

Part II. *Soil Compaction – What is its effects on Nutrient Uptake?*

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Evidence of wet soils and traffic.

Image courtesy of Iowa State University – Mahdi Al-Kaisi, PhD

Since soil compaction has numerous and significant negative impacts to soils – how though does it impact nutrient uptake and losses to row crops? It is apparent to growers in close sown or row crops trying to grow in soils compacted, we observe nutrient deficiencies. We know this due to limited rooting and that compacted soils are continually fluctuating from very wet to very dry moisture conditions. These wide swings on both



Image of soil compaction during sugar beet harvesting

sides of the moisture scale limit uptake of nutrients, especially Nitrogen. When soils are compacted and water (via rainfall or irrigation) fails to percolate below the surface few inches, the soil near the surface becomes saturated sooner with lesser amounts of water. This saturated condition contributes to nitrogen loss caused by denitrification. Early in a plants life biomass production is restricted which most often results in diminished yields. Less pore space, we know microbial life has been measured to be reduced by upwards of 50%. The microbes digest organic compounds, nutrients but they require oxygen to live, in compacted soils that is limited. When soils are squeezed and smashed, microbes take abuse but react poorly with crushed bodies, not enough pores to live in, fewer leaky roots to live near to – a harsh environment. Nutrient availability is curtailed and plant roots suffer as does the above ground factory.

Four Effects to Nutrient Uptake:

Under conditions of compacted soils and higher bulk density values, several detrimental effects have been and are presently being recognized: **1)** phosphorus and potassium being rather immobile in so many soils and water extracted per unit volume is down in compacted soils, the availability of P & K is considered extremely poor; **2)**

the increase in nutrient uptake per unit of length of the roots, is most likely insufficient to the rest of the plant to compensate for the reduction in root growth; **3**) in a less proliferated root system, the roots exploit a smaller volume of soil for plant nutrients and water particularly potassium (K), slowed root growth and extension of rooting will reduce yield; and **4**) an increase in ethylene production and other phytohormones which generally shuts down root growth, shoot growth, and cellular expansion in leaves. In severe cases the numbers of leaves developed are reduced in number compared to non-compacted soils. When much of the energy developed from an above ground and viable plant tissue is spent on dealing with compacted soils; the problem of just maintaining and not able to send enough photosynthates for good development of grain or tuber – the plant stalls and loses yield potential.

Is there a remedy?

Many of the land grant institutions have published tips, fact sheets and bulletins addressing how to alleviate or avoid compaction. Please, we encourage you to check these out on their websites and get the facts. There is no reason for us to repeat those here. Tillage timing, soil moisture conditions, use of residue more properly all season long, avoiding driving over the surface when wet, tire size and pressure, and yes tillage methods, all are what you have to consider in dealing with compaction.

As we at Orthman Manufacturing have seen as others have, in growing row crops with a continuous strip-tillage system – soil bulk density will improve (decrease) in clay loams and sandy clay loams by 0.1g/cm^3 to 0.2g/cm^3 in a 3 to 5 year period. That is significant. Early root development is rapid in corn especially in the first 55 days. In the first 20-25 days of growth after emergence (DAE), corn extends its root length between 690 to 1500 linear inches in strip-tilled trials. In conventionally farmed trials side-by-side where disking and chiseling is the norm; roots have been measured to extend only 475 to 700 linear inches in the same time period. Just after lay-by time (55DAE), we have measured the strip-tilled corn plots to have 5100 to 13100 linear inches per plant with depths exceeding 36 inches. In the more inversion tilled trials, roots are growing to 2100 – 6100 linear inches and only 26 inches in depth. Soil compaction is the limitation inversion tillage creates.

The Strip-tillage systematic promotes steady root growth and offering ways to handle soil compaction (in the upper 12 inches) from being a tyrant and menace to plant growth and yield for farmers is important.

Summary Statements –

Compacted soils can have major negative influence on uptake of water and soluble nutrients. Physical constraints for plant roots to extend and fully explore will cause roots to extract what they can from smaller areas, thusly running itself short of resources for the plant to thrive and yield.

Being aware of where soil compaction exists in your soil profile is important, how much extends from row to row and beyond and how deep will dictate subsequent plant development, water movement, nutrient usage and crop yield. Crops like soybeans, onions, certain of the small grains do not have prolific root systems in the first place, they will express (symptoms) of the compaction impact quickly, even crop failure. Yellowing, stunted growth, smaller leaves, smaller blossoms or none whatsoever will be telltale signs.

Get to know what can be done to alleviate the compaction is important. The numerous Service bulletins, Fact Sheets and fliers are easily obtainable from your land grant institutions to read and gain help on. Using reduced tillage methods like strip-till to prepare your seedbed in a zone that gives your row crop room to grow and

extend roots early on to maximize that planted seeds potential. If your soil exhibits compaction below 12 inches in depth by all means use the right tool to break it up and at the proper soil moisture condition.

All the nutrients in the world will not help a crop raise a top yield when soils are compacted in the upper portion of your soil profile and roots grow to only 15 inches. The root system will be sorely limited and you will be disappointed with crop performance. You hold the key to soil compaction!

References for further help.....

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