Designation: E549 – 87 (Reapproved 2014)

Standard Guide for Preparing Field Sprayer Calibration Procedures[1]

This standard is issued under the fixed designation E549; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide is for those who prepare field sprayer calibration procedures. The purpose is to encourage methods that will improve uniformity, accuracy, and safety of pesticide application with field sprayers.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements see Section 4.

2. Significance and Use

2.1 This guide provides information on the calibration of boom-type field sprayers used for broadcast, band, or row applications. It is easily adapted to boomless and air-carrier type sprayers for broadcast applications and to rotary atomizers such as spinning disks. A single calibration procedure that is applicable in all situations is not feasible because of the nature of the variables involved in pesticide application. Electronic controllers and other aids should be calibrated by one of these methods.

3. Apparatus

3.1 Apparatus needed will depend on the method of calibration. Common items include the following:

3.1.1 *Measuring Device*—Tape of at least 25 m (50 ft) in length, or other suitable measuring devices.

3.1.2 *Marking Devices*—Stakes or flags for marking a measured course.

3.1.3 *Container,* large enough to collect nozzle output for 30 s, and graduated to allow accuracy within 1 %.

3.1.4 *Pressure Gage,* accurate and of the proper range.

3.1.5 *Timing Device*—A watch with a sweep second hand, or a stop watch.

4. Hazards

4.1 A cautionary statement for the safe handling, storage, and disposal of agricultural chemicals shall be included with applicator calibration procedures.

4.2 Use water alone to calibrate the sprayer unless the flow rate of the actual spray mixture varies more than 5 % from the flow rate of water. (See 5.1.1.2.)

4.3 *Calibration with Actual Spray Mixture:*

4.3.1 Wear suitable approved safety equipment and protective clothing. Avoid contact with the spray.

4.3.2 Avoid contamination of the area. Collect all nozzle output. Calibrate only when the wind speed is below 8 km/h (5 mph).

5. Recommendations

5.1 The volume of spray material applied to a given area depends on three variables. Each variable must be determined when developing a specific calibration procedure.

5.1.1 *Nozzle Flow Rate*—The nozzle flow rate varies with the following:

5.1.1.1 *Nozzle Capacity*—Select the orifice size that will best fit the requirements of application, volume, pressure, and ground speed.

5.1.1.2 *Nature of Fluid*—If the spray mixture will be altered considerably by the addition of adjuvants, compare the flow rate of the mixture to that of water. If the rate difference is 5 % or more, use the actual spray mixture in the calibration.

5.1.1.3 *Fluid Pressure*—A constant pressure should be maintained to achieve uniform application. Flow rate is generally proportional to the square root of the pressure drop across the nozzle.

5.1.2 *Ground Speed of Sprayer*—This does not apply to ground-driven pumps. This parameter has an inverse relationship to the spray volume. It is the easiest factor to change for minor corrections in the application rate. Ground speed should be maintained uniformly for uniform application, even when ground-driven pumps or electronic controllers are used.

5.1.3 *Sprayed Width per Nozzle*—Calibration procedures should be used to determine the amount (in litres or gallons) of liquid applied per unit area (hectare or acre) actually treated

[1] This guide is under the jurisdiction of ASTM Committee E35 on Pesticides, Antimicrobials, and Alternative Control Agentsand is the direct responsibility of Subcommittee E35.22 on Pesticide Formulations and Delivery Systems.

Current edition approved Oct. 1, 2014. Published December 2014. Originally approved in 1975. Last previous edition approved in 2008 as E549 – 87 (2008). DOI: 10.1520/E0549-87R12.

with the agricultural chemical. For band application, the area treated is the area in the band and not the area of cropland covered. Some pesticide recommendations are based on the area of cropland covered rather than the area actually sprayed. In these cases, the spray width used in the calibration should be based on the row spacing and not on the band width. See Note in 7.1.

6. Calibration

6.1 Perform the following basic steps for the calibration of field sprayers:

6.1.1 *Nozzle Tip Selection:*

6.1.1.1 Considering the label recommendations and field condition, select a spray application rate pressure and an operating speed.

6.1.1.2 From the spray width, speed, and spray application rate, determine the nozzle output required in 7.1.2.

6.1.1.3 Select a nozzle tip that will give the required output when operating within the recommended pressure range.

6.1.2 *Pre-Calibration Check*—Be sure that all sprayer parts are free of foreign material and are functioning properly. Inspect the nozzle tips and internal parts for obvious wear, defects, proper size, and type. Check the flow rate of each nozzle using water at the planned operating pressure for uniform output, equal fan angle, and uniform appearance of spray pattern. Replace any nozzle tips having a flow 5 % more or less than the average of the other nozzles checked, or those having obviously different fan angles or patterns, or both. Recheck any nozzles that have been changed.

6.1.3 *Adjustments*—The following adjustments can be made to obtain desired spray application rate:

6.1.3.1 Change the normal operating speed to adjust output if the change is under 25 %.

6.1.3.2 Change the operating pressure to adjust only within the recommended pressure range. A greater range may affect the drop size or pattern excessively.

6.1.3.3 Change the nozzle tips to obtain volume changes greater than 25 %.

6.1.4 *Course Length*—Lay out a measured course with an accuracy of 0.5 % in the field where spraying will take place or in similar soil and terrain conditions. The course length depends on the travel speed or the spray width and spray volume. The course should be long enough so that an accurate measure of time (at least 15 s) or of spray volume (at least 10 % of the tank volume), whichever method is used, can be made.

6.1.5 *Calibration Methods:*

6.1.5.1 *Procedure A*—The liquid sprayed from one or more nozzles is accurately determined while operating (*a*) over the measured course; (*b*) over the period of time equivalent to the travel time over the course; or (*c*) for a given time such as 1 min. Select representative nozzles and maintain the desired operating pressure. Determine the spray application rate in accordance with 7.1.2 if technique (*a*) or (*b*) is used. Determine the spray application rate in accordance with 7.1.1, if technique (*c*) is employed.

6.1.5.2 *Procedure B*—The amount required to refill the tank is measured after operation as in technique (*a*) or (*b*) of Procedure A, or (*c*) for a suitable given time such as 5 min. Use an accurate liquid level mark, or fill the tank to overflowing before a calibration run; and then measure the amount required to refill to overflowing after the run. The boom and lines should be full before and after operation. For accurate measurement, the sprayer must be in exactly the same position (preferably level) before and after operation. Determine the spray application rate using the equation in 7.2.

6.1.6 *Recalibration*—Recalibration is required periodically because of nozzle wear, and to compensate for any changes in the variables listed in Section 5.

7. Calculation

7.1 Calculate spray application rate and nozzle output from the following equations:

$$V = \frac{K \times Q}{S \times W} \quad \text{or} \tag{1}$$

$$Q = \frac{V \times W \times S}{K} \tag{2}$$

where:

V = spray application rate in litres per hectare (or gallons per acre),
K = constant 60 000 (SI equivalent) or 5940 (U.S. customary units),
Q = output per nozzle, in litres/min (or gal/min),
S = speed, km/h (or mph), and
W = spray width, cm (or in.).

NOTE 1—The spray width, W, includes the following:
(a) Nozzle spacing for boom spraying,
(b) Spray swath width for boomless spraying,
(c) Band width for band spraying, and
(d) For some row crop plant applications, the spray width per nozzle is equal to the row spacing (or band width) divided by the number of nozzles per row (or band).

7.2 The spray application rate may also be calculated as follows:

$$\text{spray volume} = \frac{\text{quantity used}}{\text{area treated}} \tag{3}$$

where:

spray application rate is expressed in volume per unit area,

quantity used is the volume of liquid in litres (or gallons) used by the nozzle or boom on a measured course or in the equivalent time, and

area treated is the area actually treated in hectares (or acres) or the area that would be treated in the time used to measure the quantity sprayed.

7.3 There are several good methods for calculating spray volume and nozzle output other than those mentioned in 7.1. Nomographs, charts, and special slide rules are examples. Calculations are aided by selecting a measured course length so that an even decimal or fractional part of a hectare (or acre) is covered.

8. Keywords

8.1 agricultural; calibration; equipment; nozzle; pesticide; sprayer