Resources Conservation Practices

Manure and Tillage Management

Conservation Quiz

1. *What are the considerations that should be used for integrating manure management in conservation tillage systems?*
2. *What manure injector has the least impact on residue cover?*
3. *What implications can soil compaction have on crop growth?*

(answers on page 4)

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Conservation tillage systems are critical components of a sound conservation plan. Good residue cover is valuable in reducing soil erosion due to surface runoff compared to an unprotected soil surface. Achieving soil erosion control and minimizing surface runoff and nutrient losses is more challenging when livestock manure is incorporated into any conservation plan. Improper manure management can compromise conservation planning, soil quality, and water quality. Another challenge of manure application within conservation planning is the timing of manure application when minimum soil compaction can be expected. To effectively use animal manure as a source of nutrients for crops within a sound conservation system, significant changes in management and technology may be required.

Figure 1. Disc-covered manure applicator.

Manure Application Effect on Residue Management

Adopting best management practices throughout an operation must take both manure application and tillage management into consideration. Liquid manure application equipment typically used by Iowa producers may reduce levels of residue cover that are critical to controlling soil erosion and preventing surface runoff and nutrient loss, no matter what tillage management system is being used. In some cases, disc-covered manure application can reduce residue cover to as low as 20 percent, depending on how fragile the crop residue is. Therefore, the type of manure application equipment used can significantly affect the amount of residue cover remaining on the soil surface. Modifying manure injection units or their operation can improve residue cover by minimizing soil disturbance.

Effective manure application and residue management can be combined to improve both soil productivity and environmental quality. In a study in northeast Iowa, residue cover was measured before and after the application of liquid manure with three different types of manure applicators (disc-covering unit, a sweep incorporator, and a single-disc injector unit). The disc-covered applicator used discs to cover the manure that was applied directly on the soil surface (Fig. 1). The shovel incorporator and the slot injector applicators placed the manure below the soil surface (Figs. 2 and 3). In this study, the disc-covered manure applicator was used on corn residue and all three applicators were used on soybean residue. The disc-covered applicator with soybean residue caused a reduction of 73 percent in residue cover compared to 24 percent with corn residue (Fig. 4). This large difference in remaining residue cover can be attributed to greater rigidity and volume of corn residue compared

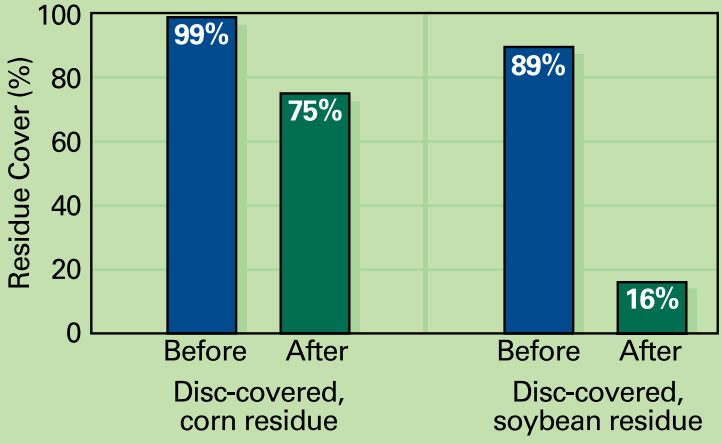

Figure 4. Effects of manure applicator disc-covered incorporators on corn and soybean surface residue covers.

Figure 2. Shovel incorporated manure applicator.

Figure 3. Slot injected manure applicator.

to soybean. Soybean residue is generally more fragile than corn residue; therefore, soybean residue will break down and incorporate easier with disc-covers than corn residue.

In the same study, three types of liquid manure applicators were compared for their impact on soybean residue cover remaining after manure application (Fig. 5). The disc-covered manure applicator caused a 73 percent reduction in soybean residue compared to 62 and 21 percent residue reductions caused by the shovel incorporator and slot injector, respectively. Disc-covered applicators were more aggressive in overturning soil and residue cover when incorporating manure. The sweep incorporator on the other hand had more visible disturbance due to the sweep mixing of the applied manure with the soil. The single-disc injector was less disruptive to soil and surface residue because it applies liquid manure below the soil surface with a narrow cut through the soil surface. Single-disc injector applicators typically disturb a minimum amount of surface residue while applying manure. However, in corn residue, a disc-covered manure applicator can leave more than 75 percent residue cover due to the rigid nature of the cornstalks.

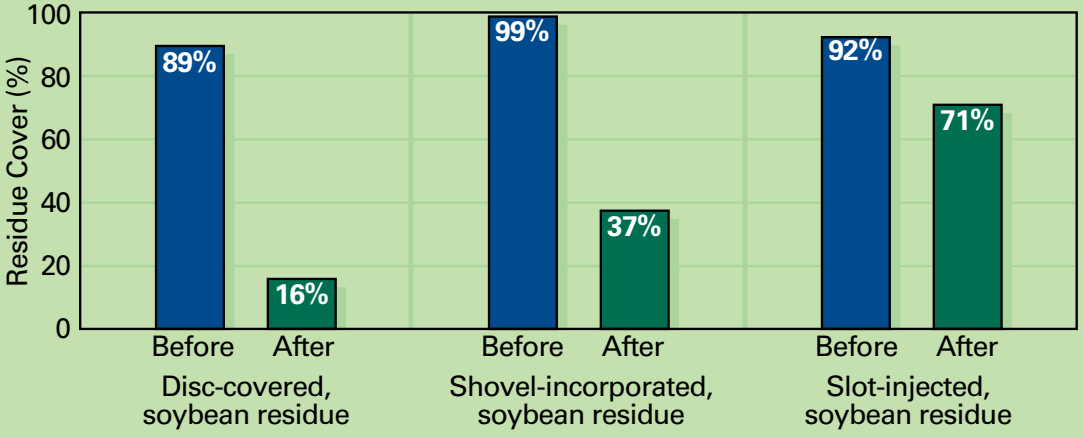

Figure 5. Effect of different manure application injectors and incorporators on soybean surface residue cover.

Manure Application in Conservation Tillage Systems

It has been found that manure injection methods resulted in higher corn yields, reduced nutrient runoff losses and lower odor than conventional methods of application. Manure application with conventional sweeps and broadcast application followed by disking can cut odor substantially, but will cause greater reduction in residue cover.

Producers using conservation tillage systems must realize the importance of leaving residue cover on the soil surface for maximum use of nutrients and preventing surface runoff. Injecting manure can mix soil, bury residue, and destroy soil structure. Therefore the value of having complete residue cover can reduce erosion significantly (95 to 98 percent) compared to unprotected soil (Midwest Plan Service, 2000). Manure injection can be considered as a tillage alternative to integrate conservation tillage and manure application similar to strip or zone tillage (see PM 1901C). This alternative will address one of the challenges farmers face in managing liquid manure while using a conservation tillage system. For producers using conservation tillage it's important that every field operation leave the maximum amount of residue cover on the soil surface to be in compliance with conservation plans and maximize the use of manure as a nutrient source.

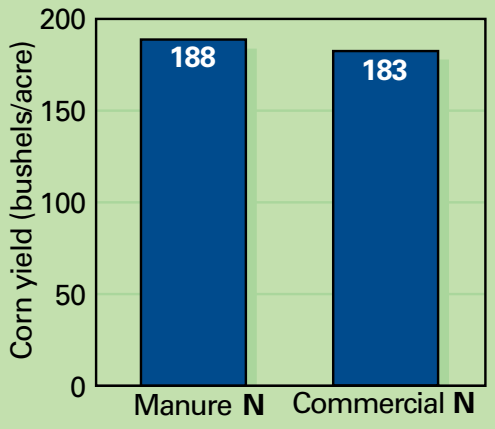

Figure 6. Corn yields comparing manure strip-tillage and conventional strip-tillage with commercial nitrogen, both at 150 pounds N/acre.

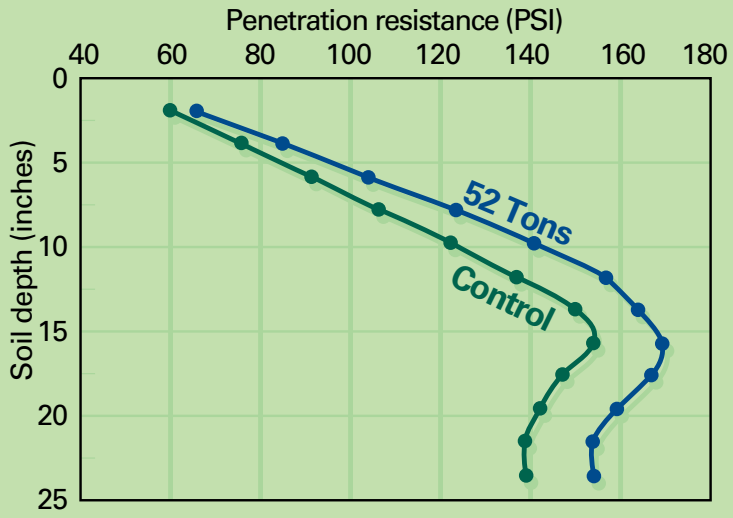

Figure 7. Soil penetration resistance after manure application. The control received no manure application and the 52 tons represents manure application using a manure applicator with an estimated weight of 52 tons across 4 axles.

This new "manure-strip-tillage" system can be as efficient as the traditional strip-tillage that was adopted for commercial nitrogen fertilizers. Manure-strip-tillage can better improve nitrogen availability, yielding slightly higher than traditional strip-tillage with commercial nitrogen (Fig. 6). Many farm operations require a delicate balance between manure application and tillage management. The best solution lies in determining an acceptable balance between existing application equipment, maintaining residue cover, odor control, and reaching optimum crop yields.

Answers to Conservation Quiz

1. Soil analysis, manure nutrient analysis, manure applicator uniformity, and applicator toolbar setup all should be considered when integrating manure management and conservation tillage systems.
2. Slot injection of manure leaves a higher percent of crop residue on the soil surface and in turn reduces the amount of soil lost to erosion.
3. Soil compaction can limit root and crop growth through decrease in soil aeration, nutrient availability, and available water resulting in a loss of crop productivity.

Manure Application Effects on Soil Compaction

The most common cause of soil compaction in row crop fields is from field operations used to till the soil, apply nutrients, plant the crop, harvest, and other maintenance operations. For many livestock producers, manure application is the most damaging practice in terms of soil compaction. Liquid manure applicators can hold up to 10,000 gallons, weighing more than 50 tons across four axles when fully loaded. Figure 7 illustrates the impact that manure application can have on soil compaction presented as resistance to penetration in pounds per square inch.

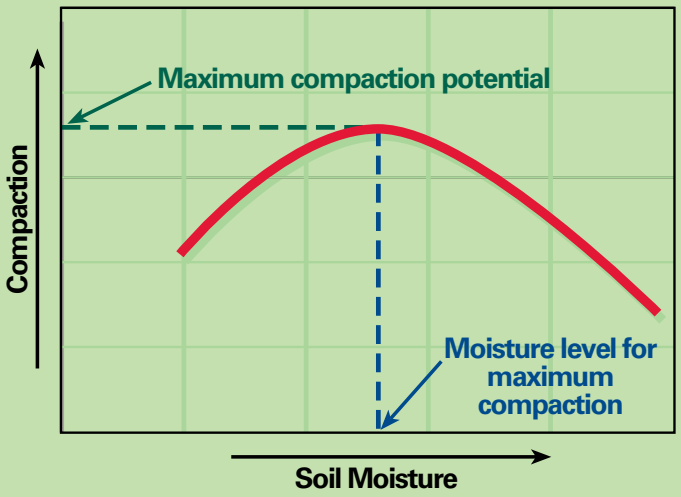

Figure 8. Moisture density curve for a medium textured soil for a given compactive effort. Adapted from Environmental soil physics.

While the degree of soil compaction is greatly affected by the weight being applied to the soil, the moisture condition at the time of manure application is very important because soils compact more easily when the soil moisture is at or near field capacity (Fig. 8). This is due to the ability of soil water to act as a lubricant between soil aggregates. Therefore, both the timing of manure application and the applicator weight are critical in reducing soil compaction at the time of manure application. Other management practices that can be used to alleviate soil compaction are: reduce the weight on each axle, properly pressurize tires, apply under proper soil moisture conditions, control traffic patterns, and implement a crop rotation that incorporates small grains or cover crops (see PM 1901B).

Top 10 Reasons to Avoid Soil Compaction

10. Causes nutrient deficiencies
9. Reduces crop productivity
8. Restricts root development
7. Reduces soil aeration
6. Decreases soil available water
5. Reduces infiltration rate
4. Increases bulk density
3. Increases sediment and nutrient losses
2. Increases surface runoff
1. Damages soil structure

Conservation and Nutrient Management Planning

Liquid manure application can be considered as a tillage operation or an alternative tillage system. The fact is that most manure injection equipment will disturb the soil and residue much like zone tillage systems. Therefore, manure application should be accounted for in conservation plans by considering the following:

1. **Establish a soil testing regime that targets nutrient levels needed to maximize crop growth.**
2. **Analyze manure for nutrient contents. Manure contents can vary from building to building and year to year depending on weather conditions, livestock diet, dilution by water, and other externalities issues.**
3. **Pay special attention to variability across the toolbar. Make sure that injectors are not plugged during manure application by examining the units to avoid any nutrient deficiency and subsequent yield loss.**
4. **Understand the impact your manure applicator can have on soil compaction. As a general rule, apply manure when soil moisture is below field capacity.**
5. **Learn about the wide variety of manure application toolbars. Each type of toobar can have different impacts on surface residue cover.**

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References

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