II.8 Calibration of Aerially Applied Sprays

Billy Tanner and T. J. Roland

Calibration is the process of measuring and adjusting the amount of pesticide your equipment will apply to the target area. Pesticide applicators need to be sure they are using the correct amount of pesticide: Too little can result in inadequate control; too much can result in injury to people, plants, or animals, illegal residues, excess runoff or movement from the target, and lawsuits and fines.

Calibration was a frightening word to most early aerial applicators. Their procedures were to mix, load, and fly. Pilots continually adjusted boom pressure and swath width as they went along to make the pesticide come out right for the acreage. Some areas were overdosed; others were underdosed or completely missed. Advancing technology, education, demands by ranchers and farmers, pesticide laws, and label requirements are forcing the modern-day aerial applicator to be calibration conscious.

An aircraft with a properly calibrated dispersal system reduces the workload of the pilot. He or she has enough to watch from the cockpit without constantly monitoring the amount of chemical remaining in the hopper and adjusting boom pressure to make chemical and acreage come out right.

The manufacturers of various nozzles, atomizers, and spray tips provide calibration formulas and/or procedures to calibrate their equipment properly. The formula used by the Plant Protection and Quarantine unit of the U.S. Department of Agriculture's Animal and Plant Health Inspection Service to calibrate aerial liquid systems is simple and accurate.

Before calibration procedures begin, learn the airspeed, swath width, application rate per acre, spray tip size (output per minute per nozzle), and the flow factor for the chemical being used. With these known factors, you can use the following calibration formulas:

• (Miles per hour × swath width in feet) ÷ 495 (a constant) = **acres per minute**

• (Acres per minute × rate per acre in ounces) ÷ 128 (oz in 1 gal) = **gallons per minute**

• Gallons per minute ÷ nozzle output = **number of nozzles to install using water**

• Number of nozzles for water × chemical flow factor = **number of nozzles to install on the aircraft for the chemical being used.**

A Practical Example of Aerial Spray Calibration

Cessna Ag Truck
Airspeed = 120 miles per hour (mi/h)
Swath width = 100 ft
Pesticide = malathion
Application rate = 8 oz/acre
Nozzle tip size = 8002 flat fan
Nozzle output = 0.2 gal/minute using water at 40 pounds per square inch (lb/in^2)
Correction flow factor for malathion = 1.1

Step 1. Calculate the acres per minute that the aircraft will cover.

(120 mi/hour × 100 ft) ÷ 495 = **24.24 acres/minute**

Step 2. Calculate the number of gallons per minute that the aircraft will put out at the desired rate per acre.

(24.24 acres/minute × 8 oz/acre) ÷ 128 (oz in 1 gal) = **1.52 gal/minute**

Step 3. Calculate the number of nozzles required to apply water at 8 oz/acre and pressure set at 40 lb/in^2.

1.52 gal/minute ÷ 0.2 (output per minute per nozzle) = **7.58 nozzles for water**

Step 4. Calculate the number of nozzles to install correcting for viscosity (flow factor—see table II.8–1 at the end of this chapter) of the chemical being used.

7.58 (nozzles) × 1.1 (flow factor) = **8.3 nozzles**

Step 5. Round to the nearest whole number.

8.3 rounded down to **8 nozzles to install on the aircraft.**

Step 6. Conduct a calibration run either static (run the system on the ground and collect discharge from each nozzle into containers to determine the actual output per minute) or fill the spray tank to a known reference mark and fly the aircraft for 1 min. Refill the tank to the known reference mark and determine the amount used. If the output was light or heavy, make small adjustments to the pounds-per-square-inch setting to achieve the correct output per minute. The final calibration check should be accomplished during actual application with a small load. The following information and flow factor table will help calibration for most sprays and aircraft.

Useful Information and Calculations

128 oz/gal ÷ rate per acre (ounces) = acres/gal
128 oz ÷ 8 oz = 16 acres/gal
128 oz ÷ 12 oz = 10.67 acres/gal
128 oz ÷ 16 oz = 8 acres/gal
128 oz ÷ 20 oz = 6.4 acres/gal
128 oz ÷ 32 oz = 4 acres/gal
128 oz ÷ 40 oz = 3.2 acres/gal
128 oz ÷ 96 oz = 1.33 acres/gal

- Total program acres ÷ acres per gallon = total gallons required

- Airspeed (mi/hour) × swath width in feet ÷ 495 (a constant) = acres per minute

- Acres per minute ÷ acres per gallon = gallons per minute

- Gallons per load ÷ gallons per minute = dispersal time per load

- Gallons dispersed ÷ acres covered × 128 = rate per acre in ounces

- Swath width in feet ÷ 8.25 = acres per mile

- Acres per mile ÷ acres per gallon = gallons per mile

- Gallons per mile × swath length in miles = gallons per swath

- Aircraft load in gallons ÷ gallons per swath = number of swaths per load

To convert knots to miles and miles to knots, multiply
Knots × 1.15 (a constant) = mi/hour
Example: 160 knots × 1.15 = 184 mi/hour
mi/hour × 0.868976 (a constant) = knots
Example: 135 mi/hour × 0.868976 = 117 knots

- 1 mi^2 = 640 acres
- 1 acre = 43,560 ft^2 = 0.405 hectare (ha)
- 1 ha = 2.471 acres
- 1 gal/acre = 9.35 L/ha
- 1 gal = 128 fluid oz = 8 pints = 4 quarts
- 1 gal = 3.785 L = 3,785 Ml
- 1 mi = 5,280 ft = 1,610 m = 1.61 km

Table II.8–1—Flow factor table for spraying solutions other than water

Weight of solution	Specific gravity	Conversion factors
(lb/gal)		
7.0	0.84	0.92
8.0	.96	.98
8.34	1.00	1.00
9.0	1.08	1.04
10.0	1.20	1.09
10.65—28% Nitrogen	1.28	1.12
11.0	1.32	1.14
12.0	1.44	1.20
14.0	1.68	1.29