Investigation Into Manure Incorporation Of Various Tillage Methods

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Abstract

Many farmers currently make use of manure spreading as a way to fertilize their crops. It is generally recommended that solid livestock manure be incorporated into the soil within 12 hours of broadcasting in order to maximize the nutritionl benefits to the soil and minimize odors and possible environmental effects the manure may have. Little research has been done to establish the most effective tillage method for this incorporation.

The AgTech Centre performed an experiment to test various tillage methods for manure incorporation. A number of commonly used tillage methods were compared, on both tilled and untilled wheat stubble. Different tillage methods provided different results in terms of surface incorporation, however soil conditions were found to have no affect on manure incorporation. Further testing and data is needed to conclude the study.

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REPORT

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Introduction

Spreading manure is a popular fertilizing method, especially among farmers running mixed grain and livestock operations. It is a cost effective and efficient way for producers to clean manure from corrals and pens and fertilize at the same time.

Currently, there are a variety of tillage methods used to incorporate manure into the soil after it has been broadcast, but little research has been done to determine which of these methods provides the best results.

Background

Although spreading manure is a common and well accepted agricultural practice, there are a number of dangers and concerns associated with the procedure.

The primary concerns are environmental. Pollution in the form of odorous gas emissions and potentially dangerous runoff can result from manure spreading operations. This runoff is a serious concern to the environment, as it may contain a high concentration of nutrients which promote eutrophication, resulting in highly accelerated plant growth and a possible danger to animal life in local waterways. Potential dangers to the environment can often be limited by incorporating manure into the soil, which will limit both the emission of odorous gasses and the potential for manure to be carried to local waterways by rainfall.

Also of major concern are the agronomical ramifications of manure spreading and incorporation. As well as preventing potentially harmful runoff, incorporation of solid manure increases the beneficial affects of spreading manure. By turning manure into the soil, the amount of useable (inorganic) nitrogen lost is greatly reduced, and the breakdown of unusable (organic) nitrogen is accelerated. The downside of incorporation is a reduction of trash cover on the crop, which promotes erosion of the soil. It also exposes sub-surface soil, which promotes evaporation and increases moisture losses.

In light of these potential dangers, it is important to discover which incorporation techniques work best to turn the manure into the soil, while having a minimum effect on trash cover and soil moisture.

Experimental Procedure

The site for this project was the AgTech farm south of Lethbridge. The plots were replicated four times in a randomized block design. Each plot measured 9.14 x 4.9 m (30x16ft) with the exception of the heavy harrow plot, which measured 9.14 x 7.3 m (30x24ft) to accommodate for the extra width of the implement. A 12.2m (40ft) strip was left between each replication to allow for machine turning and operation. To prepare the site, half of the plots were tilled prior to spreading the manure using a sweep type cultivator. The rest of the plots were left as untilled wheat stubble.

The fertilizer used for this study was a fresh solid manure taken from the corrals of a local producer. It was evenly broadcast at rate of 30 tonnes/ha (12 tons/ac) using a standard solid manure spreader.

After the manure was spread, counts were taken at 24 locations across the test site to determine the percentage of the ground that was covered with manure. The sampling tool used measured 61 x 61 cm (2 x 2 ft) overall, with strings stretched every 5 cm (2 in) along each side to form a grid. Surface coverage was measured by determining the number of places where manure lay under string intersections. These figures were averaged to determine an estimate of the overall initial ground coverage. The plots were then incorporated using a variety of the tillage methods currently used by farmers.

Tillage methods tested included a heavy tandem disk at an operating depth of 15 cm (6 in), a chisel plow with spikes at an operating depth of 15 cm (6 in), a chisel plow with sweeps at an operating depth of 12.5 cm (5 in), a heavy harrow, and a combination deep ripper and disk with an operating depth of 41 cm (16 in) on the ripper and 20 cm (8 in) on the disk. All of the incorporation was done at a speed of 6 km/hr (4 mph) with the exception of the heavy harrow which was operated at a speed of 8 km/hr (5 mph).

After incorporation, four more counts were taken on each plot. These were averaged to determine the amount of ground coverage after incorporation. These numbers were then subtracted from the initial ground coverage figures in order to determine the percent of the manure that had been incorporated into the soil.

After these counts had been taken, the plots were packed using a heavy roller. Soil samples were then taken in 3cm (1.2in) increments to a depth of 15cm (6in), to be lab tested as a further measure of manure incorporation.

Table 1: Levels of the factors used in this experiment.

Factor	Level
Soil Condition	Tilled Untilled
Tillage Method	Combination Tillage Tool Offset Disk Harrow Chisel Plow Spokes Chisel Plow Sweeps Heavy Harrow
Replications	4

Results

The lab data from the soil samples was not available at the time of this report, however an analysis of variance (ANOVA) was used to analyze the results of the ground coverage measurements.

Differences in the incorporation between the types of tillage methods used were shown by these tests to be highly significant. Differences due to soil conditions, however, were shown to be insignificant.

A Duncan Multiple Range Test was used to determine which tillage methods were significantly different from the others.

Table 2: Mean average incorporation of the various tillage methods used, with the letters representing the ranking from the Duncan Multiple Range Test.

Tillage Method	Average Incorporation (%)
Combination Tillage Tool Offset Disk Harrow Chisel Plow Spokes Chisel Plow Sweeps Heavy Harrow	96.63 (a) 94.88 (a) 91.75 (b) 89.13 (c) 86.00 (d)
Soil Condition	
Tilled Untilled	90.95 92.4

Discussion

Based on the data collected in these tests, the choice of tillage method used to incorporate solid manure does have an effect on the level of incorporation. The highest incorporation was achieved using a combination deep ripper and disk, but the offset disk provided similar results, with both achieving approximately 95% - 97% surface incorporation. The chisel plow performed slightly lower, achieving 89% incorporation with spikes and 88% with sweeps. The heavy harrows were somewhat lower again, achieving 82% surface incorporation.

Soil condition, however, did not have a noticeable effect on the incorporation of the manure. No major difference could be seen in the success of incorporation based on whether the soil was tilled or untilled.

Results from the lab tests of the soil samples taken after incorporation are needed to complete this experiment. Results from those tests will give a better indication of the incorporation of the manure in the soil profile. This will give us a better idea of the effectiveness of the different incorporation methods.

Summary and Conclusions

The type of tillage method used did have an effect on the incorporation of the manure into the soil. Current results show the combo unit to have the highest incorporation, followed closely by the disk, with the chisel plow coming up in the middle and the heavy harrow having the lowest incorporation.

Soil conditions did not effect the surface incorporation of the manure.

Lab results from the testing of the soil samples will be needed to ascertain the affects of the machinery at sub surface levels. Further experimentation may also be necessary to ensure the results in various soil types and conditions.

References

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