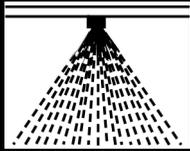


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Boom Sprayer Calibration

By Andrew Landers

Overview

Concept	Activity	Handouts
<i>Custom applicators are an important audience for this module.</i>		
Improperly calibrated spray equipment may cause environmental damage—as well as lost profits and reduced effectiveness. Farmers and applicators need to calibrate their equipment on a regular basis.	#1: Boom Sprayer Calibration	A. <i>Check Your Sprayer Tune-up Knowledge</i> B. <i>Droplet Size: Does It Match Your Target?</i> C. <i>Checklist for Boom Sprayer Maintenance</i> D. <i>Calibrating a Boom Sprayer</i>
Pre- and end-season care is crucial to prevent contamination and the build-up of sediment.		
Custom applicators are busy, too, and their calibration isn't always up to snuff. Farmers need information that helps them keep tabs on the quality of custom spraying jobs.		
Resources http://aben.cals.cornell.edu/extension/pestapp/index.htm www.nysaes.cornell.edu/recommends (Commercial Vegetable Production 2000) National Pesticide Stewardship Alliance, www.acrecycle.org/npsa/ Penn State Fact Sheet B-85, B-80, and Leaflet 339 http://psei.ext.vt.edu/pser/ercf.html		Related Topics: Module #6: IPM for Alfalfa Weevil Module #7: IPM for Corn Rootworm Module #8: IPM for Potato Leafhopper in Alfalfa Module #10: Weed Management in Row Crops

Here s what you ll do:

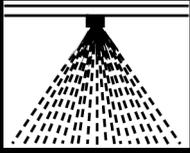
Beforehand

- ◆ set this up with a farmer who has representative equipment. Ask your host to check the equipment ahead of time, using your *Checklist for Boom Sprayer Maintenance*.

Today, on site

- ◆ discuss the costs of sprayer miscalibration;
- ◆ examine the effects of droplet size; learn the importance of reducing spray drift; learn the ins and outs of nozzle selection;
- ◆ ask your host to describe the maintenance check and results;
- ◆ calibrate a sprayer.

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Boom Sprayer Calibration

ACTIVITY #1: Boom Sprayer Calibration

Setting	Time Required	Materials	Handouts
<i>A host farmer s yard and field, preseason</i>	<i>1 1/2 hour</i>	<i>100 tape measure, wrenches containers to catch nozzle discharge, liquid measure (ounce) stopwatch or watch with sweep second hand postal or kitchen-type scale chemical resistant gloves, face shields labels, pens/pencils collecting jars or bags</i>	<i>A. Check Your Sprayer Tune-up Knowledge B. Droplet Size: Does It Match Your Target? C. Checklist for Boom Sprayer Maintenance D. Calibrating a Boom Sprayer</i>

Q:	Pose a series of questions:	A:
<i>Pass out Check Your Sprayer Tune-up Knowledge. After everyone fills it out, go over the answers and discuss. (Bone up by going over this module if you don t know all the answers.)</i>		
<i>Now, before you actually calibrate a sprayer, some questions for discussion</i>		
<i>What are the costs of over-applying sprays?</i>	<ul style="list-style-type: none"> ◆ You spend more money than you need to. ◆ You can pollute watersheds. ◆ You can kill your own crops. ◆ Spills can render the soil sterile. ◆ Sprays can drift onto neighboring properties, injuring sensitive crops or angering homeowners... and potentially leading to lawsuits that could put you into the courtroom and out of business. 	
<i>What are the costs of under-applying sprays?</i>	<ul style="list-style-type: none"> ◆ Lost effectiveness, resulting in reduced kill or no kill of pests. ◆ Weeds, diseases, and pests can develop chemical resistance. ◆ Under-application is, in effect, drift, and can promote chemical resistance in pests. 	
<i>Why is it important to clean and calibrate your sprayer?</i>	<ul style="list-style-type: none"> ◆ To avoid both over-applying and under-applying sprays. ◆ Label rates (maximum) are set by law. You should never exceed them. <p><i>(Some state laws have been modified to allow a lower rate of application: discuss particulars for your state but encourage participants to follow label recommendations.)</i></p>	

Q:	Continue your discussion	A:
<p><i>Mini-lecture:</i></p> <ul style="list-style-type: none"> • You can recoup the cost of replacing a faulty gauge that indicates 15% below actual pressure in about two hours operation. • Maintenance measures, such as fitting a new set of nozzles at the beginning of each season, also save money. Even when there is overdosing by as little as 5%, the cost of a new set of nozzles would be recovered in less than a day's work. 		
What other factors may cause under- or over-application?	<ul style="list-style-type: none"> ◆ Forward speed of sprayer is too fast or slow (consider the weight of sprayer, slope, ground conditions). ◆ Small increases in engine speed result in large increases in pressure. ◆ Pressure in sprayer unit: low pressure, droplets are too large and they bounce; high pressure, droplets are too small, don't stick, may drift. ◆ Wrong size nozzle hole (in other words, droplets are too large or too small). If too large, you'll get over-application; if too small, you get under-application and drift. Even if everything else is properly set, your flow rate and volume will be incorrect. ◆ Operator skill and training. 	
What else do you need to be concerned about when you spray?	<ul style="list-style-type: none"> ◆ Operator health hazards: headaches, nausea, long term-health problems. ◆ The possibility of spills. ◆ Spraying only under optimum conditions. ◆ Staying 50 to 100 feet from watercourses or sensitive crops. 	
What causes drift?	<ul style="list-style-type: none"> ◆ High pressure in sprayer unit: droplets are too fine and don't have enough mass to go down—they drift off instead. ◆ Nozzle size too small: small droplets more likely to drift; may stay in the atmosphere indefinitely or until they evaporate. ◆ Worn nozzles cause drift. ◆ Spraying when there's a breeze. 	
How can you reduce drift?	<ul style="list-style-type: none"> ◆ Get the boom closer to the target—use nozzles with angles of either 80° or 110°. (Go for 110° if the field is quite level and you can get closer to the ground.) ◆ Keep pressure as low as possible. ◆ Use the correctly sized nozzle. ◆ Don't spray on a windy day... if you can feel a breeze and the leaves are rustling, it's too windy to spray. Wind speeds over 4 mph are too high for spraying. ◆ Use shielded booms or low-drift nozzles. ◆ Use buffer strips or barrier crops. ◆ Use adjuvants if recommended. ◆ Stay alert to changes in wind speed and direction. 	
When and how often should you clean and calibrate your sprayer?	<p>Pre-season: tune up; clean and calibrate everything.</p> <p>Mid-season: calibrate the nozzles.</p>	

Q:	Carry on	A:
What is the function of a nozzle?	<ul style="list-style-type: none"> ◆ It creates the right-sized droplets for your target. ◆ It propels the droplet to the target. ◆ It provides even coverage. 	
How do you know what pressure to use and which size nozzle to get?	<p>New labels on pesticide containers in the near future will state nozzle classification.</p> <p>Check sprayer handbooks and nozzle catalogs.</p>	
When would you select a coarse, medium, or fine nozzle?	<p>Coarse nozzles are best for soil-acting, pre-emergence herbicides.</p> <p>Medium nozzles are best for post-emergence herbicides.</p> <p>Fine nozzles are best for insecticides and fungicides.</p>	
What is the economic impact of have one nozzle plugged, worn, or dirty?	<p>One plugged or dirty nozzle can leave unsprayed strips in your fields... these serve as safe havens for pests... if they rebound and reach endemic populations after the window of opportunity for control is past, you may be in trouble.</p> <p>Worn nozzles tend to produce smaller nozzles, therefore drift... droplets aren't distributed properly.</p> <p>Dirty nozzles alter the spray distribution pattern... you may overspray one row, underspray the next.</p>	
<i>Pass out copies of the Droplet Size handout and discuss.</i>		
How do you fix a blocked nozzle?	<p>Why, just blow through it...<i>NO!!!</i></p> <p>Clean the nozzle with a soft brush... an old toothbrush will do. Or remove it from the boom and hit it with a blast of compressed air.</p> <p><i>NEVER</i> clean it with a piece of wire.</p> <p>Always carry a spare.</p>	
<p><i>Hand out copies of Checklist for Boom Sprayer Maintenance.</i></p> <p><i>Ask your host to go over the maintenance check he/she did prior to the class, noting any consequent adjustments or repairs.</i></p> <ul style="list-style-type: none"> • <i>In essence, this is the once-yearly check that each person should do before the season begins.</i> 		
<p>If this were the midseason calibration, what routine maintenance items would we check?</p> <p><i>(These items are included on p.2 of Checklist for Boom Sprayer Maintenance.)</i></p>	<ul style="list-style-type: none"> ◆ All hoses tightly connected and free from sharp bends; cracked or damaged hoses must be replaced. ◆ All controls move freely and are fully adjustable. ◆ Pressure gauge reads zero. ◆ Pump can be turned over by hand. ◆ Air pressure in pump accumulator (if fitted) correctly adjusted. ◆ Drain plugs and clean filters in position. ◆ Tires sound and correctly inflated; wheel nuts tight. 	

Q:	<i>Now, on to actually calibrating your sprayer</i>		A:
<p>What else should you do before you begin calibrating?</p>	<p>Thoroughly clean all the screens and sprays nozzles. (This helps insure proper operation.)</p> <p>Are all the nozzles made by the same manufacturer and do all have the same part number? Are they actually the type and output you want? Look and see...</p> <p><i>Fill the tank half full of water (and don t empty it after, to be ready for the next part).</i></p> <p>See that the spray patterns from all nozzles are the same... and consistent with what we need. Replace any nozzles that lack uniform spray patterns.</p>		
<p>How do you interpret nozzle codes?</p>	<p>Consult the manufacturer’s chart... and encourage manufacturers to adopt ISO standards, so that any nozzle can be easily assessed by its color.</p>		
<p><i>Hand out the Boom Sprayer Calibration Worksheet, get out your stopwatch, and have at it.</i></p> <p><i>Note: the formulas here provide a simple, direct method of calibrating nozzle output in gallons per minute.</i></p> <p><i>Of course, you may be familiar with the traditional, indirect method for calibrating a sprayer, where you ll collect a fluid ounce output that will correspond exactly with the gallons per acre (GPA) of your sprayer, thus indicating accuracy. We have included a worksheet for those who prefer this method; instructions follow.</i></p>	<p>First, a quick check on throttle speed—you can’t always trust your tachometer. Travel speed is a critical factor in maintaining accurate application rates. Incorrect settings can skew spray rates.</p> <ul style="list-style-type: none"> ◆ <i>Follow directions on the worksheet.</i> ◆ <i>Bear in mind that a one-second error in timing could result in a 5% application error.</i> <p>What operating pressure (psi) will you use for spraying?</p> <p><i>Adjust to that pressure while the pump is operating at normal speed. Be sure water is flowing through the nozzles. (Don t change the pressure when you actually spray.)</i></p> <ul style="list-style-type: none"> ◆ <i>Record on the worksheet.</i> <p>What nozzle spacing will you be using?</p> <ul style="list-style-type: none"> ◆ <i>Note on the worksheet.</i> 		
<p>If you are spraying in bands...</p>	<p>Adjust the boom sprayer calibration figures for <i>gallons per acre per nozzle</i> to the particular bandwidth and row spacing you will use.</p> <p>The worksheet shows you how.</p>		
<p>Mini-lecture: the stats on calibration:</p> <ul style="list-style-type: none"> ◆ 60% of sprayers have a calibration error greater than plus-or-minus 10%. ◆ 43% of sprayers have greater than 10% variation in discharge from individual nozzles. ◆ 32% have inaccurate travel speed. ◆ 27% have improper boom height for the nozzle spacing and nozzle discharge angle. ◆ 13% have inaccurate pressure gauges. Many of the gauges indicate too low a pressure. Remember that in about two hours operation, you can recover the cost of replacing a faulty gauge indicating 15% below actual pressure. ◆ 8% have inadequate hose size to supply nozzles, causing pressure to drop in the system. 			

A. Check Your Sprayer Tune-up Knowledge

Worksheet for Activity 1

1. On average, what percent of farmers over-apply crop production chemicals by more than five percent of the intended rate?
 - a. 2%
 - b. 5%
 - c. 10%
 - d. 25%

2. How long does a thorough sprayer calibration take?
 - a. 1/2 hour
 - b. 1 hour
 - c. 4 hours
 - d. 1 day

3. How many times should sprayers be calibrated each year?
 - a. 1 time
 - b. 2-3 times
 - c. 5-6 times
 - d. 8-12 times

4. When should worn or damaged tips be changed?
 - a. When the day's spraying is complete
 - b. Immediately
 - c. When the spraying season is over
 - d. When time allows

5. What's the best way to determine whether a nozzle is worn?
 - a. calibrate the sprayer
 - b. look at the nozzle
 - c. insert a wire to check opening size
 - d. none of the above

6. Calibration includes...
 - a. checking tractor speed
 - b. calculating nozzle flow rate
 - c. adjusting pressure
 - d. all of the above

7. When spray nozzles wear out...
 - a. over-application occurs
 - b. patterns become uneven and spray coverage is poor
 - c. potential for chemical waste, crop burn, and environmental risks increase
 - d. all of the above

8. Spray distributed in _____ is more likely to drift.
 - a. a stream
 - b. large droplets
 - c. a fine mist
 - d. none of the above

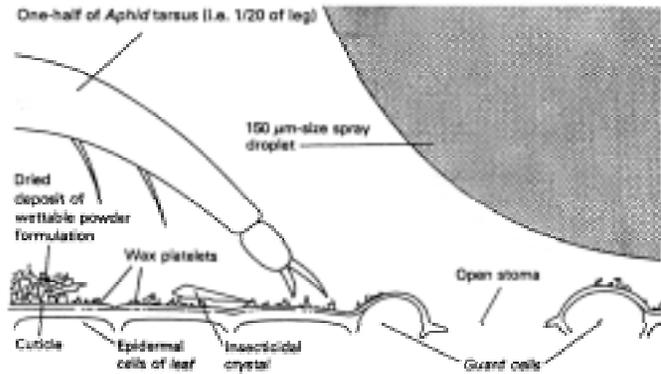
Answers:

1/d... 2/b... 3/b... 4/b... 5/a... 6/d... 7/d... 8/c

B. Droplet Size: Does It Match Your Target?

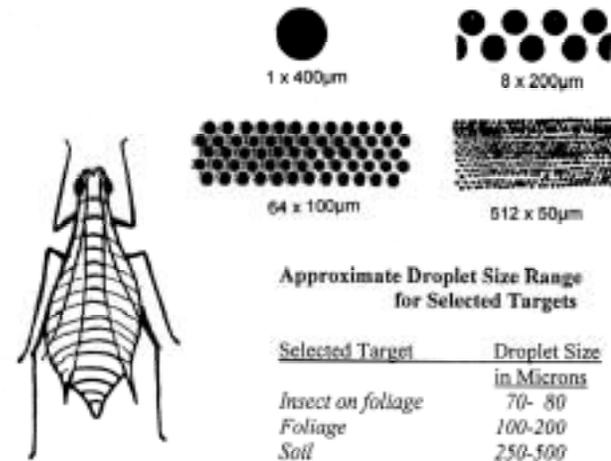
Handout for Activity 1

Some relative sizes on a cabbage leaf



Reprinted with permission from Hartley, G.S. and Graham-Bryce, I.J., 1980. *Physical Principles of Pesticide Behaviour*. Academic Press.

Relative droplet coverage same volume



Spray Quality	Size of droplets	Retention on difficult leaf surfaces	Used for	Potential drift hazard
Very fine	(Finer)	Good	Exceptional circumstances	(High)
Fine		Good	Good cover	
Medium		Good	Most products and uses	
Coarse		Moderate	Soil herbicides	
Very coarse		Poor	Liquid fertilisers	
		(Coarser)		

Reprinted with permission from Boom & Fruit Sprayers Handbook published by the British Crop Protection Council, Farnham, UK.

C. Checklist for Boom Sprayer Maintenance

Handout for Activity 1, p. 1

Before you begin

Take great care when adjusting a sprayer while the engine is running.

Engage the handbrake when leaving the seat.

Wear protective clothing to avoid contaminating yourself.

The checklist

Power Unit (tractor)

Check

- ◆ unit is powerful enough to operate properly under all conditions
- ◆ air cleaner is clean
- ◆ engine oil and filter are up to snuff
- ◆ tire pressure is to specs

Sprayer Operation

Fill tank part full of water and move to uncropped waste ground. Remove the nozzles. Don protective clothing (sprayer may be contaminated). Engage drive and gently turn shaft, increasing slowly to operating revs.

Check

- ◆ on/off valve
- ◆ pressure relief valves
- ◆ agitation system

Flush through the spray lines, then switch off the tractor and refit the nozzles.

Check

- ◆ liquid system again for leaks

Hoses

Check

- ◆ for splits, chafing, and cracks, particularly where booms fold
- ◆ connections to ensure they are water-tight

Filters

Check

- ◆ for missing filter elements and seals
- ◆ for leakage
- ◆ for blocked or damaged filters
- ◆ that you have the correct filter for nozzle size

Tank

Check

- ◆ for fractures and any other damage
- ◆ that the tank sits securely in its mount
- ◆ that the agitation is working
- ◆ that the tank is clean

Controls

Check

- ◆ the control circuitry (electrical, hydraulic, or air) for correct operation
- ◆ valves for both internal and external leaks

Pump

Check

- ◆ oil levels and look for leaks
- ◆ that the air pressure in the pulsation chamber (if fitted) is at the recommended level
- ◆ that the pump rotates freely

Pressure Gauge

Check

- ◆ the pressure gauge needle doesn't fluctuate when the nozzles are delivering the correct amount of chemical per unit time while spraying.
- ◆ the pressure gauge needle returns to zero when the sprayer is switched off

Boom

Check

- ◆ boom movement and stability
- ◆ the boom folding mechanism
- ◆ the height adjustment mechanism
- ◆ the break backs for correct operation

Boom Piping

Check

- ◆ the condition of all pipe work
- ◆ the nozzle bodies for damage or loose fit
- ◆ for any damaged units, and replace them
- ◆ for leaks under pressure

Check Valves

Check

- ◆ damaged diaphragms and seats
- ◆ that all valves stop liquid flow from the nozzles when sprayer switched off

C. Checklist for Boom Sprayer Maintenance

Handout for Activity 1, p. 2

Checklist for Boom Sprayer Maintenance, cont.**Nozzles***Check*

- ◆ that all nozzles on the boom are the same
- ◆ that all nozzles are in good condition, with no evidence of streaks or irregularities in the spray pattern
- ◆ that all nozzles are clean and free from obstruction (note: clean with a soft brush or airline—don't damage nozzles by using wires or pins)
- ◆ that all nozzles deliver to within + or - 5% of the manufacturer's chart value

Calibration

Where your sprayer has automatic controllers to monitor the speed of the sprayer and the flow, pressure, and area sprayed, check

- ◆ that they are in good condition and properly maintained
- ◆ that they are frequently calibrated for accuracy, leaks, blockages, variations in pressure or any minor damage during spraying

Routine maintenance**The following checks should be carried out routinely:**

- ◆ All hoses tightly connected and free from sharp bends; cracked or damaged hoses must be replaced.
- ◆ All controls move freely and are fully adjustable.
- ◆ Pressure gauge reads zero.
- ◆ Pump can be turned over by hand.
- ◆ Air pressure in pump accumulator (if fitted) correctly adjusted.
- ◆ Drain plugs and clean filters in position.
- ◆ Tires sound and correctly inflated; wheel nuts tight.

D. Calibrating a Boom Sprayer

Worksheet for Activity 1

Check your tractor/sprayer speed:

- Mark off a course 100, 200, or 300 feet long
- Fill your tank half full of water
- Stopwatch in hand, run the course twice, timing the seconds each way

1st run _____ seconds
 2nd run _____ seconds

Divide by 2 to average the runs: _____ seconds

MPH = ___ (ft. traveled) ___ (sec. traveled) x 60 ÷ 88 = _____ MPH

MPH = feet traveled ÷ seconds x 60 ÷ 88

Record

Your operating speed: _____ (MPH)

And corresponding gear selection: _____

Your operating pressure : _____ (psi)

Record your inputs

Nozzle type on your sprayer: _____

Recommended application volume: _____ (Gal./acre; GPA
 from manufacturer s label)

Nozzle spacing _____ (inches)

Speed in MPH	Time required in seconds to travel a distance of:		
	100 feet	200 feet	300 feet
0.5	136	273	409
1.0	68	136	205
1.5	45	91	136
2.0	34	68	102
2.5	27	55	82
3.0	23	45	68
3.5	19	39	58
4.0	17	34	51
4.5	15	30	45
5.0	14	27	41
5.5	12	25	37
6.0	11	23	34
6.5	10	21	31
7.0	10	19	29
7.5	9	18	27
8.0	9	17	26
8.5	8	16	24

Calculate the required nozzle output in gallons per minute (GPM)

GPM = GPA x MPH x nozzle spacing ÷ 5940 (constant)

GPM = ___ (GPA) x ___ (MPH) x ___ (spacing) ÷ 5940 =

_____ GPM

Now for the test are your nozzles putting out the GPM you just calculated?

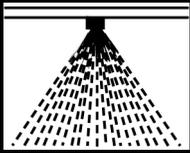
- ◆ Park the sprayer and operate it at the same pressure, same engine speed
- ◆ Set the correct pressure at the gauge using the pressure regulating valve.
- ◆ Collect and measure the output of each nozzle for exactly one minute.
- ◆ Is the output of each nozzle per minute the same as your calculated gallon per minute?
- ◆ Replace any nozzle tips that vary by more than 10%.

For band width spraying, to determine gallons per acre (GPA) for two or three nozzles:

GPA = 5490 (constant) x ___ (GPM) ÷ ___ (MPH) x ___ (row width) ÷ ___ (no. nozzles/row]

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www.nysaes.cornell.edu:80/ipmnet/ne.ipm.region



Module Feedback

Boom Sprayer Calibration

Tell us a little about yourself:

<p><i>I m a</i></p> <ul style="list-style-type: none"> ◆ Farmer _____ ◆ Crop advisor _____ ◆ Industry rep _____ ◆ Extension educator _____ ◆ Other _____ 	<p><i>My commodity area is:</i></p> <ul style="list-style-type: none"> ◆ Dairy and field crops _____ ◆ Vegetables _____ ◆ Fruits and berries _____ ◆ Greenhouse and nursery stock _____ ◆ Other _____
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Let us know what you think:

What part of the workshop was most interesting for you?
What part of the workshop was most valuable to you?
What two new ideas would you like to try on your farm or in your business?
Do you feel you understand IPM—and how to use it—better now?
What other information should be included in this module?
What other topics would you like us to cover in future modules?

Teachers, please fill out an evaluation as well. Photocopy and send all informative evaluations to:

NE-IPM Modules, NYS IPM Program, Box 28 Kennedy Hall, Cornell University, Ithaca NY 14853