Improving Spray Efficacy via Spray Calibration
Go Farm Hawaii-Waimea

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May 2017
Crop Protection Chemical

Definition of a Pesticide

Chemical used to prevent, destroy, or repel pests
Ex. Intent to control pest
Nutrient vs. chemical
Chemical Control

Rotation of Crop Protection Products & Surfactants
Sprayer Calibration

Biological Control

Biologicals, Organic Crop Protection Products

Utilizing Tolerant or Resistant Varieties

Biotechnology Resistant Seeds

Cultural & Physical Control

Habitat Modification

Environmental conditions: Wind barriers, Wind direction, Aeration, Drainage, etc

Integrated Pest Management

Pest and Disease Issues

Pest ID & Monitoring

Spacing, modifying propagation methods, changing harvest techniques, etc
Chemical Controls

- Typically considered after other control methods
- Responsible use of crop protection chemicals (pesticides)
- Treatments based on monitoring data
Pest Variables
- Life Cycle
- Vulnerable Stage
- etc.

Crop Variables
- Crop Type
- Crop Architecture
- Leaf Type
- Spacing
- Etc.

Spray Variables
- Surfactants/Wetting Agents
- Spray Equipment
- Pesticide Type (Mode of action)
- Broad Spectrum vs. Selective
- Product Composition

Environmental Variables
- Wind Speed-DRIFT, Wind Movement, Humidity, Rain, Temperature, etc.

EQUIPMENT
- Calibration and Maintenance
- Nozzle Selection
- Spray Pressure
- Speed
- Spray Volume
- Types of Sprayers
- Spray Height
- Droplet Size
- Operator

- Calibration and Maintenance
My pests are not dying...

- Comments from our growers:
  - Pesticides no longer seems to work
  - Pest wont die off (resistance)
  - Increasing pesticide rate
  - More frequent pesticide applications
Improper Chemical Application

- Could result in:
  - Uncontrolled pest populations
  - Resistance issues
  - Environmental, crop or worker hazards
  - Financial loss
  - Legal issues
Importance of Spray Calibration

- Ensure you and/or machinery is uniformly applying the product
- Maximize efficacy of the product
- Apply crop protection chemicals in accordance to label & law
Calibration Factors

- Determine product output: Gallons per Acre (GPA)
- Determine how much chemical to add to solution
- Size of area to treat
Standard Calibration Method

- **Boom method:**
  - Determine miles per hour (MPH)
  - Gallons per acre = \( \frac{5940 \times \text{gallons per minute (single nozzle (gallons))}}{\text{Miles per hour} \times \text{width (distance between nozzles)}} \)

- **Backpack method:**
  - Fill tank with 2 gallons of water
  - Calculate acre sprayed = \( \frac{X \text{ square feet you sprayed}}{43,560 \text{ ft}^2/\text{acre}} \)
  - Gallons per acre = \( \frac{2 \text{ gallons sprayed}}{\text{Acres sprayed}} \)
1/128<sup>th</sup> Method of Calibration

- The 1/128<sup>th</sup> method of sprayer calibration is a simplified way to calibrate most spray systems.
- This 1/128<sup>th</sup> calibration method requires almost no calculations.
- Utilized by other university systems:
  - University of Florida, University of Wyoming, Clemson University, Oregon State University, North Carolina State University, etc.
Boom Type Sprayer
Large, flat areas
Spray Gun Systems
Small acreage, spot sprays, hard to reach areas
Mist Blower Sprayer
Good coverage, crop penetration, fine mist, etc.
Backpack Sprayer
Common, but consistency is a challenge

PC: Banksphoto
Determining Spray Volume or GPA

- To accurately apply crop-protection chemicals, it is important to know how much spray solution is applied per acre
  - How much gallons per acre (GPA)
Calculating Spray Volume: Ratio Based

- This system is based on the ratio of 1 gallon, or 128 fluid ounces: 1/128\textsuperscript{th} of an acre, (340 square feet (sq ft)).
- Total fluid ounces of solution applied to 340 sq ft area (or 1/128\textsuperscript{th} of an acre) is equal to the estimated number of gallons of spray per acre

\[ \text{Ounces} = \text{GPA} \]
Ounces = Gallons / Acre

1 gallon = 128 fluid ounces
1/128th of an acre = 340 sq ft

_______ GPA = _______ Ounces
ONE ACRE

AMOUNT OF OUNCES APPLIED TO THE 340 SQ FT AREA

EQUALS GALLONS / ACRE RATE (GPA)
Calibrating and Consistency

- The key factors for accurate spraying area:
  - Constant speed
  - Steady tank pressure
  - Crop type
  - Nozzle selection and opening
- Spray volume used in the actual field can vary considerably if the speed, pressure, or other adjustments to the sprayer are made after calibration.
Spray Variables Constantly Change

- Spray equipment and applicator should be calibrated at the beginning of each application as variables often change.

Diagram:

- OUTPUT (GPA)
  - Pressure
  - Nozzle
  - Aperture
  - Speed
  - Applicator
  - Crop
One Change Affects Final GPA

- A change in one aspect of pesticide application (e.g. spray pressure, nozzle type, walking speed, etc.) can drastically influence the results
  - Pressure, Nozzle, Aperture, Speed, Applicator, Crop, etc.

Spray Day: WEDNESDAY
CHANGES IN SPRAY VARIABLES

OUTPUT (GPA)

- Aperture
- Speed
- Nozzle
- Applicator
- Pressure
- Crop
SPRAY DAY: THURSDAY
Change Equipment: Spray Gun
Thursday: All variables are constant
**FRIDAY:** Slowed down your speed, volume increased
Uniform Application Requires Consistency

- Aperture
- Speed
- Nozzle
- Applicator
- Pressure
- Crop

OUTPUT (GPA)
Consistency

Speed of Application

SLOW  FAST

Same Pressure

More Volume  Less Volume
1/128th Method of Sprayer Calibration

- Our goal is to increase the adoption of sprayer calibration practices to heighten product efficacy and accuracy of chemical applications
  - Simplify the steps
  - Demonstrate the process
  - Work with growers
    - Small groups
    - 1:1

Roger’s Innovation Adoption Curve

- Innovators: 2.5%
- Early adopters: 13.5%
- Early majority: 34%
- Late majority: 34%
- Laggards: 16%
Let’s start by checking your system
Nozzles, worn hoses, leaks, etc.
Step 1: Measure a test area equal to $\frac{1}{128}$th of an acre (340 sq. ft.)
Measure 340 square feet
Next Steps

- **Step 2**: Spray water on the plants in a comfortable, consistent motion to get the best spray coverage of the targeted 340 sq ft area.
- **Step 3**: Measure the time it takes you to spray the targeted area.
- **Step 4**: Repeat Step 3 several times and average the times.

50 Seconds
50 Seconds

- **Step 5**: Spray water into a container for the average time it took you to spray the targeted area.
  - Leave all other spray variables (e.g. spray pressure, nozzle) unchanged.
Example 1

- **Step 6**: Measure the amount of water collected in fluid ounces.
- **Step 7**: The amount of water collected corresponds to your calibrated spray volume in gallons of spray mix per acre.
- Example: You collected 64 fluid ounces in the time it took to spray the targeted area (340 sq ft).
- Therefore, based on your calibration, the sprayer output is 64 gallons per acre, or 64 GPA.
Ounces = Gallons / Acre

Example 1:

X GPA = 64 Ounces
Example 2

100 FLUID ounces

ONE ACRE

AMOUNT OF OUNCES APPLIED TO THE 340 SQ FT AREA

EQUALS GALLONS / ACRE RATE (GPA)
Example 2

100 FLUID ounces

ONE ACRE

AMOUNT OF OUNCES APPLIED TO THE 340 SQ FT AREA

EQUALS

100 GPA
Video: 1/128th Spray Calibration

- Spray gun
- Boom
- Mist blower
  - Additional steps
Crop needs to be listed on the label

<table>
<thead>
<tr>
<th>Crop</th>
<th>Target Diseases</th>
<th>Use Rate fl. oz. product/A (lbs. a.i./A)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herb &amp; Spices (except black pepper)</td>
<td>Corynespora blight (Corynespora cassicola)</td>
<td>6.0-15.5 (0.10-0.25)</td>
<td>Quadris applications should begin at the onset of disease development and continue throughout the season on a 7 day schedule, following the resistance management guidelines. Applications may be made by ground only. An adjuvant may be added at specified rates. Use a minimum of 30 gallons of water per acre. Do not apply more than two sequential applications of Quadris or other Group 11 fungicides before alternation with a fungicide that is not in Group 11.</td>
</tr>
</tbody>
</table>

Make sure your crop is listed on label.
Calculate Product

- You will still need to calculate the AMOUNT of pesticide(s) needed to mix with the calculated volume of solution.

- Example: Chemical XYZ:
  - 1-3 pints / acre
Read and Follow Label

Knowing how much product is applied to your crop is essential to maximize efficacy

- Example:
  - Label rate: 6.2-15.4 ounces / acre
  - Spray volume: 100 GPA
  - Minimum 100 GPA
  - Pressure: 60 PSI
  - Use of surfactant
Use of Spreader or Spreader-Sticker

- Increase good spray coverage
- Heighten product efficacy (label instructions)
- Maximize coverage area
- Be careful of phyto-toxicity issues

Stick and spread on the leaf surface.

**APPLICATION DIRECTIONS**

**Tank Mix Requirement:** Fusilade DX Herbicide may be tank mixed with other pesticides. Refer to the label of the tank-mix partner for registered crops, additional pests controlled and directions for use. Observe all precautions and restrictions on the labels of products to be used in tank mixtures. Use in accordance with the most restrictive label limitations and precautions. This product cannot be mixed with any other product whose label prohibits such a mixture.

**TIMING:** Best control of susceptible grasses is obtained when Fusilade DX Herbicide is applied to actively growing grasses before they exceed the listed growth stages shown on this label. Refer to the grass weed tables for specific recommendations on weed growth stages.

**SPRAY ADDITIVES** – Only spray additives cleared for use on growing crops under 40 CFR 180.1001 may be used in spray mixture.

Always add one of the following:

- **Crop Oil Concentrate** – Add a non-phytotoxic crop oil concentrate or a once-refined vegetable oil concentrate containing 15-20% approved emulsifier, at 0.5-1% v/v (0.5–1 gal/100 gal) in the finished spray volume for ground applications. For aerial applications, add 1 pt of crop oil concentrate per acre.

- **Nonionic Surfactant** – Add nonionic surfactant containing a least 75% surface-active agent, at 0.25-0.5% v/v (1-2 qt/100 gal) in the finished spray volume for ground applications. For aerial application, add 1 pt of surfactant per acre.

- **Other Adjuvants** – Adjuvants other than COC or NIS may be used providing the product meets the following criteria:
  1. Contains only EPA exempt ingredients.
  2. Is nonphytotoxic to the target crop.
  3. Is compatible in mixture. (May be established through a jar test).
  4. Is supported locally for use with Fusilade DX Herbicide on the target crop through proven field trials and through university and extension recommendations.

Always refer to the product label and follow directions concerning rates, target crops, environmental effect such as drought or weed stress, and use in tank mix with other labeled pesticides.

In addition to crop oil concentrate or nonionic surfactant, liquid nitrogen fertilizer (28% or similar) can be added to the spray mixture and is recommended in soybeans only. This 28% liquid nitrogen fertilizer is water soluble and should be used at a rate of one gallon per acre. Liquid nitrogen fertilizers should not be used as a substitute for crop oil concentrate or nonionic surfactant in the spray mixture.
Rotate to Minimize Resistance

- Always rotate between chemical classes
- Never use the same chemical for an extended period of time

Resistance Issues: “Fungicides not working”
Stay within Maximum Application Limits
Limited Product Sandwich Effect / Season

- Milstop
- Quadris
- Trilogy (OG)
- Fosphite or Fungi-phite
- Serenade Max (OG)
- Revus
- Double Nickel 55 (OG)
- Ranman 400 SC
- Milstop
- Quadris

Less effective

CROP SEASON
Re-entry Interval (REI)

- Do not enter fields before the re-entry period is over
- If you must enter fields, wear your PPE

EXAMPLE:
Field sprayed

<table>
<thead>
<tr>
<th>Do not enter</th>
<th>Ok to enter field</th>
</tr>
</thead>
</table>

REI: 12 hours

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and re-entry interval (REI). The requirements in this box only apply to 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.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Chemical-resistant gloves, such as barrier laminate or nitrile rubber or neoprene rubber or Viton
- Shoes plus socks

Follow directions: keep out of restricted areas.
What is PPE?

- Personal Protective Equipment

**PRECAUTIONARY STATEMENTS**

**Hazards to Humans and Domestic Animals**

CAUTION

Harmful if swallowed. Harmful if absorbed through skin. Harmful if inhaled. Causes moderate eye irritation. Avoid contact with skin, eyes or clothing. Avoid breathing dust. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet.

**Personal Protective Equipment (PPE)**

Some materials that are chemically resistant to this product are listed below.

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves made of any waterproof material such as polyvinyl chloride, nitrile rubber or butyl rubber
- Shoes plus socks

**User Safety Requirements**

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

continued...
Tank Mixtures

- Agitation
- Stay within the maximum allowed limits
- Store and dispose of chemicals properly
Post & Follow Warning Signs

- Danger
- Pesticides
- Keep out
- No Entry
Sprayer Calibration Using the 1/128th Method for Handheld Spray Gun Systems

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Calibrating spray equipment is an important step in applying crop protection chemicals to a targeted area. Proper calibration will help ensure accurate spray coverage (usually measured in gallons per acre, or GPA). The 1/128th method of sprayer calibration is a simple way to calibrate most handheld sprayer systems. It is based on the ratio of 1 gallon, or 128 fluid ounces, to 1/128th of an acre, or 340 square feet (sq ft). The 1/128th calibration method is a fast, easy way to compute the gallons-per-acre rate (GPA).

Under-application of crop protection chemicals can result in poor control and post-emergence issues. Over-application of crop protection chemicals can lead to human, legal, and environmental issues and crop injury, i.e., phytotoxicity. It is important to know the calibrated spray volume (GPA) and the amount of pesticide to be mixed with that calibrated spray volume to accurately apply crop protection chemicals. Always read the pesticide label and follow its instructions.

Simplified 1/128th Calibration Conversions

128 fluid ounces = 1 gallon
1 fluid ounce = 1/128th of a gallon
340 sq ft = 1/128th of an acre

Based on the 1/128th calibration method, each ounce of water collected during calibration corresponds to 1 gallon of spray mix per acre.

1 fluid ounce collected = 1 gallon per acre (GPA)

This 1/128th calibration method requires no math calculations. The number of fluid ounces of spray mix you apply to a 340 sq ft area corresponds to the estimated number of gallons of spray mix per acre. The accuracy of delivery is only as good as the consistency of application in the test area.

Key Spray Variables to Consider for Spray Gun Application

• Properly maintained spray equipment
• Spray gun pressure
• Spray nozzle pressure, e.g., length and size of hose
• Spray pattern setting
• Spray volume rate setting
• Target pest
• Pest incidence
• Crop height
• Crop density
• Wind speed, direction
• Field terrain, e.g., slope, weeds, etc.
• Sprayer’s walking speed: e.g., energy level, arm motion, etc.

Sprayer Calibration Using the 1/128th Method for Motorized Backpack Mist Sprayer Systems

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The motorized backpack mist sprayer, also known as the mist blower, is becoming increasingly more popular among small-acreage producers here in Hawai‘i. The backpack unit holds a small engine that powers a fan. The fan is connected to a flexible tube that directs air towards the intended target. Located near the end of the flexible tube is a discharge orifice that regulates the flow rate of the spray solution from the hopper. The force of the air causes the spray solution to be atomized into a fine mist. The fine mist in combination with the forced air can help the spray solutions penetrate the crop canopy and improve coverage.

Calibrating spray equipment is an important step in applying crop protection chemicals to a targeted crop. Proper calibration of the sprayer can help to ensure accurate spray coverage. Calibrating a motorized backpack mist sprayer can be difficult; therefore, we have developed a simple, step-by-step guide to address some important variables affecting calibration. We have adapted the 1/128th method of sprayer calibration to the backpack sprayer calibration procedure to simplify the process.

The 1/128th calibration method is a fast, easy way to compute the gallons-per-acre rate (GPA). Under-application of crop-protection chemicals can result in poor control and contribute to pesticide resistance. Over-application of crop-protection chemicals can lead to human, legal, and environmental issues, as well as possible crop injury, i.e., phytotoxicity. It is important to know the calibrated spray volume in gallons per acre (GPA) and the amount of pesticide to be mixed with that calibrated spray volume to accurately apply crop-protection chemicals. Always read the pesticide label and follow the instructions.

Simplified 1/128th Calibration Conversions

128 fluid ounces = 1 gallon
1 fluid ounce = 1/128th of a gallon
340 sq ft = 1/128th of an acre

Based on the 1/128th calibration method, each ounce of water discharged to the 340 sq ft area during calibration corresponds to 1 gallon of spray mix per acre.

1 fluid ounce collected = 1 gallon per acre (GPA)
For More Information

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