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Extension

College of Tropical Agriculture and Human Resources

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Improving Spray Efficacy via Spray Calibration Go Farm Hawaii-Waimea

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University of Hawai'i at Mānoa
College of Tropical Agriculture and Human Resources
May 2017



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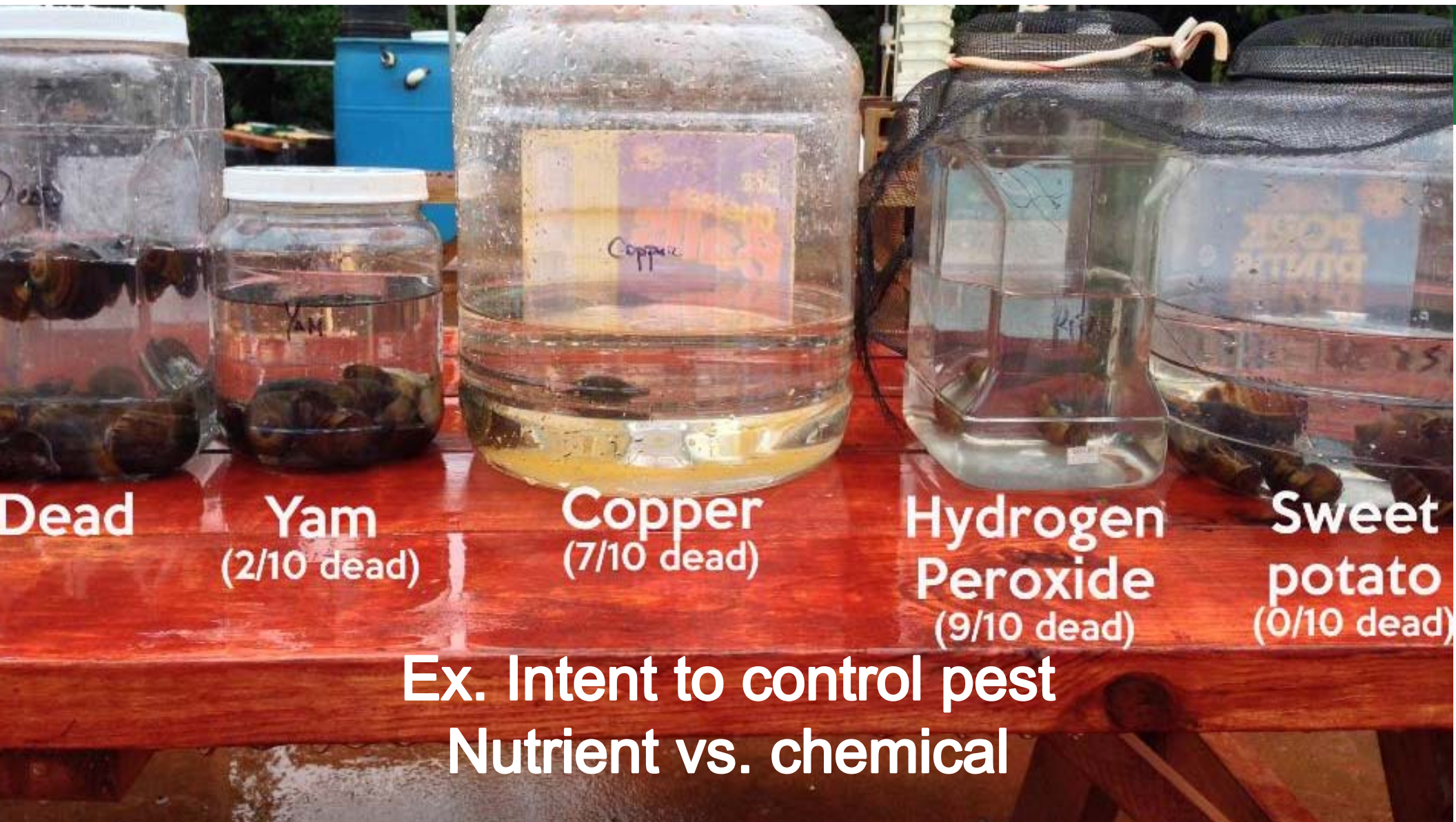
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Crop Protection Chemical

Definition of a Pesticide

Chemical used to prevent, destroy, or repel pests





with fruity ra

Allergies

Contains egg,
May contain

Ingredient

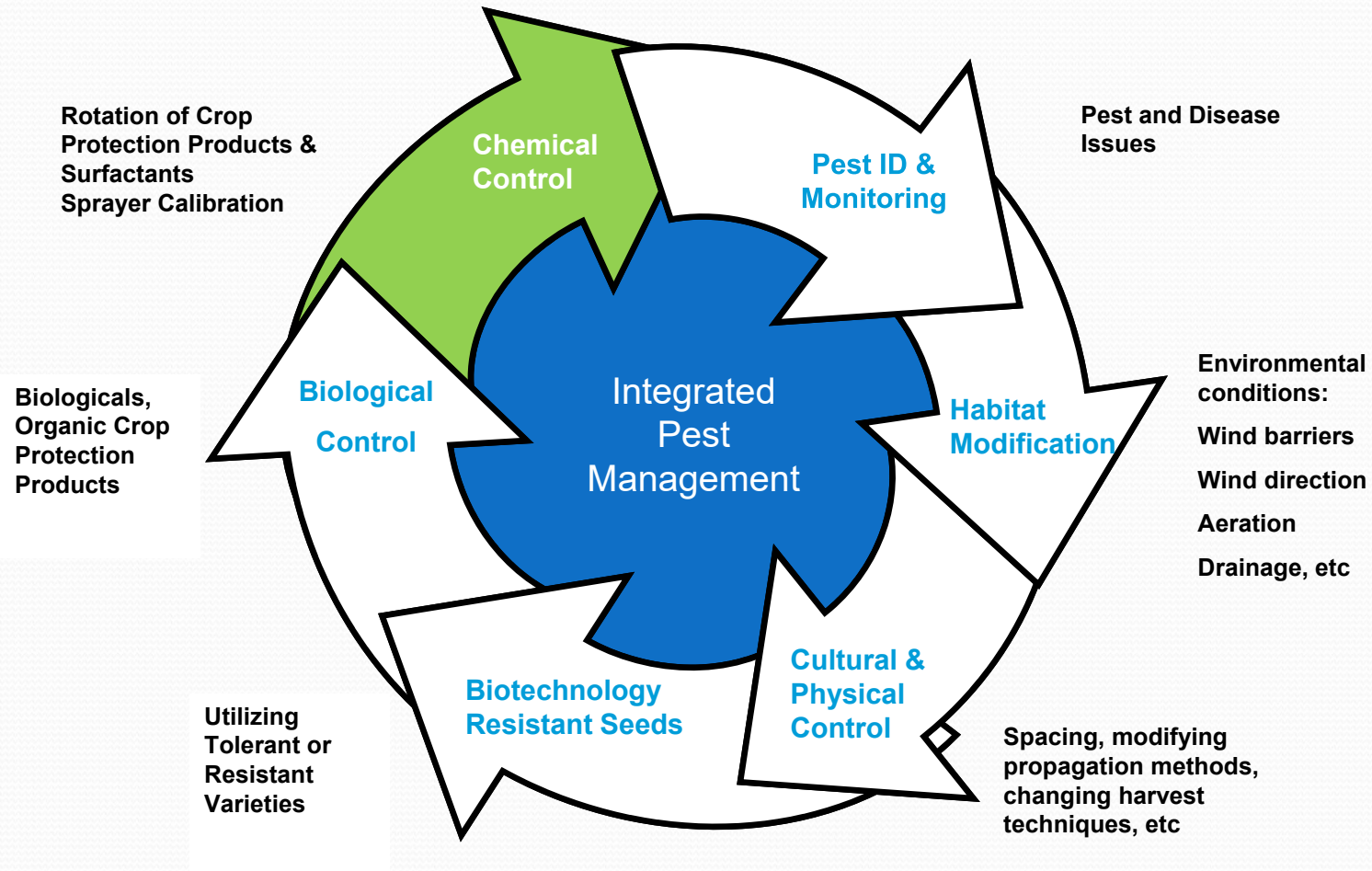




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Chemical Controls

- 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

EQUIPMENT

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

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.



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My pests are not dying...

- Comments from our growers:
 - Pesticides no longer seems to work
 - Pest won't die off (resistance)
 - Increasing pesticide rate
 - More frequent pesticide applications





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Improper Chemical Application

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



US Food Safety

Award winning food safety blog

State health officials find pesticide not approved for use on basil at 4 other Oahu farms.

Posted on May 16, 2012 by foodsaferguru

State health officials find pesticide not approved for use on basil at 4 other Oahu farms.



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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





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Calibration Factors

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



Insecticides—to control pest insects

Herbicides—to control weeds

Fungicides—to control fungi (fungus) and disease organisms

Miticides—to control mites

Nematicides—to control nematodes

Rodenticides—to control rats, mice, and other rodents

Algicides—to control algae





Standard Calibration Method

- Boom method:
 - Determine miles per hour (MPH)
 - $$\text{Gallons per acre} = \frac{5,940 \times \text{gallons per minute (single nozzle (gallons))}}{\text{Miles per hour} \times \text{width (distance between nozzles)}}$$
- Backpack method:
 - Fill tank with 2 gallons of water
 - Calculate acre sprayed = $\text{X square feet you sprayed} / 43,560 \text{ ft}^2/\text{acre}$
 - $$\text{Gallons per acre} = \frac{2 \text{ gallons sprayed}}{\text{Acres sprayed}}$$



1/128th Method of Calibration

- The 1/128th method of sprayer calibration is a simplified way to calibrate most spray systems
- This 1/128th 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.





Determining Spray Volume or GPA

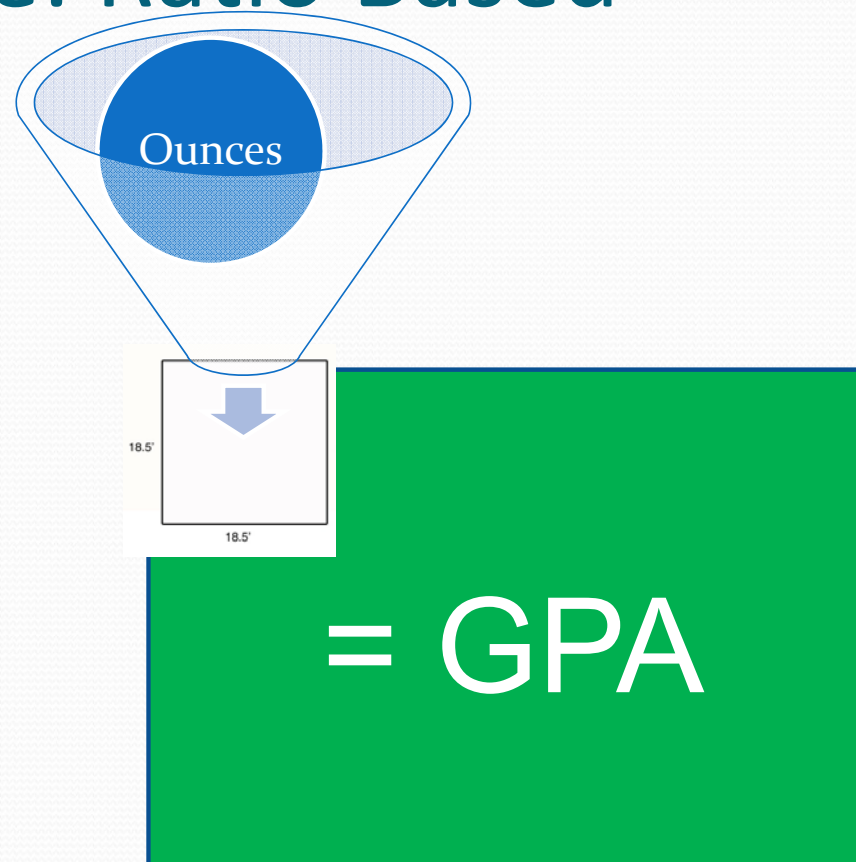
- To accurately apply crop-protection chemicals, it is important to know how much spray solution is applied per acre
 - How much gallons per acre (GPA)





Calculating Spray Volume: Ratio Based

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



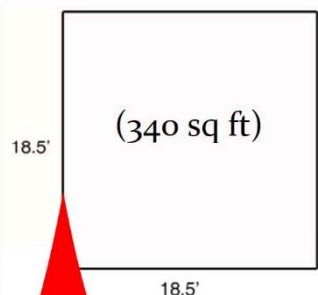


Ounces = Gallons / Acre

1 gallon = 128 fluid ounces

$1/128^{\text{th}}$ 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)



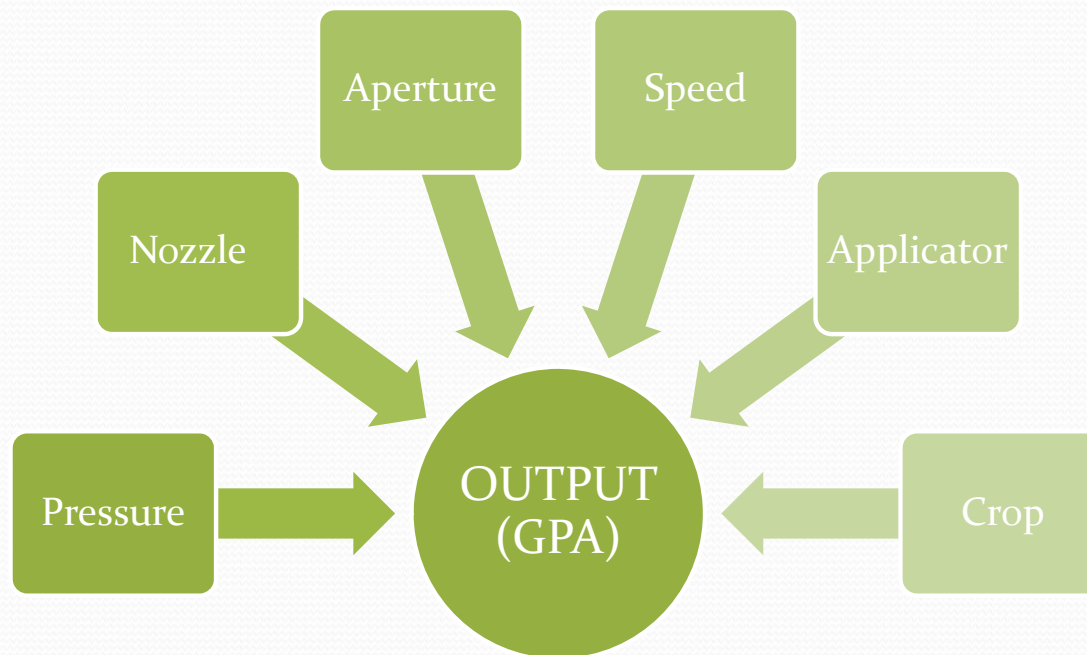
Calibrating and Consistency

- 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.



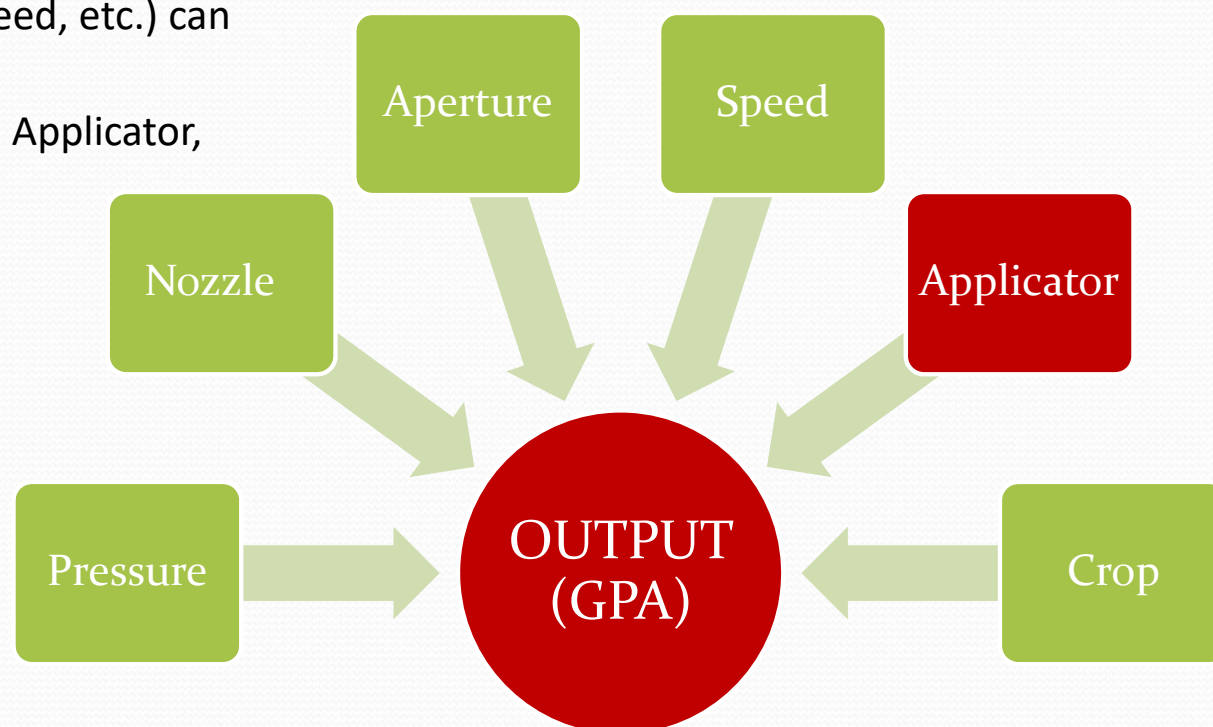


One Change Affects Final GPA

- 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



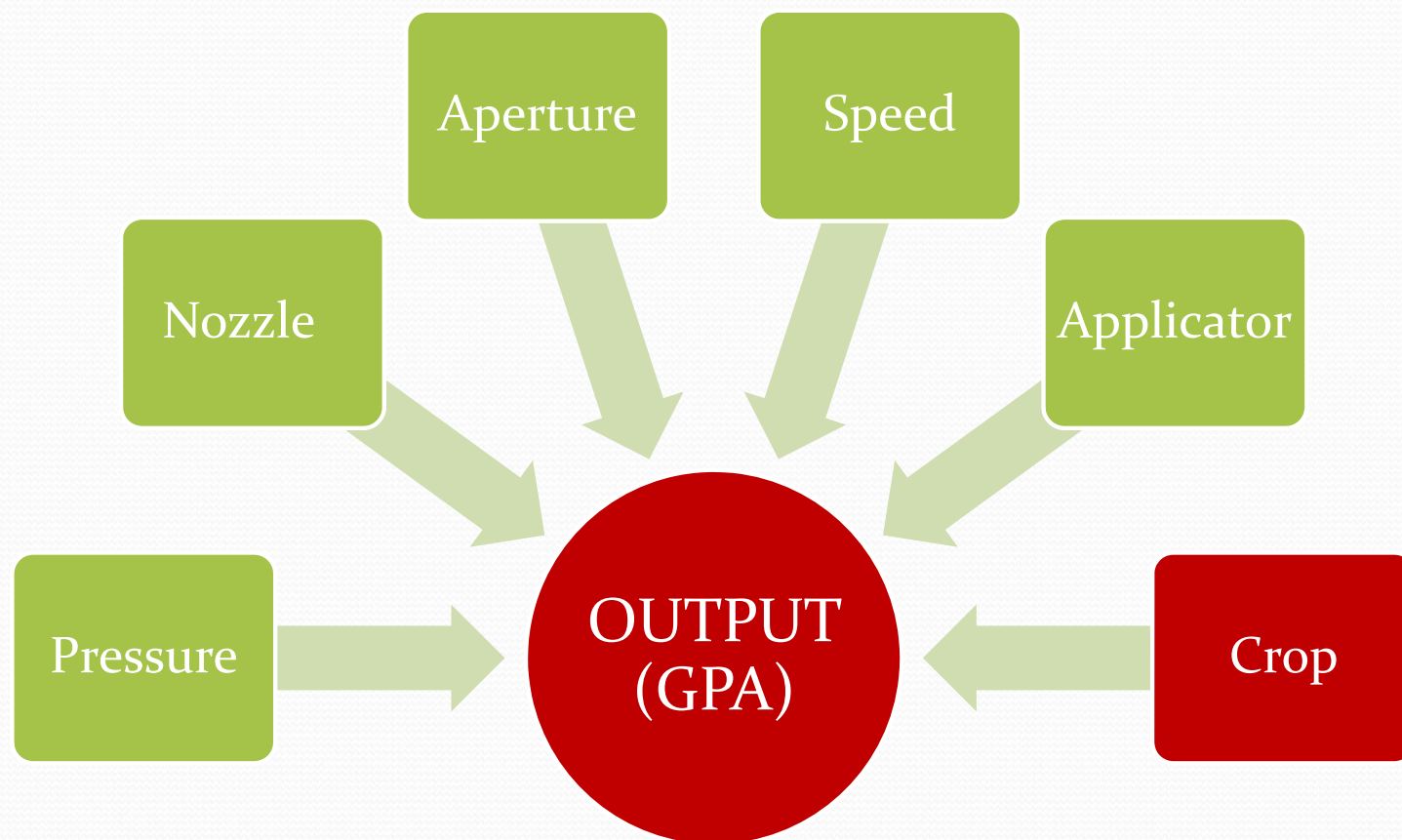


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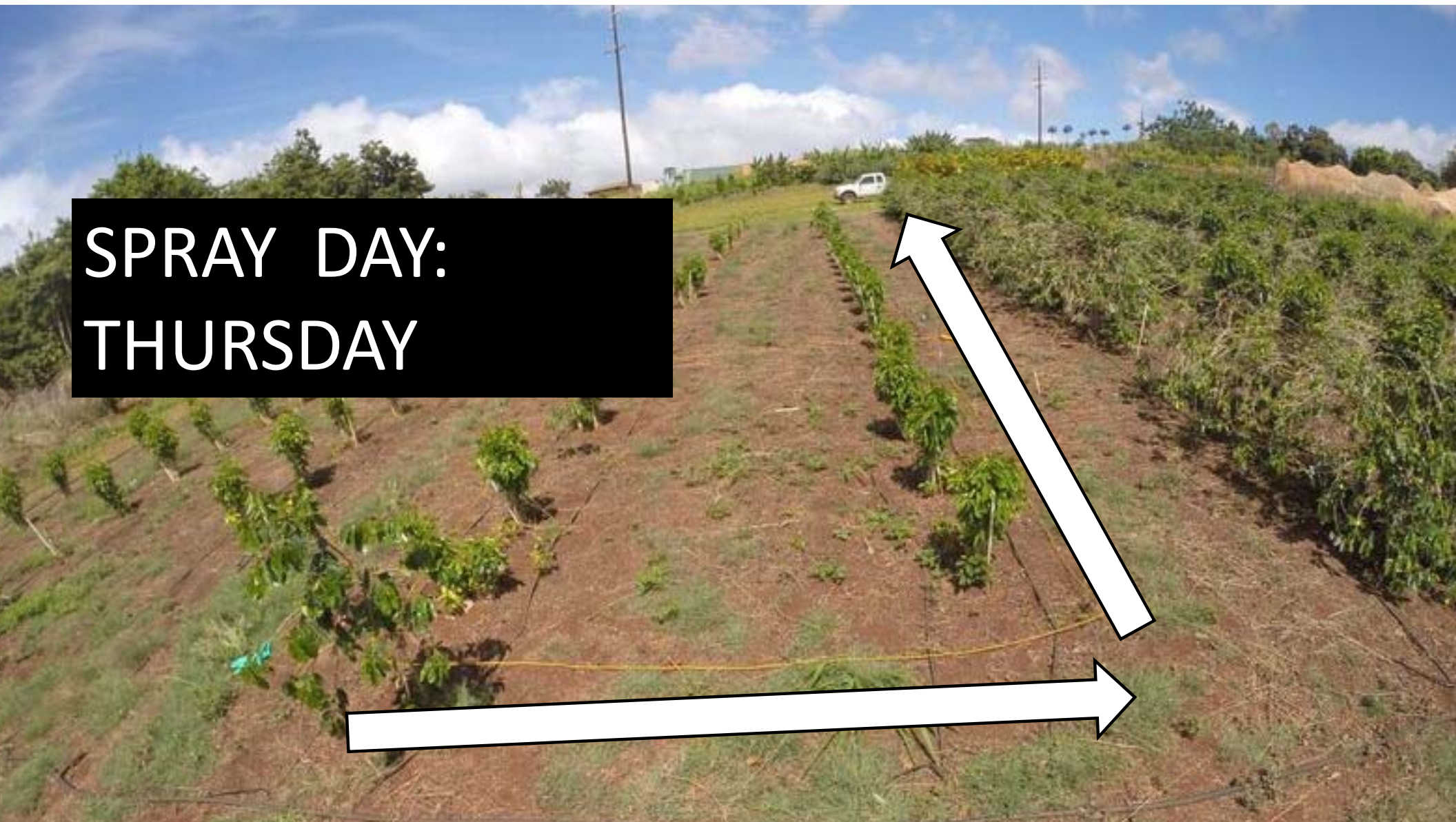
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CHANGES IN SPRAY VARIABLES



SPRAY DAY:
THURSDAY



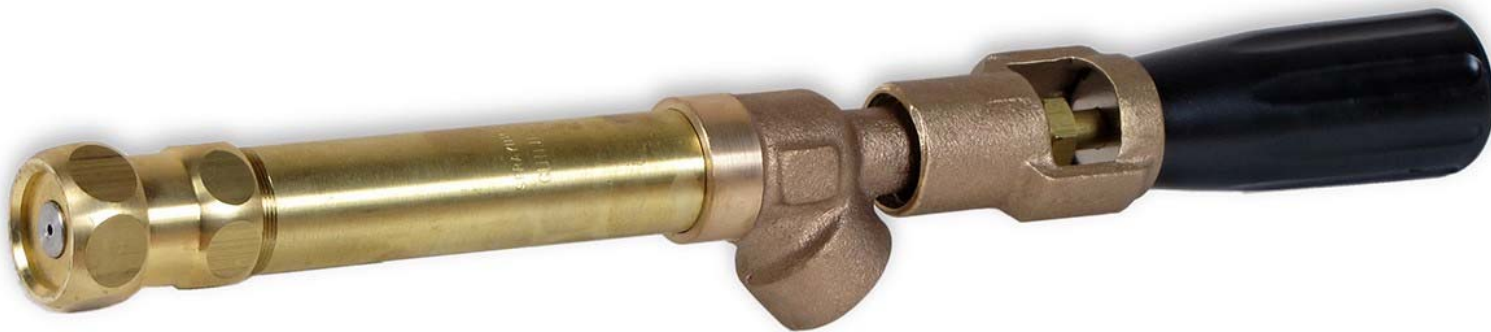


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Change Equipment: Spray Gun



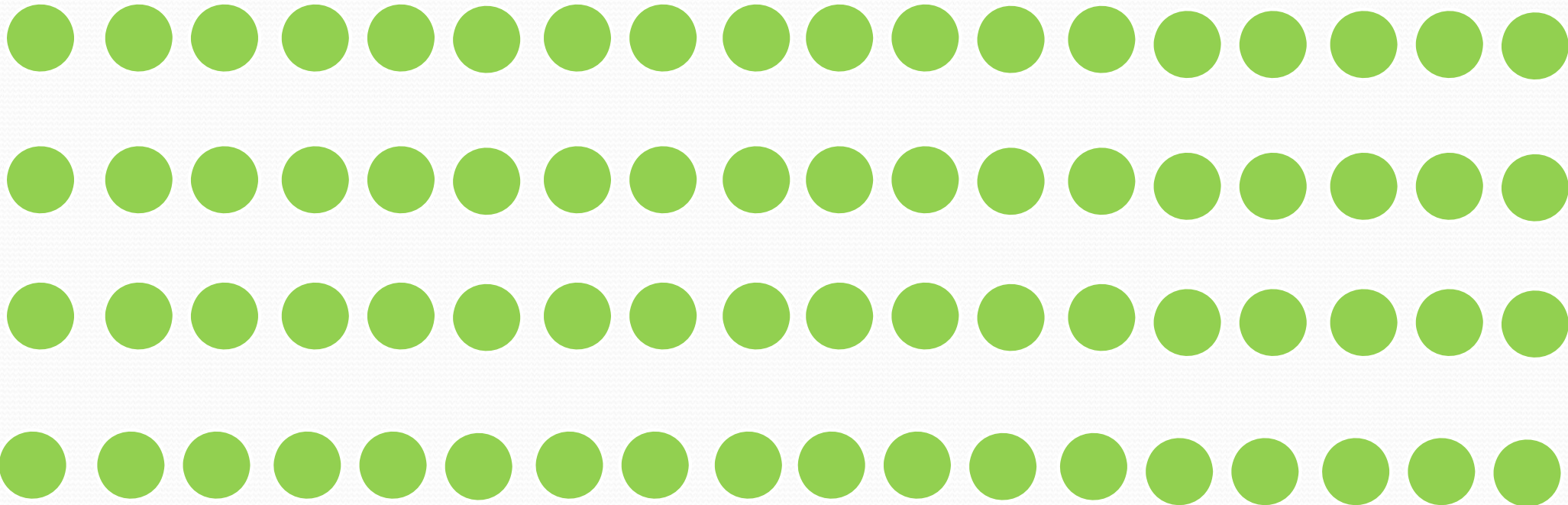


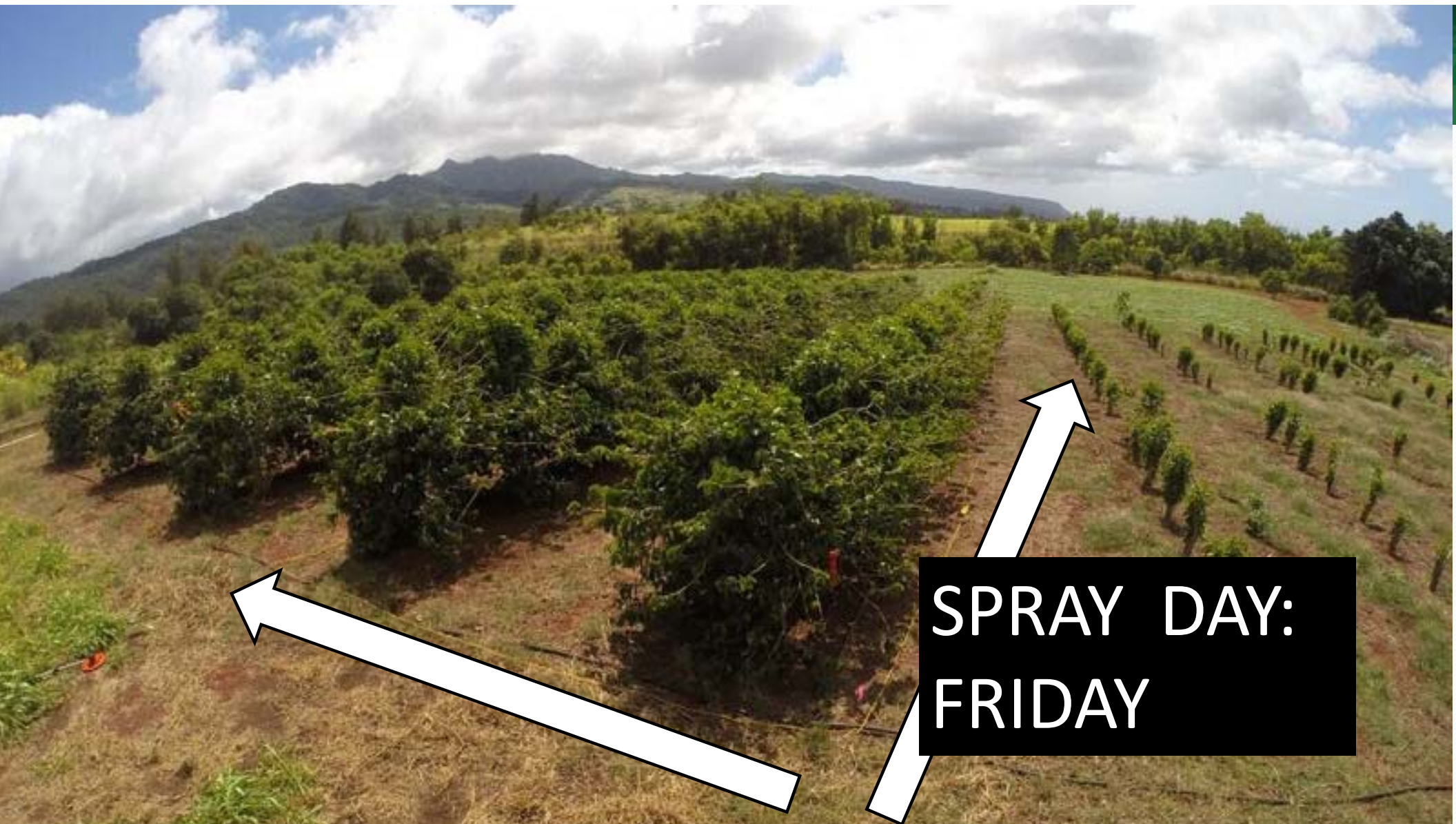
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Thursday: All variables are constant





**SPRAY DAY:
FRIDAY**

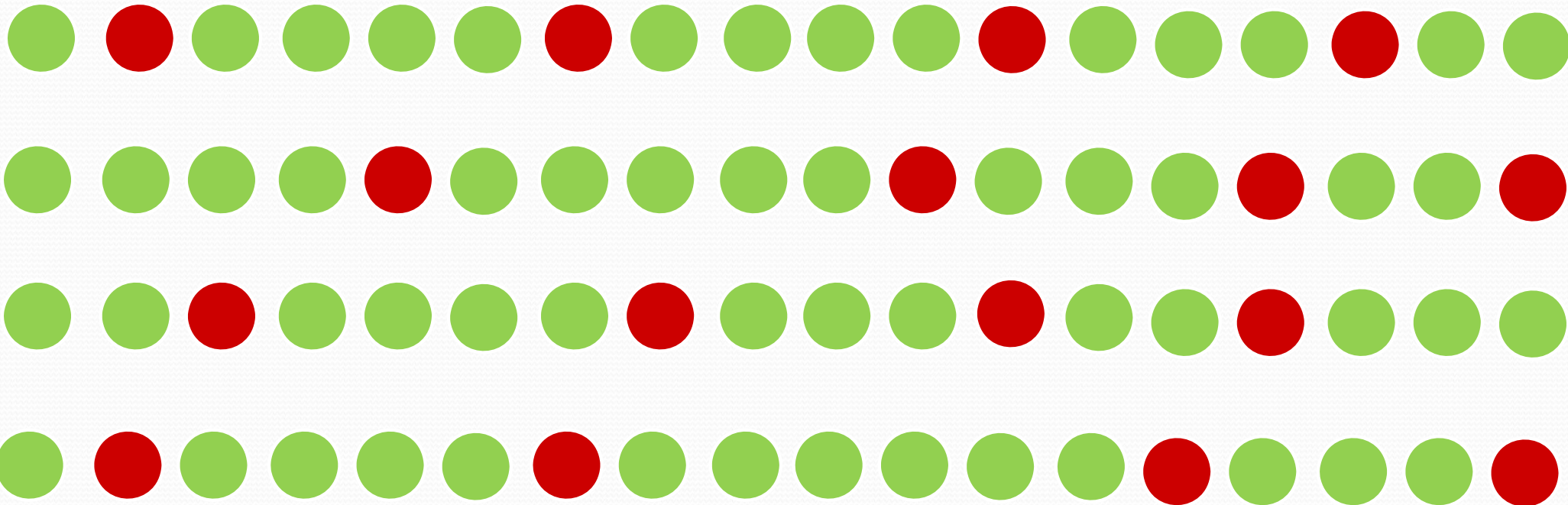


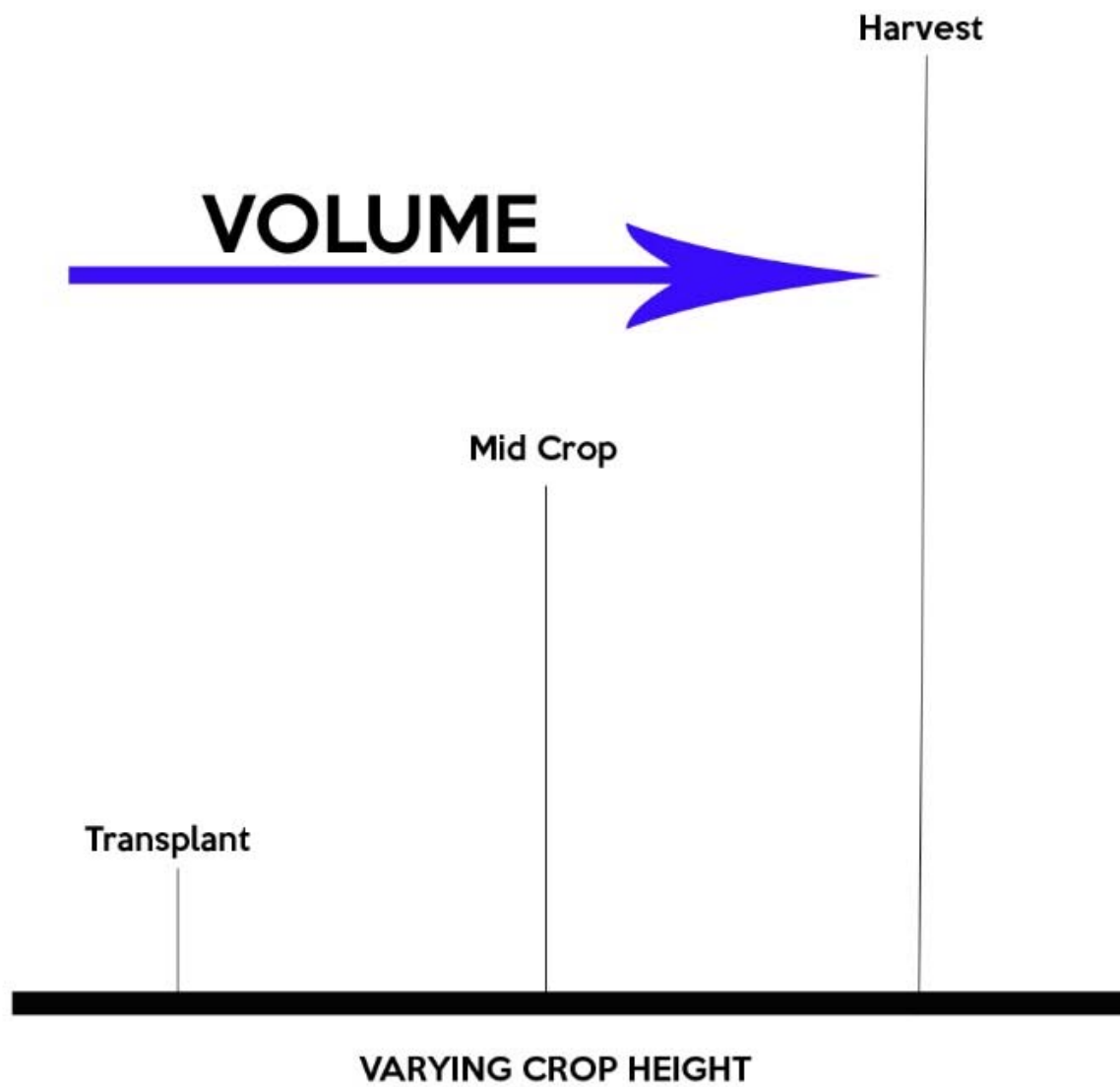
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FRIDAY: Slowed down your speed, volume increased





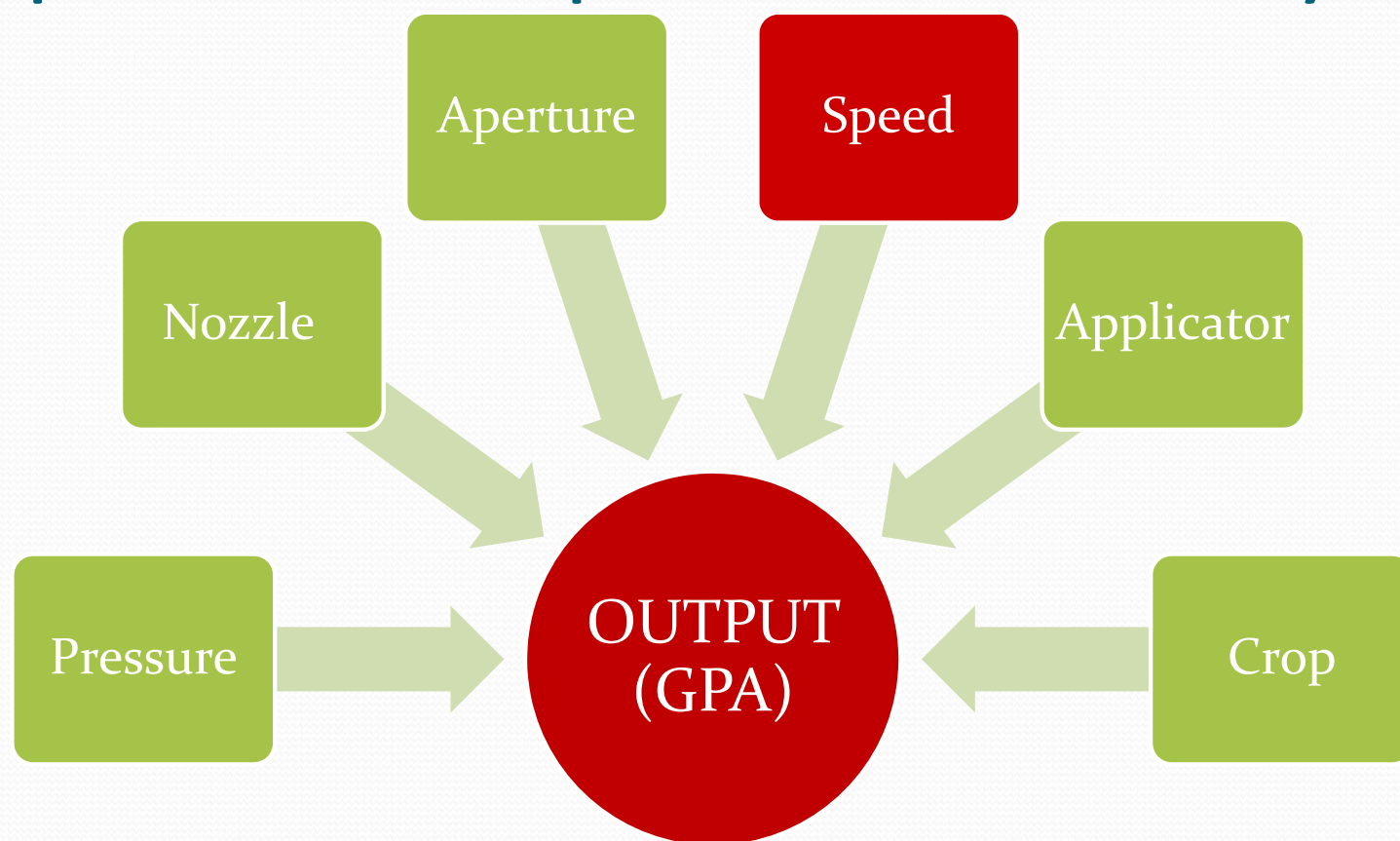


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Uniform Application Requires Consistency





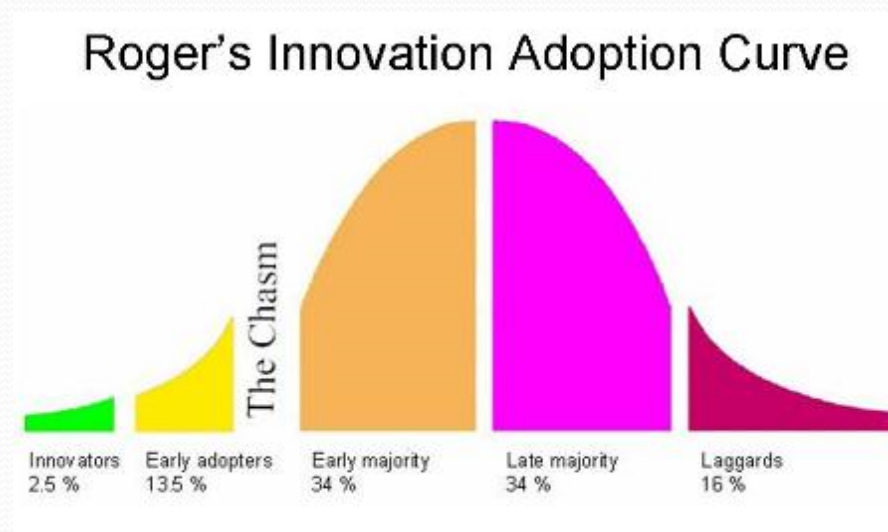
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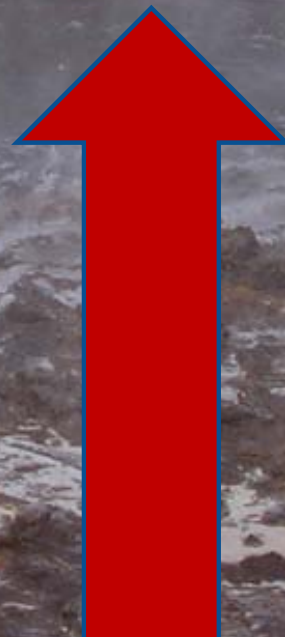


1/128th Method of Sprayer Calibration

- 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



Let's start by checking your system
Nozzles, worn hoses, leaks, etc.



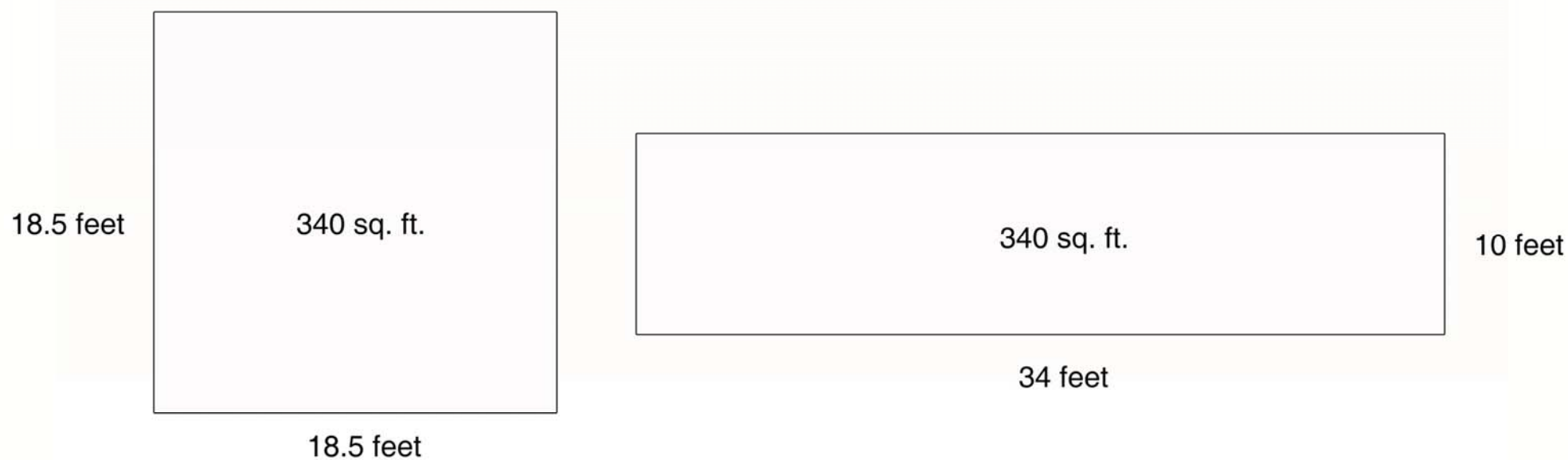


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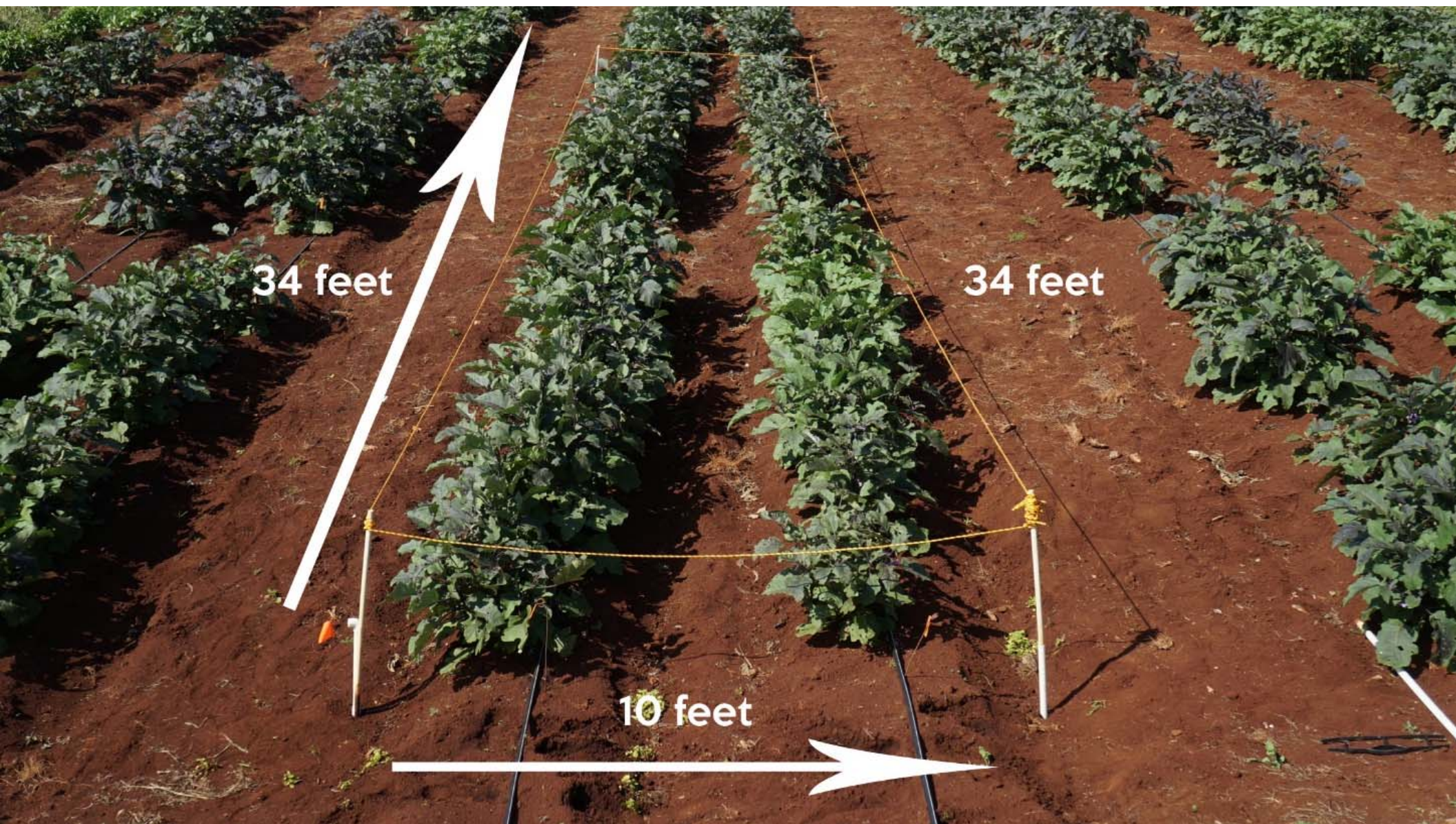
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Step 1: Measure a test area equal to $1/128^{\text{th}}$ of an acre (340 sq. ft.)





Measure 340 square feet



34 feet

34 feet

10 feet



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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





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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.



50
Seconds



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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.





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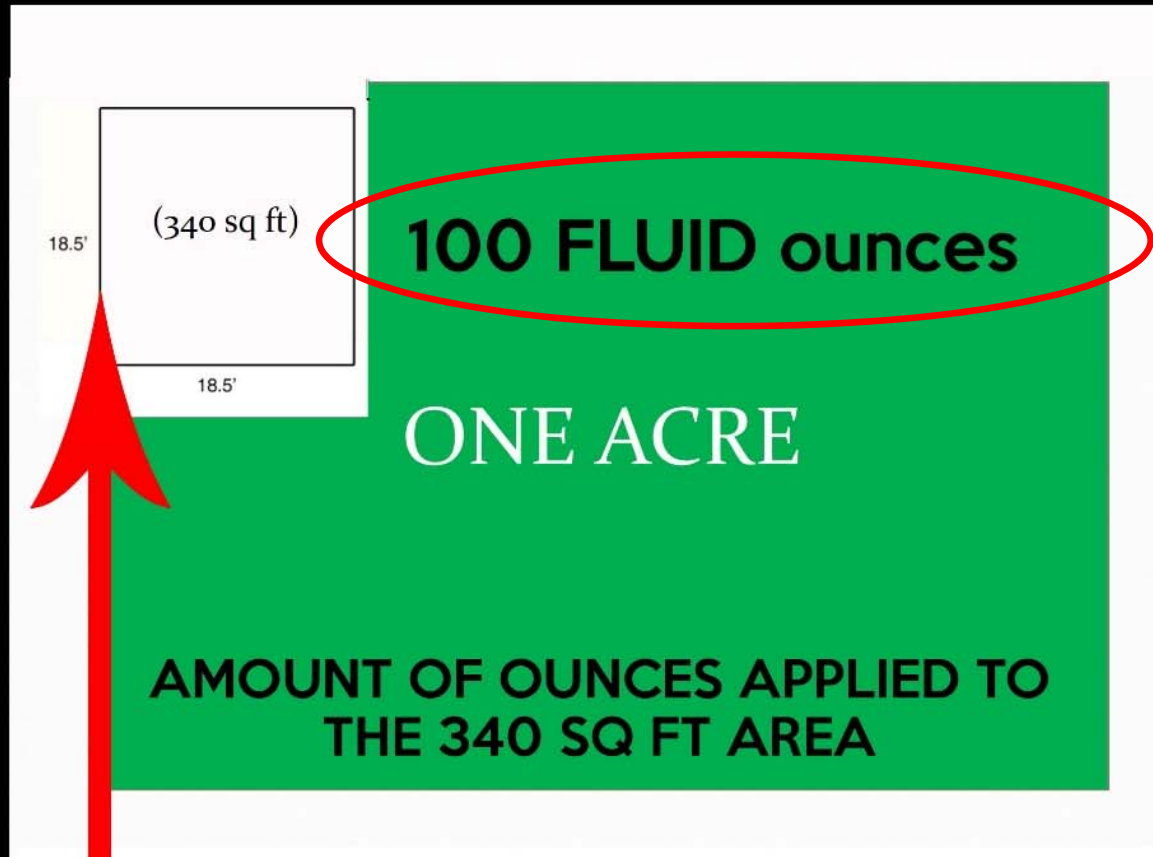
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Ounces = Gallons / Acre

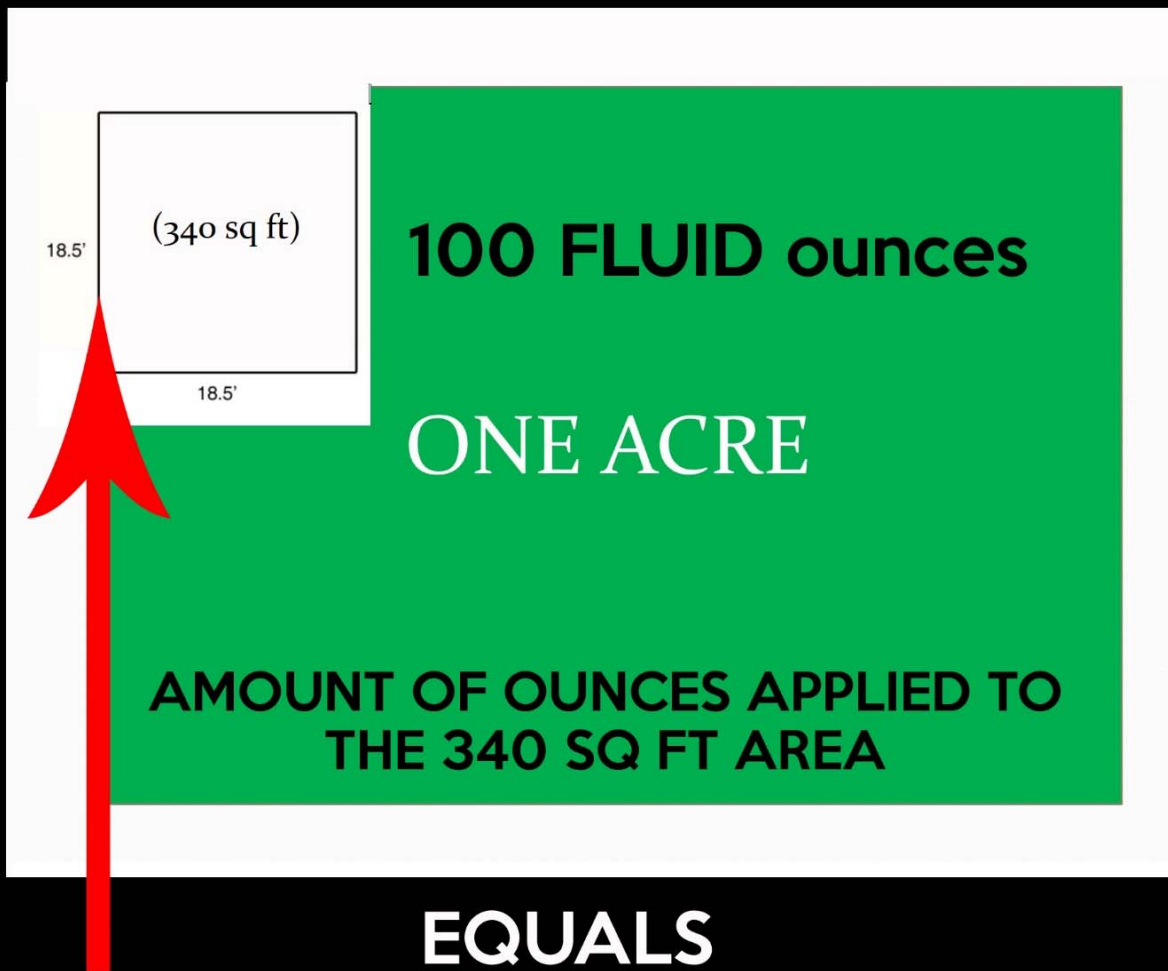
Example 1:

X GPA = 64 Ounces



**EQUALS
GALLONS / ACRE RATE
(GPA)**

Example 2



Example 2

100 GPA



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Video: 1/128th Spray Calibration

- Spray gun
- Boom
- Mist blower
 - Additional steps





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Crop needs to be listed on the label

Crop	Target Diseases	Use Rate fl. oz. product/A (lbs. a.i./A)	Remarks
Herbs & Spices (except black pepper) Allspice; Angelica; Anise (seed); Anise, star; Annatto; Balm; Basil; Borage; Burnet; Camomile; Caper (buds); Caraway; Caraway, black; Cardamon; Cassia (buds); Catnip; Celery seed; Chervil (dried); Chive; Chive, Chinese; Cinnamon; Clary; Clove (buds); Coriander (cilantro or Chinese parsley) (leaf); Coriander (seed); Costmary; Culantro (leaf and seed); Cumin; Curry (leaf); Dill (seed); Dillweed; Fennel, common; Fennel, Florence (seed); Fenugreek; Grains of paradise; Horehound; Hyssop; Juniper (berry); Lavender; Lemongrass; Lovage (leaf and seed); Mace; Marigold; Marjoram; Mustard (seed); Nasturtium; Nutmeg; Parsley (dried); Pennyroyal; Pepper, white; Poppy seed; Rosemary; Rue; Saffron; Sage; Savory, summer and winter; Sweet bay; Tansy; Tarragon; Thyme; Vanilla; Wintergreen; Woodruff; Wormwood	Corynespora blight (<i>Corynespora cassiicola</i>) Dill blight (<i>Cercosporidium punctum</i>) Phoma blight (<i>Passalora puncta</i>)	6.0-15.5 (0.10-0.25)	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.

Specific Use Restrictions:

- 1) Do not apply more than 92.3 fl. oz. of product/A/season.
- 2) Do not apply more than 1.5 lbs. a.i./A per season of azoxystrobin-containing products.
- 3) May be applied the day of harvest (0 day PHI).

Make sure your crop
is listed on label



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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

Quadris

Flowable Fungicide

Broad spectrum fungicide for control of plant diseases

GROUP 11 FUNGICIDES

Active Ingredient:

Azoxystrobin: methyl (E)-2-[2-[6-(2-cyanophenoxy)
pyrimidin-4-yloxy]phenyl]-3-methoxyacrylate*

22.9%

Other Ingredients:

77.1%

Total:

100.0%

SYSTEMIC

FOSPHITE[®] Fungicide

A FUNGICIDE FOR THE CONTROL OF DOWNY MILDEW, PHYTOPHTHORA, PYTHIUM AND VARIOUS OTHER DISEASES ON AGRICULTURAL AND GREENHOUSE CROPS, INDOOR AND OUTDOOR ORNAMENTALS, BEDDING PLANTS, TURF, FORESTRY APPLICATIONS AND DOMESTIC TREES, INCLUDING CONIFERS, PINES, OAKS AND POST-HARVEST TREATMENT OF POTATOES FOR PINK ROT AND LATE BLIGHT

ACTIVE INGREDIENT:
Mono and dipotassium salts of Phosphorous Acid* 53.0%

OTHER INGREDIENTS: 47.0%

TOTAL: 100.0%

*Contains 6.25% of the active ingredients, mono- and di-potassium salts of Phosphorous Acid, Equivalent to 3.96 lbs. Phosphorous Acid/gallon.

**KEEP OUT OF REACH OF CHILDREN
CAUTION**

See inside booklet for First Aid and additional precautionary statements.
FOR MEDICAL EMERGENCIES CALL 1-800-856-7378.

NET CONTENTS:

- ☐ 1 gallon (3.785 liters)
- ☐ 262.5 gallons (18.9 liters)
- ☐ 5 gallons (18.925 liters)
- ☐ 30 gallons (113.55 liters)
- ☐ 55 gallons (208.175 liters)
- ☐ 250 gallons (946.25 liters)
- ☐ Bulk containers (100-4000 gallons)

MANUFACTURED BY:
JH Biotech, Inc.
4014 Olsen Park Drive
Winters, CA 95703

EPA Reg. No. 63572-2
EPA Est. No. 63572-CA001

JH Biotech Inc.

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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



Quadris[®]
Flowable Fungicide

PULL HERE TO OPEN ►

GROUP 11 FUNGICIDES

syngenta[®]

Broad spectrum fungicide for control of plant diseases

Active Ingredient:

Azoxystrobin: methyl (E)-2-{2-[6-(2-cyanophenoxy)pyrimidin-4-yloxy]phenyl}-3-methoxyacrylate* 22.9%

Other Ingredients: 77.1%

Total: 100.0%

Contains 2.08 lbs. of active ingredient per gallon

*IUPAC

**KEEP OUT OF REACH OF CHILDREN.
CAUTION**

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

See additional precautionary statements and directions for use inside booklet. Reformulation is prohibited. See individual container labels for repackaging limitations.

EPA Reg. No. 100-1098 EPA Est. 100-NE-001

Product of the United Kingdom Formulated in the USA

SCP 1098B-L2J 0910 325402

1 gallon
Net Contents



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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.

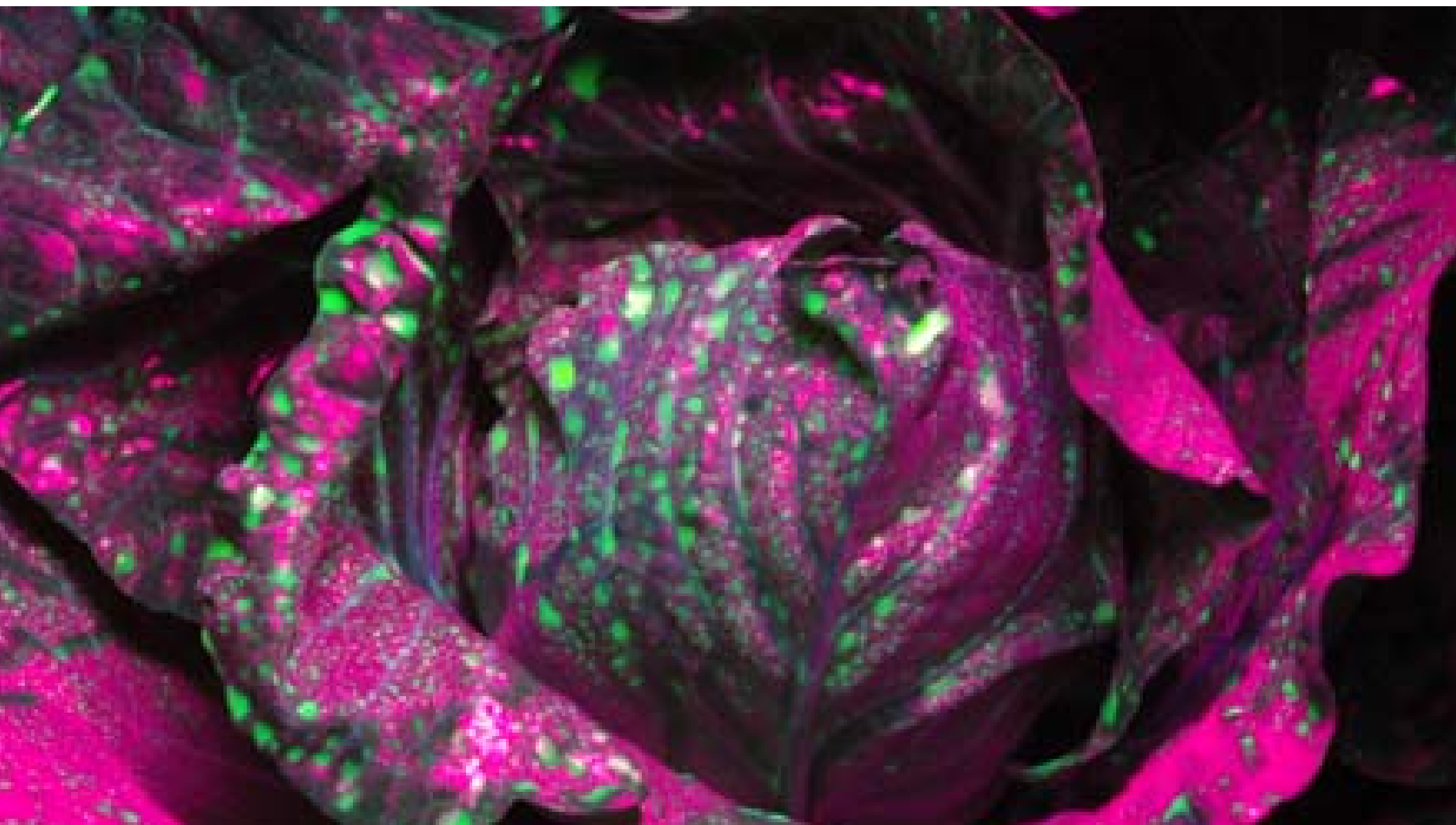
Always add one of the following:

- **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 at least 75% surface-active agent, at 0.25-0.5% v/v (1-2 qt/100 gal) in the finished spray volume for ground application. 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.







WETCIT
0 oz. / 100 gals.

WETCIT
12 oz. / 100 gals.

WETCIT
50 oz. / 100 gals.

WETCIT
6 oz. / 100 gals.

WETCIT
25 oz. / 100 gals.

WETCIT
70 oz. / 100 gals.



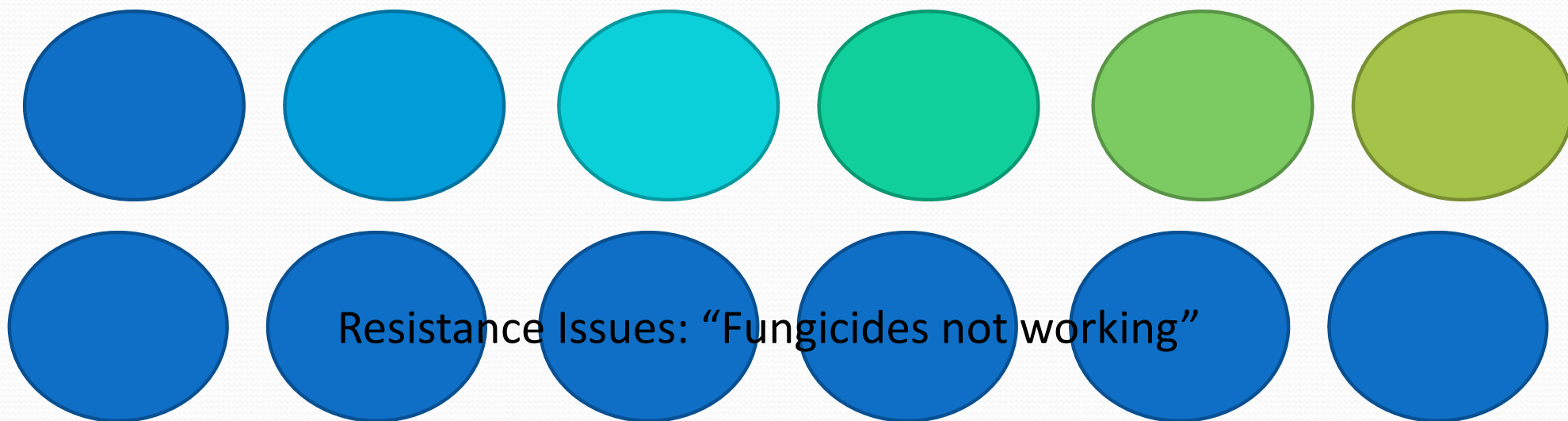
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Rotate to Minimize Resistance

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





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Stay within Maximum Application Limits

Limited Product Sandwich Effect / Season





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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

Do not enter

Ok to enter field

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 restricted entry interval. 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



遵从指示：不可擅进「限制进入的区域」。

Follow directions: keep out of restricted areas.



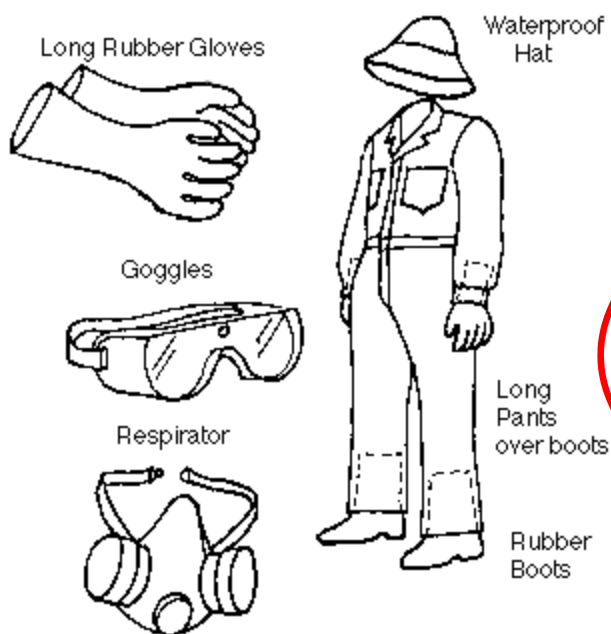
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What is PPE?

- 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...



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Tank Mixtures

- Agitation
- Stay within the maximum allowed limits
- Store and dispose of chemicals properly





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Post & Follow Warning Signs



- Danger
- Pesticides
- Keep out
- No Entry



Sprayer Calibration Using the 1/128th Method for Handheld Spray Gun Systems

Jensen Uyeda,¹ Jari Sugano,² Steve Fukuda,⁴ Mike Kawate,² Robin Shimabuku,² and Koon-Hui Wang²
¹Tropical Plant and Soil Sciences, ²Plant and Environmental Protection Sciences, ³O'ahu County Extension

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 simplified way to calibrate most hand spray 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 gallon-per-acre rate (GPA). Under-application of crop-protection chemicals can result in pest-control and pest-resistance 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 almost no 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 pump pressure
- Spray nozzle pressure; e.g., length and size of hose
- Spray aperture setting
- Spray nozzle orifice size
- 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.

Step 6

Measure the amount of water collected in fluid ounces (Fig. 6a, b).

Step 7

The amount of water collected in fluid ounces corresponds to your calibrated spray volume in gallons per acre. Example: You collected 64 ounces in the time it took to spray the targeted area (sq ft). Therefore, based on your calibration, the output is 64 gallons per acre, or 64 GPA (Fig. 7).



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/pest. Proper calibration of the sprayer can help to ensure accurate spray coverage. Calibrating a motorized backpack mist sprayer can be difficult; therefore, we have produced 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 pest 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)



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