Calibration of aircraft and application systems. By Alan McCracken

To obtain good results with any agrochemical it is essential that the equipment is in good condition and correctly calibrated. Having worked in the chemical industry for many years it has been my experience that most product failures are related to faulty application, so we all have a need to pay attention to the details. Small errors in the concentration of a pesticide can be very expensive because it implies a waste of chemical due to over-dosage, or poor results in the case of under dosage. For example if we consider a typical days work for an aircraft of 2000 acres with a product that costs US$15/acre, this corresponds to US$30,000 worth of chemical. In this example if there is an error of 10% in calibration this means an error of US$3,000 per day!
A serious operator should consider using flow meters and calibrate his aircraft daily with a pre-flight check as is normal for all aircraft operations. The ultimate of course should be a system that adjusts the flow rate to match the aircraft speed in which the GPS unit is linked with a flow meter and an integrated flow control valve.

With respect to my numerous pilot friends many admit to flying for the love of flying and while open to investing large sums of money in a new high tech aircraft are often reluctant to invest in new application equipment and many aircraft may be found operating with old nozzles with worn spray tips and even worse leaking shut-off valves.

Calibration procedures:

Pre-flight test:
Physically check that all the equipment is thoroughly cleaned, remove and clean all filters, check that nozzle diaphragms etc are in good condition. If the aircraft is equipped with rotary atomizers check that are clean and rotate easily. Do not over grease since could cause problems with internal seals and heavy grade grease could also cause unnecessary drag.

Calibrate volume/pressure and all systems on the ground:
It is fundamental that ALL nozzles or atomizers deliver the same flow rate otherwise it will be impossible to obtain a uniform swath deposition. The only exception is when alternate nozzle sizes are used to obtain a specific application volume. Operate the spray system on the ground to check that all components work effectively, with no leakages and to calibrate flow rate desired.

a) Operate the aircraft engine when equipped with an hydraulic driven spray pump
b) When equipped with a windmill driven pump recommend use a large loading pump to pressure the system on the ground to check operation of all components, by-pass valve, pressure gauge, flow meters, nozzle check valves and the output per nozzle or atomizer. Remove the spray pump and connect directly onto the aircraft hopper and return flow to the by-pass valve such that the ground pump simply substitutes the aircraft pump. This method enables complete control and test of All components without starting the aircraft engine. [Design available on request]
c) A simpler partial check may be conducted by connecting the ground pump to the centre of the spray boom and then measure the flow rate per nozzle.
d) WATER: For practical purposes calibration checks may be conducted with water, however the flow rate with a mixture of chemicals will be different in most cases, and it is strongly recommended that an "in-flight" test be made during each spray load. The actual flow rate may be easily determines by checking on the "application time" as recorded by the GPS unit, and then dividing the Tank volume by the elapsed time to determine what the true flow rate was, and then adjust if needed.
e) Low volume application with Oils, ULV products for mosquito control etc. For these products the system must be calibrated with the product since the flow rate will be different from water.

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Recommend use a ground calibration pump unit connected to the aircraft with a collection system under the nozzles, or atomizers to collect the product. [Design available on request]

Spray deposition analysis of the effective swath width:
The effective swath width of an agricultural aircraft depends on a number of factors including the following:

- Aircraft size: wingspan and weight – wider swath widths feasible with heavier aircraft and with wider wingspan.
- Flying speed: higher speeds break up the spray droplets and hence permit a wider swath
- Droplet size: wider swaths are feasible with smaller droplets since the spray curtain is more subject to displacement due to the aircraft turbulence.
- Spray volume; wider swaths also feasible with lower volumes, though only when the spray droplet size is smaller, in which case special attention must be given to “off-Target” displacement.
- Flying height: Many misunderstandings in this area, since flying too low can not only cause streaking but also result in increased drift, since spray is more likely to be forced into the wingtip vortices. Also flying to high can result in severe off-target losses due primarily to evaporation of the spray droplets.
- Height and density of the target crop being sprayed: The effective swath width is directly related to the height and density of the target crop. For example to spray aphids on young wheat a much wider swath may be used than when spraying an insecticide in tall sugarcane 10ft in height. The reason being is that the spray droplets are being captured by the foliage canopy.

How to determine the realistic swath test. [Conduct a minimum of three swaths over the target crop and evaluate the deposit on both horizontal and vertical deposition cards. An alternative and more accurate method is to use a highly concentrated colour dye and or flourescent tracer product to observe deposition directly on the foliage.
The real swath width my be determined by observing the swath overlap at the two positions.

Evaluation of the effective swath

Wind @90°

Normal height +/-3 mts (wheels above crop)

Papers a 45° ----*----*----*----*----*----*----*----*----*----*----*----*

30 mts

Interval between lines of flight = 30 mts

Determine the effective swath based on swath overlap

Alan McCracken