Late Season Effects of Soil Compaction

- Late season soil compaction can reduce water infiltration and restrict root development which can result in the potential reduction of crop yields in subsequent years.
- Yield loss as result of soil compaction caused by wheel traffic can range between 10 to 20%.[1]

Soil moisture is considered the single most important factor contributing to soil compaction. Heavy clay content soils are particularly vulnerable to severe compaction under wet conditions. Soil density also influences the level of compaction. Soil density is dependent on soil organic matter, soil texture, the density of soil minerals (sand, silt, and clay), and their packing arrangement. Generally, a courser textured soil has higher density as there are less pore spaces.

When a soil is compacted, bulk density increases and porosity decreases, as larger pores are compressed resulting in a soil with a greater proportion of fine pores. The result is a soil with reduced capacity for the movement of water, air, and greater resistance to root penetration. Compaction increases the diffusion rate of nutrients, as soil particles are moved closer together. This effect may, in fact, increase nutrient uptake per unit length of root; however, total plant uptake is generally reduced because the increased root penetration resistance reduces root growth. Where aeration is greatly reduced, nitrogen (N) availability may decrease because of denitrification, and potassium (K) uptake may be reduced if respiration within the root is reduced.[2] Plant growth is potentially adversely affected because of a combination of these effects, most of which are related to the water status of the soil.

A study conducted at the Bayer Learning Center at Scott, MS investigated the impact of soil compaction on corn growth and yield (Figure 2 and Table 1). The results showed reduced plant height and lower yield when soil was compacted.

Figure 1. Harvesting or field work under wet conditions can lead to soil compaction.

Figure 2. Impact of soil compaction on corn plant height.

Table 1. Impact of soil compaction on corn yield at the Bayer Learning Center near Scott, Mississippi.

Irrigation / Compaction Treatment	Average yield (bu/acre)
Furrow / Non-Compacted	248
Furrow / Compacted	173
Dryland / Non-Compacted	99
Dryland / Compacted	44
Sprinkler / Non-Compacted	194
Sprinkler/ Compacted	136

Management Considerations

While it is always best to prevent soil compaction and wait until conditions are conducive to minimizing compaction, that is often not possible. One method to determine soil condition involves working a small ball of soil (half the size of a golf ball) in the hand, and rolling it into a thread between two hands.

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- If the soil cannot be rolled but smears easily, then it is much too wet. Compaction will result from traffic by virtually all vehicles.
- If a long, thin thread is rolled easily, the soil is too wet, and compaction will result from traffic by many, perhaps most, vehicles.
- If the soil can just be rolled without crumbling, but is "on the edge" of crumbling, some vehicles will compact the soil, and some lower ground pressure vehicles will not.
- If the soil cannot be rolled into a thread, but crumbles or breaks into hard crumbs, compaction is unlikely to occur and is unlikely to be severe.

Wheel traffic is the most common factor in causing soil compaction. In fact, soil compaction, induced by wheel traffic from large agricultural equipment, has been shown to extend well below the tillage zone, reducing crop growth and yield in many situations. Reducing vehicle load or controlling traffic should be considered when harvest or field work is necessary under wet soil conditions. Compaction near the surface (3 to 6 inches) is generally associated with the amount of surface pressure. Compaction at deeper depths is primarily associated with axle (tractor or heavy implement) weight. If soil (12 inches) below the surface is at field capacity and the tractor's axle load is (7 to 8 tons) or greater, compaction can occur at this depth despite lower surface pressures. Consider spreading out the load by using multiple axles, dual tires, lighter equipment if possible, and maintain proper air pressure in tires, particularly radial tires. If possible, developing dedicated traffic lanes for all in-field traffic can also help prevent compaction across the entire field. Additional methods to reduce compaction include minimize or eliminate tillage, perform only those tillage operations that are necessary, for example, for field leveling, weed control, or fertilizer incorporation. Ruts that are made in the fall, can be filled with light tillage by running equipment at an angle. This can require up to 2 to 3 passes, these areas won't yield as well as the non-rutted area.

Suggestions for Harvesting Under Wet Soil Conditions[1]

- Use dedicated travel lanes for grain carts. Approximately 60 to 80% of soil compaction occurs from the first wheel passes, subsequent passes cause a much smaller amount of compaction.
- Do not run at full capacity. Reducing the combine and grain cart axle loads in the farther parts of the field, while increasing loads near end rows or field exits can help restrict compaction potential to a smaller area.
- Use dual tires and appropriate tire size and air pressure. Large tires with lower air pressure will result in less soil compaction.
- Keep trucks and grain carts along field end rows, but only compacting smaller areas, the over impact of soil compaction will be less.
- Avoid the wettest field areas, getting equipment stuck adds to the frustration of a wet harvest and increases the risk of compaction in the wetter areas.
- Limit tillage operations and wait until soil is at the proper soil moisture before working to fill in ruts, working wet soil increases the potential for compaction.

Sources

[1] Al-Kaisi, M., and Licht, M. 2019. Plan ahead to minimize soil compaction during harvest. Integrated Crop Management. Iowa State University Extension. https://crops.extension.iastate.edu/cropnews/2019/09/plan-ahead-minimize-soil-compaction-during-harvest#:~:text=Damage%20from%20soil%20compaction%20can,the%20extent%20of%20soil%20compaction.

[2] Kaiser, D., Carlson, B., and Vetsch, J. 2019. How soil compaction impacts fertilizer decisions. Minnesota Crop News. University of Minnesota. https://blog-crop-news.extension.umn.edu/2019/10/how-soil-compaction-impacts-fertilizer.html

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