

# PLANT NUTRITION TODAY

2018 ISSUE 2, NO. 5

## SUBSURFACE SOIL COMPACTION RESTRICTS ROOTING DEPTH AND ACCESS TO NUTRIENTS AND MOISTURE



Soil compaction is a problem that can often cause reduced crop yields without being easily noticed. It can restrict crop rooting depth and turn a normally deep productive soil into a less productive shallow soil.

Most agricultural top soils have “bulk densities” of around 1.2 g per cubic centimeter, in which roots can grow and penetrate with little difficulty. Compacted soils have bulk densities greater than 1.8. Roots can stop growing at this level of compaction.

To review, soils are physically made up of three main parts:

- 1 Minerals (~45%), originating from weathered rocks, usually a mix of sand, silt, and clay particles.
- 2 Pore space (~50%), the space between soil particles, normally half filled with water and half filled with air.
- 3 Organic matter (~5%), including weathered humus material, decomposing crop residues, and soil organisms or biomass.

The pore space in most agricultural soils is made up of different size classes, but they can be simplified into what are called macro and micro pores. Roots grow into and within soil macro pores. A compacted soil will have many of the macro pores squished to the extent that they effectively become micropores. A normal soil can have up to 40% porosity,

compared to a compacted soil that can soil porosity as low as 5 to 10%. Crop roots grow downward until they contact a compacted soil layer, then grow sideways. Sometimes this can happen at soil depths as shallow as 6 in. or 1 ft. (15 or 30 cm).

In the early summer of 2017, I was asked by a crop agronomist to accompany her to a farm near Nipawin in northeast Saskatchewan. The farm customer was generally disappointed with crop yields on a section of his main farm compared to those achieved on neighboring farms. His farm admittedly was on lower-lying land compared to its surroundings and he thought the problem was just poor drainage. He wondered if installation of subsurface drainage tile was a possible solution. We went with the farmer to look at the affected fields. Some of the poorest growth areas occurred in somewhat straight lines in the fields. We took a shovel and dug a couple of soil pits to look at the soils in both poor and good growth areas. Yes, the soils were poorly drained and consideration for improved drainage might be feasible. But both the poor and good growth areas were similarly poorly drained. The poor growth area had wheat crop roots that grew down to about 1 ft. and then turned and grew sideways. The poor growth area had severely compacted soil from about 1 to 2.5 ft. The straight lines corresponded to harvest equipment wheel traffic from the previous Fall. It had been a wet and delayed harvest, and the region had been



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experiencing wetter than normal growing seasons (and harvests) for the past 5 to 6 years. Much of the severe compaction had occurred while operating heavy harvest equipment on the affected fields.

Shallow crop rooting restricts a crop to only withdrawing its nutrients and water requirements from the shallow uncompacted soil above the compacted layer. Instead of rooting down to the normal depth of 4 ft., the crop is forced to pull resources from a much smaller volume of soil. Plant available nutrients and moisture are essentially trapped in and below the compacted soil layer. Depending on the amount of soil compaction, yields can often be reduced by 30% (Table 1).

Table 1. Corn crop yield as affected by subsoil compaction.

Axle weight of equipment, t/axle	Corn yield, bu/A	Yield decrease
< 5	170 a	-
10	155 a	9%
20	117 b	31%

Adapted from Voorhees et al. 1989. Agron. J. 81:294-303.

\*Letter within columns denote a significant difference at a confidence level of 95%.

There are ways to reduce soil compaction such as deep tillage using a subsoiler, or to grow cover crops including plant species with deep soil penetrating roots (e.g., tillage radish), or plant a field to a perennial forage mixture including alfalfa where the alfalfa roots will push

through the compacted soil and reduce the compaction over the length of the forage stand. One way to prevent soil compaction is to equip harvest equipment with sufficiently wide and low-pressure tires or tracks to reduce the pressure on the soil surface, and transferred compression to subsoils.



Top image shows heavy wheel traffic during a wet fall. Bottom image is the same field planted to field pea.



Two examples of subsoiler equipment.