Lesson Number 10

Title: Backpack and Hand-Held Sprayer Calibration

Purposes / Objectives:

1. To identify the situations in which a backpack sprayer must be calibrated.
2. To list the reasons for proper sprayer calibration.
2. To calibrate a backpack sprayer.
3. To demonstrate proper pesticide handling decisions and practices.

Overview:

The instructor and/or course participants perform backpack sprayer calibration operations with water alone, or water with visible (blue) or fluorescent dye added.

This activity fits well with other pesticide safety lessons, including #5: Pesticides and Exposure (Pesticides et Exposition), #6: Protective Clothing and Equipment: who, when, why and how (Vêtement de protection: quoi, quand, pourquoi et comment), #7: Tolerances for Pesticides in Food; and The Consequences of Pesticide Misuse (Tolérances des Pesticides dans la Nourriture; et Consequences d'une Mauvaise Utilisation des Pesticides), and #8: Applying Pesticides Safely and Effectively (Appliquer les Pesticides Efficacement et Avec Securité).

It is an opportunity to reinforce the reasons for proper calibration:
- safety;
- efficacy;
- crop acceptance (avoid unacceptable residues); and
- economics.

Materials:

Necessary	*Optional*
area markers (ex: sticks, flags)	calculator(s)
measuring tape (50 – 100 meters in length)	clipboard(s)
water	blue dye or
backpack sprayer	fluorescent dye
watch / stopwatch	+ blacklight
graduated containers (1 L / 50 mL / 10 mL w/ volume marks)	eyedropper
bucket	
PPE	
product label*	

*This lesson is written for applying Decis with a backpack sprayer: dilute 35 or 40 mL Decis in 15 L water to treat 350 or 400 m^2.

If you use another product, you may need to change the size of the test area.

Instruction Outline:

1. *Introduction* - Introduce yourself and your assistants / volunteers. Discuss the learning objectives for the session.

2. *Activity* - Backpack sprayer set up, the test area is marked, and the calibration operation is done with farmers.

    If a fluorescent indicator is used and you want to show exposure after the calibration activity is finished, work on a tarp when you fill the sprayer with water + dye. After the calibration exercise, the handlers, the sprayer, and the tarp can be brought into a dark room and blacklighted.

3. *Discussion and Problem-Solving* – Here is a list of suggestion questions or things to discuss before beginning:

- Ask course participants to identify why their sprayers must be calibrated.
    Explanation:
        - You do not need to calibrate your sprayer if the label reads like this: Mix 20 mL of RoundUp with 980 mL of water to make 1 L of a 2% solution. Spray to wet the foliage of the plants you wish to treat.
        - You must calibrate your sprayer if the pesticide label tells you to apply a specific volume per unit area -- for example: Dilute 35 or 40 mL Decis in 15 L water to treat 350 or 400 m^2.
- Ask them if/how farmers can calibrate other application devices like atomizers, misters, straw bundles, and watering cans.
    Explanation:
        - It is not possible to calibrate a broom/balai or a watering can/arrosior because the output is variable and hard to control.
        - Likewise, it is not easy to calibrate an atomizer.
        - It is possible to calibrate a small hand sprayer (mister) using the same techniques that will be described for a backpack sprayer.
- List the variables that affect the calibration process for backpacks:
    - release height (how far above the ground the nozzle is held), which will determine the swath width.
    - walking speed
    - nozzle selection: orifice size (and output volume), pattern, condition
- Discuss pesticide handling operations in general, and backpack spray applications specifically, to identify when / where exposure is most likely to occur (ex: mixing and

loading concentrate, overhead application, area spraying which requires the applicator to walk through a just-treated area).

4. *Wrap-Up and Conclusion* - Have a Question & Answer / Discussion session, in which you ask the students to:
   - list the reasons for / benefits of calibration,
   - discuss the variables in backpack sprayer set-up and use, and
   - list the steps and procedures involved in calibrating a backpack sprayer.

If a colorant was used, ask the students to identify the operations that caused exposure(s), and to list the reasons for use of protective clothing.

Advance Planning:

1. Be sure the backpack sprayers you'll use are clean and in good working order.

2. Gather all materials ahead of time.

3. Have at least one copy of the label of the product the farmers will apply.

Comments for the Trainer:

It is possible to do this demonstration with water only. However, you can add blue marker dye or water-soluble fluorescent dye to the water, and a pesticide exposure demonstration/discussion lesson may follow (see Lesson #5).

Lesson List:

A worksheet is provided for each group. It serves as a handout and a place to record data. Pre-measured test courses and a conversion chart are included.

1. Discuss the reasons for calibration.

2. Ask participants to list the variables involved in backpack sprayer calibration and use:

   a. Nozzle selection: orifice size (and output), pattern, condition.

   b. Sprayer configuration: wand length, wand angle (straight or curved).

   c. Operator: walking speed, nozzle height.

   d. Combination Factors: swath width.

Prior to the actual calibration exercise, it may be useful to demonstrate different nozzle tips and patterns; for example:

- fan vs. cone;
- a tip in good condition vs. a worn or damaged tip of the same type.

Demonstrate comfortable nozzle height for several different people. Show how, for different users of one backpack, the distance between the nozzle and the target will vary. The release height, in turn, determines the swath width. Show the swath width for two or more people using the same backpack. Discuss: what is an acceptable range?

Discuss the need for each person to walk at his/her normal speed and hold the wand in a comfortable position, and calibrate accordingly rather than to try to walk or hold the wand in an unnatural way.

(An applicator may use a sling to keep his arm at the same height all the time when necessary.)

Summarize: how do these factors affect the calibration of hand-held equipment?!
- If several different people use one sprayer, it must be calibrated for each.
- If one applicator uses several different backpack sprayers with different configurations, he/she must calibrate each one.

3. Discuss course set-up:

   A test course should not be too small. A good size is somewhere between 1/10 and 1/5 the size of the area the backpack sprayer should treat with a full load. The Decis label says a full load (15L) should treat 350-400 m^2…so a test course should be about 35 m^2 or 70 m^2.

4. Mark off the start and end of a linear course. (Refer to the chart on page 10.) Use sticks or flags to mark the beginning and end.

5. Add a colorant (optional).

6. Do the calibration exercise as described in the **Methods** section of the worksheet. Compute the output for the test course. (If possible, have both a tall and a short person calibrate the same sprayer.)

7. Do the math for each person on the worksheet. Calculate the volume (in mL, and then convert to L) needed to treat 35 m^2 or 70 m^2.

8. Ask the farmers what they can do if their sprayers, as configured, are putting out too much or too little?

- One way to change output is to change pressure…but that is not usually possible with a backpack. (Most are set up to operate at a more or less constant pressure, about 30 psi.)

- Another way to change output is to change speed:
faster = less per unit area, slower = more per unit area.
Walking slower may be possible as long as the person is conscious of the need to walk slowly. Walking faster is hard to do for a long period of time…people go back to their normal pace.

- The best way to change output is to change nozzles. A nozzle with a larger orifice will release more liquid per minute. A nozzle with a smaller orifice will release less liquid per minute. (An 80-04 nozzle usually works for most people.)

9. Conclusion/Wrap-Up: Q/A - reinforce objectives (page 1) - thank participants.

Methods:

1. Start with a clean backpack sprayer, set up exactly as it will be used.

2. Mark off a test area.

When the area to be treated is small, the calibration test area should be between 1/10 and 1/5 of the size of the area a full sprayer load will treat. For example, the Decis label reads:
Dilute 35 or 40 mL Decis in 15 L water to treat 350 or 400 m^2.
To calibrate a backpack sprayer to apply Decis, calibrate in a test area between 35 to 70 square meters.

You can either determine the swath width of the sprayer and set up a linear course, or simply mark off an area.
ex: 7 x 5 = 35 square meters;
ex: 7 x 10 or 2 x 35 = 70 square meters.

3. Fill your sprayer (about 1/2 full), and pump it to the normal operating pressure.

4. Time yourself as you spray the test area with water.

5. Spray into a bucket for the same amount of time it took for you to spray the test area.

6. Pour the water from the bucket into a graduated container. This will allow you to measure the volume you would apply to the test area accurately.

7. Calculate:

- Your output in mL and L per minute.

- The volume you apply to 350-400 square meters.

  If your test area is 35 m^2, you should apply about $1/10^{th}$ of the amount you would use for 350 m^2 = 1.5 liters.

  If your test area is 70 m^2, you should apply about $1/5^{th}$ of the amount you would apply to 350 m^2 = 3 liters.

- For green bean farmers, calculate the size of an average plot.

  - How many should you be able to treat with a full backpack load?

    For example, if one small section (three short rows) is one meter wide and two meters long = 2 m^2, a farmer should be able to treat 175 or 200 sections this size (2 m^2) with a full 15 L backpack.

  - How many sections should one liter treat?

    If 15 L should be applied to 350-400 square meters, then one liter should treat about $1/15^{th}$ of 350-400 square meters = 23-27 square meters.

    350 m^2 is to 15 L as ?? is to 1L:

    $$\frac{350}{15} = \frac{??}{1} \qquad \frac{400}{15} = \frac{??}{1}$$

    350 m^2 x 1 L divided by 15 L = 23.333 m^2
    400 m^2 x 1 L divided by 15 L = 26.666 m^2

    If the farmer's sections are one meter wide and two meters long = 2 m^2, he or she should be able to treat 11.5 - 13.5 (about 12 or 13) of them with a liter of spray.

    Average plot or section size:
    L _____
    W: _____
    Area: _____

    Divide this average area into 23 or 27 (average 25) to compute how many sections the grower should treat with one liter of spray.

- If a farmer uses a small spray bottle, how much solution should be applied to one planche?

For example, the Decis label says to dilute 35 or 40 mL of product in 15 L to spray 350-400 square meters.

15 L = 15,000 mL.

So:

15,000 mL is to 350 m^2 as ?? is to 2 m^2:

$$\frac{350}{15{,}000} = \frac{2}{?} \qquad \frac{400}{15{,}000} = \frac{2}{?}$$

15,000 mL x 2 m^2 divided by 350 m^2 = 86 mL
15,000 mL x 2 m^2 divided by 400 m^2 = 75 mL

However, 35-40 mL Decis in 15,000 mL water is the equivalent of using 0.2 mL Decis in 75-86 mL water:

$$\frac{35}{15{,}000} = \frac{?}{86} \qquad \frac{40}{15{,}000} = \frac{?}{75}$$

To mix the right amount for one planche, you would need to measure 0.2 mL of Decis and add that to 75-86 mL water.

It may be more convenient to mix up enough for ten planches:
To mix the right amount for ten planches, put 2 mL of Decis in 750-860 mL water.

Another way is to count the number of planches, and mix enough pesticide + water to treat all of them.
For example, if there are 20 planches, multiply x 20:

0.2 mL of Decis x 20 = 4 mL Decis
~ 80 mL water x 20 = 1,600 mL total solution

Discussion / Notes to Trainers:

Here are some things to ask growers:

Why is calibration important?
- legal requirements
- efficacy
- environmental stewardship
- $$ (not waste time, material inputs, equipment wear and tear, etc.)

What other common tasks involve area figuring out how much to use to cover an area?
- Whitewash for a wall, room, or house
- Lumber or siding to build a deck or platform
- Tin or straw panels for a roof
- Fabric for a dress

You can show this with some paint or whitewash, and something to paint!

Use a wide brush and water-based paint or whitewash on a board or wall. Apply paint from left to right with a slow, medium, and fast brush stroke. Dip the brush into the paint each time – try to use more or less the same amount of paint on the brush each time. (If possible, wet the brush before you start, and rinse it between applications.) Let the paint dry and observe how far it goes, and how thickly it is applied. Like paint, if a pesticide is under- or over-applied, there is no good way to fix the problem!

If you underapply (too thin):

Paint:	*Pesticide:*
- poor appearance	- poor coverage
- poor durability	- reduced efficacy
- excess material	- excess material used, and there is no way to treat the area evenly or properly!

If you overapply (too thick):

Paint:	*Pesticide:*
- waste $	- waste $
- waste time	- waste time
- not enough material	- not enough material, and no way to 'extend' to the proper coverage!
- poor performance	- phytotoxicity, reduced efficacy, crop may be rejected if residues are over limits, etc.

Conclusion:

Summarize and review the main points about calibration – what, why, and how. Be sure they know how to mix the amount they need for the area they need to treat. Ask the growers if they have any questions. End the lesson by thanking them for their time and participation.

Notes:

Decis Rate: *Préparation* Section of Label

35-40 mL in 15 L per 350-400 m^2 ≈ 1 oz in 4 gallons to treat 3780 ft^2

Calculations: Decis Rate w/ Sprayer (Pulvérisateur)

35-40 mL in 15 L per 350 m^2 ≈ 1 oz in 4 gallons to treat 3780 ft^2
10-11 mL in 4.25 L per 100 m^2 ≈ 1/4 oz in 1 gallons to treat 1000 ft^2

2-3 mL in 1L to treat 23.3 m^2
(4.8m x 4.8m; ≈ 1m x 23m; ≈ 2m x 11.5m ≈ 3m x 7.8 m; ≈ 4m x 6m)

5 mL in 2L to treat 46.6 m^2
(6.8m x 6.8m; ≈ 1m x 46.6m; ≈ 2m x 23.3m ≈ 3m x 15.5 m; ≈ 4m x 12m)

6 mL in 2.5L to treat 58.3 m^2
(7.6 m x 7.6 m; ≈ 1m x 58.3 m; ≈ 2m x 29.15 m ≈ 3m x 19.4 m; ≈ 4m x 14.6m)

7 mL in 3L to treat 70 m^2
(8.4m x 8.4m; ≈ 1m x 70m; ≈ 2m x 35m ≈ 3m x 23.3 m; ≈ 4m x 17.5m)

9-10 mL in 4L to treat 93.3 m^2
(9.7m x 9.7m; ≈ 1m x 93.3m; ≈ 2m x 46.7m ≈ 3m x 31.1 m; ≈ 4m x 23.3m)

Conversions:

1 m ≈ 3 feet

1 m^2 ≈ 10.8 ft^2

m^2 x 10.8 = # ft^2
ft^2 x 0.093 = # m^2

18.6 m^2	≈	200 ft^2
(4.31 m x 4.31 m)		(14.14 ft x 14.14 ft)
(2 m x 9.3 m)		(4 ft x 50 ft)
93 m^2	≈	1,000 ft^2
(9.64 m x 9.64 m)		(31.62 ft x 31.62 ft)
(5 m x 18.6 m)		(20 ft x 50 ft)

350 m^2	≈	3,780 ft^2
(18.7 m x 18.7 m)		(61.5 ft x 61.5 ft)
(5 m x 70 m)		(20 ft x 189 ft)

30 mL ≈ 1 oz

10 L ≈ 2.5 gallons = 2.64 gallons

gallons x 3.785 = liters
liters x 0.264 = gallons

10 drops = 1 mL

Course Layout:

Swath Width of a Linear Course Length to = 25 m^2 (x 17.5 = 350 m^2)
Swath Width of a Linear Course Length to = 35 m^2 (x 10 = 350 m^2)
Swath Width of a Linear Course Length to = 70 m^2 (x 5 = 350 m^2)

Using a TXA 8004 Cone Jet Hollow Cone Nozzle - 2 MPH walking speed

Swath Width	Linear Distance for:		
(cm / m)	20 m^2	35 m^2	70 m^2
30 / 0.3	66.7 m	116.6 m	233.5 m
40 / 0.4	50.0 m	87.5 m	175.0 m
50 / 0.5	40.0 m	70.0 m	140.0 m
60 / 0.6	33.3 m	58.3 m	116.7 m
70 / 0.7	28.6 m	50.0 m	100.0 m
80 / 0.8	25.0 m	43.8 m	87.5 m
90 / 0.9	22.2 m	38.9 m	77.8 m
100 / 1.0	20.0 m	35.0 m	70.0 m
110 / 1.1	18.2 m	31.8 m	63.6 m
120 / 1.2	16.7 m	29.2 m	58.3 m
130 / 1.3	15.4 m	26.9 m	53.8 m
140 / 1.4	14.3 m	25.0 m	50.0 m
150 / 1.5	13.3 m	23.3 m	46.7 m

BACKPACK SPRAYER CALIBRATION
Worksheet

SET-UP:

For this backpack, output in gallons per minute: _____

Nozzle type: _____
Ex. Tee-Jet Hollow TXA 8004 (hollow cone nozzle)

Calibration Test Area Information / Volume Applied to _____ square meters:

RESULTS:

Example #1:

Person's Name: _____

Tip Used: _____

Boom Height: _____

Swath Width: _____

Size of test area (ex. 35 m^3 or 70 m^3): _____

Time to spray test area: _____

Volume (ml/L) used to spray the test area: _____

Multiply to compute:
Volume (L) to spray 350 m^3: _____

Does this match the product label directions? _____

Example #2:

Person's Name: _____

Tip Used: _____

Boom Height: _____

Swath Width: _____

Size of test area (ex. 35 m^2 or 70 m^2): _____

Time to spray test area: _____

Volume (mL/L) used to spray the test area: _____

Multiply to compute:
(x 5 if test area is 1/5th; x 10 if test area is 1/10th)
Volume (L) to spray 350 m^2: _____

Does this match the product label directions? _____

Example #3:

Person's Name: _____

Tip Used: _____

Boom Height: _____

Swath Width: _____

Size of test area (ex. 35 m^2 or 70 m^2): _____

Time to spray test area: _____

Multiply to compute:
(x 5 if test area is 1/5th; x 10 if test area is 1/10th)
Volume (L) to spray 350 m^2: _____

Does this match the product label directions? _____

HAND (Bottle/Mister) SPRAYER CALIBRATION
Worksheet

SET-UP:

For this device, output in liters per minute: _____

Sprayer Description: _____

RESULTS:

Example #1:

Person's Name: _____

Hand Sprayer Type Used: _____

Release Height: _____

Swath Width: _____

Size of test area (ex. 2 m^2): _____

Time to spray test area: _____

Volume (mL/L) used to spray the test area: _____

Multiply to compute application volume:

(if the test area was 2 m^2, x 175 to calculate the volume in (L) needed to spray 350 $m^{2)}$: _____

(if the test area was 10 m^2, x 17.5 to calculate the volume in (L) needed to spray 350 $m^{2)}$:

Does this match the product label directions? _____

(The Decis label directs you to apply 35-40 mL Decis in 15 L water. This is the equivalent of applying 75-86 mL Decis solution to 2 m^2, or 750-860 mL Decis solution to 10 m^2.)

REVIEW:

1. **Why** is calibration necessary?

2. **What variables** affect backpack sprayer calibration?