43.5 gallons per acre) to ensure uniform coverage. For best results, use 2 to 5 gallons of water per 1,000 square feet. A color agent or other marking device is advised to avoid skipping and/or overlapping.

Treatment Coverage Chart[1]

Rate of Active Ingredient per Acre	Fluid Ounces of Product per Acre
0.10 lbs. ai/A	6.4 oz.
0.25 lbs. ai/A	16.0 oz.
0.50 lbs. ai/A	32.0 oz.
0.75 lbs. ai/A	48.0 oz.

[1]Product should be mixed with minimum 1 gallon water per 1,000 square feet. Use 2 to 5 gallons per 1,000 square feet for best results.

Specific Rates

Warm Season Grasses	Cool Season Grasses[1] (except Putting Greens)	Bentgrass Putting Greens & Overseeded Bermudagrass
0.50 lbs. ai/A (sandy soils)	0.25 to 0.50 lbs. ai/A	0.10 to 0.25 lbs. ai/A
0.75 lbs. ai/A (clay soils)		

[1]Reduce by 50% if *Poa annua* is a significant portion of turfgrass population.

Apply 0.5 to 0.9 pounds nitrogen per 1,000 square feet of a nonburning fertilizer product on warm and cool season grasses. Apply 0.25 to 0.5 pound nitrogen per 1,000 square feet on bentgrass greens and overseeded bermudagrass.

Results to Expect from Application of TRIMMIT 2SC:

When applied as directed, vertical growth of turf will be slowed within 3 to 10 days, resulting in reduced mowing frequency for a 6- to 8-week period. Following applications, turf will gradually undergo increased greening and density, which may persist up to 12 weeks.

Following application of product, weed populations should not be any greater than on untreated turf, although weed visibility may be higher on regulated turf.

Growth and competitive ability of *Poa annua* will be reduced within 1 to 2 weeks after application; regulation will last 3 to 8 weeks. Shoot and leaf tissue will become discolored for 3 to 8 weeks following onset of growth regulation. With proper fertilization, desired turfgrasses will be stimulated to crowd out weakened *Poa annua*.

As density of treated fairways increases due to altered growth habit, ball playability may improve, causing ball to sit higher on turf. This result is most evident on hybrid bermudagrass.

Seedhead formation will not be prevented. Seedheads should be mowed off as they grow above turf cutting height to maintain a desirable-looking turf.

Excessive irrigation and/or nitrogen fertilization may shorten period of growth regulation.

Regulator response will vary somewhat according to turf variety. For St. Augustinegrass, Bitter Blue will be the most responsive and Floratam the least responsive.

HYBRID BERMUDAGRASS

Cultivar	Sensitivity/Activity	Period of Growth Regulation	Period of Color Response
Tifway I, II	Medium/Good	5 to 6 weeks	6 to 8 weeks
Tifgreen	High/Excellent	6 to 8 weeks	8 to 10 weeks
Ormond	High/Excellent	6 to 8 weeks	8 to 10 weeks

ST. AUGUSTINEGRASS

Cultivar	Sensitivity/Activity	Period of Growth Regulation	Period of Color Response
Floratam	Low/Moderate	4 to 6 weeks	5 to 8 weeks
Floralawn	Low/Moderate	4 to 6 weeks	5 to 8 weeks
Floratine	Medium/Good	6 to 7 weeks	7 to 8 weeks
Raleigh, Texas Common	Medium/Good	6 to 7 weeks	7 to 8 weeks
Bitter Blue, Seville	High/Excellent	7 to 8 weeks	8 to 10 weeks

Program Scheduling:

If crabgrass or other annual grassy weeds have been a problem in the past, an application of the appropriate preemergence weed control product should be made before the use of TRIMMIT 2SC. Space applications of TRIMMIT 2SC and preemergence product (goosegrass/crabgrass preventer) at least 4 weeks apart.

If a weed, disease, or insect problem occurs after application of TRIMMIT 2SC, apply control product at recommended rate. TRIMMIT 2SC is compatible with most existing control products.

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Figure 7.3 Sample pesticide label – Part 2.

For Growth Regulation:

A repeat application within the same growing season may be made, but no sooner than 8 weeks following initial application. Do not make more than 3 applications per calendar year. Do not apply more than 4 quarts per acre per year (2 pounds active ingredient per acre).

For Color and Quality Enhancement:

On bentgrass and overseeded bermudagrass greens, repeat applications can be made 4 to 6 weeks apart. Do not make more than 4 applications per calendar year. Do not apply more than 4 quarts per acre per year (2 pounds active ingredient per acre).

Do not apply to overseeded bermudagrass greens after March 15th to avoid delay of spring greenup of bermudagrass.

Do not aerify or topdress and drag greens with steel mats while under growth regulation.

Do not seed within 6 weeks prior to or 2 weeks after application of TRIMMIT 2SC.

If Embark is used for *Poa annua* seedhead control, apply this product **at least** 14 days after application of Embark.

Precautions to take during and after use

GENERAL PRECAUTIONS

NOT for use on bermudagrass putting greens except for winter overseeding enhancement use.

NOT for use on athletic fields under heavy traffic where maximum growth potential of turf is desired.

NOT for use on shrubs, flowers, fruits, or vegetable plants (applications to turf areas under trees will not affect/harm trees).

DO NOT use during periods of extreme dry or cold weather conditions, or during heavy insect or disease activity.

DO NOT apply product when soil is already saturated. Heavy rainfall or irrigation in the treated areas may cause active ingredient to move laterally on slopes and collect in low areas. These areas may undergo more severe growth control for a longer period of time.

DO NOT use on areas containing greater than 70% *Poa annua*, since discoloration of *Poa* may be unacceptable.

Delay treatment of newly-sodded or sprigged turf until grass has knitted down and rooted firmly.

Delay sprigging for at least 4 weeks and sodding at least 2 weeks after application is made.

DO NOT apply this product through any type of irrigation equipment.

Withhold application on large turf areas that have been thinned from winter drainage, disease, or insects until desired fill-in is achieved.

Assure that dosage rates are measured accurately since rates greater than those recommended may cause undesirable turf growth control and may discolor areas temporarily.

Shake container thoroughly before use.

DO NOT mow treated grass for at least 3 days following application.

Broadleaf weeds are not significantly affected by TRIMMIT 2SC. To control the growth of weeds, treat with an appropriate herbicide when weeds are actively growing. Carefully follow label directions.

DO NOT use on areas to be cultivated for food or food crops or to be resown with grasses within 2 years of treatment.

DO NOT apply more than 4 quarts per acre per year (2 pounds active ingredient per acre).

DO NOT graze treated areas or harvest for forage or hay.

TRIMMIT® is a trademark of a ZENECA company.

Embark® is a trademark of PBI/Gordon Corp.

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This is a specimen label and may be inaccurate or out of date. It is intended as a guide in providing general information regarding use of this product. Always read and follow the EPA approved label on the product container.

For current information, contact ZENECA Professional Products at 1-888-617-7690.

030001

The name and address of the manufacturer

Made in UK; Packaged in U.S.A.

ZENECA Professional Products
1800 Concord Pike
Wilmington, DE 19850-5458
www.zenecaprofprod.com

A business of ZENECA Ag Products Inc.

ZPP-TRI-001 5/00

Figure 7.4 Sample pesticide label – Part 3.

Ounces or Ounces

When calculating the amount of pesticide needed to treat an area, the first question you need to ask is, “Do I have a dry or liquid product?” Products are available in many formulations. However, each formulation can be categorized as either a dry or liquid.

Dry

WP, wettable powder

WDG, water dispersible granules

G, granules

D, dusts

SP, soluble powder

WSP, water soluble powder

W, wettable powder

DF, dry flowable

WSB, water soluble bags

B, bait

When the product is a dry formulation, active ingredient is expressed as % active ingredient (a.i.).

Liquid

EC, emulsifiable concentrate

E, emulsifiable concentrate

SC, suspension concentrate

F, flowable

L, liquid

S, solutions

M, microencapsulated

ME, microencapsulated

When the product is a liquid formulation, active ingredient is expressed as lbs active ingredient (a.i.) per gallon (gal).

Examples

Figure 7.5 Ronstar dry (50 WSP) formulation.

50% active ingredient (0.50 lb a.i./1 lb product), water soluble powder

Figure 7. Mach2 liquid (2 SC) formulation.

2 lb active ingredient per gallon, suspension concentrate

USEFUL CONVERSION FACTORS

Liquid

1 gallon = 128 fluid ounces (fl oz)

1 quart = 32 fl oz

1 pint = 16 fl oz

1 cup = 8 fl oz

1 gallon = 4 quarts, 8 pints, 16 cups

Dry

1 pound = 16 ounces (oz)

Pesticide Applications – Amount of Product

How much pesticide is needed to treat an area at a given rate?

General formula

Rate	Area to be treated
1,000 ft^2	

or

Rate	Area to be treated
Acres	

Example 1. How many ounces of Roundup Pro are needed to treat 0.4 acres of bentgrass at a rate of 2 quarts per acre?

2 quarts	0.4 acres	32 oz
1 acre		1 quart

This should be computed as 2 quarts × 0.4 acres × 32 oz ÷ 1 acre ÷ 1 quart = ________

Answer = 25.6 ounces of Roundup Pro

Amount to Add to the Spray Tank

How much product do we add to the tank?

General formula

Tank size (gallons)	Rate
Gallons per acre	Acre

Example 2. How many ounces of Roundup Pro do we add to the tank? We have a 150-gallon spray tank that is calibrated to spray 50 gallons per acre. We need to treat 20 acres of turf with 2 quarts of Roundup Pro per acre.

150 gallons	2 quarts	32 ounces
50 gallons per acre	Acre	1 quart

This should be computed as 150 gallons × 2 quarts × 32 oz ÷ 50 gallons per acre ÷ 1 acre ÷ 1 quart = ________

Answer = 192 ounces of Roundup Pro (1.5 gallons of Roundup Pro)

How Many Tank-Fulls Does It Take?

How many tanks will it take me to treat this area?

General formula

Gallons per acre	Total area (acres)
Tank size (gallons)	

Example 3. How many full tanks will it take to treat 20 acres of turf with Roundup Pro? We have a 150-gallon spray tank that is calibrated to spray 50 gallons per acre. We need to treat 20 acres of turf with 2 quarts of Roundup Pro per acre.

50 gallons per acre	20 acres
150 gallons per tank	

This should be computed as 50 gallons per acre × 20 acres ÷ 150 gallons per tank = ________

Answer = 6.7 tanks

Pesticide Applications – Active Ingredient

How much pesticide is needed to treat an area at a given rate?

General formula – dry

Rate	1 lb	Area to be treated
1,000 ft^2	Percent a.i.	

or

Rate	1 lb	Area to be treated
Acre	Percent a.i.	

General formula – liquid

Rate	1 gallon	Area to be treated
1,000 ft^2	Pounds a.i.	

or

Rate	1 gallon	Area to be treated
Acre	Pounds a.i.	

Example 4. How many ounces of Ronstar 50 WSP are needed to treat 2,000 ft^2 of perennial ryegrass fairways at 3 pounds of a.i. per acre?

3 lb a.i.	1 lb	2,000 ft^2	1 acre	16 oz
Acre	0.5 lb a.i.		43,560 ft^2	1 plb

This should be computed as 3 lb a.i. × 1 lb × 2,000 ft^2 × 1 acres × 16 oz ÷ 1 acre ÷ 0.5 lb a.i. ÷ 43,560 ft^2 ÷ 1 lb = ________

Answer = 4.4 ounces of Ronstar 50 WSP

Example 5. How many ounces of Aatrex 4L are needed to treat 0.4 acres of bentgrass at 1 lb a.i. per acre?

1 lb a.i.	1 gallon	0.4 acre	128 oz
Acre	4 lb a.i.		1 gallon

This should be computed as 1 lb a.i. × 1 gallon × 0.4 acres × 128 oz ÷ 1 acre ÷ 4 lb a.i. ÷ 1 gallon = ________

Answer = 12.8 ounces of Aatrex 4L

Amount of Active Ingredient Applied

It may be necessary to calculate the amount of active ingredient that is applied after an application. Here is the general formula.

General formula – dry

Amount of product applied	lbs. a.i.
Area applied	1 pound

General formula – liquid

Amount of product applied	lbs. a.i.
Area applied	1 gallon

Example 6. How much active ingredient is applied per acre when 4.4 ounces of Ronstar 50 WSP is applied to 2,000 ft^2?

4.4 ounces	0.5 lb a.i.	43,560 ft^2	1 lb
2,000 ft^2	1 pound	1 acre	16 oz

This should be computed as 4.4 oz × 0.5 lb a.i. × 43,560 ft^2 × 1 lb ÷ 2,000 ft^2 ÷ 1 lb ÷ 1 acre ÷ 16 oz = _________

Answer = 3.0 pounds of active ingredient per acre

Cost of Product Per Acre

General formula

Rate	Cost
Area	Unit size

Example 7. What is the cost per acre for Mr. Bill's BUGKILLER 1EC when applied at a rate of 16 ounces per 1,000 ft^2 at a price of $49 per gallon? NOTE: this is a liquid product.

16 ounces	\$49	1 gallon	43,560 ft^2
1,000 ft^2	1 gallon	128 ounces	1 acre

This should be computed as 16 oz × \$49 × 1 gallon × 43,560 ft^2 ÷ 1,000 ft^2 ÷ 1 gallon ÷ 128 oz ÷ 1 acre = ________

Answer = \$267 per acre

Example 8. Two fungicides are available for purchase. Which one is the best buy?

FUNGICIDES	***Unit Size***	***Unit Cost***	***Rec. Rate ozs/M***
Pythium-killer 5G	**22 lb**	**\$475**	**4.00**
Turf Doctorcide 2EC	**1 gal**	**\$360**	**2.00**

Fungicide 1: Pythium-killer 5G
NOTE: This is a dry product as indicated by the G formulation.

4 ounces	\$475	1 lb	43,560 ft^2
1,000 ft^2	22 lb	16 ounces	1 acre

This should be computed as 4 oz × \$475 × 1 lb × 43,560 ft^2 ÷ 1,000 ft^2 ÷ 22 lb ÷ 16 oz ÷ 1 acre = ________

Answer = \$235 per acre

Fungicide 2: Turf Doctorcide 2EC
NOTE: This is a liquid product as indicated by the EC formulation.

2 ounces	\$360	1 gallon	43,560 ft^2
1,000 ft^2	1 gallon	128 ounces	1 acre

This should be computed as 2 oz × \$360 × 1 gallon × 43,560 ft^2 ÷ 1,000 ft^2 ÷ 1 gallon ÷ 128 oz ÷ 1 acre = ________

Answer = \$245 per acre

Fungicide 2: Pythium-killer 5G is the best buy when considering price per acre.

Liquids Without a Designation

Some liquid pesticide labels lack a designation of pounds active ingredient per gallon on the label. Instead, the percentage (%) a.i. is listed. This may cause confusion because the percentage is a percent by weight of product, not a percent by volume.

To determine the pounds of a.i. per gallon requires the specific gravity or density of the liquid (found on the MSDS sheet). The specific gravity will be listed as pounds liquid per gallon (lbs/gal), grams/milliliter (g/mL) or grams/cubic centimeter (g/cc). This information can be used to determine the lb a.i. per gallon.

A good example of this problem is Banner MAXX. The product label states that it contains 14.3% a.i. This means that the product contains 14.3% of the weight of a gallon. The weight of a gallon from the MSDS sheet states that its specific gravity is 1.09 g/ml. To determine the amount of a.i. in one gallon, we must first determine the weight of a gallon.

We can do this simply by converting the specific gravity from g/ml to lbs/gallon.

1.09 grams	1 lb	3,785 mL
1 mL	454 grams	1 acre

This should be computed as 1.09 grams × 1 lb × 3,785 mL ÷ 1 mL ÷ 454 grams ÷ 1 gallon = ________

Answer = 9.09 pounds per gallon

The a.i. is determined by multiplying the weight/gal (9.09) by the % a.i. (14.3%).

9.09 lb	0.143 a.i.
1 gallon	

This should be computed as 9.09 lb × 0.143 a.i. ÷ 1 gallon = ________

Answer = 1.3 pounds active ingredient per gallon

Therefore, Banner MAXX contains 1.3 lb a.i./gal.

syngenta

MATERIAL SAFETY DATA SHEET

Syngenta Crop Protection, Inc.
Post Office Box 18300
Greensboro, NC 27419

In Case of Emergency, Call
1-800-888-8372

1. PRODUCT IDENTIFICATION

Product Name:	**BANNER MAXX**	Product No.:	A6780D
EPA Signal Word:	Warning		
Active Ingredient(%):	Propiconazole (14.3%)	CAS No.:	60207-90-1
Chemical Name:	1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-1H-1,2,4-triazole		
Chemical Class:	Triazole Derivative Fungicide		
EPA Registration Number(s):	100-741	**Section(s) Revised: 2, 8, 11**	

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Yellow to orange liquid
Odor:	Aromatic solvent
Melting Point:	Not Applicable
Boiling Point:	331°F (166°C)
Specific Gravity/Density:	1.09 g/ml
pH:	5 - 8 (10% emulsion in H2O)

Solubility in H2O

Propiconazole: 0.1 g/l @ 68°F (20°C)

Vapor Pressure

Propiconazole: 4.2 x 10(-7) mmHg @ 77°F (25°C)

Figure 7.7. Material Safety Data Sheet for Banner Maxx.

Using a Spreadsheet to Calculate Pesticide Needs

In addition to calculating pesticide math problems by hand, computer spreadsheets can also be a useful tool for calculating your pesticide needs. Using spreadsheet software programs such as Microsoft Excel will allow managers to more rapidly calculate various problems. Figure 7.8 provides step-by-step instructions for calculating

- the cost per ounce
- the cost per 1,000 ft^2
- the cost per acre

Calculating the cost per unit ounce is the first step in determining the cost per area. Cost per unit ounce is calculated differently for dry and liquid products. Cost per unit ounce requires the conversion from gallons to ounces or from pounds to ounces. As discussed earlier in this chapter, these conversion factors are different (128 vs. 16). Therefore, use caution when entering data into a spreadsheet for calculating pesticide cost. Additionally, some new products are sold in small quantities by the ounce and no conversion is needed. When creating these spreadsheets, always check your spreadsheet answers with hand-calculated answers.

This spreadsheet can be used to compare products and make purchasing decisions. It is possible to compare a couple of products or hundreds of products using spreadsheets.

This is just one example of how a spreadsheet can be used to help make purchasing decisions. Spreadsheets like this can be customized in order to calculate specific pesticide problems relevant to your company's needs.

Step 1. Enter pesticide information

	A	B	C	D	E	F	G	H
1						***Rec. Rate***		
2	***FUNGICIDES***	***Unit Size***		***Unit Cost***	***Cost/ Oz***	***Ozs/M***	***Cost/M***	***Cost/Acre***
3	Pythium-killer 5G	22	lb	$475		4.00		
4	Turf Doctorcide 2EC	1	gal	$360		2.00		

Step 2. Calculate cost per ounce using 16 for dry and 128 for liquid

	A	B	C	D	E	F	G	H
1						***Rec. Rate***		
2	***FUNGICIDES***	***Unit Size***		***Unit Cost***	***Cost/ Oz***	***Ozs/M***	***Cost/M***	***Cost/Acre***
3	Pythium-killer 5G	22	lb	$475	$1.35	4.00		
4	Turf Doctorcide 2EC	1	gal	$360	$2.81	2.00		

Type "=D3/(B3*16)" in this box. Use 16 (oz.) since this is a dry product

Type "=D4/(B4*128)" in this box. Use 128 (oz.) since this is a liquid

Step 3. Calculate cost per 1000 ft^2

	A	B	C	D	E	F	G	H
1						***Rec. Rate***		
2	***FUNGICIDES***	***Unit Size***		***Unit Cost***	***Cost/ Oz***	***Ozs/M***	***Cost/M***	***Cost/Acre***
3	Pythium-killer 5G	22	lb	$475	$1.35	4.00	$5.40	
4	Turf Doctorcide 2EC	1	gal	$360	$2.81	2.00	$5.63	

Type "=E3*F3" in this box

Type "=E4*F4" in this box

Step 4. Calculate cost per acre

	A	B	C	D	E	F	G	H
1						***Rec. Rate***		
2	***FUNGICIDES***	***Unit Size***		***Unit Cost***	***Cost/ Oz***	***Ozs/M***	***Cost/M***	***Cost/Acre***
3	Pythium-killer 5G	22	lb	$475	$1.35	4.00	$5.40	$235.13
4	Turf Doctorcide 2EC	1	gal	$360	$2.81	2.00	$5.63	$245.03

Type "=43.56*G3" in this box

Type "=43.56*G4" in this box

Step 5. Choose product based on cost per acre

	A	B	C	D	E	F	G	H
1						***Rec. Rate***		
2	***FUNGICIDES***	***Unit Size***		***Unit Cost***	***Cost/ Oz***	***Ozs/M***	***Cost/M***	***Cost/Acre***
3	Pythium-killer 5G	22	lb	$475	$1.35	4.00	$5.40	$235.13
4	Turf Doctorcide 2EC	1	gal	$360	$2.81	2.00	$5.63	$245.03

Figure 7.8 How to create a pesticide price list with Microsoft Excel.

Problems (see page 103 for answers)

2 pints	=	1 quart	1 pound	=	454 g
4 quarts	=	1 gallon	1 yard	=	3 ft
1 gallon	=	128 ounces	1 mile	=	5,280 ft
1 gallon	=	3,785 ml	1 acre	=	43,560 ft^2
1 gallon	=	8 pounds	P_2O_5	is	44% P
1 pound	=	16 ounces	K_2O	is	83% K
1 ton	=	2,000 pounds	1 gallon	=	3.785 liters

37. How many pounds of Barricade 65 WSG are needed to treat 125,000 ft^2 of turf at 1.15 lbs product/acre?

38. How many ounces of Blade 60DF are needed to treat 4 acres of polo fields at 0.5 oz/acre?

39. What is the cost per acre of Basagran T/O applied at 0.85 liquid oz/1,000 ft^2? Basagran is $149 per gallon.

40. What is the cost per acre of Trimec 992 applied at 3 pints/acre if Trimec 992 is purchased in a 55-gallon drum for $1,490?

41. How many pounds of Merit 0.5G are needed to apply 0.3 lb a.i./A to 10 acres of home lawns?

42. How many pounds of Balan 2.5G are needed to apply 3 lb a.i./A to 3 acres of a campus?

43. How many gallons of Primo 1EC are needed to apply 0.25 ounces/1,000 ft^2 to 11 acres of golf course fairways?

44. Using Chipco Choice, a 0.1G insecticide, to control Mole Crickets at an application rate of 25 pounds of product per acre, how many pounds of active ingredient is applied per acre?

45. Prograss has a specific gravity of 0.95 g/mL and contains 19% ethofumesate (active ingredient). How many pounds of active ingredient are contained in 1 gallon of this product?

Section

8

Calibration

Calibrating is the first and most important step to product application.

Calibrating is often a dreaded task that is usually skipped or performed seldom by many turfgrass managers. Apathy toward calibration can lead to over- or under-application of pesticides and fertilizers, which will injure turf, waste money and potentially harm the environment. Miscalibration is the number one reason for pesticide performance failure. Calibration is not as difficult as it may initially seem. Worksheets contained in this section will aid managers in calibrating their equipment regardless of the application method.

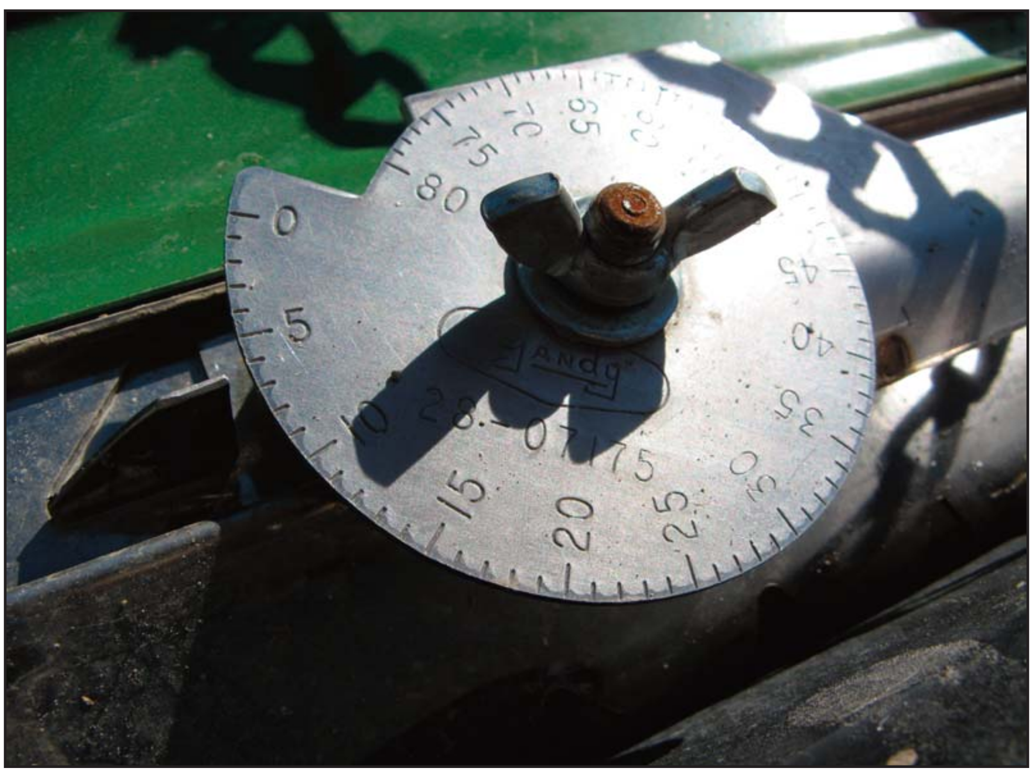

Figure 8.1 Proper calibration is essential for proper pesticide and fertilizer application.

Calibration of a Boom Sprayer

Calibration is essential to ensure that the desired amount of a pesticide or fertilizer is applied to the turfgrass site. Improper calibration may cause poor pest control, environmental contamination, injury to the desired turf and unnecessary expenditures for pesticides.

Improperly calibrated sprayers are common on golf courses. A study conducted by Varner et al. (1990) showed that only 17% of the sprayers used on golf courses in Nebraska applied within 5% of the intended amount.

A sprayer should be calibrated at the start of every growing season, and the calibration should be checked at least once a month during the growing season. Nozzles should be checked for wear each time the sprayer is calibrated, and all screens should be cleaned each time the sprayer is used.

Steps to Calibrating a Boom Sprayer

Step 1 Measure a calibration course 100 feet in length over terrain that is similar to terrain where the sprayer will be operating so that the load on the engine will reflect actual conditions.

Step 2 Determine the amount of time required to cover the 100-foot calibration course when operating the sprayer at the desired spraying speed. Be sure the sprayer is at the desired spraying speed when passing the start and end points of the calibration course. It is best to make two passes over the calibration course in opposite directions and use the average time for calibration calculations. The spray tank should be half full when making the calibration runs. Be sure to record the gear, rpm or mph, and pressure at which the calibration runs were made (whichever is appropriate to the machine). If calibrating your walking speed for application with a lawn care gun, use a shorter distance course since some hoses may be shorter than 100 feet.

Step 3 Pavement test the sprayer using water for proper nozzle adjustment and to determine the effective spray width. First, clean all nozzle screens and inspect each nozzle. Next, fill the sprayer with water and spray at the desired speed. Observe the wet pavement as it dries. Adjust the nozzles until the coverage is uniform across the spray width. Lastly, operate the sprayer again while spraying. Mark the edges of the effectively covered area and measure to determine the effective spray width. This should be equal to the width of the boom and/or the same as the number of nozzles multiplied by the distance in feet between nozzles. Now, it is possible to calculate the area of the calibration run. (100 feet × effective spray width).

Step 4 Measure the nozzle output of the sprayer by placing a collection vessel under each nozzle and operating the sprayer for the same duration it took to cover the calibration course (Step 2) while at the same rpm. Record the output in ounces (oz) or milliliters (mL) of each nozzle and add to determine the output of all nozzles for the sprayer. Replace the nozzle and repeat step 4 if an individual nozzle is 10% higher or lower than the average nozzle output.

Step 5 Calculate the number of gallons output per ft^2 of calibration course. (1 gal = 3,785 mL; 1 gal = 128 oz)

Step 6 Convert from gallons/ft^2 to gallons per 1,000 ft^2 or to gallons per acre. (43,560 square feet = 1 acre)

Boom Sprayer Calibration Worksheet

A. Amount of time needed to travel the calibration course.

	Direction A	Direction B	Average
Seconds to travel 100 ft			

Notes:
(Gear: ________ RPM & MPH: ___________ Pressure: ________ Nozzle type: _______)

B. Width of boom _________________ feet. NOTE: This is the effective spray width.
Width of boom (ft) = Spacing between nozzles (ft) x number of nozzles
Width of boom (ft) = _____________________ (ft) x ________________

Width of boom (ft) = _______________ (ft)

C. Calculate the number of square feet covered in the calibration course.
100 ft (from A) × ________ ft boom width (from B) = ________ sq ft covered

______________ seconds to travel the calibration course. Average of two directions.

D. Measure the sprayer output for the same number of seconds it took to complete the calibration course. (Collect data as either mL or oz.) Convert from mL to oz by dividing by 29.57.

Nozzle # 1	____________________	mL	____________________	oz
2	____________________	mL	____________________	oz
3	____________________	mL	____________________	oz
4	____________________	mL	____________________	oz
5	____________________	mL	____________________	oz
6	____________________	mL	____________________	oz
7	____________________	mL	____________________	oz
8	____________________	mL	____________________	oz
9	____________________	mL	____________________	oz
10	____________________	mL	____________________	oz
11	____________________	mL	____________________	oz
12	____________________	mL	____________________	oz
Total	____________________	mL	____________________	oz

In summary:

Total ________ mL collected in _____ seconds or per ________ sq ft (from C)

Total ________ oz collected in _____ seconds or per ________ sq ft (from C)

E. Calculate the output per sq ft of the calibration course.

Total output in mL _______(from D) ÷ 3,785 ÷ sq ft covered __________(from C)

=___________________ (gallons per square foot covered).

<u>or</u>

Total output in oz _______(from D) ÷ 128 ÷ sq ft covered __________(from C)

=___________________ (gallons per square foot covered).

F. Convert gallons per number of square feet of the calibration course to gallons per 1,000 square feet or gallons per acre.

Gallons per 1,000 ft^2

= ________________ (gal/sq ft, from part E) x 1,000

= ________________ (gallons per 1,000 ft^2)

Gallons per Acre

= ________________ (gal/sq ft, from part E) x 43,560

= ________________ (gallons per acre)

Checking for Worn Nozzle Tips

Step 1 Measure the output of each nozzle in comparison to one new nozzle placed in the boom. Output can be measured by a collection vessel placed under each nozzle and operating the sprayer for one minute.

Step 2 Record the output from each nozzle. If the output from any nozzle is 10% or greater than the output from the new nozzle, the old nozzle should be replaced. If two or more nozzles have an output 10% or greater than the new nozzle, all nozzles on the boom should be replaced. It is important to have uniform output from all nozzles.

Calculating Flow Rate

Certain pesticides may be more effective at lower or higher spray volumes (i.e., gallons per acre). One method to modify your spray volume is by first calculating your flow rate and then selecting a nozzle for its flow rate at a certain sprayer pressure. The first step in determining flow rate is to calculate your sprayer's travel speed in miles per hour (MPH).

MPH

General formula

$$= \frac{\text{Distance in feet} \times 60}{\text{Time in seconds} \times 88}$$

Example 1. Calculate the MPH for a sprayer traveling 100 feet in 17.05 seconds.

$$= \frac{100 \times 60}{17.05 \times 88}$$

= 4 miles per hour (MPH)

FLOW RATE:

General formula

$$= \frac{\text{Gallons per acre (GPA)} \times \text{MPH} \times \text{nozzle spacing (inches)}}{5{,}940}$$

Example 2. Calculate the flow rate in gallons per minute for a sprayer calibrated at 44.8 gallons per acre with a 14 inch nozzle spacing and traveling 4 MPH.

$$= \frac{44.8 \times 4 \times 14}{5{,}940}$$

= 0.42 gallons per minute

Sprayer Calibration Problems

Regardless of method there are two main steps:

1. Determine the amount of water per time
2. Determine the amount of time per area

When Measuring Traveling Speed as MPH

General formula

Collection (mL)	Number of nozzles		1 gallon		1 mile		43,560 ft^2	60 min	60 sec
1 nozzle		Collection time	3,785 mL	MPH	5,280 ft	boom width (ft)	acre	1 hour	1 min

Example 3. How many gallons per acre would be applied using the following sprayer?

- 12 nozzles
- Each nozzle releases 800 mL in 30 seconds
- 14 foot wide boom
- The sprayer is traveling at 4 mph

800 mL	12 nozzles		1 gallon	1 hour	1 mile		43,560 ft^2	60 min	60 sec
1 nozzle		30 sec	3,785 mL	4 miles	5,280 ft	14 foot boom	1 acre	1 hour	1 min

This should be computed as 800 mL × 12 nozzles × 1 gallon × 1 hour × 43,560 ft^2 × 60 min × 60 sec ÷ 1 nozzle ÷ 30 sec ÷ 3,785 mL ÷ 4 miles ÷ 5,280 ft ÷ 14 ft ÷ 1 acre ÷ 1 hour ÷ 1 min = ________

= 44.8 gallons per acre

SHORTCUT:

General formula

$$= \frac{\text{Gallons per minute (GPM) per nozzle} \times 5{,}940}{\text{MPH} \times \text{nozzle spacing or sprayed width (inches)}}$$

Example 4. How many gallons per acre would be applied using the following sprayer?

$$= \frac{(800 \times 2/3{,}785) \times 5{,}940}{4 \times 14}$$

= 44.8 gallons per acre

When Measuring Traveling Speed as Time/Distance

General formula

Collection (mL)	Number of nozzles		1 gallon	time		43,560 ft^2
1 nozzle		Collection time	3,785 mL	Distance traveled	boom width (ft)	1 acre

Example 5. A sprayer has a 14-ft boom and 12 nozzles. Each nozzle releases 775 mL of spray in 20 seconds. A 200-ft test strip is established and the sprayer is timed to travel the distance in 45 seconds. How many gallons per acre are being applied?

800 mL	12 nozzles		1 gallon	34.1 sec.		43,560 ft^2
nozzle		30 sec	3,785 mL	200 ft	14 ft boom	1 acre

This should be computed as 800 mL × 12 nozzles × 1 gallon × 34.1 sec × 43,560 ft^2 ÷ 1 nozzle ÷ 30 sec ÷ 3,785 mL ÷ 200 ft ÷ 14 ft ÷ 1 acre = ________

= 44.8 gallons per acre

Calibrating a Lawn Gun

Calibrating a lawn care gun is difficult because every applicator will walk at slightly different speeds as well as using slightly different spray techniques. Therefore it is important to calibrate each individual with each gun. A lawn gun delivers the majority of the material directly in front of the applicator as he/she walks and sprays with a rapid side-to-side shoulder/arm motion. Therefore, less material is applied on the applicator's right or left compared to directly in front of the applicator. Therefore, lawn guns require 100% overlap on subsequent passes (50% overlap on right and 50% overlap on left) to ensure uniform application. When determining the effective spray width while calibrating the lawn gun, the effective spray width should be calculated as one-half of the area covered in one pass. In other words, if a 10-foot width of spray is applied in one pass, then the effective spray width would be 5 feet. Use the following worksheet to calibrate a lawn gun.

Individual 1: Test 1

Step 1 Lay out a rectangular area 50 ft long by 20 ft wide (1,000 ft^2).

Step 2 Record the amount of time it takes for an applicator to uniformly apply water to this area.

________________ seconds

Step 3 Spray into a five-gallon bucket for the amount of time recorded in Step 2. Measure the amount of water collected in the bucket in fluid ounces.

________________ oz

Step 4 Divide the water collected in Step 3 by 128 (1 gallon = 128 fluid ounces) to calculate spray volume in gallons/1,000 ft^2.

___________ oz ÷ 128 oz/gallon = _________gallon/1,000 ft^2

Step 5 Divide the gallonage in the spray tank by the answer in Step 4 to calculate the area that can be covered with one tankful.

___________ gallons in spray tank ÷ _________gallons/1,000 ft^2 = ___________ft^2/tank

Individual 1: Test 2

Step 1 Lay out a rectangular area 50 ft long by 20 ft wide (1,000 ft^2).

Step 2 Record the amount of time it takes for an applicator to uniformly apply water to this area.

________________ seconds

Step 3 Spray into a five-gallon bucket for the amount of time recorded in Step 2. Measure the amount of water collected in the bucket in fluid ounces.

________________ oz

Step 4 Divide the water collected in Step 3 by 128 (1 gallon = 128 fluid ounces) to calculate spray volume in gallons/1,000 ft^2.

___________ oz ÷ 128 oz/gallon = _________gallon/1,000 ft^2

Step 5 Divide the gallonage in the spray tank by the answer in Step 4 to calculate the area that can be covered with one tankful.

___________ gallons in spray tank ÷ _________gallons/1,000 ft^2 = ___________ft^2/tank

Calibrating Ride-on Spreader/Sprayers

The use of ride-on sprayer/spreaders has increased recently (Figure 8.2). Ride-on sprayers/spreaders increase work efficiency by allowing areas to be fertilized and sprayed more quickly while preserving employee energy. Additionally, ride-on sprayer spreaders allow the combining of two separate pieces of equipment into one for added convenience. Since this type of equipment is new to the turfgrass industry, there are many who do not have experience calibrating ride-on spreaders/sprayers. Specific procedures for calibrating the sprayer and spreader functions of ride-on equipment are included here.

A sprayer should be calibrated at the start of every growing season, and the calibration should be checked at least once a month during the growing season. Nozzles should be checked for wear each time the sprayer is calibrated. All screens should be cleaned each time the sprayer is used. There are two main types of ride-on spreader/sprayers – those with a boom-type sprayer and those with a single-nozzle applicator (Figure 8.2). Specific procedures for calibrating both are included in this publication.

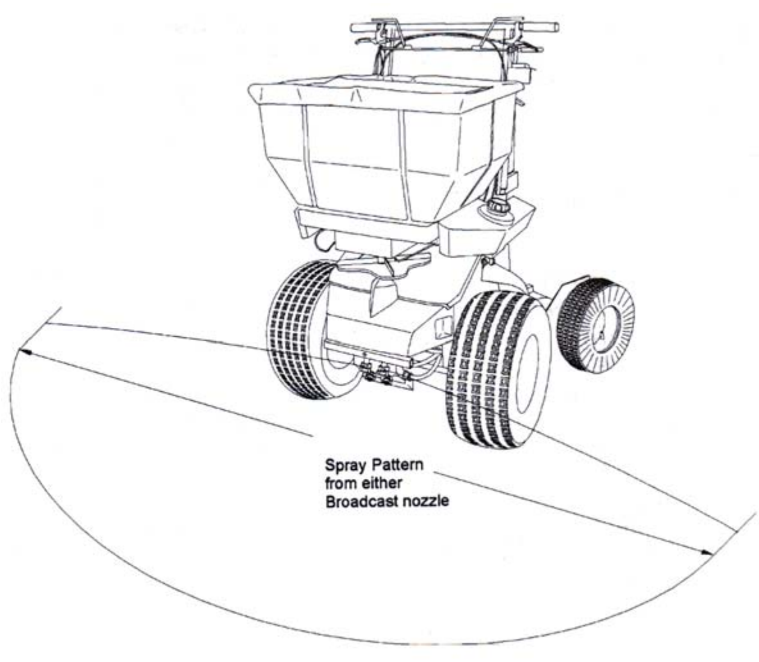

Figure 8.2. Single nozzle applicator broadcast pattern.

Steps to Calibrating a Spreader/Sprayer
(Any Type)

(example: PermaGreen or Z-Spray)

Step 1 Measure a calibration course 100 feet in length over terrain that is similar to terrain where the sprayer will be operating so that the load on the engine will reflect actual conditions.

Step 2 Determine the amount of time required to cover the 100-foot calibration course when operating the sprayer at the desired spraying speed. Be sure the sprayer is at the desired spraying speed when passing the start and end points of the calibration course. It is best to make two separate passes over the calibration course in opposite directions and use the average time for calibration calculations. The spray tank should be half full when making the calibration runs. Be sure to record the gear, rpm and pressure at which the calibration runs were made (whichever is appropriate to the machine).

Step 3 Pavement test the sprayer using water for proper nozzle adjustment and to determine the effective spray width. First, clean the nozzle screen and inspect the nozzle(s). Next, fill the sprayer with water and spray at the desired speed. Observe the wet pavement as it dries. Adjust the nozzle(s) until the coverage is uniform across the spray width. Next, operate the sprayer again while spraying. Mark the edges of the effectively sprayed area and measure to determine the effective spray width.

Step 4 Measure the nozzle output of the sprayer by placing a collection vessel under one nozzle and operating the sprayer for one minute while at the same rpm. Record the output of one nozzle to determine the approximate output of the sprayer.

Step 5 Calculate gallons per acre with the formula in the calibration worksheet on the following page.

Spreader/Sprayer Calibration Worksheet
(Any Type)

A. Calculating sprayer speed in miles per hour (MPH). First record the time needed to travel 100 feet (or shorter for lawn guns).

Direction A	Direction B	Average time(s)
___________	___________	___________

Seconds to travel 100 feet (or shorter for lawn guns). Answer = ___________.

(Gear: ________ RPM: ________ Pressure: ________ Nozzles: ________)

MPH

$$\frac{\text{distance traveled}}{\text{average time (seconds)}} \;\Bigg|\; \frac{60}{88}$$

This should be computed as distance traveled × 60 ÷ average time (sec) ÷ 88 = Answer = ________ MPH

B. Single nozzle applicator effective spray width = ______________ feet. Convert to inches by multiplying by 12 = ___________ inches.

Nozzle spacing ____________ (inches) on boom-type sprayers.

C. Measure the sprayer output for one nozzle for one minute (record values in gallons, milliliters or ounces).

Nozzle 1 ______________ gallons ______________ mL ______________ oz

If recorded as mL, divide by 3,785 to get gallons per minute. Answer = _______
If recorded as oz, divide by 128 to get gallons per minute. Answer = _______

D. Calculate gallons per acre with formula below.

GPA Equation

$$\frac{5{,}940\ \times}{\text{MPH}\ \times} \;\Bigg|\; \frac{\text{GPM (per nozzle)}}{\text{W (inches)}} \quad \text{or} \quad \frac{5{,}940 \times \text{GPM (per nozzle)}}{\text{MPH} \times \text{W (inches)}}$$

W = nozzle spacing in inches (or effective spray width for single nozzle applicator)(from part B)

GPM = gallons per minute (from part C)

GPA = gallons per acre

MPH = miles per hour (from part A)

This should be computed as 5,940 × gallons per minute (C) ÷ MPH ÷ W = Answer = ____________ gallons/acre (GPA)

NOTE: Gallons per 1,000 ft^2 can be calculated by dividing by 43.56. This should be computed as gallons/acre (D) ÷ 43.56 = Answer = ____________ gallons/1,000 ft^2

Sprayer Coverage

Once you have determined the sprayer output in gallons per acre, you can determine the amount of turf you will be able to spray per tank. This can also be converted to 1,000 ft^2/tank.

Divide the size (gallons) of the spray tank by the GPA to calculate the acres that can be covered with one tank.

__________ gallons in spray tank ÷ __________ gallons/acre = ___________ acres/tank

__________ acres/tank × 43,560 = ____________ ft^2/tank

Calibrating a Hand Sprayer

To calibrate a backpack sprayer, you must first figure how many square feet the filled sprayer will cover. This will vary from person to person because people walk at different speeds.

Steps to Calibrating a Hand Sprayer

Step 1 Fill the sprayer with about 1 gallon of water and pump it up.

Step 2 Holding your arm extended, as you would when spraying, spray water onto dry pavement while standing still. Measure and record the width of the spray line.

Step 3 Walk in a straight line, while spraying, for 15 seconds at the pace you would use when spraying. Measure the distance you walked in 15 seconds.

Step 4 Multiply the width of the spray pattern by the distance covered in 15 seconds to determine the area sprayed in 15 seconds.

Step 5 Spray for 15 seconds into an empty container. Measure the amount of water collected in the container in fluid ounces.

Step 6 Multiply the area sprayed that was calculated in Step 4 by the capacity of the sprayer in fluid ounces (1 gallon = 128 fluid ounces.). Divide the resulting quantity by the number of fluid ounces collected in 15 seconds of spraying. The result is the amount of square feet that can be covered with a full tank of spray solution.

Calibrating a Hand Sprayer

A. Width of spray pattern: ________________ ft

B. Distance covered during 15 seconds of spraying: ________________ ft

C. Area covered in 15 seconds of spraying:
width ___________ ft x distance ____________ ft = ____________ square feet

D. Fluid ounces collected in 15 seconds: ______________ fl oz

E. Capacity of the sprayer: ____________ (gallons)

F. Capacity of the sprayer in fluid ounces. Since there are 128 fluid ounces per gallon, then 128 multiplied by the number of gallons in one tank will give us the capacity in fluid ounces.

(E) × (128) = ______________ fluid ounces

G. Calculate the area that can be sprayed by a full tank of spray solution.

Area covered in 15 seconds of spraying × capacity of the sprayer in fluid ounces ÷ fluid ounces collected in 15 seconds = the area that can be sprayed by a full tank of spray solution

(C) × (F) ÷ (D) = the area that can be sprayed by a full tank of spray solution

________ × ________ ÷ ________ = ____________ square feet covered by a full tank of spray solution

Rotary Spreader Calibration

A properly maintained and calibrated spreader is an essential piece of equipment for all professional turfgrass managers. Fertilizers and pesticides are formulated for application at a specific recommended rate. Over-application of a fertilizer or pesticide is an unnecessary expense that may injure turf and potentially harm the environment. Under-application may be more costly because of poor turf response and the need to re-treat sooner because of poor product performance.

A fertilizer spreader should be calibrated at least once a week if it is used frequently or once a month if used infrequently. The spreader must be calibrated for each material to be used and for each speed (gear) at which it is used.

Before calibrating a spreader, it should be thoroughly checked to be sure it is in proper working condition. Items to check include:

- tires properly inflated
- axels greased and tires turn freely
- spreader hopper and impeller clean
- screen inside the hopper
- agitation bar inside the hopper
- adjustment knob will hold its position
- rain cap present
- gears greased (if recommended) and all teeth on gears present
- pattern adjustment set

Calibration of a rotary spreader includes three aspects: uniform distribution across the pattern, effective pattern width and the rate of application.

Uniform Distribution Across the Pattern

The purpose of this procedure is to ensure that equal amounts of the material are being thrown to the right and left of the spreader.

Step 1 Place shallow boxes or pans side by side in a line perpendicular to the direction the spreader will be pushed. One box should be placed directly beneath the spot where the spreader will pass, leaving space for the spreader wheels to pass on either side of the box. Below is a diagram showing placement of the boxes.

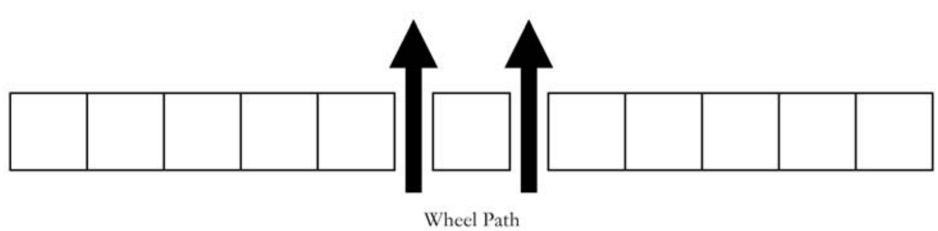

Figure 8.3. Diagram of collection box layout for determining a rotary spreader's distribution pattern.

Step 2 Set the spreader at the opening that is suggested for the material.

Step 3 Set the pattern adjustment so it is completely open. The diagram below indicates the location of the pattern adjustment for two types of spreaders.

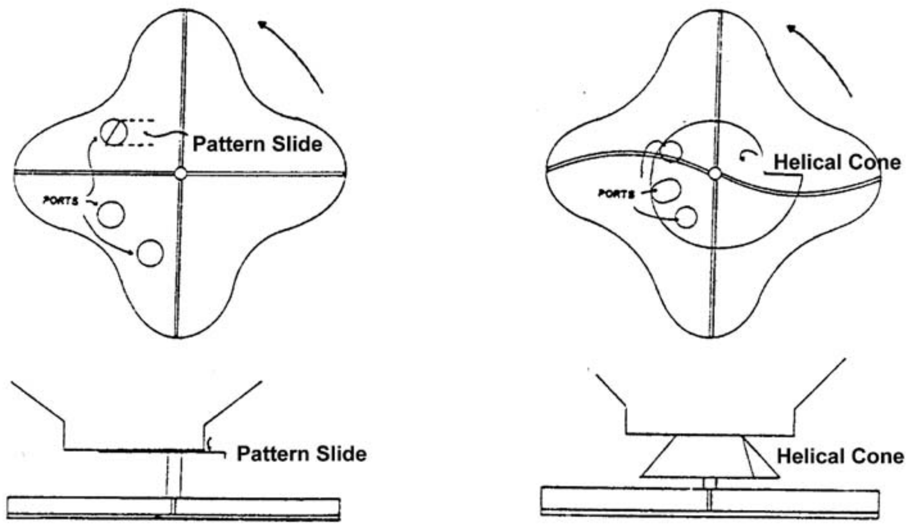

Figure 8.4. Pattern slides and helical cones are used to adjust product distribution on rotary spreaders.

Step 4 Fill the spreader half full and make 8 to 10 passes over the boxes, pushing the spreader in the same direction each time. This is best done over a clean garage floor. Be sure the spreader impeller is parallel to the ground and a constant walking speed is used for each pass. Full walking speed should be achieved before turning on the spreader.

Step 5 The contents of each box should be weighed separately or poured into a small bottle. The bottles should then be placed side by side in order. This will allow you to see the spreader pattern variation. The diagram below illustrates possible spreader patterns.

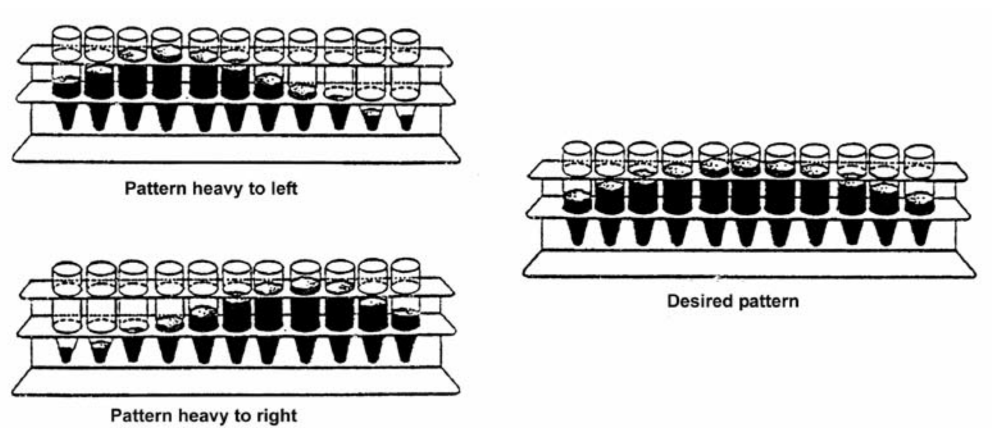

Figure 8.5. Sample pattern distributions from various helical cone or pattern slide settings.

Step 6 Weigh the material collected in the boxes on the right and then weigh the material collected in the boxes on the left. The weight of material collected on each side should be within 15% of each other. If not, change the pattern adjustment setting.

Step 7 Repeat the test until the distribution pattern is uniform.

Determine the Effective Pattern Width

When a uniform pattern is achieved, the effective pattern width can then be determined.

Step 1 Read the volumetric measurements on the side of the vials. Determine at what distance from the center of the pattern the distribution rate decreases to one-half the amount contained in the center vial.

Step 2 The effective pattern width is the distance between the tray on the left and the tray on the right at which the distribution rate is one-half the amount contained by the tray in the center. Measure this distance.

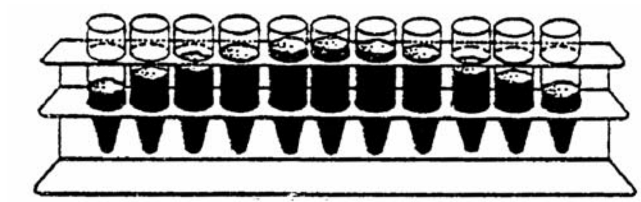

Figure 8.6. Uniform pattern distribution indicating proper helical cone or pattern slide adjustment.

Step 3 This distance is the effective pattern width and is the distance between spreader passes necessary to obtain uniform distribution.

Rate of Application

Step 1 The effective swath width and distribution pattern must be known for the material.

Step 2 Measure a line to equal 1,000 sq ft

$$\text{Line distance} = \frac{\text{1,000 sq ft}}{\text{effective swath width (ft)}}$$

Step 3 Calculate the required weight of fertilizer per 1,000 ft^2 needed to apply the desired amount of nitrogen. Example: If you want to apply 1.0 lb actual nitrogen per 1,000 ft^2 using urea (46-0-0), you should apply 2.17 lb of urea per 1,000 ft^2.

General formula

Rate	1 lb fertilizer	Area to be treated
1,000 ft^2	Analysis	

Example 1. How much 46-0-0 is needed to apply 1.0 lb N/1,000 ft^2 to a 5,000 ft^2 lawn?

1.0 lb N	1 lb fertilizer	1,000 ft^2
1,000 ft^2	0.46 lb N	

This should be computed as 1.0 lb N × 1 lb fertilizer × 1,000 ft^2 ÷ 1,000 ft^2 ÷ 0.46 lb N = Answer = 2.17 lb 46-0-0 fertilizer

Step 4 Weigh 20 lb of the product and place it in the spreader hopper and spread it over the distance required to equal 1,000 ft^2. Two or more passes will improve accuracy of the calibration. If you make two or more passes with the spreader, be certain to make the appropriate adjustments for the extra square feet covered.

Step 5 Weigh the product remaining in the hopper and subtract this amount from the amount with which you started.

Step 6 The result is the application rate for this product in lb per 1,000 ft^2. Adjust the spreader opening either up or down to achieve the desired setting.

Step 7 Repeat steps 4 through 6 until the correct application rate is achieved.

Rate of Application Calibration Worksheet

General formula

desired amount of actual nitrogen	1 lb fertilizer	1,000 ft^2
1,000 ft^2	nitrogen content of fertilizer	

This should be computed as desired amount of actual nitrogen (lb N) × 1 lb fertilizer × 1,000 ft^2 ÷ 1,000 ft^2 ÷ nitrogen content of fertilizer (lb N) = pounds fertilizer needed per 1,000 ft^2.

Calibration run #1

desired amount of actual nitrogen	1 lb fertilizer	1,000 ft^2
1,000 ft^2	nitrogen content of fertilizer	

This should be computed as _______ × 1 lb fertilizer × 1,000 ft^2 ÷ 1,000 ft^2 ÷ _________ = _________.

Calibration run #1 Spreader setting ____________

__________ lb fertilizer in spreader initially - ___________ lb fertilizer remaining in spreader = __________ lb fertilizer applied

---

Calibration run #2

desired amount of actual nitrogen	1 lb fertilizer	1,000 ft^2
1,000 ft^2	nitrogen content of fertilizer	

This should be computed as _________ × 1 lb fertilizer × 1,000 ft^2 ÷ 1,000 ft^2 ÷ __________ = __________.

Calibration run #2 Spreader setting ____________

__________ lb fertilizer in spreader initially - ___________ lb fertilizer remaining in spreader = __________ lb fertilizer applied

---

Calibration run #3

desired amount of actual nitrogen	1 lb fertilizer	1,000 ft^2
1,000 ft^2	nitrogen content of fertilizer	

This should be computed as _________ × 1 lb fertilizer × 1,000 ft^2 ÷ 1,000 ft^2 ÷ __________ = __________.

Calibration run #3 Spreader setting ____________

__________ lb fertilizer in spreader initially - ___________ lb fertilizer remaining in spreader = __________ lb fertilizer applied

---

Drop Spreader Calibration

Calibration of a drop spreader is more simple than for a rotary spreader. Drop spreaders have a fixed uniform distribution across the pattern, a fixed spread width. Therefore, only the rate of application requires calibration.

Step 1 Calculate the required weight of fertilizer, seed or pesticide per 1,000 ft^2 needed to apply the desired amount of product. Example: If you want to apply 1.0 lb actual nitrogen per 1,000 ft^2 using urea (46-0-0), you should apply 2.17 lb of urea per 1,000 ft^2. NOTE: It is common to apply one-half the product in one direction and then to apply the second half in a perpendicular direction. If applying in two directions, then calculate half of the required application rate.

General formula – fertilizer

Rate	1 lb fertilizer	Area to be treated
1,000 ft^2	Analysis	

General formula – seed

Seeding rate	1 lb seed	Area
1,000 ft^2	PLS	

General formula – pesticide product

Rate	Area to be treated
1,000 ft^2	

or

Rate	Area to be treated
Acres	

General formula – pesticide dry active ingredient

Rate	1 lb	Area to be treated
1,000 ft^2	percent a.i.	

or

Rate	1 lb	Area to be treated
acre	percent a.i.	

Step 2 Fill the drop spreader with the chosen product used in Step 1.

Brand of Spreader: __________ Brand of Product: __________

Step 3 Lay out a calibration course. Record the total length of the course, the spreader width, and then calculate the area covered in the calibration course.

A. Total length traveled: __________ (ft)
NOTE: Multiply the number of passes (i.e., down and back = 2 passes) by the length of one pass across the calibration course.

B. Spreader width: __________ (ft)

C. Area of calibration course: ___________ (ft^2)
Calculate as A × B = C.

Step 4 Calculate the amount of product that will be collected from the calibration course when calibrated correctly.

lb product (from Step 1)	Area of calibration course (from Step 3) (ft^2)	454 g
1,000 ft^2		lb

This should be computed as ________ × ________ ft^2 × 454 g ÷ 1,000 ft^2 ÷ ________ lb = __________ grams.

or

lb product (from Step 1)	Area of calibration course (from Step 3) (ft^2)	16 oz
1,000 ft^2		lb

This should be computed as ________ × ________ ft^2 × 16 oz ÷ 1,000 ft^2 ÷ ________ lb = __________ oz.

Step 5 Estimate the required setting to deliver the appropriate amount of product and adjust the spreader to that setting.

Step 6 Apply product to the calibration course and collect the fertilizer that has been released and weigh it. NOTE: This is best done by applying the product to a clean garage floor or plastic sheet or by using a specially constructed "catch tray."

Step 7 Weigh the product (in ounces or grams) released and note the setting in the chart below.

Step 8 Repeat steps 6-7 until the spreader delivers the appropriate amount of product.

Spreader Setting	Weight of Fertilizer Applied (oz)	Weight of Fertilizer Applied (g)

Step 9 Record the proper setting for this product at this rate using this particular drop spreader.

Spreader setting: ________ Product: ________ Brand of Spreader: ______________

Problems (see page 103 for answers)

2 pints	=	1 quart	1 pound	=	454 g
4 quarts	=	1 gallon	1 yard	=	3 ft
1 gallon	=	128 ounces	1 mile	=	5,280 ft
1 gallon	=	3,785 mL	1 acre	=	43,560 ft^2
1 gallon	=	8 pounds	P_2O_5	is	44% P
1 pound	=	16 ounces	K_2O	is	83% K
1 hectare (ha)	=	10,000 m^2	1 gallon	=	3.785 liters

46. A sprayer has a 14-ft boom and 10 nozzles. Each nozzle releases 775 mL of spray in 20 seconds. A 200-ft test strip is established and the sprayer is timed to travel the distance in 45 seconds. How many gallons per acre are being applied?

47. How many gallons per acre would be applied using the following sprayer?
    - 12 nozzles
    - Each nozzle releases 700 mL in 25 seconds
    - 12 foot wide boom
    - The sprayer is traveling at 3 mph

48. Based on this information, calculate the flow rate in gallons per minute of the nozzle you should choose?

    - GPA = 50
    - MPH = 3
    - Nozzle spacing = 18 inches

49. Using the handout on calibrating a hand sprayer, determine the area covered by a hand sprayer and an applicator with the following information.

Spray width = 18 inches (1.5 feet)
Traveled 60 feet in 15 seconds
Collected 12 fluid ounces in 15 seconds
Sprayer has a total capacity of 3 gallons

Based on this information, how many square feet will be covered by a full tank of spray solution?

___________ square feet

50. You wish to calibrate your drop spreader to seed some bermudagrass. You measure out a test area 50 feet long and you are using a drop spreader with a width of 36 inches. You wish to seed at a rate of 1.0 lb/1000 ft^2. You travel down 50 feet and back 50 feet once. How many grams of seed must you collect (down and back) in order for your spreader to be calibrated accurately?

51. You wish to calculate the sprayer portion of your ride-on spreader/sprayer. You travel an average of 19.74 seconds per 100 feet in low gear and collect 1,350 mL of water in 30 seconds using the high volume output nozzle. Assuming that your effective spray width is 7 feet, how many gallons per acre would you be applying with this sprayer?

Additional fact sheets available at:
http://publications.uaex.edu/

For more information about turfgrass visit:
http://turf.uark.edu/

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Disclaimer

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Answers to Problems

1. 5,750 ft^2
2, 5,000 ft^2
3. 9,180 ft^2 landscape bed with 20,820 ft^2 turf
4. 6,221 ft^2
5. 0.70 yd^3
6. 10.2 yd^3
7. 44.4 yd^3
8. 13.3 yd^3
9. 9.09 yd^3 to fill holes, 3.86 yds^3 to topdress for a total of 12.95 yd^3
10. 101.1 yd^3
11. $821.24
12. $37,752
13. 55.5 inches
14. 44,443,048 gallons
15. 74% = CU, repairs needed; 54%=$DU_{(LQ)}$, adjustment needed.
16. PLS = 0.805
17. 124.23 lb seed
18. $3.54
19. $353.97
20. 14.3% cr. red fescue, 0.97% perennial ryegrass and 84.8% Kentucky bluegrass
21. ASU = $3.86/pound PLS, Razorback = $3.64/pound PLS = best buy
22. 30,492 ft^2
23. 2.02 Acres
24. 8 lb N, 0 lb P_2O_5, 0 lb K_2O
25. 9.5 pounds 12-24-6 fertilizer
26. 1.61 lb 31-0-0 fertilizer
27. 8.3 pounds of 12-12-12
28. 38.3 pounds 24-8-12
29. 3,896 pounds 18-4-24
30. 257.4 pounds of 8-22-14
31. 50 pound bag costs $2.55/pound whereas the 40 pound bag costs $2.37/pound N
32. $2.24/pound N
33. 2.16 lb N, 0.43 lb P_2O_5, 1.08 lb K_2O
34. 8.98 gallons 20-4-10 liquid fertilizer
35. 0.97 pounds N/1,000 ft^2
36. 1.39 pounds N/1,000 ft^2
37. 3.3 pounds Barricade
38. 2 ounces of Blade 60DF
39. $43.10
40. $10.16
41. 600 pounds Merit 0.5G
42. 360 pounds Balan 2.5G
43. 0.94 gallons of Primo Maxx
44. 0.025 pounds active ingredient
45. 1.5 pounds active ingredient/gallon
46. 71.7 gallons per acre
47. 73.2 gallons per acre
48. 0.45 gallons per minute
49. 2,880 ft^2
50. 136.2 grams
51. 14.6 GPA

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