Calibration Basics for
Spreaders and Sprayers
Large and Small

STMA 2017

sdoak@vt.edu

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WHY CALIBRATE

SAVES MONEY

MATERIALS AND APPLICATION COSTS

SAVES THE ENVIROMENT

RIGHT AMOUNT, IN RIGHT PLACE

SAVES YOURSELF

YOU KNOW, AND YOU CAN PROVE IT

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WE WILL COVER

- Why calibrate
- General concepts
- Spreaders
  - Drop – small area
  - Broadcast – small and large area
- Sprayers
  - Handheld – small area
  - Boom - large area

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Purpose of Calibration

- **Verify that your machines [spreaders and sprayers] are applying the correct amount of material over the correct area.**
  - **Issues with over-application**
    - Harm to target and non-target species
    - Potential harm to environment
    - Costs money – extra materials - waste
    - Legal and Other comlications
  - **Issues of under-application**
    - Not effective control – creating a safety issue?
    - Need to re-apply -- Costs money – wasted materials, re-apply costs
    - Other – professional or not ??

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"You did order the chemical-free insecticide."

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What questions need to be answered in order to successfully calibrate?

- **1) How much material needs to be applied in a specific area?**
- **2) How to calculate the size of the calibration collection area?**
- **3) How to collect the material from the collection area?**

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Before Calibration **ALWAYS!!**

- **CHECK YOUR EQUIPMENT**
  - PUMPS, HOSES, SWITCHES, VALVES, ETC
  - NOZZLES
    - 5 -10% different from others = REPLACE IT
    - If 2 or more are 5-10% = REPLACE **ALL** NOZZLES
  - **CONSISTANT PRESSURE A MAJOR FACTOR IN SPRAYER CONSISTANCY**
  - **CONSISTANT SPEED A MAJOR FACTOR IN SPREADER CONSISTANCY**

SO, CHECK !!!!!!

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Question to be answered

- **Sprayers**
  - 1) How much **water** is **sprayed** in a specific area?
    - Water amount per area = flow
      - Usually in ***Gallons Per Acre*** **[GPA]**
      - or in *gallons per* 1,000ft^2
  - 2) Use this flow **[GPA]** to determine how much product to put in the container
    - Fill the container with amount for the area to be sprayer
    - Add the amount of product for the area to be sprayed

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TYPES OF SPREADERS AND SPRAYERS

- **Spreaders**
  - DROP
  - BROADCAST / ROTARY
    - PUSH [small area] AND PULLED [Large area]
- **Sprayers**
  - HAND HELD [small area]
  - BOOM [large area]

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Question to be answered

- Sprayers
  - Use the GPA to find how many acres a tank will spray
- Example: If you use a 100 gallon tank and the GPA is 20. Then a full tank will spray 5 acres

  100 gallon / tank = **5 acres per tank**

  20 gallons / acre

So you would place enough product for 5 acres in a full tank

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Question to be answered

- **Spreaders**
  - 1) Calculate how much **PRODUCT** is needed in a specific area?
    - Product amount per collection area **= target amount**]
      - Square feet - usually 1,000ft^2 or per acre
      - Small spreaders = per square foot
  - 2) Compare this **target amount** to what is *actually* collected
  - 3) Adjust, so target amount and collected are the same

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YOUR QUESTIONS ??

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SPREADERS


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HOW MUCH PRODUCT?

PER SQUARE FOOT
PER MINUTE

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SPREADERS

NEED TO FIND THE TARGET AMOUNT !!

1) HOW MUCH
2) OVER A GIVEN AREA

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1) How much material needs to be applied in a specific area?

– **Spreaders – granular** – Example #1

- If 2.8 lb of product is needed per 1,000ft²
- Find how much product per one ft²
  - *by dividing the rate by 1,000*
  - = 2.8 lb / 1,000 = 0.0028 lb per ft² OMG That's Small !!
- This is such a small number you will need to convert to grams or ounces - in order to measure on a standard scale
- Do this by multiplying the answer by 454 to get grams
  - Or multiplying by 16 to get ounces
  - 0.0028 * 454 = **1.27 grams per one ft²**
  - 0,0028 * 16 = 0.045 ounces per one ft² *TO SMALL FOR USE BY A SCALE*

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1) How much material needs to be applied in a specific area- THE TARGET AMOUNT ?

– **Spreaders – granular**

- 1) Amount of product to be applied – the recommended rate
- 2) THEN covert rate to pounds per square foot
  - » or ounces per square foot
  - » or grams per square foot
- 3) KNOW how big is the collection area
- 4) Multiply #2 by #3 = TARGET AMOUNT
- 5) Adjust openings so amount captured will equal the target amount

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1) How much material needs to be applied in a specific area?

1 Acre = 43.560 ft²

– **Spreaders – granular** – example # 2

- If the rate is 150 lb per acre
- Find how much is per one ft² by dividing the rate by 43,560 = 150 lb / 43,560 = 0.00344 lb per ft²
- This is such a small number you will need to convert to grams or ounces
  - Do this by multiplying the answer by 454 to get grams
  - Or multiplying by 16 to get ounces
  - 0.00344 * 454 = **1.56 grams per one ft²**
  - 0,0028 * 16 = 0.055 ounces per one ft² *TO SMALL FOR USE BY A SCALE*

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1) How much material needs to be applied to the calibration area?

- **Multiply the amount of material per square foot by the number of square feet in the *calibration collection area* to find**
- **THE TARGET AMOUNT TO BE COLLECTED.**

- If you collect LESS than the target amount = make the spreader opening LARGER and repeat the calibration run.
- If you collect MORE than the target amount = make the spreader opening SMALLER and repeat the calibration run.

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2) How to calculate the calibration collection area?

- - ***Width of spread***
  - – Measured
    - Drop spreader – *size of spreader opening*
  - – Effective - calculated
    - Broadcast spreaders – effective width
  - – ***Length of spread – per one minute***
    - Distance traveled
      - – Measured [small spreaders or hand sprayers]
      - – **Per minute [large spreaders]**
      - – **E.G. covers 4,500 ft² in one minute**

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2) How to calculate the calibration collection area?

Width
Spreader or Boom width

Area covered in one minute
Area of a rectangle = Width times Length

- **Length** traveled in one minute

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HOW BIG AN AREA?

SQUARE FOOT – COLLECTION
OR
PER MINUTE

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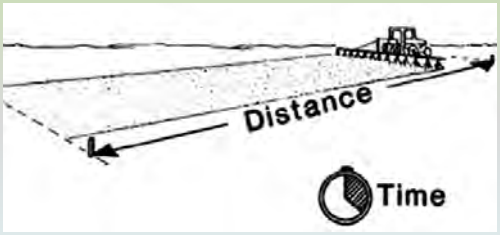
Area covered in one minute
Area of a rectangle = Width times Length



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2) How to calculate the calibration collection area?

- The machine has a boom of 25' and travels 220' in one minute.
  - **AREA = 25' * 220' = 5,500 ft² *per minute***
- The machine has a boom of 15' and travels 308' in one minute.
  - **AREA = 15' * 308' = 4,620 ft² *per minute***

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Two methods to COLLECT the amount of product being applied

- **Catch method**
  - Attach a "catch can or tray" under the hopper to catch the product being applied.
    - Small calibration area =
      - Run the machine over the calibration area -
    - **LARGE calibration area =**
      - **Run the machine for the length of time it would take to cover the calibration area**
      - ***Usually one minute***
    - – **Run the machine at the same RPM as the machine would use for spraying or spreading operations - KEY**

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2) How to calculate the calibration collection area?

- For DROP spreaders [small spreaders]
  - ***The calibration area is usually a piece of plastic or a smooth flat concrete area***
  - ***The width will be the width of the spreader opening***
  - ***The length will be the length of the plastic***
  - ***Example: A 3 foot spreader is pushed over a 10' by 10' sheet of plastic.***
    - ***Width times length = 3' times 10'***

= 30 ft² calibration area

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Spreader Examples Covered

- **Drop spreader**
  - Sweep method
  - Catch method
- **Rotary spreader**
  - Catch method
  - Finding **effective spread width**

- Motorized spreaders
  - Finding the speed

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Two methods to COLLECT the amount of product being applied

- Sweep method and the Catch method
- **Sweep method** – used for drop spreaders
  - Apply the product by pushing the spreader over a measured paved surface or plastic sheet
    - – **Pushing spreader at a constant speed, each time, is key point**
  - Then sweep/collect the product, **weigh the product and compare to target weight.**
  - Adjust the opening so the collected weight matches the target weight

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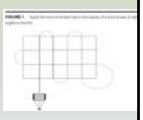
Drop Spreader

- Fixed spread width
- The most accurate distribution of material
- Skips or overlaps very noticeable
  - Best to apply ½ of the amount, then cover same area again but from right angles to the original direction with the remaining ½



- Takes more time than rotary spreaders

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Sweep Methodology

- **Mark an area on a smooth piece of pavement**
  - **Usually a set length**
  - **Or use a sheet of plastic of a set length**

HOW TO:

- **Set the hopper opening in a low to medium range setting**
- **Put some product in the hopper [1/4 to1/2 full]**
- **Push the spreader at a comfortable walking speed**
  - **At same pace used to actually apply product**
- **Open the hopper just prior to reaching the marked area or plastic sheet**
- **Travel the marked off distance**
- **Close the hopper after you are off the plastic or area**

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Catch Method

- Conceptually similar to the sweep method
  - Push the spreader over a measured length
  - Collect the product released in a catch pan mounted under the spreader opening
- The amount caught compared to the target amount calculated for the area covered
  - E.g. 3' wide spreader pushed 5' = 15 ft^2
    - Calibration can be faster that the area method but the spreader has to be equipped to hold a catch pan

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Drop spreader ---- Sweep Methodology

- **Sweep the product and put into a pre-weighted container**
- **Or collect the product on the plastic sheet and pour into a pre-weighted container**
- **Weigh the product**
- **Record the weight of the product that was collected**
- **Compare to the target amount [weight]**
- **Adjust the opening to better match the target weight**
- **Repeat the procedure until consistent results are obtained within 5% of target weight**

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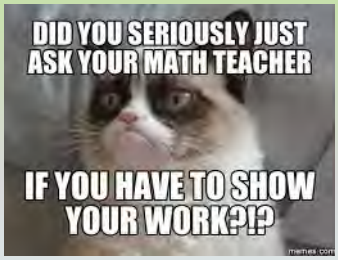

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Catch method

– Attach a "catch can or tray" under the hopper to catch the product being applied.

- Small calibration area =
  - Run the machine over the calibration area -
- LARGE calibration area =
  - Run the machine for the length of time it would take to cover the calibration area
  - ***Usually one minute***
- – **Run the machine at the same RPM as the machine would use for spraying or spreading operations - KEY**

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Put it together – drop spreader

- 1) Length of collection area [plastic sheet]
- 2) Spread width [drop spreader width]
- 3) How much product is needed per ft^2
- 4) NOW you can find the **target amount** need to collect in one minute
  - *Remember to use the same walking speed each time*

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- **THE TARGET AMOUNT IS THE RATE [PER FT^2] TIMES THE CALIBRATION AREA [in ft^2]**
  - **Example #1 :**
  - **RATE: The amount is 4.67 lb product per 1,000 ft^2**
    - **Find the rate per ft^2 by dividing the rate by 1,000**
    - **so, 4.67 /1,000 = 0.0047 lb per ft^2**
  - **THE CALIBRATION AREA: is 5' wide drop spreader pushed over 10' plastic sheet**
    - **Calibration area is 5' * 10' = 50 ft^2**
  - **THE TARGET AMOUNT IS**
    - **0.0047 lb per ft^2 * 50 ft^2 = 0.235 lb per 50 ft^2**

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You try

Spreader width = 3 feet

Plastic size is 5' by 5'

Product amount is 0.0035 lb/ft^2

Collection area = 3' * 5' = **15 ft^2**
Width times length = area

Amount needed to collect = **0.0525** lbs.
[15 ft^2 * 0.0035 lb/ft^2]

Amount needed to collect = **23.8** grams
[0.0525 lb * 454]
454 grams per lb

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Area used to calibrate = 50 ft^2

Rate worked to * 0.0047 lb / ft^2

0.235 lb / 50 ft^2 => target weight

OMG that is a small amount. Won't be able to find a scale that can handle that many decimals!!

SO, convert the answer into a unit that will give you an equal but larger number.

USE GRAMS !!

Multiply by 454 to get 106.69 grams / 50 ft^2 = target weight

THIS IS A WEIGHT YOU CAN MEASURE ON A SCALE

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YOU try – *help your neighbors!*

- **Example # 2**
- Spreader width = 8'
- Plastic sheet 10'X10'
- Product amount = 0.00459 lb/ft^2

TARGET AMOUNT =
0.3673 lb or 166.76 gms

- **Example # 3**
- Spreader width = 6'
- Plastic sheet 30'X30'
- Product amount = 0.0036 lb/ft^2

TARGET AMOUNT =
0.648 lb or 294.19 gms

CATCH METHOD !!

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The "how to"

- ***Make passes over the plastic and weigh after each try and adjust the spreader opening until the weight is close to the TARGET WEIGHT*. Make several more attempts to make sure the weights are within 5% of target weight**
- **-The spreader is now calibrated to that rate and product**
- ***-Record the spreader setting, fertilizer and the rate.***
  (unless you want to do this every time)

REMEMBER to open and close the spreader OFF of the plastic !!!! [when you open you get extra material]
JUST LIKE A DROP SPREADER !

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Does a BROADCAST SPREADER throw the same amount over the entire width of spread?

Where does the largest amount end up?
Middle or edge?

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Effective spread Width
Broadcast Spreaders

Broadcast spreaders DO NOT evenly distribute material evenly across the spread width

- **Places MORE material closer to the spinners**
- **Spreads LESS material at the end of the pattern**

- **The key** is to find how far from the center [in feet] is the point(s) where exactly half of the amount of material as that placed at the center is located.

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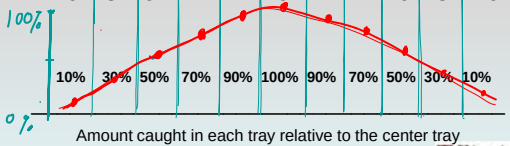
Spreader pattern uniformity

- **Granular product throw distance to either side of spreader with "collection trays"**
- **Distribution is not uniform**
- **Spread distance in feet from center**
- **10' 8' 6' 4' 2' 0 2' 4' 6' 8' 10'**



Amount caught in each tray relative to the center tray

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Broadcast spreaders

MUST FIND THE EFFECTIVE WIDTH

NOT JUST THE TOTAL WIDTH OF THE SPREAD

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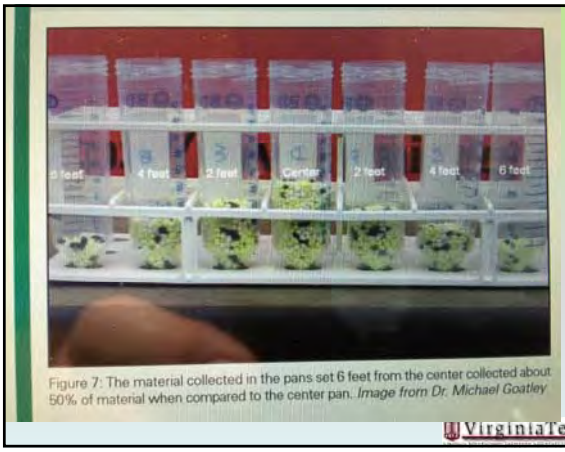

Figure 7: The material collected in the pans set 6 feet from the center collected about 50% of material when compared to the center pan. *Image from Dr. Michael Goatley*

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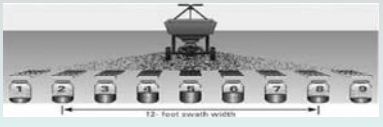
The Calibration setup --- drawing of pan placements

All the catch devices must be identical !!



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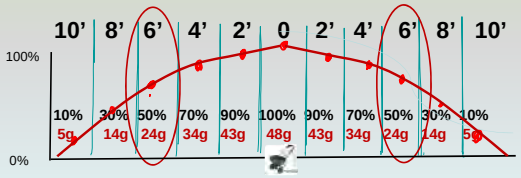
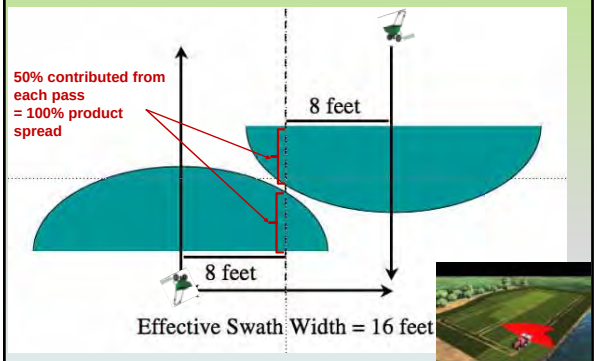
Broadcast spreader pattern uniformity

- **The maximum amount collected [next the the spinner] is 100%**
  - **Example:**
  - **If the center amount is 48 grams So, 48g = 100%**
    - **Then 24 grams is 50% 24 grams/ 48 grams = 0.50 = 50%**
    - **Then 34g / 48g = 0.708 = 70%**

Divide collected by 48g



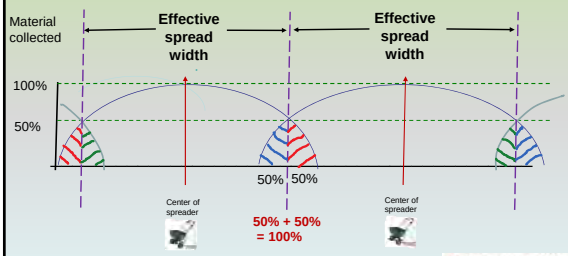
Amount caught in each tray relative to the center tray



Based on psu.edu drawings

The effective spread [swath] width is the distance on either side of the center where ½ of weight of the center tray was collected

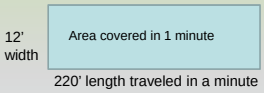
- This overlap will have uniform coverage (100%)



Based on PSU diagrams

Use the Effective width in calculations to find the area covered

- Example
  - **Effective width is 12' and the machine moves 220' in one minute.**



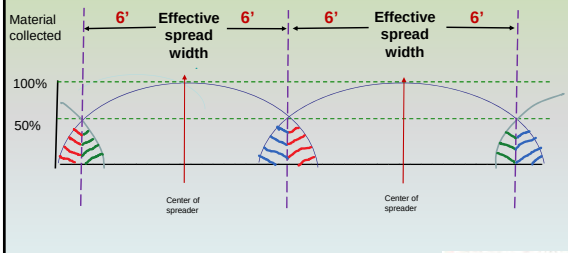
220' length traveled in a minute

  - Area covered in one minute is :
    - Width * length = Area
    - **12' * 220' = 2,640.0 ft² / minute**

This example show that 6' from the center is the point where 50% weight of the center tray is collected.

The Effective Width is 6' + 6' = 12 feet wide

- This allows overlap that will have uniform coverage



Based on PSU diagrams

Use the area covered to calculate the Target Amount needed to be collected in one minute

220' length traveled in **a minute**

- Area covered in **one minute** is :
  - **12' * 220' = 2,640.0 ft² / minute**
- **What if you need 0.0047 lb per ft²**
- **Then 0.0047ft² * 2,640.0 ft² / minute =**

= 12.41 lb per 2,640 ft² = Target Amount

Calibrate Broadcast Spreaders-

the mechanics

- How To Calculate the Effective Width
  - Use evenly spaced catch devices
  - Repeat several times and calculate percentages
    - With the max amount [next the spinner] set as 100% amount Next find the "effective swath width"
    - Use a series of uniform [same sized] trays
    - About 6 x 6 or larger – all the same size
  - Equally spaced = measured

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The quickest way to determine speed - MPH per Dr. Dale Wolf

- Note: **88 feet per minute = 1 MPH**

5280 ft/mile = **88 ft/min**
60 sec/min

- 1) Measure a track **88 feet long**
- 2) Be at operating speed before entering the track
- 3) Time how long it takes to travel the 88 ft (in seconds)

E.g. 60 sec= 1 MPH, 30 sec = 2 MPH
20 sec = 3 MPH 15 sec = 4 MPH

Other times => **Divide 60 by the number of seconds it takes to travel the 88 ft**

23 seconds => $\frac{60}{23}$ = 2.6 MPH 40 sec => $\frac{60}{40}$ = 1.5 MPH

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Speed – a key factor in spreading uniformity

- Need steady motion to spread evenly
- Steady walking pace
  - Calibrate at spreading speed
- Motorized spreaders
  - **Use rpm and gear number to get consistent speed**
  - **Calibrate at spreading speed**
    - **Double check the speedometer versus actual**

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You try ----- remember: $\frac{60}{\text{time}}$ = MPH

Time to cover 88 ft	equals MPH
23 seconds	**2.6 MPH**
18 seconds	**3.33 MPH**
15 seconds	**4.0 MPH**
11 seconds	**5.45 MPH**

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Measure your speed in miles per hour [MPH]

-Will show a simply way next

Then convert MPH into feet per minute

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Then, convert MPH into feet per minute

- **MPH** times **88 ft/min =**

FEET TRAVELED IN ONE MINUTE

EXAMPLES:

1.0 mph * 88 = 88 feet traveled in 1 minute
2.0 mph * 88 = 176 feet traveled in 1 minute
2.7 mph * 88 = 237.6 feet traveled in 1 minute
5.6 mph * 88 = 492.8 feet traveled in 1 minute

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Example #1 continued

So this setup covers 4,576 ft² every minute

Flow = 250 lb/A = 0.00574 lb/ft²

How much product is needed per minute? [target amount]

4,576 ft²/min * 0.00574 lb/ft² = 26.26 lb/minute

Put it together

- 1) Speed – **how far it moves in one minute**
- 2) Spread width
- 3) How much product is needed **per ft²**
- 4) NOW you can find the **target amount** need to collect in one minute
  - *Remember to use the same rpm as you did when calculating the speed*

Example #2 - small spreader

1) Speed = 1.8 MPH

1.8 * 88 ft/min = 158.4 ft in 1 minute

2) Width of spread = 10 ft

area covered in 1 minute = 158.4ft* 10ft = 1,584.0 ft²

So this setup covers 1,584 ft² every minute

3) Flow = 250 lb/A = 0.00574 lb/ft² *[trust me]*

$\frac{250\ lb}{43{,}560 ft^2} = 0.0057392\ lb/ft^2$

Example #1

1) Speed = 2.6 MPH

2.6 * 88 ft/min = 228.8 ft in 1 minute

2) Width of spread = 20 ft

area covered in 1 minute = 228.8ft* 20ft = 4,576 ft²

So this setup covers 4,576 ft² every minute

3)Flow = 250 lb/A = 0.00574 lb/ft² *[trust me]*

$\frac{250\ lb}{43{,}560 ft^2} = 0.0057392\ lb/ft^2$

Example #2 continued

So this setup covers 1,584 ft² every minute

Flow = 250 lb/A = 0.00574 lb/ft²

How much product is needed per minute?

1,584 ft²/min * 0.00574 lb/ft² = 9.09 lb/minute

SKIP TO SPRAYERS

The next slides are for additional ways of using the information you have gathered.
Pus you will see similar material with boom sprayers!

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$\frac{43{,}560\ ft^2 / acre}{2{,}112\ ft^2 / minute}$ = **20.625 minutes / acre**

9.7 lb of product / minute -- measured with the catch method

Rate per acre:

9.7 lb/min * 20.625 min/acre **= 200 lb / acre**

EXTRA:

2,112 ft^2/min * 60 min/hr = 126,720 ft^2 covered in 1 hr.

Then $\frac{126{,}720\ ft^2 / hour}{43{,}560\ ft^2 / acre}$ = 2.91 acres / hour

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If you already know how much is dropped in one minute and want to find the *amount spread per acre*

- 1) Speed – **how far it moves in one minute**
- 2) Spread width
- 3) Amount of material dropped – in one minute
- With these three pieces of information you can find:
  - How much material is spread per acre
  - How long it will take to spread one acre

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Your turn #1:

2.5 MPH and a **20 foot width**
25 lb product per minute flow

Find minutes per acre and lb per acre:

2.5 MPH * 88 ft/min = 220 ft / min

220 ft / min * 20 ft swath = **4,400 ft^2 / min**

$\frac{43{,}560\ ft^2 / acre}{4{,}400\ ft^2 / min}$ = **9.9 minutes / acre**

25 lb / min {flow} * 9.9 min / acre = **247.5 lb / acre**

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Spreader example:

for a given 1) **speed** and given 2)**width** and known 3)**flow**
Find the lb of product spread per acre

- **1) 2 MPH** * 88 ft/min = **176 ft / min** in a straight line
- **2) 12 foot wide swath**
- **3) 9.7 lb product / minute =** spread rate per minute

SO:

176 ft/min * 12ft = **2,112 ft^2 covered in 1 min.**

Remember 43,560 ft^2 per acre

SO

$\frac{43{,}560\ ft^2 / acre}{2{,}112\ ft^2 / minute}$ = **20.63 minutes /acres**

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Your turn #2:

4.5 MPH and a 30 foot wide
70 lb per minute flow [catch method]
Find product per acres:

4.5 MPH * 88 = 396 ft / min

396 ft / min * 30 ft [wide] = 11,880 ft^2 / min

$\frac{43{,}560\ ft^2 / acre}{11{,}880\ ft^2 / min}$ = 3.67 minutes/acres

70 lb product / min * 3.67 min/acres =

256.9 lb product per acre

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EXTRA / FYI : **Find the MPH to produce a desired RATE [lb product / acre]**

-- Given: 1) the FLOW [product lb / minute]
-- 2) and WIDTH [boom]

$$\text{MPH} = \frac{43{,}560}{\frac{\text{Rate}}{\text{Flow}} * (88 * \text{width})}$$

Example #1 : **Want a RATE of 300 lb product per acre:**
Given: a **30 foot** width [boom] and a **flow of 60 lb product /minute**
FIND THE MPH FOR THE MACHINE TO RUN TO SPREAD THE DESIRED RATE OF 300 LB PRODUCT PER ACRE.

$$\text{MPH} = \frac{43{,}560}{\frac{300}{60} * (88 * 30)} = \frac{43{,}560}{5.0 * 2640} = \frac{43{,}560}{13{,}200} = \mathbf{3.30\ MPH}$$

VirginiaTech

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EXTRA / FYI #2 : **Find the MPH to produce a desired RATE [lb product / acre]**
-- Given the FLOW [product lb / minute]
-- and WIDTH [boom]

$$\text{MPH} = \frac{43{,}560}{\frac{\text{Rate}}{\text{Flow}} * (88 * \text{width})}$$

Example #2 : **Want a RATE of 175 lb product per acre:**
Given: a **20 foot** width [boom] and a **flow of 40 lb** product /minute

FIND THE MPH FOR THE MACHINE TO RUN TO SPREAD THE DESIRED RATE OF 175 LB PRODUCT PER ACRE.

$$\text{MPH} = \frac{43{,}560}{\frac{175}{40} * (88 * 20)} = \frac{43{,}560}{4.375 * 1760} = \frac{43{,}560}{7{,}700} = \mathbf{5.66\ MPH}$$

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SPRAYERS

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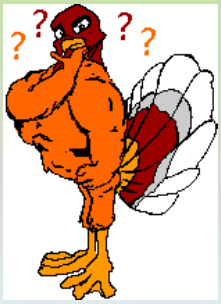
QUESTIONS?



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Handheld sprayers

- **Find how much area [ft²] one gallon will cover**
  - Put ½ or 1 gallon of water in sprayer
  - Pump to "normal" pressure
  - Find a sidewalk or driveway
    - An area easily measured
    - With well defined sides
  - Walk at regular pace
  - Move nozzle back and forth
  - Measure "wet" area that 1 gallon covers
- This gives you **ft² per gallon** of water used

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Handheld sprayers

- The pace of walking and the speed of the side to side sweeping has a MAJOR effect in the area covered.
  - » Some companies train [or have employees carry] with a battery powered metronome for consistence of application or adjust the pump pressure [on each truck] to match each employee for consistent application rates
- Best to first spray on pavement to see the pattern and type of coverage
  - Look at drying patterns to find consistency
- Then calibrate on actual terrain

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2.5 gallons * 1,250 ft^2 = **3,125 ft^2 per full tank**

- The product label directs you to **add 1.0 oz** per **1,000 ft^2** (unit)
- So, find how many 1,000 ft^2 (units) are in a full tank

3,125 ft^2 per full tank = 3.125 units per full tank
1,000 ft^2

3.125 units * 1.0 oz per unit = 3.125 oz per full tank

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Once you know how many square feet a gallon covers

- Use the information to load the sprayer with:
  - 1) The correct amount of water for the area
    - Or a full tank [you calculated how much area a full tank will cover]
  - 2) The correct amount of product for the spray area

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You try

- You have a **5.0 gallon** pump sprayer
- One gallon covers **850 ft^2** [you calibrated]
- The label directs you to add **1.25 oz / 1,000ft^2**
- **HOW MUCH AREA WILL A FULL TANK COVER?**

  5 GALLONS * 850FT^2 = **4,250 FT^2 PER FULL TANK**
- **HOW MUCH PRODUCT DO YOU ADD FOR A FULL TANK?** **[units per tank * rate per unit]**

  4,250 FT^2/ 1,000ft2 = 4.25 UNITS

  4.25 UNITS * **1.25 OZ** = **5.13 OZ PER FULL TANK**

VirginiaTech

Example

- You have a **2.5 gallon** pump sprayer
- One gallon covers **1,250 ft^2** [you calibrated]
- **HOW MANY FT^2 WILL A FULL TANK COVER?**

Number of gallons * area covered by 1 gallon

2.5 gallons * 1,250 ft^2 = **3,125 ft^2 per full tank**

VirginiaTech

Work with your neighbors ---
How much product needs to be added per full sprayer?

#1

- You have a **5.0 gallon** pump sprayer
- One gallon covers **1,350 ft^2** [you calibrated]
- The label directs you to add **0.75 oz / 1,000ft^2**
- **Ft^2 per tankful**

  6,750 ft^2 per tankful
- **Product per tank**

  5.06 oz per tankful

#2

- You have a **2.5 gallon** pump sprayer
- One gallon covers **1,525 ft^2** [you calibrated]
- The label directs you to add **1.50 oz / 1,000ft^2**
- **Ft^2 per tankful**

  3812.5 ft^2 per tankful
- **Product per tank**

  5.72 oz per tankful

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To find the gallons per acre (GPA) in a handheld sprayer

- There are several methods, but the 128th takes less space and time.
- You can then divide the GPA by 43.56 and find the gallons per 1,000 ft^2

Note: There are 43.56 blocks of 1,000 ft^2 each in one acre

VirginiaTech

Handheld GPA method #2

- Put one gallon [or ½ gallon] in the sprayer
- Have the person walk along a driveway and spray as normal
- Measure how much area the liquid covered

- One gallon sprayed: covered up and down a 50 ft driveway 2.5 times [5 lengths] with a spray width of 6' each time.
  - 50' * 5 lengths = 250' * 6' width = 1,500ft^2/gallon
  - **So 1 gallon covers 1,500ft^2**
  - Now divide 1 acre [43,560 ft^2] by 1,500ft^2/gallon = **29.04 gallons per acre**

43,560 = 29.04
1,500

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Handheld Sprayer - 128 method

- 1) **Layout** an area 18.5' X 18.5'
  - ***This is 128th of an acre***
- 2) **Time** how long it takes to spray the area
- 3) **Spray into a measuring can** for the same length of time (as #2).
- 4) **The result in ounces** is equal to the GPA
  - WHY: 128 oz in a gallon over 128th of an acre

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Handheld #2 continued

- One gallon covered 1,500ft^2
- **So, add enough product for 1,500 ft^2 and add one gallon of water**
  - Your 2.5 gallon sprayer will cover how much?
    - 2.5 gallons * 1,500ft^2 **= 3,750ft^2**
  - **Now, add the amount of product needed to cover 3,750ft^2 and 2.5 gallons of water**

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Handheld 128 - example

- 2) It takes 45 seconds to spray the 18.5'X18.5'
- 3) You collect 32 ounces in 45 seconds
- **4) THE RESULT IS 32 GALLONS PER ACRE**

- ***If you want oz per 1,000ft^2***
- 32 GPA / **43.56** = 0.74 gallons per 1,000ft^2
- 0.74 gallons per 1,000ft^2 * 128 oz/gal
  = 94.0 oz per 1,000ft^2

128 fluid ounces = 1 gallon

1 acre = 43,560 ft^2
So,
There are **43.56** 1,000 ft^2 blocks

VirginiaTech

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Boom Sprayers – large area sprayers



VirginiaTech

Quickest way to determine **or double check** speed – refresher per Dr. Dale Wolf

Setup to determine MPH

- Measure a track 88 feet long
- Be at speed before entering the track
- Time how long it takes to travel the 88 ft

Other times => divide 60 by the number of seconds it takes to travel 88 ft

Example:
23 seconds => 60 / 23 = 2.6 MPH

- **Note: 88 feet per minute = 1 MPH**
- **Therefore: If the sprayer is traveling at 3MPH it covers:**

3.0 MPH * 88 ft/min = 264 feet per minute
4.5 MPH * 88 ft/min = 396 feet per minute
5.3 MPH * 88 ft/min = 466.4 feet per minute

VirginiaTech

GPA = Gallons per Acre

Calibrate Boom sprayers

- **Boom sprayers**
  - **Determine the gallons per acre for a given setup** – machine speed, boom width, nozzle GPM & spacing
  - **Then add the amount of material to match the acreage**.

EXAMPLE:

If the setup sprays 40 GPA and you want to spray 1.5 acres.

Then you fill the tank with 60 gallons [1.5 acres* 40 GPA]. Next, add the product needed for 1.5 acres. Mix and spray

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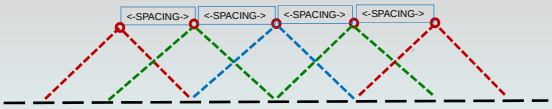
Effective boom width

is not measured from the first nozzle to the last

- Number of nozzles
- Spacing between nozzles
  - Assume proper height

Generally 100 % overlap

so the outside nozzles only spray ½ of the required



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Speed – a key factor in spray uniformity. Just like motorized spreaders

- Needs consistent motion to spray evenly
  - Calibrate at spreading speed
- Motorized boom spreaders
  - Use rpm and gear number to get consistent speed
  - Always calibrate at spraying speed
    - **Know the RPM and pressure**

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Effective boom width =

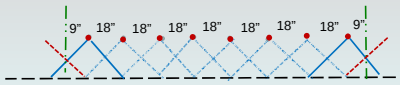
[# of nozzles] times [Spacing between nozzles]

Example:

8 nozzles * 18 inches = **144 inches**

144 inches = **12 foot** [**effective boom width**]
12 inches / ft

- ***Must convert inches into feet*** [area is in ft^2]



8 nozzles
* 18" between
= 144 inches

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Consistent or Even Flow

- Nozzles and pressure GREATLY influence the amount of water sprayed & nozzle performance
- Therefore all the nozzles must be the same to have the same flow. Nozzles will wear and change over time.
  - **Check each one** - catch in a measuring cup for a set time
    - **Example measure the amount of water caught in 15 seconds for each nozzle. Several times per season.**
    - **CHANGE IF DIFFERENCES ARE GREATER THAN 5%**
- **Pressure must be constant**
  - Install a pressure gauge and regulator

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How many minutes does it take to spray one acre?

- 1) **Use the area sprayed in one minute**
  - For your sprayer set-up
    - (boom width * feet traveled in one minute)
- 2) **Divide the ft² of one acre (43,560 ft²) by "1) Use the area sprayed in one minute"**

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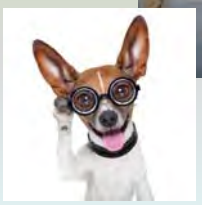

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How many minutes does it take to spray one acre?

- **EXAMPLE #1**
  1) The calculated area sprayed in one minute is 4,525 ft² [for your set-up]
  2) 43,560 ft²/acre = **9.625 minutes/acre**
     4,525 ft²
- **EXAMPLE #2**
  1) The calculated area sprayed in one minute is 9,900 ft² [for your set-up]
  2) 43,560 ft²/acre = **4.40 minutes/acre**
     9,900 ft²

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FLOW

GPM = Gallons per Minute

- Nozzle types INFLUENCE PRODUCT PERFORMANCE
  - Flat fan - Air induction - Twin
  - Flood - Drift Guard - Extended range
- ***TOTAL FLOW FOR THE BOOM***

equals the number of nozzles times the flow of each nozzle

- Ex.# 1 - 8 nozzles * 0.20 GPM = **1.6 GPM total**
- Ex.# 2 - 6 nozzles * 0.35 GPM = **2.1 GPM total**
- Ex.# 3 - 20 nozzles * 0.55 GPM = **11.0 GPM total**

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How many minutes does it take to spray one acre?
YOU TRY – with your neighbors

- You sprayer covers 8,500 ft² in one minute.
- How long does it take to spray one acre?

5.125 minutes

- You sprayer covers 3,750 ft² in one minute.
- How long does it take to spray one acre?

11.616 minutes

One acre = 43,560 ft²

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Put it together - Examples

- Speed [feet traveled in one minute]
- Boom / Spray width [in feet]
- Total spray volume [gallons per minute]
- Time to spray one acre [in minutes]

- Just like a broadcast spreader
  - Except for the "spray thing"

You try -- with neighbors!

- **3.6 MPH**
  20 foot boom
  5.2 GPM
  - 5.2 GPM * 6.88 min / acre = **35.78 gallons / acre**
- **5.6 MPH**
  40 foot boom
  10.6 GPM
  - 10.6 GPM * 2.21min / acre = **23.43 gallons per acre**

SIMPLER EXAMPLE – FEWER CALCULATIONS REQUIRED
FIND THE SPRAYER GPA

2.2 MPH
30 foot boom {Given, not calculated}
2.3 GPM {Given, not calculated}

- 2.2 MPH * 88 feet = 193.6 ft / min [straight line]
- 193.6 ft / min * **30 ft** (boom) = **5,808 ft² / min**
  [area sprayer in one minute]

43,560 ft /acre = **7.5 min / acre** [time to spray one acre]
5,808 ft / min

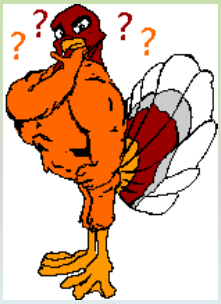
2.3 GPM * **7.5 min / acre** = **17.25 gallons / acre**

A Full Example:

- **2 MPH**
  - 2 mph * 88 ft/min = **176 ft / min** [straight line]
- **8 nozzles spaced 18 inches apart**
  - 8 noz * 18" = 144"
  - 144" / 12 in/ft = **12 foot boom**
- **Each nozzle is 0.2 GPM**
  - 8 noz * 0.2 = **1.6 GPM flow**

SO:
176 ft/min * 12ft = **2,112 ft² per min.**
[AREA SPRAYED IN ONE MINUTE]

QUESTIONS?



176 ft/min * **12ft** = **2,112 ft²** covered in 1 min.
[Leads to]

43,560 ft² / acre = **20.625 minutes / acre**
2,112 ft² / minute
[Combines with]
1.6 GPM flow = all nozzles running for one minute
[should double check with the catch flow method]

NOW: CALCULATE THE GALLONS PER ACRE
[Gallons per minute times minutes per acre]
1.6 GPM * **20.625 min/acre** =
33.0 gallons per acre
For this specific setup

You try

4.0 MPH
15 nozzles
18 inch spacing
0.35 GPM

- 22.5' boom
- 5.25 GPM
- 7,920 ft² /min

5.50 min / acre = **28.88 gallons / acre**

5.5 MPH
25 nozzles
20 inch spacing
0.55 GPM

- 41.67' boom
- 13.75 GPM
- 20,168.28 ft² /min

2.16 min / acre = **29.70 gallons / acre**

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PUTTING IT TOGETHER

- You have a 150 gallon sprayer
- Calibrated at 30 Gallons Per Acre
- **HOW MANY ACRES WILL A FULL TANK SPRAY?**

150 gallons = 5 acres per tankful
30 GPA

SO PUT 5 ACRES OF PRODUCT IN THE full TANK

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You now know the reasons behind the steps in calibration and can double check any part of the process.

KNOWLEDGE IS POWER !

- FYI -- There is the mathematical index [short cut] to finding the **GPA**

$$GPA = \frac{GPM_{[PER\ nozzle]} * 5940}{MPH * NSI}$$ [nozzle spacing in inches]

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How many acres will the full tank spray?

- You have a 200 gallon sprayer
- Calibrated at 35 Gallons Per Acre
- **HOW MANY ACRES WILL A FULL TANK SPRAY?**

200/35 =
5.714 acres

- You have a 125 gallon sprayer
- Calibrated at 25 Gallons Per Acre
- **HOW MANY ACRES WILL A FULL TANK SPRAY?**

125/25 =
5.00 acres

VirginiaTech

$GPA = \frac{GPM_{[PER\ nozzle]} * 5940}{MPH * NSI}$ [nozzle spacing in inches]

4.0 MPH
15 nozzles
18 inch spacing
0.35 GPM

28.88 gallons / acre

5.5 MPH
25 nozzles
20 inch spacing
0.55 GPM

29.70 gallons / acre

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EXAMPLES USING REAL FORMULAS

- Dimension (dithiopyr)
  - 1.5 oz of 1EC **per 1,000 ft²**
- **Your 300 gallon sprayer is calibrated at 25.0 gallons per acre**
  - 1) How many acres can a full tank spray?
  - 2) How much Dimension is needed for a full tank?

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Your 300 gallon sprayer is calibrated at 25.0 gallons per acre

1) How many acres can a full tank spray?

Gallons for a tankful= Acres per tankful
Gallons per Acre

300 gal per tankful= Acres per tankful
25.0 GPA

= 12.0 Acres per tankful

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Just for "full discloser"

784 oz per tankful = 6.125 gallons
128 oz per gallon

6 .125 gallons = 6.0 gallons + **0.125 gallons**

0.125 gallons * 128 oz/gal = 16 oz

6 .125 gallons = 6.0 gallons + 16 oz

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Dimension (dithiopyr)
1.5 oz of 1EC per 1,000 ft²

Remember that there are 43.56 blocks of 1,000ft² each in one acre

- **2) How much product is needed per acre?**

Product rate [per 1,000 ft²]
*** 43.56** [1,000 ft² blocks per acre]
Product per acre

1.5 oz [per 1,000 ft²]
*** 43.56** [1,000 ft² blocks per acre]
65.34 oz **Product per acre**

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Example [for later – yeah right]

- You calibrated your 125 gallon sprayer 22.0 gallons per acre
- Product directions say to use 0.73 oz per 1,000 ft²

- How much product per tankful?

» 5.682 acres per tankful
» 31.80 oz per acre

- **180.68 oz per tankful = 1 gallon + 52.7 oz**

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300 gal per tankful= Acres per tankful
25.0 GPA
= **12.0 Acres per tankful**

1.5 oz [per 1,000 ft²]
*** 43.56** [1,000 ft² blocks per acre]
65.34 oz **Product per acre**

How much product is needed for a tankful?
12.0 Acres per tankful *** 65.34 oz** Product per acre

= 784 oz per tankful

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Example [for *much* later – yeah right]

- You calibrated your 500 gallon sprayer 32.0 gallons per acre
- Product directions say to use 6.0 oz per 1,000ft²

- How much product per tankful?

» 15.63 acres per tankful
» 261.36 oz per acre

- **4,083.75 oz per tankful = 31 gallon + 115.75 oz**

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BMP

- READ THE LABEL – CAREFULLY THREE times
  - **THE LABEL IS THE LAW** ----- **don't miss anything**
- Proper rate [label rates]
- Correct amount applied on allowed turfgrass
- Correct target pest
- Inspected and calibrated equipment
- Knowledgeable operators
- Avoid drift
  - Lowest pressure
  - Nozzles to create large droplets
    - Fan versus flood
    - Fungicide versus herbicide

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Some STMA references on calibration

- http://www.stma.org/sites/stma/files/STMA_Bulletins/Rotary_Spread_Calib_Final.pdf

- **SDOAK@VT.EDU**

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