Agronomic Spotlight

Soil Structure and Compaction in Corn-on-Corn Management

- Continuous corn systems may be more prone to soil structure compaction which may delay field entry longer than fields rotated to different crops.
- Poor root development from compacted soil can prevent the uptake of nutrients, leading to nutrient deficiency and sensitivity to environmental stress.
- Timely field operations and addressing drainage issues can reduce or prevent soil compaction in continuous corn.

Fundamentals of Compaction

Soil compaction occurs when mechanical loads are applied to susceptible soils with moisture at field capacity. Field capacity is the point at which the pore space surrounding soil particles is completely occupied with water, displacing the air portion present in soils.

Figure 1. Corn-on-corn production has a greater potential for compaction due to the high level of traffic required to remove the volume of harvested corn bushels.

Coarse-textured soils with high organic matter are less prone to compaction. Medium- and fine-textured soils typically have a higher water holding capacity, are slower to dry, and are more likely to develop compaction problems. The degree of compaction is determined by the weight of the equipment transferred to the susceptible soil, and the amount of moisture present at the time of the field operation.

The two main types of compaction are compaction caused by traffic and tillage (Figure 1) and sidewall compaction (Figure 2). Both types of compaction can put corn plants under similar stresses. However, the type of compaction can damage corn roots differently and the tools used to help alleviate compaction may vary.

Potential Effects of Sidewall Compaction

Sidewall compaction occurs during planting when soils are at field capacity. Furrow openers can move the soil to the side of the furrow, sealing it and making a barrier to seedling root growth. Sidewall compaction can cause poor seed-to-soil contact and an open seed furrow. If dry conditions develop after planting, the seedling may suffer from inadequate amounts of moisture, and the seed furrow may open wider, exposing developing roots. If seed placement is too shallow relative to the press wheel positioning, compaction can occur below the seed, again causing difficulty for root penetration.

Possible consequences of sidewall compaction include reduced germination, uneven emergence, restricted root growth, and stunted seedlings. Roots will often proliferate within the area opened by the disc openers, but not the surrounding soil. The result is a 'tomahawk'-shaped root system (Figure 2). Plants with restricted root growth often show symptoms of nutrient deficiencies, as the roots are restricted and unable to reach enough soil nutrients. Floppy corn or rootless corn syndrome can often result from sidewall compaction, open seed furrows and/or planting too shallow.

Figure 2. 'Tomahawk'-shaped root structure from sidewall compaction.

Restriction on Roots

Root growth can also be restricted due to low soil oxygen availability.[1] Above average rainfall can result in low soil oxygen, which can be especially problematic when corn is at peak vegetative growth, prior to tassel. Nutrient deficiencies such as nitrogen (N) and potassium (K) may occur due to reduced or slow root growth. Restricted root development can also increase lodging and have a negative effect on yield potential, especially if the latter half of the growing season is hot and dry. Reduced root growth in the first half of the growing season can result in water deficiencies during the second half, and most critical growing period: tassel to black layer.

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Residue Management

Figure 3. Uneven germination as a result of continuous corn residue.

Managing residue is essential for effective continuous corn systems. Incorporation of residue after harvest increases organic matter and improves soil structure. Leaving corn residue on the soil surface can impede germination (Figure 3) and increase moisture retention, delaying entry into the field the following spring.

Monmouth Demonstration

A continuous corn and a corn-soybean rotation were compared in both conventional tillage and strip-tillage plots at the Monsanto Learning Center in Monmouth, IL. Root pits were dug in late summer to illustrate the effect of the treatments on root growth and ear development (Figure 4). Roots in the continuous corn, conventional tillage treatment were not as deep as those in the other treatments. A dense layer from tillage and traffic compaction was likely the cause. Ear size was also smaller in the continuous corn conventional tillage treatment.

Continuous Corn	**Corn-Soybean Rotation**
Conventional Tillage	
	
Strip Tillage	
	

Figure 4. Effect of rotation and tillage on root growth and ear development in corn. Monmouth, IL, 2011. Conventional tillage, continuous corn roots were shallower than those in other treatments.

Effect on Yield Potential

During years when adequate water and nutrients are available, compaction is less likely to affect grain yield potential. When a crop is water or nutrient stressed, compaction can reduce yield potential by up to 50%.[2] While it is impossible to conduct field operations without affecting the soil, the goal should be to minimize any negative effect on the crop. In some years, even an average amount of soil compaction can have a negative effect on root growth, nutrient uptake, and yield potential.

Reducing Compaction

Managing field operations, addressing drainage issues, and removing other existing problems can reduce or prevent soil compaction.[3] Field operations can be managed by staying out of fields that are too wet, limiting vehicle load, using proper weight during tillage operations, and managing traffic within fields. Existing drainage problems can be addressed by incorporating organic matter to the soil which can help build soil structure and strength. If possible, rotating to tap-rooted crops like soybean can help to create channels in the soil for subsequent crops. Existing compaction can be removed by using conventional tillage to help remove compaction in the plow layer. Deep tillage may also be used, but should not be used often because it can damage soil structure.

Altering tillage depth may be a useful method to minimize the development of compaction zones. During wet years, tillage should be kept shallow to help prevent formation of a deep tillage pan. If a shallow pan forms, it can be easily fractured once the soil is dry. In dry years, tillage can be deeper for more soil incorporation.[4] Tillage depth should be determined based on proper use of the tool and what is needed to accomplish the goals at hand: compaction reduction, residue management, or seed bed preparation.

Sources

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