FIELD FACTS

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Soil Compaction

Soil compaction causes yield loss in crop production by restricting root growth and by reducing air and water movement in the soil. Soil compaction is caused by soil particles being pressed together by mechanical or natural forces. An ideal soil structure consists of 50% soil, 25% water space and 25% air space.

IMPACT OF SOIL COMPACTION:

The end result of soil compaction is less yield potential from crop production. Yield loss can vary widely depending on the extent of the compaction of the soil and environmental conditions in which the affected crop is grown in. Favorable growing conditions, such as timely precipitation and high soil fertility can minimize compaction effects. Severe compaction can cause up to 60% yield loss, however, it is estimated that compaction on average reduces yield potential in the 10 – 20% range.

COMPACTION POTENTIAL

Soils that are above field capacity in moisture have the greatest potential for compaction. Water acts as a lubricant between soil particles that allows soil to be pushed together. As more air space is replaced with water, the potential for compaction increases. There is a point however, when most air space is filled with water (near saturation) that compaction potential of a soil decreases. Therefore, a very wet soil has less compaction potential than a moderately moist soil.

Soil texture (% of sand, silt and clay in a soil) has, to some degree, an effect on compaction. Soils that consist of particles of equal size have less compactive potential than soils that have particles of varying sizes. Smaller particles can fill spaces between larger particles, thereby increasing soil density. A sandy loam soil is the most susceptible to compaction, while pure sands, clays, and silt soils are least.

Soil structure also plays a role in compaction potential. Soil structure is defined as how well a soil breaks up into small, cohesive clumps. Organic matter improves soil structure by creating soil aggregates (easily crumbled soils). Soils higher in organic matter generally have better soil structure and resist compaction better than low organic matter soils.

TYPES OF SOIL COMPACTION

Surface crusting is a form of soil compaction that reduces seed emergence and water infiltration rates. It is caused by the impact raindrops on surface soil particles. Heavy impact causes soil particles to sift together. Rapid soil drying increases potential of surface crusting. Soils with higher organic matter or high in sand content have less potential for crusts to form.

Sidewall compaction is caused by planting into wet soils. The action of the planting disc openers shearing into wet soils can cause seed furrow sidewalls to become hard after planting. The result can be poor crop emergence and poor root development out of seed slice.

Shallow compaction occurs from the surface down to the normal tillage zone. This type of compaction is normally caused by light wheel traffic or animal traffic. Shallow compaction is usually temporary and can be eliminated by normal tillage.

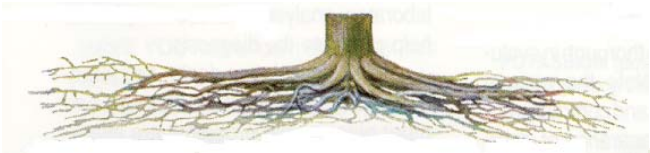
Tillage pan is subsoil compaction only a few inches thick right beneath the normal tillage zone. This type of compaction is caused by types of tillage implements that shear the soil, such as discs, moldboard plows and sweep type tools.

Deep Compaction lies beneath the tillage zone and is caused by maximum axle weight load to the soil. Harvest equipment such as grain carts and combines have high axle loads, and most often are the biggest contributors to deep compaction. Deep compaction is the most difficult to eliminate, so prevention is important.

SYMPTOMS AND DETECTION OF SOIL COMPACTION

Since soil compaction affects root growth, above ground symptoms can take on many forms. Signs of compaction may include:

- Visible wheel track patterns across field.
- Malformed root growth, including stubby , flat, thin, or twisted roots. Roots growing into a tillage pan can grow horizontal rather than vertical and will have flat, shallow root system.



- Stunted plant growth. Above ground growth is directly related to below ground root growth. If root growth is being impaired, vegetative growth above ground will likely be stunted. Look for specific patterns or areas in field, such as wheel track patterns. In some cases, a

specific pattern is not visible. Many times these areas are a result of repeated overlapping of the same areas with different tillage passes that, over time, have an additive affect on areas within the field.

- Nutrient stresses on crops can be another sign of compaction. Since roots are the avenues of soil nutrients to the crop, root restrictions can decrease root interception of nutrients in the soil. Phosphorous, potassium and nitrogen deficiencies can be secondary symptoms to soil compaction.
- Standing water or excessive water erosion can be caused by soil compaction. Compaction reduces pore space within soil so water is not absorbed into soils as readily.
- Wilting of plants in certain areas of a field can signal compaction. This can result from shallow root systems preventing the crop from uptake of subsoil moisture.
- Increased power requirements for field operations can be a sign of compaction as well. If field tillage operations encounter certain areas in a field where the tractor "pulls down" and soil is uniform across area, this can signal a compaction area.

Once compaction is suspected, the next step is to verify and isolate compaction areas. Sidewall, surface crusting, and tillage pan compaction are the easiest forms to detect with a shovel or other type of digging device. Deep soil compaction is harder to find since it occurs deeper in the soil.

Cone tipped penetrometers can be used to locate compaction. These have limitations however. Penetration resistance is a function of soil density and moisture content. Compacted and non-compacted soils of equal moisture and texture need to be compared. Therefore, there is no specific numerical value of resistance (psi) that identifies compaction. Comparative values need to be evaluated. Constant rates of push also must be maintained to give accurate readings. Motor drive penetrometers, which penetrate the soil at a fixed rate, give the most accurate readings.

Soil probes are another useful tool. These are also subject to moisture content and soil density. A drier soil will probe harder than a wet soil; clays will probe harder than loam soils for instance. Soil probes can be used effectively to monitor differences in the soil moisture profile. If the top foot of soil is extremely dry, but second foot is very moist, this suggest that crop's roots are not penetrating into the second foot, possibly because of compaction

The best indicator of compaction is viewing root growth patterns into the soil profile. This is accomplished by using a spade or shovel to dig holes or trenches along side the existing crop. Holes should be dug along side the existing crop in suspected compaction areas.

Examining below ground root growth and soil characteristics will tell if compaction exists.

MINIMIZING SOIL COMPACTION

The best strategy to minimize compaction is to avoid working wet soils, especially in the spring. Elimination of all soil compaction is nearly impossible however. Here are some tips to reduce compaction when forced onto to wetter soils.

- Control wheel traffic. Research shows that 80% of wheel traffic compaction occurs on the first pass, so try to limit the number of trips across field and use the same traffic pattern whenever possible.
- Increase surface area of tire to soil contact by using duals, larger diameter tires, radial tires, or decreasing tire inflation. This may increase potential for surface compaction, but will reduce deep soil compaction, which is the hardest form to deal with.
- Alter tillage depths to avoid additive tillage pan effects.
- Avoid excessive tillage. Tilled soils are more easily compacted than non-tilled soils.

SOIL COMPACTION REMEDIES

- Freeze/thaw and wet/dry cycles are good natural remedies to alleviate compaction.
- When subsoiling (deep ripping tillage) is used, first identify the depth of compaction and subsoil an inch or two below affected area. Be sure soil is dry enough - subsoiling when the field has soil moisture at field capacity or above may create more compaction rather than eliminate it. Be careful not to re-compact soil. Ohio research indicates that only 2 traffic passes can quickly compact soil to the level it once was.
- Use deep rooted perennials, such as alfalfa to alleviate deep compaction. Root channels are excellent ways of loosening soil
- Compensate for decreased nutrient and water availability due to compaction by using row applications of fertilizers to improve nutrient availability. Increase irrigation frequencies to compensate for decreased root availability to the moisture profile.