AGRONOMY

Soil Compaction

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. The pore space can be changed if a heavy weight or force is applied to the soil, reducing pore space, increasing soil density and causing poor internal drainage and reduced aeration. The direct result of an increasingly dense soil is a loss of relative crop yield. As field machinery becomes heavier and growers are attempting to become more efficient, the risk of soil compaction becomes a much greater concern.

Compaction also significantly reduces water infiltration rates because of the reduced internal drainage through the smaller channels of connected pores. Unfortunately, the reduced infiltration leads to other problems as well: pools or puddles on the soil surface cause crusts to form, further limiting infiltration; even though infiltration is reduced the poor drainage and crust prevent the soil from drying in the spring, delaying planting; and if there is surface runoff the potential of erosion increases. A dense, or compacted, also soil restricts root growth which limits uptake of moisture and nutrients by the crop.

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 soil compaction does reduce crop yields. The amount of yield reduction depends on soil texture (ex., heavy or clayey soils are more affected than others). Generally, the smaller the soil particles (i.e., clay) the more that 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 problems coming from 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.