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Procedures for Evaluating Variable-Rate Granular Material Application Accuracy of Broadcast applicators



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ASABE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA, phone 269-429-0300, hq@asabe.org

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1 Purpose and scope

1.1 The purpose of this Standard is to provide a method to evaluate application accuracy of granular materials applied using variable-rate application systems including spinner-disc and pneumatic broadcast applicator or similar equipment that distribute fertilizers. Specifically, this standard will facilitate the collection and reporting of map-based application accuracy of both single and multiple granular products.

1.2 Testing of equipment commonly used to support site-specific management, machinery guidance, and other precision agriculture practices forms the basic scope of this Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies unless noted. For undated references, the latest approved edition of the referenced document (including any amendments) applies.

ASAE S341, Procedure for Measuring Distribution Uniformity and Calibrating Small Granular Broadcast Applicators

ASAE EP371, Procedure for Calibrating Granular Applicators

ASAE S327, Terminology and Definitions for Chemical Application

ASABE S660, Procedure for Evaluating the Distribution Uniformity of Large Granular Broadcast Applicators

ANSI/ASABE AD3600:2016 MAY2016, Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Operator's manuals — Content and format

3 Definitions

3.1 Global positioning system (GPS) or global navigation satellite system (GNSS) receiver: an instrument capable of determining the position of its antenna in geographic coordinates and in near real-time

3.2 Variable-rate technology (VRT): a system of controls, positioning device, and a task computer integrated into application equipment capable of varying inputs to crop production systems based on a predetermined prescription map or sensor (individual or array) evaluating crop, soil or other in-field variability. This control system details how the inputs are to be varied across the soil landscape to include at a minimum, an application rate tied to geographic entities in either raster or vector format.

3.3 Prescription (Rx) map: a map with spatial features such as polygons called zones that spatially describe unique application rates of various soil amendment and other inputs to crop product systems. A single layer prescription map includes information for an individual product or input whereas a multiple layer prescription represents information for varying multiple products. For a single layer prescription map, for each zone there exists one unique application rate for the soil amendment or crop production input.

3.4 Look-ahead time: a feed-forward time period that is specified with the specific purpose of alternating the initiation of an application rate change or response in time to where the change or response shall occur to make up for system response lag or latency that arises from external influences or is inherent to system components, configuration, or control algorithm.

3.5 Collection pan matrix: an array of collection pans designed to obtain the spatial distribution mass or volumetric discharge from granular application equipment.

3.6 Rate delay time: elapsed time between when control commands are sent to the rate controller, and the overall VRT system response necessary to affect a 5% change in the actual application rate. ISO11783-11 outlines a similar parameter that should be noted, referred to as DDI 142 “Physical Setpoint Time Latency”, which is used on VRT capable equipment to communicate the rate delay time between system components.

3.7 Rate transition time: elapsed time required to affect 90% of a rate change. Determined by transition between the point at 5% of the total change (in the proper direction whether increasing or decreasing the rate) from initial rate and the point at 95% of the final rate.

4 Background

4.1 Variable-rate technology (VRT) has become an accepted method for spatially varying inputs within production agriculture. Elimination of application errors through proper calibration and operation is critical to ensure accurate VRT performance.

4.2 ASABE Standard ASAE S341, *Procedure for Measuring Distribution Uniformity and Calibrating Granular Broadcast Applicators*, and S660 *Procedure for Evaluating the Distribution Uniformity of Large Granular Broadcast Applicators*, provides a uniform method for assessing and reporting the performance of broadcast granular applicators and pneumatic applicators. This standard focus on uniform-rate (UR) application and does not contain considerations for testing VRT equipment. No standard or defined test protocol has been published to evaluate VRT. Standard test and reporting procedures are needed to assess VRT equipment since traditional UR application errors might not be indicative of VRT application inaccuracies.

4.3 With VRT application of granular materials, application rates change dynamically based on spatial location. A typical VRT applicator system integrates components such as a GPS receiver, rate controller, task computer with appropriate software or firmware and product delivery system. Each component produces some level of error which in turn contributes to the overall system error. The overall error is a summation of individual component errors with the understanding that interactions between these components can also affect overall VRT system errors.

4.4 The addition of VRT components to traditional application equipment may require unique calibration and operating procedures to minimize application errors when contrasted with traditional practices.

4.5 Most, if not all, VRT systems control the volumetric flow of granular materials. However, if satisfactory pattern uniformity cannot be maintained during flow rate adjustments with a VRT system, then speed adjustments or a combination of speed and mass flow may be an option for achieving acceptable distribution.

4.6 The “look-ahead” feature provided in most software packages may reduce application errors providing VRT system latency or delay time can be quantified, and there is a similar system response for increasing and decreasing rate changes. These delay times produce application errors by having the rate transition occur after or before the desired time. Considerable improvement in VRT performance can be achieved through feed forward control. However, distribution pattern errors may be introduced with the existence of substantial lag times at application points across the spread width.

4.7 Accurate spatial application of granular materials requires instantaneous flow and distribution control. Reported rate response time for VRT granular applicators can be up to 10 s. The variation in rate response times from an individual system may require different “look ahead” times for increasing versus decreasing rate changes. Software supporting VRT can provide the ability to set an individual “look-ahead” time. For some systems multiple “look-ahead” times may be required. These “look-ahead” times are an important setup feature for VRT.

5 Collection pan matrix layout

5.1 Deposition tests shall be performed in keeping with ASABE Standard ASAE S341, or ASABE S660, using defined pans and test protocols. In particular pan size, layout and summary.

5.2 The collection pan matrix will consist of at least 12 rows of pans containing the corresponding pans within each row to capture material spread to each side of applicator or spreader. Row-to-row pan spacing shall be adjusted so that the complete rate transition event is captured, and that at least three rows of pans at the beginning and end of the matrix of the matrix contain the initial and final nominal application rates. Considerations should be given to the radial pattern plus the expected time to make a rate change. As an example, a spinner spreader applicator has a distribution pattern of 24 m. Due to its radial pattern, the applicator shall travel 12 m into the test area to capture the original spread rate in the first row of pans in order to capture the pattern inside the test area. Then, we need 3 rows before the rate change, and 10 rows after the rate change, making a 144 m long test length for the pans, plus speed up before and slow down after the run.

5.3 Pan spacing within each row should be adjusted to permit the applicator to track within the collection pan matrix plus capture the full-width of spread. Further, the pans shall be spaced uniformly across the entire application width as outlined in ASABE Standard ASAE S341 or ASABE S660. Sufficient space should be provided for application equipment to navigate the test pan matrix by straddling the center of the collection pan matrix. The test site shall be laid out with a suitable measuring device

5.4 A typical pan collection matrix used for assessing the rate transition times for VRT application of granular materials is presented in Figure 1.

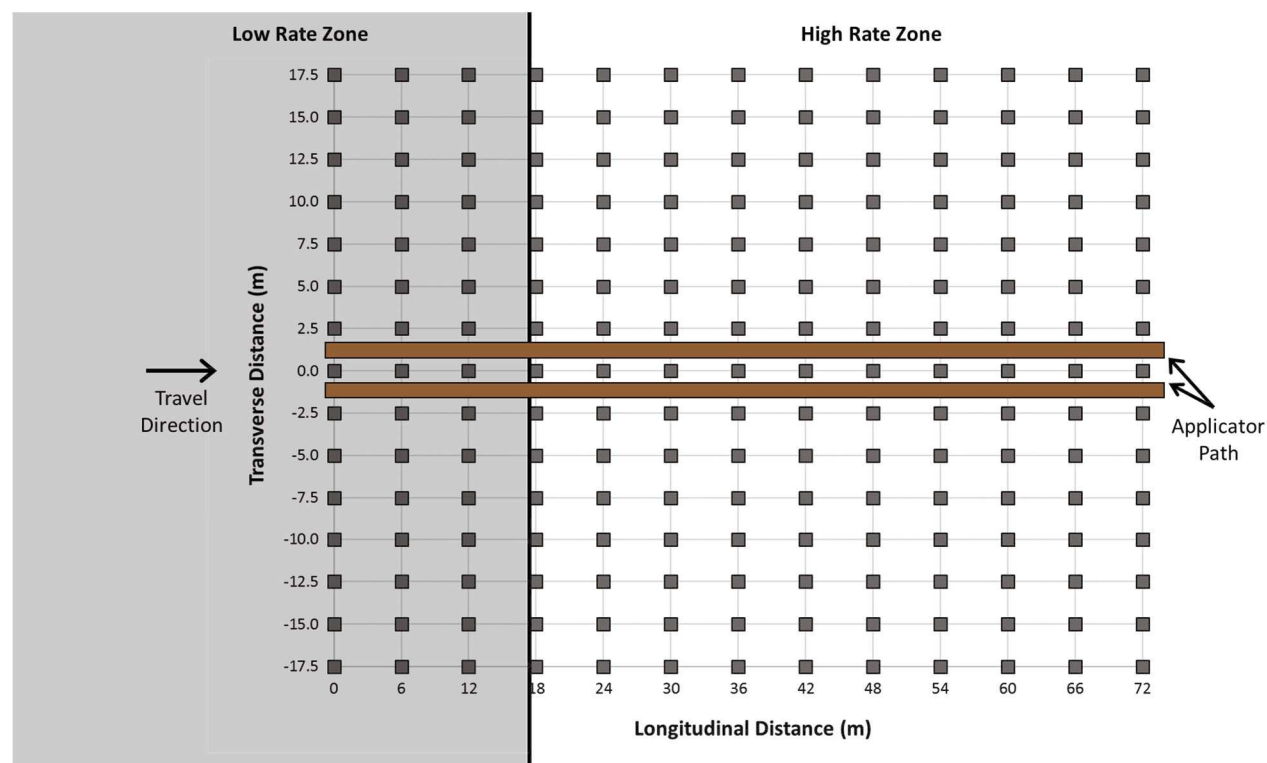


Figure 1 – Example collection pan matrix for rate transition tests (low-to-high test illustrated). In this example, pans were not removed to allow applicator to pass over pan matrix