SOP: Calibration for Aerial Application Equipment

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Timeline

Version	Date	Reviewed by	Institution
1	12/07/23	Katherine Gleave	LSTM, I2I
2			

Version Control[1]

Version	Date	Updated by	Description of update(s)
2	04/07/23	Annabel Murphy	Updated: Format and structure of content under sub-headings and footnotes.

[1] Historical versions of SOPs can be found on the I2I website (https://innovationtoimpact.org/)

			Added related documents and glossary of terms.

Related documents

- I2I Best Practice SOP Library, 30 October 2020 (https://innovationtoimpact.org/)
- Operation and Maintenance of the Track Sprayer, I2I-SOP-025
- Calibration for Backpack and Truck-Mounted Sprayers, I2I-SOP-030

1. Purpose

There is a wide range of different aerial systems used in public health sprays with many custom-built systems in use. The following guidelines can be used to calibrate aerial application equipment.

2. Background

It is highly recommended that the user consult with personnel that have extensive experience with aerial application systems to ensure proper calibration and droplet size analyses. Weekly calibration is recommended. The spray system should be designed using information from nozzle manufacturers to provide an appropriate droplet size distribution and flowrate. Each machine must then be calibrated to ensure that the correct amount of insecticide is delivered in the desired droplet size distribution. First the coverage needs to be calculated and this depends on the aircraft speed and the effective track spacing (commonly referred to as swath width), which is the distance between each spray line. Once the desired spray rate is known or specified by the chemical manufacturer on the product label, the required flow rate can be calculated from an equation.[2]

1.1 Droplet size distribution of rotary and fixed winged aircraft

[2] Flowrate (L/min) = (VS * TS * AR) / 600, where VS (km/hr) = Aircraft speed during normal spray operations, TS (m) = Track spacing or swath width, AR (L/ha) = Target application rate, 600 is used for unit conversion. Example: If an aircraft's speed is 120 km/hour and the track spacing or swath width is 300 m with an application rate of 0.5 l/ha, the flow rate would be 30 l/min.

It is essential that the droplet size distribution is known and adjusted if necessary. The droplet size should be checked at the beginning of the study, or between different application rates. The droplet size distribution required should range between a Dv0.5[3] of 25 to 45 µm depending on formulations, operational parameters, and environmental conditions. Follow the label and instructions provided by the equipment manufacturer. The statistics requested from droplet sizing analysis are the Dv 0.1, Dv 0.5 and Dv0.9; where 10%, 50% and 90% of the spray volume is in droplets of a smaller diameter. For aerial application, rotating impactors are the only practical droplet collection devices that can be used in the field, with the aircraft being flown as low as safely possible over the devices at normal operating speeds.

3. Materials and equipment

3.1. Measuring flow rate

- Personal Protective Equipment
- Graduated Cylinder
- Stopwatch

3.2. Droplet size distribution of rotary and fixed winged aircraft

- Personal Protective Equipment
- Stands for the rotary impactor
- Rotary impactors
- Slides
- Microscope

[3] Dv represents a diameter of which a % of droplets are smaller than e.g., Dv0.1 would represent the diameter of which 10% of droplets are smaller than and Dv0.9 would represent the diameter that 90% of droplets are smaller than

- Aircraft
- Radios

4. Procedure

4.1. Measuring flow rate

- Wear gloves, overalls, a suitable respirator, ear protection and protective goggles as a minimum for protective equipment. Spill Containment Kit, MSDS and Labels, and Emergency Contact should be readily available in the aircraft.
- Load the chemical to be calibrated to the chemical tank.
- Start the spray pump system from ground-based source.
- Place a graduated measuring device under each of the chemical spray nozzles.
- Run the spray system until primed and then empty and reset all collection devices.
- Turn the spray system back on for 60 seconds.
- Measure and record the volume collected from each nozzle and total the amount sprayed.
- The flow rate can be adjusted by increasing or decreasing spray pressure, changing the nozzle orifice size, changing the number of nozzles, or making slight adjustments to aircraft speed.
- Repeat until a minimum of three replicates are achieved within ± 10% of that specified on the label.

- Return insecticide collected to the main tank and wash all measuring containers following an appropriate protocol. The graduated cylinder and additional tubing should be dedicated to this role and not used for anything else.

4.2. Droplet size distribution of rotary and fixed winged aircraft

- Ensure that there is a place for workers to take cover when the aircraft flies over (e.g., truck or car).

- Wear gloves and goggles.

- Place a minimum of 3 rotating impactors, with Teflon coated slides, in a straight line 15m apart, in an open field perpendicular to the direction of flight. The aircraft should fly into the wind and the wind speed should be less than 15 km/h).

- Mark the flight line for the pilot.

- The first pass over the sampling line should be made with the spray system turned off so the pilot can practice the approach safely as they will be flying low and fast.

- Turn on the rotating impactors.

- Call the aircraft in wet, the spray should be turned on 500m prior to reaching the sample line and be left on for 500m past the sample line.

- The spray altitude should be as low as safely possible, but no more than 15m, with the forward speed, and spray system configured to follow operational settings.

- Wait for 5 minutes after spray to be sure that the whole droplet size distribution is sampled.

- Collect the slides, place in sealed containers with the position annotated.
- Repeat a minimum of three times.
- Return to the laboratory for microscopic analysis.

4.3. Data Analysis

Image analysis software can rapidly compute the required statistics. For manual assessment use an eye piece graticule, measure the diameter of a minimum of 200 droplets per slide. Cube the diameter[4] and calculate the volume fraction in each size class and from the cumulative volume fraction calculate the Dv0.1, Dv0.5 and Dv0.9. With both image analysis and manual assessment ensure that the operator traverse the slide widthwise because smaller droplets will preferentially collect to the outer edge of the slide[5].

5. Additional data collection

6. Deviations from standard protocol

If droplets are not within the desired range for the application, various adjustments must be made, depending upon the method being used to atomize the pesticide into droplets. Generally, the higher the airspeed, the smaller will be the droplets.

[4] Note on accuracy of spinning slide method for calculating droplet size statistics of larger (>30 microns Dv0.5) droplets used in aerial space spray applications: The spinning slide method, coupled with "Yeomans' correction", produces a reasonable estimation of droplet sizes from truck-based equipment (typically having a Dv0.5

[5] As the air flows around an object (the slide) suspended particles will continue in their original direction due to their inertia. Smaller particles have less inertia, streamlining with the air, so the impact probability will increase closer to outer the edge

7. Glossary of terms

µm	Micrometer
km/hr	Kilometres per hour
l/ha	Litres per hectare
l/min	Litres per minute
m	metre
MSDS	Material Safety Data Sheet

8. References