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ASABE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA, phone 269-429-0300, fax 269-429-3852, [hq@asabe.org](mailto:hq@asabe.org)

# **Procedure for Evaluating the Distribution Uniformity of Large Granular Broadcast Applicators**

*Developed by the Dry Materials Application Systems Subcommittee of ASABE Agricultural Application Systems Committee; approved by ASABE and ANSI September 2022.*

**Keywords:** Distribution, Fertilizer, Granular, Pneumatic, Spreaders, Test

## **1 Purpose and Scope**

**1.1 Purpose.** The purpose of this Standard is to establish a uniform method of determining and reporting spreading performance of large (18.3-m swath width or greater) broadcast spreaders and pneumatic applicators designed to surface apply granular materials. Results from tests performed according to this Standard make it possible to predict distribution uniformity of a particular broadcast spreader or pneumatic applicator or to compare the performance of different machines operated under similar test condition.

**1.2 Scope.** This Standard pertains to centrifugal, pendulum, pneumatic and other types of broadcast spreaders designed for dry granular product application while operating on common crop production field surfaces. Portions of the test procedures outlined herein are suitable for evaluating spread uniformity and spread width; however, additional tests not covered in this Standard are needed to completely evaluate the performance of gravity spreaders.

## **2 Normative References**

ASABE S281, *Capacity Designation for Fertilizer Pesticide Hoppers and Containers*

ASABE S327, *Terminology and Definitions for Application of Crop or Forestry Production and Protection Agents*

ASABE S341, *Procedure for Measuring Distribution Uniformity and Calibrating Granular Broadcast Spreaders*

ASTM E11, *Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves*

ISO 565, *Test Sieves — Metal Wire Cloth, Perforated Metal Plate and Electroformed Sheet — Nominal Sizes of Openings*

## **3 Definitions**

**3.1 application, one-direction:** An application method in which successive adjacent swaths are made in the same direction of travel (racetrack or circuitous application). This method produces a right-on-left overlapping of adjacent patterns.

**3.2 application, progressive:** An application method in which the spreader applies adjacent swaths in alternate directions (back and forth application). This method produces a right-on-right pattern overlap alternately with a left-on-left pattern overlap.

**3.3 application rate:** Application rate defined in ASAE S327.

**3.4 application, single-pass:** An application method in which the spreader applies one swath over the collection trays.

**3.5 collector efficiency:** The percentage of true application rate caught in a collection device, i.e., the weight of material caught in the collection device divided by the area of the collection device and expressed as a percentage of the true application rate at that location in the pattern.

**3.6 swath spacing:** The lateral distance between spreader centerlines for adjacent swaths.

**3.7 swath width, effective:** The swath spacing that will produce acceptable field distribution uniformity for the intended application.

### **3.8 Applicator Types**

**3.8.1 centrifugal spreader:** Commonly referred to as single or dual-disc spreader or spinner spreader. This type of applicator uses a conveying system to meter materials onto the disc(s) that rotate to surface apply material(s).

**3.8.2 pendulum spreader:** An applicator that utilizes a swinging arm or spout in an oscillating or reciprocating motion to sling material.

**3.8.3 pneumatic applicator:** An applicator equipped with a tubular boom and distributors along it that uses air to transport material(s) from the metering system to the distributors.

**3.9 metering system:** Device used to determine application rate.

**3.10 Spread Distribution:** Three-dimensional distribution of material from the spreader's distribution mechanism(s).

**3.10.1 transverse distribution:** Distribution of material perpendicular to the direction of travel.

**3.10.2 longitudinal distribution:** Distribution of material in the direction of travel.

**3.11 Quick test:** Distribution test performed in a field with limited, abridged testing requirements, typically performed by an end user as a maintenance operation.

**3.12 Complete test:** Distribution test performed in a field or indoor lab with more extensive requirements, typically being performed by a testing lab, university or equipment manufacturer. Data collected from this test is reported using standard reporting procedures.

## **4 Test Conditions**

**4.1** The spreader to be tested shall be in good mechanical condition and shall be properly adjusted per manufacturers recommendation. It shall be clean from any fertilizer or debris build-up.

**4.2** Tests may be conducted on the application machine to evaluate an experimental model, to qualify a new production model, or to verify the distribution uniformity of an existing production model. Tests may also be conducted to evaluate the distribution uniformity and to verify the adjustments for a specific granular material being applied under conditions similar to actual field conditions.

**4.3** Geometric dimensions shall be measured with the machine standing on an impenetrable, horizontal surface in normal operating position. Dimensions of length and width shall be measured along horizontal lines and dimensions of height along vertical lines.

**4.4** The test may be conducted with a standardized test material such as uniform size spherical prills, a specific granular product, or an inert product simulant. A description of the material including sieve size, moisture content, bulk density, and product name shall be specified in the test report (see ASABE S281).

**4.4.1** Results of a sieve analysis shall be reported. The percent of material retained on each screen shall be stated. The sieves used shall conform to ASTM E11.

**4.4.2** A description of the test material's particle shape and surface texture shall be included in the test report.

## **5 Test Procedure**

### **5.1 Guidelines for test setup**

**5.1.1** The accuracy of the test can be influenced by wind, granule or particle size, critical relative humidity of the product, rate of application, ground slope, travel speed, ground roughness, temperature, relative humidity, method of collecting samples, and method for weighing samples. Conducting tests on a hard surface can impact the measured distribution patterns. This effect is more pronounced as particle size and particle density increases. The following recommendations should be followed to maintain test accuracy and be documented in the final report(s):

**5.1.1.1** All spreading shall be completed when the wind velocity is less than 8 km/h (5 mile/h) measured at the height of distribution of material from the spreader. In the final report, the distribution height must be noted. If a wind exists, the direction of travel shall be parallel (within  $\pm 15$  deg) to the general direction of the wind. If winds are  $< 4$  km/h (2.5 mph), simply record wind speed and direction and vehicle direction of travel.

**5.1.1.2** Tests should be conducted on a surface having a slope of less than 2%. If desired, the spreader may also be tested on a sloping surface provided the degree and direction of slope are reported.

**5.1.1.3** The spreader or applicator shall be operated for a period of time sufficient to allow the material output and spread distribution to stabilize prior to covering the collection trays. Spread operation shall be maintained past the last row of collection trays a sufficient distance to ensure distribution of material at full width and rear throw of the spread distribution.

**5.1.1.4** If the test results are to be used for the specific purpose of adjusting the field performance of an individual spreader, the test should be conducted on the actual field surface or in a manner that effectively simulates the pattern to be obtained on the actual field surface since the effective swath width, rate, and pattern uniformity will be affected by particle bounce into or out of the collection devices when tests are conducted on hard surfaces. When tests are conducted on a hard surface using shallow collection trays over those recommended in this standard, the collection efficiency (i.e. the weight of granules collected per tray) can be as much as twice that observed due to particles bounced into the trays. Similarly, shallow or improper trays and baffles can lead to material bouncing out reducing the actual amount captured. Both issues can lead to invalid results. Recommended approaches to eliminate this problem, when needed, are:

**5.1.1.4.1** The test can be conducted on the actual field or paddock surface (grass, crop residue, soil, etc.) so that test results will be the same as field results.

**5.1.1.4.2** If the actual field application surface is turfgrass, sod, etc., the test can be conducted on carpet to imitate the bounce characteristics of the field.

**5.1.1.4.3** The collection trays can be placed over a bed of lime or similar powdered material to minimize particle bounce into the trays. It is recommended that the bed of powdered material extend at least 2 m (72 in) beyond the collection trays in all directions.

**5.1.1.4.4** Collection trays, 10 cm (4 in.) in height, can be used and the spreader elevated an equal amount. This setup will minimize any material bouncing into the trays. If the spreader is to be run on an elevated track, the track surface will allow some particle bounce into the trays since it will be level with the tops of the trays, and thus the width of this track should be minimized.

**5.1.1.4.5** During all tests, the tops of the trays shall not be more than 10 cm (4 in.) above the test surface.

**5.1.2** The spreader shall be filled the day of the test. If the test is not conducted within 4 hours after filling, the spreader shall be emptied and refilled.

**5.1.3** Tests shall be conducted with the machine hopper or box filled and leveled to at least 40% of capacity as defined by ASABE S281.

**5.1.4** Relative ground speed between the spreader and the collection trays shall be in the range recommended within manufacturer's literature and shall be kept constant during the entirety of the test. The actual speed of the spreader and/or collection trays at which the tests were conducted shall be reported.

## **5.2 Collection trays**

**5.2.1** The dimensions of the collection trays shall be 0.5 m wide by 0.5 m in length by 0.1 m in height (20 in. by 20 in. by 4 in.). Deviation from the standard should be noted in the report.

**5.2.2** Collection trays shall be plastic or of similar material that is durable and moisture resistant.

**5.2.3** To decrease the possibility of particles ricocheting out of the trays, each tray should be divided into compartments. The maximum size of the compartments shall be 10 cm (4 in.) wide by 10 cm (4 in.) long. The minimum size of the compartments should be 5 cm (2.0 in.) by 5 cm (2.0 in.). Precautions such as covering the tray floor with soft material may be taken if the granule being tested contains no small particles that may lodge in the covering material.

### **5.2.4 Complete test and Quick test collection tray spacing**

**5.2.4.1 Complete tests:** Complete tests shall be conducted using a continuous row of collection trays (i.e., collection spacing of 0.5 m) allowing no gaps between trays regardless of the type of applicator.

**5.2.4.2 Quick tests:** Quick tests shall be conducted using a tray spacing equal to 1.5 m (60 in) for centrifugal and pendulum spreaders. For pneumatic applicators, a row of continuous collection trays must be used allowing no gaps between collection trays.

### **5.2.5 Number of rows of collection trays**

**5.2.5.1** For Complete tests, two rows of continuous collection trays shall be used. These rows should be spaced 5 m apart. See Figure 1.