CALIBRATION OF FERTILIZER APPLICATION EQUIPMENT ON-FARM

INTRODUCTION

The objective of this fact sheet is to provide accurate methods to calibrate broadcast, drill and pneumatic type fertilizer spreaders on-farm.

An agrologist that specializes in nutrient management for specific soil and crop situations can help the farm operator determine the application rate and when granular fertilizer should be applied to each crop and field. Fertilizer spreader calibration will determine the required overlap and thus the swath spacing width necessary to uniformly achieve the desired application rate. This in turn saves money and reduces risks to the environment from over fertilization.

FERTILIZER SPREADER TYPES

Broadcast spreaders use a single or double spinner disc or a reciprocating (pendular) tube to distribute fertilizer on the field. These devices are mounted on drawbar trailing or 3-point hitch units. The spinner disc distributor requires a mechanism that accurately places fertilizer in the correct location of the rotating disc. Correct placement allows the fertilizer to discharge from the disc at the proper instant to achieve an even spread pattern on both sides of the spreader. A double spinner system has a flow divider that requires front to back adjustment so fertilizer is placed in the correct location on the spinner discs. Acceptable spread patterns are shown in Fig. 1.

Drill type spreaders are mounted on various types of planting equipment. Augers, stainless steel conveyor chain, belt conveyors, or a series of flutes rotated by a shaft are used to meter fertilizer to a down spout tube. The down spout is attached to a soil opener device which places the fertilizer in the soil at a specific location adjacent to the seed so as to provide nutrients but not damage the seed at the vulnerable germination stage. This process of metering and placement of fertilizer will involve calibration of the spreader and careful observation of the placement of the fertilizer in the soil.

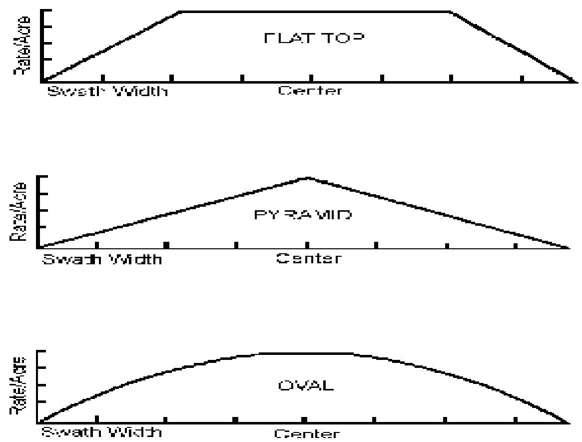

Figure 1. Broadcast spreader patterns

Pneumatic type spreaders can be installed on boom style machines that are 3 point hitch, self propelled or trailing units. Pneumatic planter and fertilizer system combinations can be installed on a trailing cultivator unit with an opener and packer combination for direct seeding. The boom spreader system can apply fertilizer more accurately than broadcast spreaders because of the design of the metering flute mechanism and individual nozzles that are spaced evenly on the boom. However, to be accurate, the boom type spreaders require as much or more attention to setup and proper adjustment. Booms must be parallel to the soil surface to achieve proper overlap at each nozzle on the boom. Caution is advised when attempting to apply high fertilizer rates at excessive field speed because it often results in plugging of the metering and air flow system.

UNIFORMITY OF SPREADING

Once a fertilizer application rate has been determined, it is important for this amount to be spread uniformly for maximum crop benefit. Fertilizer application in excess of this amount may result in nutrients being lost to the environment. Under application in other areas may result in less than optimal crop growth. The application of granular fertilizer, as accurately as possible, involves important machinery operation set up and considerations as well as other things

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such as smooth and level fields that will allow the spreader to operate effectively.

Travelling speed and engine rpm in the field: When operating most broadcast type fertilizer spreaders, it is essential to keep a constant field speed and engine rpm. A change in engine rpm of 30% when either going up or down the slope will increase or decrease the application rate by the same 30%. The tractor engine rpm controls the PTO (power take off) rpm and will also have a significant effect on the width of the spread pattern. Operator manuals provide information on the specific range of PTO and engine rpm values for accurate spreading. Ground driven fertilizer units like those found in grain drills and potato planters can operate at different rpm but may require specific field speeds to achieve accurate seed spacing. Pneumatic spreaders require high PTO speeds to achieve sufficient air velocity to carry granular products to the boom nozzles.

Equipment set up: The second important set of factors for uniform spreading relates to the spreader components: their inspection, maintenance and set up. When a farm operator uses a trailing hitch spinner type spreader similar to that shown in Fig. 2, it is necessary to set the fertilizer distributor height from the ground surface, then level the spreader and finally adjust the spinner disc vane angle. Inspection and maintenance of components such as flow dividers, flow tubes, pipes, augers, conveyors and air systems that deliver the granular product to the distributor are critical. These devices eventually can be damaged because granular fertilizer is very abrasive and corrosive. Keeping fertilizer components in good working condition is a challenge that requires constant attention as specified in the operator's manual.

Figure 2. Broadcast (double spinner) spreader

Overlap of spreader patterns: With a broadcast spreader, overlapping is necessary in order to evenly distribute fertilizer over the entire field. In many cases, operators use visual observation of the adjacent spreader wheel tracks to achieve parallel swaths in the field. The placement of special collection trays in the field can be used for broadcast and pneumatic spreaders, as illustrated in Fig. 3. The fertilizer collected from each tray is placed in test tubes to evaluate the spread pattern. The test tubes illustrated in Fig. 4 show an uneven spread pattern. This is due to improper boom level and poor distribution of the fertilizer by the primary metering mechanism where fertilizer is placed in the pneumatic tubing.

Figure 3. Pneumatic fertilizer spreader operation with collection trays

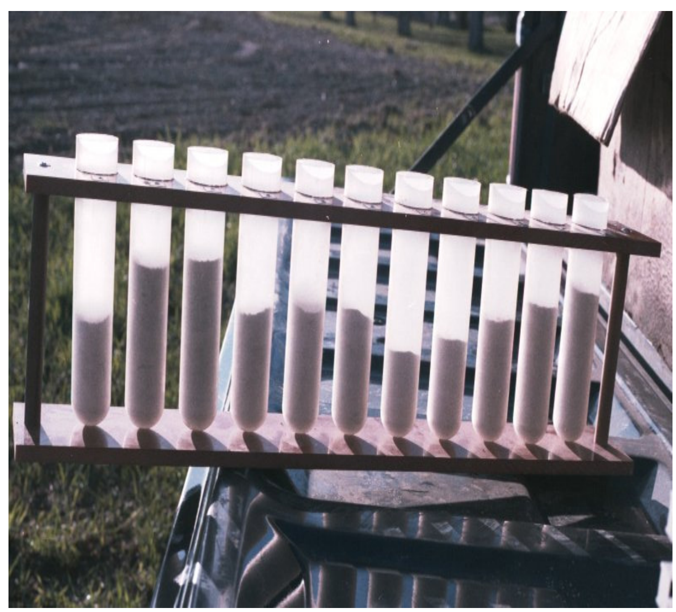

Figure 4. Spread pattern shown in test tubes

Swath spacing width is the lateral distance between spreader centerlines from overlapping broadcast applications. The "one direction" application method is where successive adjacent swaths are made in the same direction of travel. It produces a right-on-left overlapping of adjacent patterns. If one side of a spread pattern is applying a different rate than the other side, then this method will improve uniformity in the field. The "progressive" application method, on the other hand, is where the spreader applies adjacent swaths in alternate directions (back and forth) producing a right-on-right and a left-on-left pattern overlap. This can magnify the application error if one side of the spreader is applying more heavily than the other. Use of a foam marker system will keep swath spacing parallel and overlapping patterns uniform as seen in Fig. 5.

Figure 5. Foam marker system

GPS technology: GPS instrumentation can improve the accuracy of fertilizer applications. It is important that the farm operator understands the GPS components and how they operate in order to keep them working properly. GPS technology can be used to obtain parallel swaths that are accurately spaced across the entire field. GPS location accuracy depends on the differential correction system that is available. It is very important to accurately calibrate the GPS unit for each farm power unit such as a self-propelled sprayer, field truck, or tractor with implement. In turn the GPS will more accurately calculate field area and application rate. The GPS memory will also record and re-locate the center line of the spreader passes in the field and record complete application work for that date and field.

CALIBRATION

The trial and error method of calibrating spreaders can involve several calibrations to achieve a desired application rate. The formulas provided later in this section with each spreader type will speed up the calibration process. It is recommended to calibrate the existing application rate which will provide a benchmark for the calibration of a desired application rate. The calculations are set up to first calculate the existing application rate of the equipment. The second set of formulas calculates the amount of fertilizer that should be collected to arrive at a desired application rate.

Broadcast Spreader

The calibration of a broadcast fertilizer spreader begins by measuring the **spread pattern width**. The spread pattern width value can be obtained from an operator's manual or by spreading fertilizer on a surface such as bare soil and then measuring the width covered. The **swath spacing width** (value **D** in the worksheet), which is the lateral distance between spreader centerlines, is less than the spread pattern width for broadcast spreaders. As mentioned before, proper overlap will provide an even application over the entire field. An overlap of 100 percent is normally required to achieve even coverage. To explain further, if the spread pattern width is 10 meters wide, then a 100 percent overlap will result in a 5 meter swath spacing width.

Next, the **weight of fertilizer applied** in one minute (60 seconds) (value **B** in the worksheet) must be measured (in pounds or kilograms). This is done either in the shop or at a location away from the wind. The safest and easiest method to collect fertilizer from a spinner type spreader is to remove the spinners and collect the fertilizer with a large bucket. If there are two spinners, it is best to collect into two buckets and compare the amounts before combining the weights. If spinner removal is not possible then a large plastic sheet or tarp should be placed a safe distance from the rotating spinners and wrapped up high enough to collect the fertilizer without losing any. Collecting fertilizer from a pendular or reciprocating type broadcast spreader will require the removal of the spout or a tarp method as explained above. In all cases weigh the amount collected in 60 seconds.

The next step is to measure the **distance traveled** in one minute (60 seconds) (value C in the worksheet) in either feet or meters. There is no need to spread fertilizer, but it is very important to operate the tractor at the recommended PTO-rpm and desired gear selection. To obtain an accurate distance make sure the tractor/spreader is up to speed when it goes by the first stake. Start the stop watch when the front of the tractor/spreader goes by this first stake and then mark the ground where the front of the tractor is after a total of 60 seconds. Measure the distance between the stake and this one minute mark. Do this at least twice for each test. A field speed of 1 mph = 88 ft/min and 1 kmph = 16.7 meters/min.

Insert these values into the appropriate calculation in the worksheet to measure the existing application rate. If the existing application rate is higher or lower than the desired rate, then the spreader must be adjusted. The easiest variable to change is the amount of fertilizer collected from the spreader in sixty seconds, which is directly proportional to the change in application rate desired. For example, if the application rate measured is too low and needs to be increased, then the spreader must be adjusted to allow more fertilizer to flow in 60 seconds. The fertilizer weight (B) that is desired can then be calculated using the worksheet. **The spreader should be adjusted to arrive at this value.**

Selecting another field speed will affect the calibration inversely proportional. If for example the speed is reduced by half, then the application rate (A) doubles when D remains the same. The application rate is double because the distance traveled in 60 seconds has been halved while B has remained the same.

Drill Type Spreader

Calibration of a drill type fertilizer spreader needs to be performed in the farm shop and then in the field. Both methods require that the fertilizer is collected from the down spouts and weighed. Row crop planters for crops such as corn, potato, or vegetables that have two fertilizer downspouts per row require a collection bag on each down spout. The **weight of fertilizer** from the two down spouts will be compared and machine adjustments need to be made to equalize the output in both downspouts per row and in fact all downspouts for all rows will need to be adjusted to have the same output.

The shop method requires that the planter drive wheel be elevated with a jack so that this wheel can be turned by hand for a **specific number of revolutions**. It is recommended to rotate the drive wheel at least 30 revolutions. The planter drive clutch mechanism must be engaged during this process so that the fertilizer metering system will deliver fertilizer to the down spouts that have collection bags attached. Measure the **planter row spacing distance** and the planter drive wheel circumference. Tie a string around the drive wheel and measure its length to estimate the drive wheel's circumference. Drive wheel slippage in soft soil can be up to 10 %, thus a field calibration is necessary.

The field calibration method is needed to verify and fine tune the shop method calibration. In the field, measure the total distance the planter drive wheel travels for the same number of revolutions used in the shop calibration. Then divide this field distance by the number of revolutions to get the **"actual" drive wheel circumference** value that incorporates drive wheel slippage.

Insert these values into the appropriate calculation in the worksheet to measure the existing application rate. If the existing application rate is higher or lower than the desired rate, then the spreader must be adjusted. The easiest variable to change is the amount of fertilizer collected from the spreader in sixty seconds, which is directly pro-

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Pneumatic Spreader

Calibration of a pneumatic type spreader will require the operator to follow, step by step, the manufacturer's calibration method as described in the operator's manual. A custom built collection tray designed for this type of spreader is placed under the metering mechanism during calibration. A crank provided with the machine is used to rotate the fertilizer delivery system a specific number of revolutions. The fertilizer collected in the tray is then weighed and the value inserted in a formula provided by the manufacturer.

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For further information on the calibration of fertilizer or manure application equipment, please contact your local agrologist, crop consultant or Agri-Environmental Club Coordinator.

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Fertilizer Application Equipment Calibration Worksheet

Calculations to measure the existing application rate:

1. Broadcast fertilizer spreader:

43,560 ft2/acre x ____ **B** (lbs) ÷ ___ **C** (ft) ÷ ___**D** (ft) = ___**A (lbs/acre)**

10,000 m2/ha x ____ **B** (kg) ÷ ____**C** (m) ÷ ____ **D** (m) = ____ **A (kg/ha)**

A = application rate (lbs/acre or kg/ha); **B** = weight of fertilizer (lbs or kg) collected from spreader in sixty seconds; **C** = distance traveled (ft or meter) in sixty seconds; **D** = swath spacing width (ft or meter).

2. Drill type fertilizer spreader:

43,560 ft2/acre x ___ **B** (lbs) ÷ ____ **C** (rev) ÷ ____**D** (ft) ÷ _____ **E** (ft) = ______ **A (lbs/acre)**

10,000 m2/ha x ___**B** (kg) ÷ ___**C** (rev) ÷ ____ **D** (m) ÷ _____**E** (m) = ______ **A (kg/ha)**

A = application rate (lbs/acre or kg/ha); **B** = weight of fertilizer (lbs or kg) collected from down spout(s) from one row during **C** revolutions; **C** = number of revolutions of drive wheel; **D** = "actual" drive wheel circumference (feet or meter) **E** = row spacing (feet or meter).

Calculations to determine weight of fertilizer (B) for desired application rate:

1. Broadcast fertilizer spreader:

_____ **A (lbs/acre, desired amount)** x _____ **C** (ft) x _____**D** (ft) ÷ 43560 = ______ **B (lbs)**

_____ **A (kg/ha, desired amount)** x _____ **C** (m) x _____ **D** (m) ÷ 10,000 = ______ **B (kg)**

A = application rate (lbs/acre or kg/ha); **B** = weight of fertilizer (lbs or kg) collected from spreader in sixty seconds; **C** = distance traveled (ft or meter) in sixty seconds; **D** = swath spacing width (ft or meter).

2. Drill type fertilizer spreader:

____ **A (lbs/acre, desired rate)** x____ **C** (rev) x _____**D** (ft) x _____ **E** (ft) ÷ 43560 = ______ **B (lbs)**

____ **A (kg/ha, desired rate)** x _____ **C** (rev) x _____ **D** (m) x _____ **E** (m) ÷ 10,000 = ______ **B (kg)**

A = application rate (lbs/acre or kg/ha); **B** = weight of fertilizer (lbs or kg) collected from down spout(s) from one row during **C** revolutions; **C** = number of revolutions of drive wheel; **D** = "actual" drive wheel circumference (feet or meter) **E** = row spacing (feet or meter).