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Research examines liquid manure application in no-till farming

Study gives no-till farmers new options for injecting liquid manure

When applying manure, the goal is to get it where it needs to go, with the nutrients intact and with the least amount of odour released. The ability to do all three gives injection a distinct advantage over broadcast application.

Research conducted by the AgTech Centre looked at which opener type injects the liquid the best with a minimal amount of odour and nutrient loss. Because of the strong growth of no-till farming in Alberta, and because of the advantages of injecting fertilizer, more applicators use liquid manure injection equipment than ever before.

In a no-till operation, injecting liquid manure is the most common way to apply manure even though it does cause some disturbance. Surface applied manure does occur but results in losses of nutrients and odour issues can present a challenge.

Measuring for success

"We tested five different tillage/injection systems that are designed to apply liquid hog manure," says Blaine Metzger, a project technologist with the AgTech centre in Lethbridge. "Two were low disturbance, two high disturbance and one aerator. The majority of the tests were done to simulate rates from 34,000 to 146,000 L/ha (3,000 to 13,000 gal/ac)."

Over the course of three summers, the injectors were tested in a variety of settings at the AgTech Centre in Lethbridge. In the first year, injectors were tested using a draft cart. Soil and trash disturbance was measured, as were the draft forces from each opener. The openers were tested at three tillage depths and at three different speeds.

Alberta

In the second year the injectors were tried at test plots. Each injector was run at different speeds but at one depth. "We measured the soil profile before and after the soil opener went into the ground," says Metzger. "We measured the furrow, the amount of soil that was disturbed, lifted and thrown and the fracturing of the soil. Residue disturbance was also calculated."

In addition, the test measured pooling by taking a look at how much liquid was left on the surface immediately after the injector went through the soil at the different speeds and application rates. Then the furrows were excavated to observe how the liquid went through the fractured soil.

"We found that the higher the soil fracturing and disturbance, the better the placement of the liquid into the soil, with minimal pooling," says Metzger. "Some openers fractured all 12 inches of soil between each opener row and some only five inches so the liquid wasn't distributed across the entire profile which in turn had a reduced furrow area preventing absorption of the liquid. Pooling of the manure at the surface is the source of the odour and that's what concerns the community."

Evaluating odour

Odour measurement accounted for the last year of testing. Following the measurement of disturbance and application, liquid hog manure was used with all of the injectors at different rates and speeds. An olfactometer was used to gauge odour concentration.

Odour was measured immediately following application, four hours later and 24 hours after application. However, high odour concentrations were only found from measurements immediately following an application, even with openers that had the lowest degree of pooling.

The testing found that all the systems worked better than they had expected at getting the manure where it is most effective. However they found that the ones with low disturbance had the highest amount of pooling.

"We're trying to promote low disturbance injection of hog manure for minimum tillage seeding operations and to give producers more options for applying their liquid manure," says Metzger. "This would include forage and grass pasture, so we'd like to see a low disturbance opener that can go through the pastures without killing the forages while enhancing the vegetative growth and soil structure."

Weighing options

Disk injectors produce much less soil disturbance than shank injectors, and angled disks had the lowest disturbance at all speeds making them the best option for direct seeding and forage applications. The drawback of disk injectors is that they do not penetrate the soil as well as the shank injectors, which is currently incompatible with low disturbance cropping systems. Aerators have the lowest soil and residue disturbance, but also resulted in the highest surface liquid pooling.

Selecting the best injection technology is not straightforward. Each injection type has several pros and cons. All options had acceptable nutrient placement. The study found that high disturbance injectors controlled odor the best, but as was expected, they resulted in high amounts of residue and soil disturbance. And in all cases the odour had dissipated within four hours of injection.

The report concluded that the individual farming practice would dictate the best system to use. ✦

AgTech's search for technology solutions

Development of new injector may solve applicator dilemmas in low disturbance settings

If the ideal tool isn't available, the AgTech Centre looks for a solution. A manure injector currently in development by the AgTech Centre aims to allow producers to apply more manure deeper into the soil with minimal soil disturbance.

The best commercially produced injectors for minimum or no-till operations are a coulter or angled disk, but they are limited in the amount of manure they can apply. Once the furrow has filled with liquid manure, the manure starts to run out over the sides of the furrow, almost eliminating its effectiveness.

"The growth of the livestock industry will depend on making better use of the nutrients in manure and controlling odour, I think there's going to be more of a demand for this type of equipment," says Lawrence Papworth, project engineer with the AgTech Centre. "Custom applicators are still looking for the ideal tool and we'd like to help create one that is low disturbance for no-till operations."

The first prototype was a bent leg shank style injector, which entered the soil on a curve so the flat edge could lift the soil. The good news was that it was able to accommodate higher rates of manure without any sign of surface pooling and the power requirements were reduced for the depth of operation. The bad news was that it was still fairly high disturbance.

Based on what was learned with the initial prototype development a second version of the injector addresses the issue of disturbance. Because of the smaller shank and depth of operation, the disturbance should be minimal. This injector will be tested in the upcoming growing season. ✦

Identifying the best tillage tool for the job

Study shows how to incorporate manure in a sustainable manner

The application of manure can be a cost effective way for farmers to fertilize, especially for those running mixed grain and livestock operations. Research shows that the type of tillage method used has an effect on the effectiveness of incorporation of the manure into the soil.

The use of manure in a fertilizer rotation has been increasing in recent years. While advances are being made in broadcast application, incorporation of solid livestock manure into the soil shortly following application is recommended in order to maintain ammonia levels and minimize odours and runoff.

Five years ago, the AgTech Centre completed research on the most effective tillage methods for incorporating manure. Little has changed in terms of tillage tools and how they operate. The research measured the percentage of manure incorporated using different tools and took a frank look at how much disturbance each tool made.

The case for incorporation

For this study a number of commonly used tillage methods were compared on both tilled and untilled wheat stubble. While there were different results depending on the type of tillage method used, soil conditions had virtually no effect on manure incorporation.

There are a number of concerns with the broadcast application of manure, despite the fact that it is a common and accepted practice. The biggest concern is the impact in terms of odour and runoff into water sources. These concerns can be somewhat mitigated by incorporating manure into the soil.

When manure is turned into the soil, a greater amount of usable nitrogen is available. Liquid manure spread over a field and not incorporated can lose up to 90 percent of its ammonia. Once injected, those ammonia losses can be as low as five percent. Similarly, a broadcast application of manure can lose up to 80 percent of the ammonia while the losses range from 10-15 percent if the manure is incorporated.

Weighing the benefits

Each plot was replicated four times. A strip was left between each replication for machine turning and operation. Half the plots were tilled prior to manure application and the rest of the plots were left as untilled wheat stubble.

Fresh solid cattle manure was evenly broadcast at a rate of 30 tonnes/ha (12 tons/ac) using a manure spreader. Tillage methods tested included a heavy tandem disk and a chisel plow with spikes at a depth of 15 cm (6 in), a heavy harrow and a combination deep ripper and disk at a depth of 41 cm (16 in) on the ripper and 20 cm (8 in) on the disk. Speeds were consistent with the exception of the heavy harrow, which was 2 km/hr (1.2 mph) faster.

After visual incorporation measurements had been taken the plots were packed using a heavy roller. Soil samples were then taken in 3 cm (1.2 in) increments for lab analysis to test manure incorporation. The different incorporation tillage methods showed quite a difference in the percentage incorporated. The difference was as much as 10 percent from the highest to the lowest average incorporation.

The highest incorporation came from a combination deep ripper and disk, with the offset disk providing similar results. The heavy harrows had the lowest percentage of surface incorporation. However these benefits have to be measured against the effect on trash cover and loss of soil moisture. ✦

When too much, or not enough manure can damage your crop

Demonstration sites showcase the problems associated with incorrect manure application

Just like with a granular application, when applying manure to a field it's important to get the rate nailed down. A demonstration plot set up by the AgTech Centre aims to show producers what happens when they get it right, and wrong.

The five-year site was set up in 2006 at the AgTech Centre's field sites to demonstrate how over or under applying manure or compost to cropland can have a negative effect on both the environment and annual and perennial crops.

"We compared applying compost, liquid and solid manure onto different crops at different rates," says Blaine Metzger, a project technologist with the Ag Tech Centre. "Some of the manure was incorporated, some was not and some had urea nitrogen added to the mix."

A total of 338 plots of winter wheat, barley, canola, corn, alfalfa, brome and an alfalfa/brome mixture were each seeded. The area of each crop was approximately one-third of an acre, with grass borders to allow for tours. Over the five years of the trials, one crop will have manure applied each year, one will be applied on a three year rotation and the final third will be on a five year rotation.

Four different levels of application rates were used in each section. In the first, manure was applied at recommended rates. The second had added granular fertilizer, no fertilizer was added with the third, and in the final section, manure was applied at three times recommended agronomic rates.

Perennial crops were seeded at the end of April with the annuals planted in the beginning of May. Weed management was practiced at the site and the borders were controlled. The crop was assessed by performing plant counts with soil samples also completed. Emergence and yield were also looked at to determine if there are issues with any of the treatments tested.

"We hope that producers can use the data from this site in combination with other nutrient management tools to better utilize manure in their cropping systems," says Metzger. "These sites could also encourage producers to reduce their fertilizer inputs and application of manure to what is best for the crop and the land."

If the nutrients in manure and compost are not managed properly they can cost a producer money in lost nutrients and can potentially impact the environment. By optimally applying nutrients, producers can reduce volatile losses of ammonia into the atmosphere, reduce the amount of nutrients in the water aquifer, control surface runoff and reduce the build-up of nutrients on cropland while enhancing the vegetative and soil environment.

"Our goal is to identify any possible application problems with different types of manure," says Metzger. "This will determine if there are any issues with the different rates, nutrient sources, the application timing and different application methods. If there is an issue there will be a need for further research in the future."

Metzger says that as it is a demonstration trial, he hopes that other industry groups will come to visit the site near Lethbridge ✦

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