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KRCD
Kings River Conservation District

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IRRIGATION NEWS

Soil Compaction Compounds Management Difficulties

One of the most basic rules of agriculture is that soil compaction is inevitable. As soon as any soil is deposited upon the surface, compaction begins. The consequences of compaction range from the reduced infiltration of air and water into the root zone to the reduction of drainage (perched water) from the root zone in the case of sub-surface compaction. These consequences have negative impacts on crop growth and yields, as well as promoting surface runoff. This newsletter will address what compaction is, its causes, how it can be actually beneficial, its major problems, options for dealing with existing compaction, and prevention strategies.

Compaction occurs when the normal open space percentage within the soil (about 50 percent) is changed due to the application of an external force. Whether this compaction is permanent or temporary depends upon the soil's texture and moisture content at the time of the compaction event. A soil is considered compacted when the open space volume drops to around 30 percent.

Dry soils have a considerable mechanical resistance to compaction, as the soil particles move in all directions away from where the forces are applied. The soil particles are free to move independently of one another when not being bound by soil moisture, so they are more likely to move away from the applied forces, rather than be compressed by them. As soil textures move towards a more loamy character, the compaction problems tend to increase, as the finer particles readily move into the available soil voids. Once the soil texture passes the loamy stage and approaches a more clayey texture, the resistance to compaction increases again. This is mainly due to the higher density of high-clay soils when compared to the lighter sand or silt soils.

As soil moisture increases towards field capacity, the lubricating effects of the soil water increase the risk for soil compaction. Here, the soil particles will move into the voids while being bound together by soil moisture. The effect decreases when the soil moisture passes field capacity, because hydraulic resistance begins to take effect as the compacting force is applied, thus keeping the soil particles apart.

Compaction occurs in several ways. The first way is the most obvious: driving across the field with a truck, tractor, or performing tillage when the soil is too wet. Repeated passes along the same track will create not only surface ruts, but will spread the compaction effects several feet into the soil profile. Discs and plows apply a great deal of force at the bottom of the implement as they work, which creates a zone of high compaction at the bottom of the tillage zone (called a plow pan). The presence of such layers can impede the downward movement of soil water from rain or irrigation, creating a perched water table.

The second way is less obvious, and that is via the application of water to the soil surface. It does not matter how the water is applied (rain, sprinklers, flooding), the results are nearly the same. A mass (the water) has been applied to the soil surface, which must now support that weight in addition to its own. The soil gives a little as the particles move to a position that holds the new weight, and compaction occurs.

But how does rain or sprinklers cause compaction? Falling water drops has both mass (the weight of the rain drop) and velocity, which creates a force. The impact on the surface presses the grains downward in response. Some of the finer surface particles are dislodged and carried into the surface pores by the moving water. Over time, the cumulative effect is that the upper surface of the soil (about one-eighth to one-quarter of an inch) is compressed. While this does not sound like very much, the results are that the water does not infiltrate into the soil as well as before, and collects on the surface. That water also has mass (more as it gets deeper), which causes the soil to compress to a deeper depth.

Compaction, in some instances, is beneficial to the grower. After the soil is tilled and prepared for planting, compaction is done to seal in the available moisture from evaporation, and the higher density of

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Kings River Sub-Watershed Coalition Participants Have You Paid Your 2007 Fees For Participation?

Bills have been mailed for land covered by the Coalition. If you are a lessee and your landowner has not given you the bill, you need to contact the landowner to get the bill. The bills were sent to the landowner shown in the County Records. Payment must be made to the Coalition by July 16, 2007, in order for the land to continue to be covered by the Coalition. The assessment is $0.12 per acre within KRCD's boundaries, $0.42 for acreage outside the district, plus $8.00 for operational expenses by the District. Should you have questions, call the Coalition at (559) 476-0539.

Soil Compaction Compounds (Continued)

the soil allows it to warm more quickly than before. After planting, compaction insures that the soil is in solid contact with the seed, allowing it to draw moisture and germinate properly. Some compaction within irrigation furrows helps promote irrigation efficiency, by equalizing the time that the water is available for infiltration along the length of the furrow. It is also helpful in preventing wind erosion of the top soil.

Despite these benefits, compaction is a problem for growers that once started, it does not go away. The loss of the ability to quickly infiltrate water into the soil and the increased resistance to root growth that occurs with compaction eventually translates into lost yields for the grower. Some studies have showed that the toxicity of certain herbicides is enhanced in compacted soils, meaning that herbicide damage can occur to a previously tolerant crop.

Compacted soils have poor gas exchange rates, meaning the oxygen does not get to the roots quickly, and carbon dioxide concentrations within the air space increases. This can slow the uptake of water from the soil, thus stressing the plant further. The formation of plow pans further restricts root growth into the deeper root zone, meaning that available water is not utilized, and other irrigation water trapped above the pan layer can kill roots from a lack of oxygen. Beneficial leaching is limited by pan layers, and the salts that a grower is trying to remove from the root zone become trapped at the bottom, eventually reaching levels harmful to plant growth.

Compaction also costs the grower in other ways. Tight soils require more horsepower to do the same operation, thus either requiring a larger tractor (increasing the risk of more compaction), or running the tractor with a slower groundspeed, which increases fuel and labor costs.

In some cases, compaction in shallow zones can be partially reversed through natural forces (fibrous root growth, freeze-thaw, etc.), but mostly the only reliable means of reducing the impact of compaction is through deep tillage.

Since the use of tractors and other equipment is required for current cultural practices, a technique of limiting the damage caused by compaction has been developed called “controlled traffic.” Here, the tractors deliberately travel in the same tracks, essentially creating a “road” of compacted soil that can handle the weight of the tractor without transferring the pressure to the surrounding soil. The addition of GPS guidance to tractors makes this approach even more reliable for field crop growers, as the paths the tractor takes through the field are repeatable to within inches of each other.

Do not confuse soil compaction with late season soil crusting. These are two very different conditions. Soil crusting is the response of the finer soil particles to the removal of calcium from the soil surface, allowing the soil aggregates to disperse and clog the pores at surface. Supplemental applications of calcium (usually gypsum) slow this process by having extra calcium available within the soil, adding to aggregate stability.

Soil compaction cannot be prevented, but it can be managed. The primary way to reduce the risk of compaction is to only work the field when the moisture levels are correct. If a handful of soil can be shaped into a ball and it holds it shape, it is too wet. Once the soil can no longer hold its shape (crumbles easily), the soil is ready to work. Be sure to check the moisture levels at various depths, to prevent the formation of deeper compaction zones.

The addition of organic matter has been shown to prevent the reformation of soil compaction. Organic matter does not compress very well, and as it degrades, it leaves voids behind. Reapplication is required to maintain the presence of organic matter within the soil. Organic matter also improves soil health, helps stabilize the soil, and keeps the soil surface open, reducing runoff.

Disrupting the pan layers through deep ripping is also beneficial. Typically, ripping to 18 inches is sufficient to remove surface compaction layers, and an occasional slip plowing to several feet (usually 5 or more) can remove any deeper layers. Once the compacted zone is shattered, the water will migrate freely from the surface to the deeper sub soil, thus allowing subsequent irrigations to “flush” the root zone of accumulated deposits.

Irrigation system evaluations can be scheduled by contacting Eric Athorp at (559) 237-5567, ext. 117. Eric is also available to answer irrigation related questions. Irrigation pump and system tests are available to growers within the Kings River Conservation District. To schedule an appointment contact Ray Johnson at (559) 237-5567, ext 121. Appointments are scheduled on a first-come-first-served basis.

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