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1

Turfgrass Mathematics

Essential for applying inputs at the correct rates

2

Ratios and Proportions

- A ratio is a comparison of the relative size 2 quantities. It is usually expressed as a fraction or as two numbers separated by a colon. ½ or 1:2. These ratios would be read as a ratio of 1 to 2.

3

Ratios and Proportions

A Proportion is a statement that says 2 ratios are equal. i.e. 1/2 = 3/6. This would be expressed as 1 is to 2 as 3 is to 6. When written with a colon the product of the means is equal to the product of the extremes 1:2 = 3:6. The means being the numbers nearest the = sign and the extremes being those farthest from it. In this case 1*6 = 2*3.

4

Ratios and Proportions

This leads us to one of the most powerful tools in turgrass math cross multiply and divide.

or a*d = b*c

$$\frac{a}{b} = \frac{c}{d}$$

Much of turfgrass math deals with ratios and many of the problems we face involve applying a rate of material over an area.

5

Ratios and Proportions

The % is a special proportion that is related to 100. Basically is parts per 100. The % symbol itself reminds us to move the decimal point 2 places to the left.

6

Ratios and Proportions

- If we can learn to determine areas and then manipulate the mass and volumes specified in input labels and recommendations we can solve most of the common math problems faced by turfgrass managers.

7

Using a ratio

- Your chainsaw requires a 32:1 ratio of gasoline to oil. You have purchased an 8 fl. oz container of 2 cycle oil. How much gas must this be mixed with to produce a 32:1 mixture.

$$\frac{32}{1} = \frac{x\ oz}{8\ oz} \qquad \frac{32}{1} = \frac{256\ oz}{8\ oz}$$

8

Using a ratio

So we need 256 oz of gas to make this mixture. 256 oz * $\frac{1\ gal}{128\ oz}$ = 2 gallons of gas are needed to make this mixture.

9

Determining Area

- The area determinations of many common shapes are given in the handout. Athletic fields are usually rectangular and calculating the area is just a matter of length times width. The one exceptions are baseball/softball fields which have a quarter circle shape.

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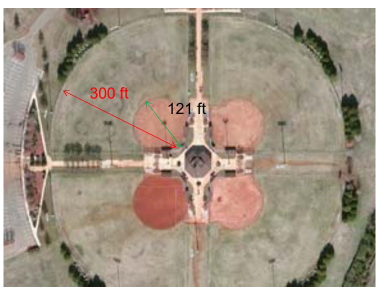

Softball field with 285 ft fence, 65 ft base lines, 46 ft pitch distance, infield arc 65 ft off pitchers plate. Total area 70,462 ft^2 infield area 11,500 ft^2

11

No No's

- **"I don't understand that <u>new math</u>"!**
- **"I work it a different way"!**

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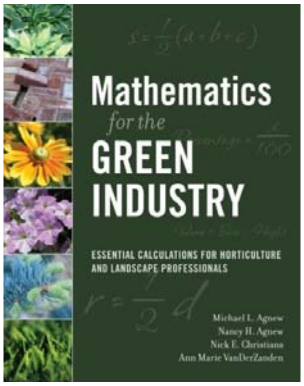

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FERTILIZER ANALYSIS`

- Percent by weight of fertilizer nutrients
- For a bag of 13-13-13 fertilizer
  - 13% elemental nitrogen (N)
  - 13% phosphoric acid (P_2O_5)
  - 13% potash (K_2O)
- P_2O_5 contains 44% elemental P
- K_2O contains 83% elemental K

%N　　%P_2O_5　　%K_2O

13 – 13 – 13

14

FERTILIZER CALCULATIONS (Part I)

How much 20-5-15 fertilizer must be applied per 1,000 ft² to deliver 1 lb of N per 1,000 ft²?

$$20\ \%\ \text{N} \therefore \frac{20}{100} = \frac{0.20\ \text{lb N}}{1\ \text{lb 20-5-15}}$$

$$1\ \text{lb N} \times \frac{1\ \text{lb of 20-5-15}}{0.2\ \text{lb N}} = 5\ \text{lb 20-5-15}$$

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FERTILIZER CALCULATIONS (Part II)

How much triple super phosphate (0-48-0) fertilizer would be needed to apply 2.5 lb P_2O_5 per 1,000 ft^2 to a 90,000 ft^2?

$$2.5 \text{ lb } P_2O_5 \times \frac{1 \text{ lb of TSP}}{0.48 \text{ lb } P_2O_5} = 5.2 \text{ lb TSP}$$

$$\frac{5.2 \text{ lb TSP}}{1{,}000 \text{ ft}^2} \times 90{,}000 \text{ ft}^2 = 468.75 \text{ lb TSP}$$

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FERTILIZER CALCULATIONS (Part III) liquid fertilizers

If one gallon of 12-4-4 liquid fertilizer weighs 10 lb, how much 12-4-4 should be applied to deliver 0.2 lb N 1,000 ft^2?

$$\frac{10 \text{ lb 12-4-4}}{\text{gal 12-4-4}} \times \frac{0.12 \text{ lb N}}{\text{lb 12-4-4}} = \frac{1.2 \text{ lb N}}{\text{gal 12-4-4}}$$

$$0.2 \text{ lb N} \times \frac{\text{gal 12-4-4}}{1.2 \text{ lb N}} = 0.17 \text{ gal 12-4-4}$$

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FERTILIZER CALCULATIONS (Part IV) liquid fertilizers

If the application volume is 2 gal per 1,000 ft^2 and the spray tank size is 100-gal, how much 12-4-4 must be added to a full tank load?

$$\frac{0.17 \text{ gal 12-4-4}}{1{,}000 \text{ ft}^2} \times \frac{1{,}000 \text{ ft}^2}{2 \text{ gal sol}} = \frac{0.085 \text{ gal 12-4-4}}{\text{gal sol}}$$

$$\frac{0.085 \text{ gal 12-4-4}}{\text{gal sol}} \times 100 \text{ gal sol} = 8.5 \text{ gal 12-4-4}$$

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TANK LOAD CALCULATIONS

If the application volume is 2 gal per 1,000 ft^2 and the spray tank size is 100-gal, how many loads will it take treat 130,000 ft^2?

$$\frac{1{,}000\ ft^2}{2\ gal} \times \frac{100\ gal}{load} = \frac{50{,}000\ ft^2}{load}$$

$$130{,}000\ ft^2 \times \frac{load}{50{,}000\ ft^2} = 2.6 \therefore 3\ loads$$

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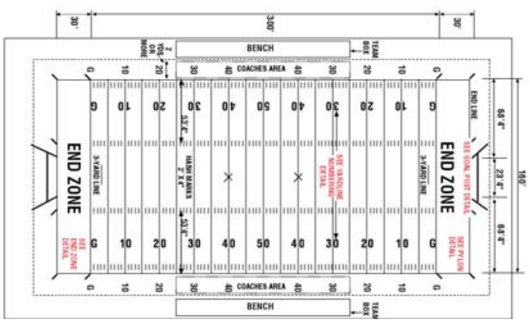

DETERMINING TREATED AREA

20

DETERMINING TREATED AREA

What is size of the field of play in acres?

Determine

Determine field dimensions

- 360 ft x 160 ft = 57,600 ft2

Convert

Convert dimensions to A

- 57,600 ft2 x 1/A = 1. 32 A
- A = 43,560 ft2

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SPRAYER CALIBRATION BROADCAST APPLY A KNOWN VOLUME

Formula: $GPM = \frac{GPA \times S \times W}{5940}$

- GPM - gallons per minute
- GPA - gallons per acre
- S - speed (miles per hour)
- W - nozzle spacing (inches)

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- Based on the desired output (GPA), speed, and type of application, this equation allows you to calculate how much carrier should be applied over a set time to be properly calibrated

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Example: 40 GPA, 4 MPH, 20” nozzle spacing

$$GPM = \frac{GPA \times S \times W}{5940}$$

$$GPM = \frac{40 \times 4 \times 20}{5940}$$

$$= 0.54$$

Catch 0.54 gal of water from one nozzle in one minute

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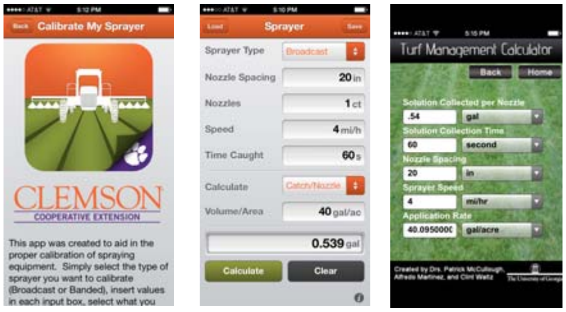

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How many oz of water must be caught from one nozzle in 1 min for a broadcast application, if the desired output is 32 GPA and the speed is 3.5 MPH and the nozzles a spaced 12" apart on the spray boom?

$$GPM = \frac{GPA \times S \times W}{5940}$$

$$GPM = \frac{32 \times 3.5 \times 12}{5940}$$

$$= 0.23\ \frac{gal}{min} \times \frac{128\ fl\ oz}{gal} = \frac{29\ fl\ oz}{min}$$

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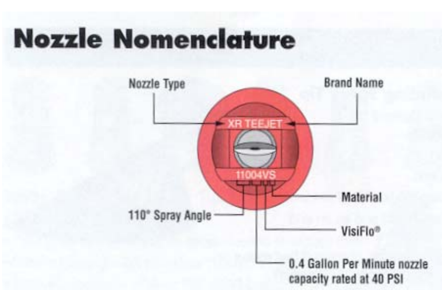
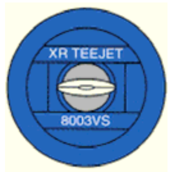


11004VS

27



8003

80º spray angle

Output is 0.3 GPM @ 40 psi

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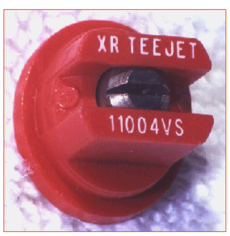
How many gal of water must be caught from one nozzle in 1 min for a broadcast application if the desired output is 40 GPA, speed is 3 MPH, and nozzle spacing is 20"?



$$GPM = \frac{GPA \times S \times W}{5940}$$

$$GPM = \frac{40 \times 3 \times 20}{5940}$$

$$GPM = 0.4$$

11004 would be the optimal tip size

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HERBIDIDE CALCULATIONS
(Part I) Spot treatments

Adding some herbicide amount to the spray tank based on the volume of solution the tank holds is only appropriate for spot treatment **not broadcast application**

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HERBIDIDE CALCULATIONS
(Part I) Spot treatments

If you want to apply a 2% Eraser solution, how many fl oz of Eraser must you add to a 3-gal pump-up sprayer?

$\frac{2}{100} = 0.02 \times 3 \text{ gal} \times \frac{128 \text{ fl oz}}{\text{gal}} = 7.68 \text{ fl oz}$

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Dry Calibration

There are two types of spreaders normally used for application of dry materials to turfgrass these are rotary spreaders and drop spreaders. Drop spreaders are usually used for small areas or when definition is needed while rotary spreaders are used in larger areas. It is usually a good practice to calibrate the spreader for half the needed rate and spread in 2 directions to avoid skips

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Drop Spreaders

Usually have a width of 2 to 6 ft. Usually easiest to measure a test strip and add a known amount of product to the hopper, spread over the test strip and then back weigh the remaining product. Sweeping up applied product or catch pans are also options.

33

Drop Spreaders

Our drop spreader is 4 ft wide and we need to apply 5.0 lbs of product per 1000 ft^2 and we have chosen to apply a half rate 2.5 lbs in 2 directions. We choose a test strip that is 50 ft long. How much product should be applied to the test strip if we are correctly calibrated?

$$\frac{2.5\ lbs}{1000\ ft^2} = \frac{0.5\ lbs}{200\ ft^2}$$

34

Drop Spreaders

So we apply product to our test strip and zero in on our target of putting 0.50 lbs of product out over our test strip. Once we have done this we are calibrated. Some fertilizer products have recommendations for spreader settings and these are good starting points but should not be considered as gospel.

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Rotary Spreaders

Rotary spreaders are used to cover larger areas. The spread pattern should be examined to assure uniformity. Again I have had the best luck weighing in a known amount of product, spreading a test strip and then weighing what's left.

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Rotary Spreaders

Our rotary spreader has a 10 ft wide spread and we need to apply 5.0 lbs of product per 1000 ft^2 and we have chosen to apply a half rate 2.5 lbs in 2 directions. We choose a test strip that is 50 ft long. How much product should be applied to the test strip if we are correctly calibrated?

$$\frac{2.5\ lbs}{1000\ ft^2} = \frac{1.25\ lbs}{500\ ft^2}$$

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Rotary Spreaders

So we apply product to our test strip and zero in on out target of putting 1.25 lbs of product out over our test strip. Once we have done this we are calibrated. Some fertilizer products have recommendations for spreader settings and these are good starting points but should not be considered as gospel.

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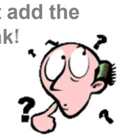
HERBIDIDE CALCULATIONS (Part II) Broadcast

- For broadcast applications, label direction typically provide herbicide rates in some amount over some unit area
  - oz/1,000 ft^2
  - pt/A
- Without calibrating the sprayer, you cannot add the correct amount of herbicide to the spray tank!



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Key Weeds Controlled or Suppressed and Application Rates:

Weeds Controlled	Application Rate[1] (pt/acre)	Application Rate[1] (fl oz/ 1000 sq ft)
bedstraw, catchweed deadnettle, purple purslane, common	2/3 – 1	0.25 – 0.38
bindweed, field burnweed, American burweed, lawn buttonweed, Virginia chickweed catsear, common cinquefoil, oldfield clover, white ivy, ground lespedeza, common medic, black sida, southern speedwell, slender strawberry, wild velvetleaf woodsorrel, common woodsorrel, yellow	1 – 1 1/3	0.38 – 0.5
clover, hop dandelion, common henbit knotweed, prostrate matchweed plantain, broadleaf plantain, buckhorn spurge, spotted	2 1/2	0.9
Dollarweed (suppression only) Veronica species (suppression only)	1 – 2 1/2	0.38 – 0.9

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HERBIDIDE CALCULATIONS
(Part II) Broadcast

If you want to apply 1 fl oz of Princep 4L per 1,000 ft², how much Princep 4L must you add to a 50-gal sprayer calibrated to deliver 2 gal per 1,000 ft²?

$$\frac{50\text{ gal}}{\text{load}} \times \frac{1000\text{ ft}^2}{2\text{ gal}} = \frac{25{,}000\text{ ft}^2}{\text{load}}$$

$$\frac{1\text{ fl oz Princep 4L}}{1000\text{ ft}^2} \times \frac{25{,}000\text{ ft}^2}{\text{load}} = \frac{25\text{ fl oz Princep 4L}}{\text{load}}$$

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HERBIDIDE CALCULATIONS
(Part II) Broadcast

If you want to apply 1.5 qt/A of Roundup Pro, how much Roundup Pro must you add to a 100-gal sprayer delivering 30 gal/A?

$$\frac{100\text{ gal}}{\text{load}} \times \frac{\text{A}}{30\text{ gal}} = \frac{3.3\text{ A}}{\text{load}}$$

$$\frac{1.5\text{ qt Roundup Pro}}{\text{A}} \times \frac{3.3\text{ A}}{\text{load}} = \frac{4.95\text{ qt Roundup Pro}}{\text{load}}$$

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HERBIDIDE CALCULATIONS (Part II) Broadcast

If you want to apply 0.5 oz/A of Manor, how much Manor must you add to a 100-gal sprayer delivering 40 gal/A?

$$\frac{100\text{ gal}}{\text{load}} \times \frac{\text{A}}{40\text{ gal}} = \frac{2.5\text{ A}}{\text{load}}$$

$$\frac{0.5\text{ oz Manor}}{\text{A}} \times \frac{2.5\text{ A}}{\text{load}} = \frac{1.25\text{ oz Manor}}{\text{load}}$$

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WEED & FEED CALCULATIONS (Part I)

- Andersons 14-0-14 Poly S with Pendimethalin
  - 1.07% Pendimethalin
  - 14 % N
  - 0% P_2O_5
  - 14% K_2O

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WEED & FEED CALCULATIONS (Part I)

A park commission worker applies 4 bags of Andersons 14-0-14 Poly S with Pendimethalin Weed Control on bermudagrass in mid-March. If the treated area in the park was 100 x 300 ft and one bag of Andersons 14-0-14 Poly S with Pendimethalin Weed Control contains 50 lbs of product, how much product did he apply per 1,000 ft^2?

$$\frac{50\text{ lb}}{\text{bag}} \times 4\text{ bag} = \frac{200\text{ lb}}{30{,}000\text{ ft}^2} \times 1{,}000\text{ ft}^2 = 6.67\text{ lb}$$

45

WEED & FEED CALCULATIONS (Part II)

If the desired rate for effectively controlling the weeds in the park area is at least 0.066 lb Pendimethalin per 1,000 ft², did he put out enough Pendimethalin with the fertilizer plus weed control?

1.07 % Pend. $\therefore \frac{1.07}{100} = \frac{0.0107 \text{ lb Pendi.}}{1 \text{ lb pr}}$

6.67 lb pr x $\frac{0.0107 \text{ lb Pendi.}}{1 \text{ lb pr}}$ = 0.071 lb Pendi. <u>YES</u>

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WEED & FEED CALCULATIONS (Part III)

If recent soil test results recommend that area in the park needs 1.5 lb N per 1,000 ft², did the he put out enough N with the fertilizer plus weed control product?

14 % N $\therefore \frac{14}{100} = \frac{0.14 \text{ lb N}}{1 \text{ lb pr}}$

6.67 lb pr x $\frac{0.14 \text{ lb N}}{1 \text{ lb pr}}$ = 0.93 lb N <u>NO</u>

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WEED & FEED CALCULATIONS (Part VI)

How much ammonium nitrate (34-0-0) is needed per 1,000 ft² to satisfy the N requirement?

Need: 1.50 lb N per 1,000 ft²

Applied: - <u>0.93 lb N per 1,000 ft²</u>

$\therefore$ 0.57 lb additional N needed per 1000 ft²

0.57 lb N x $\frac{1 \text{ lb 34-0-0}}{0.34 \text{ lb N}}$ = 1.68 lb 34-0-0

48

TOPDRESSING CALCULATIONS (Part I)

Problem: How much sand is needed to topdress a high school football field between the harshmarks from endzone to endzone to a depth of ¼ inch? Hashmarks are 53 ft 4 inches wide in HS times 300 ft = 16,000 ft^2 of area

Equation needed:

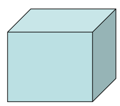
Volume of sand = Desired depth x Area

49

Problem: How much sand is needed to topdress a 16,000 ft^2 of football field to a depth of ¼ inches?

1. Convert ¼ inches to feet

   $0.25 \text{ in} \times \frac{\text{ft}}{12 \text{ in}} = 0.021 \text{ ft}$



2. Multiply desired depth (ft) by area (ft^2)

   $0.021 \text{ ft} \times 16{,}000 \text{ ft}^2 = 336 \text{ ft}^3$ of sand

3. To convert ft^3 to yd^3

   $336 \text{ ft}^3 \times \frac{\text{yd}^3}{27 \text{ ft}^3} = 12.4 \text{ yd}^3$ of sand

TURFGRASS MANAGMENT

50

TOPDRESSING CALCULATIONS (Part II)

If the field is aerified before topdressing, the volume of the aeration holes must be accounted for before ordering topdressing material.

51

TOPDRESSING CALCULATIONS (Part II)

If aeration creates 9 holes per ft^2 with a core diameter of ¾ inch and a depth of 8 inches, what is the volume of all cores per ft^2?

Equations needed:

Radius (r) = 1/2 (diameter)

Area of a core = $\Pi \times r^2$

Volume of 1 core = Area x height (h)

Volume of cores per ft^2 = Volume of 1 core (in^3/hole) x aeration density (hole/ft^2)

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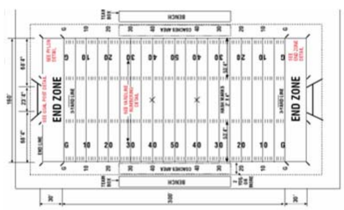
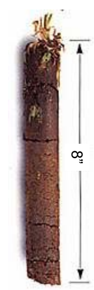
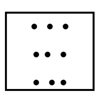




9 holes/ ft^2



8-in depth

53

If aeration creates 9 holes per ft^2 with a core diameter of ¾ inch and a depth of 8 inches, what is the volume of all cores per ft^2?

1. Determine the radius of one core

   ½ x (0.75 inch) = 0.375 inch

2. Determine surface area of one core

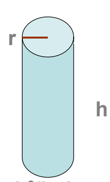
   3.14 x $(0.375)^2$ = 0.442 $inch^2$

3. Determine the volume of one core

   0.442 $inch^2$ x 8 inches = 3.53 $inch^3$/hole

4. Determine volume of cores per ft^2

   $\frac{3.53\ inch^3}{hole} \times \frac{9\ holes}{ft^2} = \frac{31.8\ inches^3}{ft^2}$



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TOPDRESSING CALCULATIONS (Part III)

How much sand is needed to fill the core holes?

1. Convert core volume (in^3/ft^2) to (ft^3/ft^2)

$$\frac{31.8\ in^3}{ft^2} \times \frac{ft^3}{1{,}728\ in^3} = \frac{0.0184\ ft^3}{ft^2}$$

2. Multiply core volume by area to determine volume of sand needed to fill the core holes

$$\frac{0.0184\ ft^3}{ft^2} \times 16{,}000\ ft^2 = 294.5\ ft^3 \times \frac{yd^3}{27\ ft^3} = 10.9\ yd^3$$

55

TOPDRESSING CALCULATIONS (Part IV)

So how much total sand is needed to topdress the 16,000 ft^2 of football field and fill the holes after aerification?

Equation needed:

Amount of sand needed to topdress green to 1/4 inch depth + Amount of sand needed to fill holes left from aerifying

$12.3\ yd^3 + 10.9\ yd^3 = 23.2\ yd^3$

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Overseeding Rates that Maximize Performance and Quality

- 6-10 pounds pure live seed/1000 sq ft
- 10-20 pounds pure live seed/1000 sq ft for superior football/soccer turf
- Baseball: Use above rates or as a rule of thumb, 100# on infield + 500# in outfield

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Seed Calculations

Rebel Landshart Special Blend
Ima Kiffin Seed Co.
Taylor, MS   Lot # 325

Grasses	Germination	
34.62% Hotty perennial ryegrass	80%	= 27.7
37.33% Toddy perennial ryegrass	80%	= 29.9
21.97% Landshark perennial ryegrass	75%	= 16.5
		74.1%

Other ingredients
1.19% Other Crop Seed
4.89% Inert Matter

So, if your target rate for seeding was 20 lbs PLS/1000 sq ft you will need 20 ÷ 0.74 = 27 lbs of Blackbear Special for every 1000 sq ft. No consideration of PLS? Actually would apply only 14.8 lbs/1000 sq ft with every 20 pounds of this seed.

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Liquids vs Granular Formulations

You are looking at putting out oxadiazon as a PRE on your athletic field as you are concerned about root pruning from most other PRE's. You have two choices Oxadiazon 2G 50lbs for $110.00 for 50 lbs or Ronstar Flo (35.1% AI) for $199.60 per gallon. Which product offers the least expensive application?

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Liquids vs Granular Formulations

From the label Oxadiazon 2G is applied at 200 lbs per acre. Cost per Acre =

200 lbs / 50 lbs per bag = 4 bags

4 bags X $110 per bag = $440. So the cost is $440 per acre

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Liquids vs Granular Formulations

From the label Ronstar Flo is applied at 122 fl oz per acre. The cost of Ronstar Flo was $199 per gallon (128 fl oz per gallon).

$199 / 128 oz = $X / 122 oz solving for X ($199 * 122) / 128 = $189.67. So the cost per acre is $189.67.

So Sprayed Ronstar is the less expensive application.

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Liquids vs Granular Formulations

You are looking at putting out prodiamine PRE on your athletic field. You have two choices Barricade DG (0.48% Dispersing Granules) 50 lbs for $76.48) or Barricade 4 FL (4 lbs per gal AI) for $218.45 per gallon. We are applying 1.5 lbs AI per ac. Which product offers the least expensive application?

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Liquids vs Granular Formulations

From the label Barricade DG is applied at 313 lbs per acre. Cost per Acre =

313 lbs / 50 lbs per bag = 6.25 bags

6.25 bags X $76.48 per bag = $478. So the cost is $478 per acre

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Liquids vs Granular Formulations

From the label Barricade 4 FL is applied at 1.5 lbs AI per acre. The cost of Barricade 4 FL is $218.45 per gallon (4 lbs AI per gallon).

$218.45 / 4 lb = $X / 1.5 lb solving for X ($218.45 * 1.5) / 4 = $81.92. The cost per acre is $81.92

So Sprayed Barricade is the less expensive application.

64

Irrigation Problems

Commonly Used Convesions in working with water.

1 ft^3 = 7.48 gallons of water

325,851 gallons of water = 1 acre-foot

27,152 gallons of water = 1 acre-inch

65

Irrigation Problems

You apply 0.7 inches of water per week at your 60 acre sports complex, of which 41 acres are irrigated. If you irrigate 17 weeks of the year, how many gallons will you consume?

$$\frac{0.7\ in}{week} x41\ ac\ X\ \frac{27{,}152\ gallons}{Acre - Inch} \text{x 17 weeks} = \text{13,247,460 gallons}$$

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Irrigation Problems

34 acres of turf are to be irrigated with 1.3 in. of water per week for 16 weeks of the season. The water must be purchased from the city for $0.04 per cubic foot. How many need to budgeted to purchase water? (1.3 in / 12 in / ft) = 0.108 ft

$$34\ ac\ x\ \frac{43{,}560\ ft^2}{ac} \text{ x } \frac{0.108\ ft}{wk} \text{ x } 10 \text{ wk} = 1{,}599{,}523\ ft^3$$

$1{,}599{,}523\ ft^3 \text{ x } \frac{\$0.04}{ft^3}$ = \$63,981

67

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