Soil Compaction

AGRONOMY

Ideally, a "good" soil for crop production contains about 25 percent water, 25 percent air and 50 percent soil particles. The volume of water and air is referred to as pore space. Anything that leads to a reduction in pore space results in increased soil density causing poor internal drainage and reduced aeration. The direct result of an increasingly dense soil is a loss of relative crop yield. This is where tillage and wheel traffic come in. As field machinery becomes heavier and the motivation for the grower to become more efficient with his time (working fields that are ideally too wet), soil compaction becomes a much greater concern.

Compaction drastically reduces water infiltration rates due to the soil having smaller pores causing fewer well-defined natural drainage channels. Unfortunately, this cycle sets up a long list of chain-event problems; greater surface wetness with increased water runoff, resulting in increased surface soil erosion, thus requiring longer drying times, which in turn delays planting and harvesting, that ultimately leads to decreased crop yields. In addition, roots aren't able to fully develop in dense soils, resulting in reduced access to soil moisture and nutrients.

Common Causes of Compaction

Compaction is directly affected by machine weight, tire size, tire-inflation and most importantly soil moisture conditions. Some farm machines can weigh as much as 30 tons. While lighter loads may cause as much surface compaction, heavy loads cause compaction at depths that cannot be corrected by tillage.

The most significant cause of compaction is performing field operations (planting, harvesting, tillage) when the soil is too wet. The use of duals or flotation tires encourages or allows this to happen.

Surface compaction is primarily affected by tire-inflation pressure. By selecting large, low-pressure tires and/or duals, a 200 hp tractor may cause no more surface compaction than a light tractor; however, the heavier one will cause compaction at deeper depths. In addition, running narrower, lighter equipment at higher speeds will allow tillage equipment to break up some or most of the surface compaction. The degree with which the tillage is successful depends upon soil moisture conditions.

Effects of Soil Compaction

Enough studies have been conducted to indicate that indeed soil compaction does reduce crop yields. The amount of yield reduction is dependent upon conditions such as soil type (ex., heavier soil types are more affected than others). Generally, the smaller the soil particles (i.e., clay) the more compaction reduces yields. The impact can be significant. Depending upon the overall yield, potential reductions due to compaction can be as much as 50 percent of the relative yield.

Soil compaction also serves to further increase pre-existing soil issues, such as poor soil moisture conditions and distribution, early planting (cool soil temperatures), low soil fertility and severe soil acidity

Compensating for Compaction

Compaction restricts root development. This affects the plant's ability to explore for water and nutrients, tolerate insect feeding and its ability to resist disease pressure. Some of these factors can be minimized through nutrient placement and irrigation.

Irrigation provides adequate water at the soil surface where the root system is concentrated. If irrigation is not available, dry conditions will reduce yields. Placement of fertilizers above the compacted zone will allow the root system to proliferate in the amended soil. This is particularly true with immobile nutrients such as phosphorus, magnesium, trace elements and to a lesser degree potassium. Because of this restricted root system you may need to increase your rates of fertilizer. An alternative is to utilize a starter application in early spring development to compensate for the poor uptake of nutrients in compacted soils.

Summary

In years when soil moisture is plentiful, the impact on crop growth due to soil compaction may not have a direct effect on crop yields. In years of a moisture shortage, the plants will more easily be stressed, production reduced and yields suppressed. To some extent, shallow compaction (less than 12 inches deep) can be remediated with deep tillage (subsoiling). Deep compaction cannot be corrected with tillage.

If possible, it is best to operate field equipment when fields are dry, avoiding excess axle loads, and using dual or flotation tires to distribute weight on the soil surface. This will help to avoid deep compaction (greater than 12 inches) that is more difficult to remediate.

Crop growth can also be managed with careful nutrient and/or irrigation management that will compensate for the limited plant root development resulting from soil compaction.