

A Quick Primer on Soil Diagnostics

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Soil Texture

Soil particles come in three main sizes: sand, silt and clay. Within these, especially the sand there are further breaks in particle size. There is a lab test called a particle size analysis that will give a complete breakdown of soil texture. Soil texture in many fields is highly variable. It can be assessed quickly by hand with a little practice. See the Appendix for the soil texture triangle and hand texturing flowchart.

Soil Structure

Soil structure refers to the arrangement and organization of soil particles or how soil particles are bound together and the spaces or pores in between. It has a significant impact upon crop growth and productivity through water movement in and through the soil, aeration, and crop germination and root growth.

The structure of a soil is influenced through climate, biological activity, and soil management practices. In agricultural soils in Ontario, the soil management practices are the key influence on soil structure.

Soil structure is formed through the actions of:

- Drying and wetting or shrinking and swelling, this creates cracks and planes of weakness for roots
- Freezing and thawing
- Roots
 - the removal of water
 - root exudates or organic materials that bind soil particles
 - formation of root channels
- soil animals like worms and beetles, moving soils, mixing and releasing organic materials
- microorganisms breaking down plant and animal residues
- tillage - reduces the size of aggregates, this is an artificial way of creating structure in some soils and is generally not long lived.

The larger scale structure of a soil is described with terms like blocky, massive or platy to name a few. Within this structure are **aggregates** or soil crumbs, a number of soil particles bound together. Aggregates are a dynamic form within the soil. They form and re-form over time. They are a result of microbial activity, organic and mineral components of the soil, plant root growth and the ecosystem over time.

Aggregate stability is the ability of aggregates to resist destructive forces like water. This is influenced by:

- soil organic matter content
- clay content

Stable aggregates do not break down under rain and resist crusting.

Water stable aggregates can be measured and used as a way of evaluating soil quality and measuring the impact of soil management practices.

Compaction

Compacted soils often exhibit:

- **a decrease in porosity, especially the macropores that are involved in air and water movement.** Excess water does not drain easily from compact soil and usually the crop available water holding capacity is reduced which makes the crop more drought prone. Plants can look waterlogged or droughty.
- **increased soil strength, which means more resistance to roots and tillage.** This can result in a restricted root system. Of course, this has an impact on nutrient and water uptake. Look for flattened roots or restricted or bunched up root mass.
- **reduced soil stability** which can take the form of crusting or setting up, causing problems with crop emergence.

All of this can result in **stunted crop growth and reduced crop yields**, although this is highly dependent upon weather conditions during the growing season. Research has documented yield reductions 0 to 75 per cent due to compaction.

Detecting compaction – for more information on detecting/diagnosing compaction and compacted layers take a look in:

- pg. 36 Soil Management Best Management Practices booklet

Soil Sampling

The type and depth of soil sampling will be determined by the purpose or use of the sample. Regardless the basic sampling method remains the same.

- Use a stainless-steel soil probe or auger for collecting the sample.
- Use a clean plastic pail/bucket.
- Use a zig zag pattern across the field to ensure the sample reflects the whole field.
- Take at least 20 cores/augers per composite sample. Take one composite sample for every 20 acres or less.
- If sampling problem areas, ensure that the sample represents the problem area and take a sample from the “good” or better area too for comparison.
- Ensure that the sample in the bucket is well mixed. Subsample from the bucket into a bag to send to the lab.

- **Sample to 6 in (15 cm) for soil fertility & pH**
- **Sample to 12 in (30 cm) for soil nitrate** – these samples need to be stored below 4C for transport or can be frozen or air dried if they cannot be analyzed within 3 days.
- **Nematode samples are treated a bit differently; sample 8 in (20 cm) deep and discard the top 1-2 in** – the purpose of this is to remove the soil that is most subject to moisture and temperature extremes. Mix samples gently and box or bag. Keep cool – avoid temperature extremes and transport to the lab immediately. Refer to Pub 628 Sampling Soil and Roots for Plant Parasitic Nematodes for more detailed instructions.

Sample	Depth	Handling Concerns
Soil fertility, pH, EC	6 in/15 cm	Room temperature
Soil nitrate	12 in/30 cm	Cool immediately & send to lab or freeze for later analysis
Nematode – plant parasitic and others - soil	Usually 8 in/20 cm remove top 2 in/5cm	Cool immediately and send to lab promptly

Soil pH

Soil pH is the measurement of the hydrogen ion activity or concentration in the soil solution. This has an impact on the availability of most nutrients. It can cause the concentration of some elements to rise to toxic levels i.e., aluminum. It also affects the activity of soil organisms that build soil structure, cycle organic matter or fix nitrogen in legumes nodules. Soil pH also has a dramatic effect on the performance and breakdown of some pesticides i.e., Pursuit. pH can be measured with a standard lab test using an electrode and a saturated paste. There are also a number of handheld meters available. They range greatly in cost and accuracy. Generally, any meter that is directly inserted into the soil is not adequate (think of the variation that we get with soil moisture over the season – soil moisture carries the hydrogen ions, so pH is very difficult to measure in a dry soil). Usually, a reasonably accurate meter costs \$100 to \$400.

For more soil information

Soil Fertility Handbook Pub 611, OMAFRA
 Agronomy Guide for Field Crops Pub 811 OMAFRA
 Ontario CropIPM – ontario.ca/cropIPM
[BMP booklet series](#)

Tools of the Trade

As you walk into a field there is a lot you can tell about the field even before you look at the crop or take a soil test. Take advantage of all the tools available to you when assessing a problem.

<i>Tool</i>	<i>What can you assess?</i>
hands	Texture, soil moisture
knife	Soil density or compaction, crusting
drainage flags	Give a good indication of shallow compaction
soil probe	Gathers a soil sample for chemical testing, soil compaction or density, soil moisture, soil profile, texture, colour, historical drainage at depth
soil auger	Gathers a soil sample for chemical testing, soil moisture, soil profile, texture, colour, historical drainage at depth
tile probe	Soil compaction or resistance
shovel or trowel	Gather a sample, soil moisture, soil structure, soil profile and horizons, soil compaction or density
backhoe	Create a soil pit, observe soil horizons, soil colour, texture and structure etc.
pH meter	Soil pH, some are also able to do electrical conductivity EC

For suppliers of these soil tools try:

Halltech Environmental Inc.
503 Imperial Road N
Guelph, Ontario
N1H 6T9
1866- 425-5832
www.htex.com

Gemplers
100 Countryside Drive
P.O. Box 270
Belleville, Wisconsin
USA
53508
1-800-382-8473
www.gemplers.com

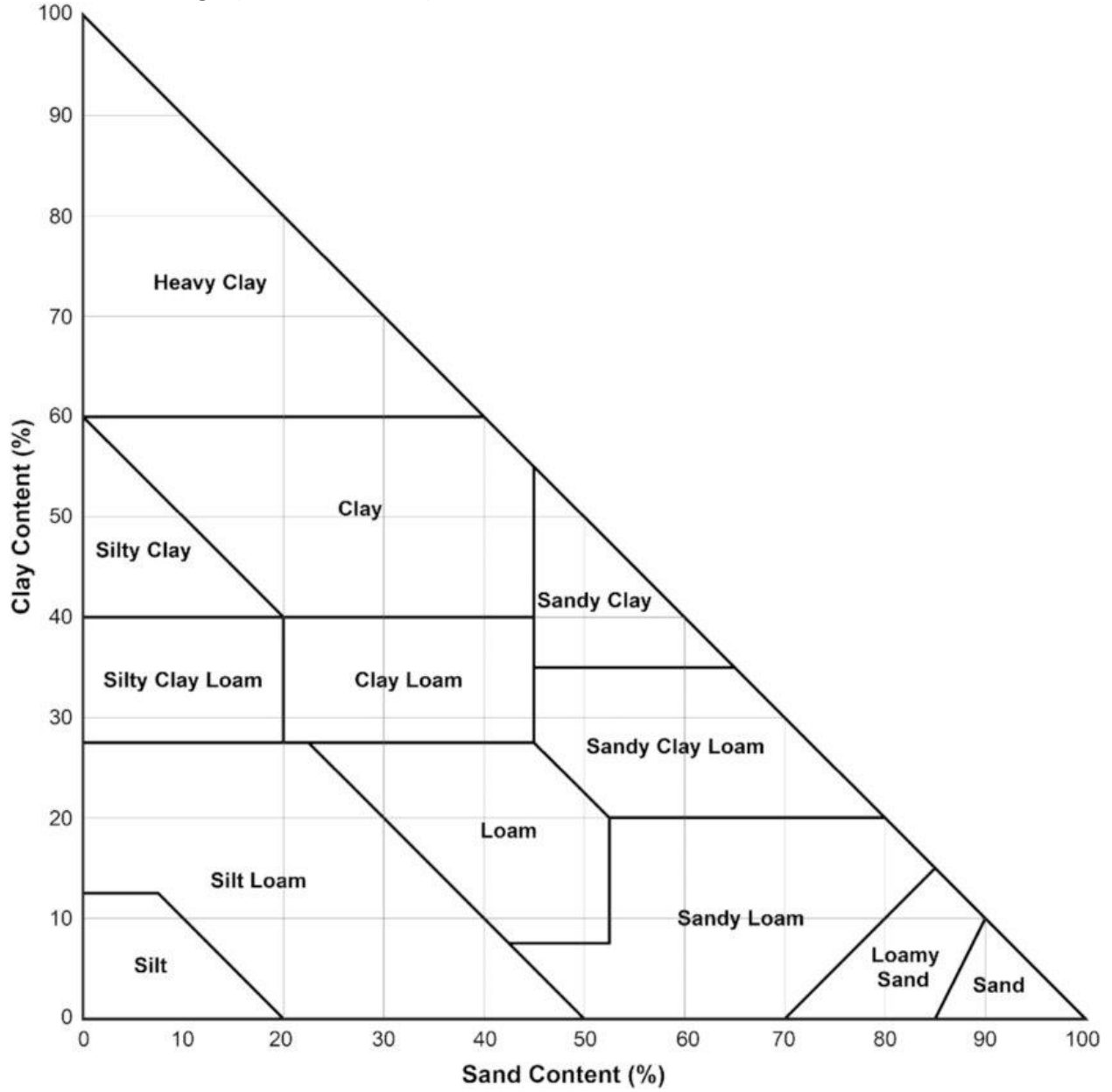
BAP Equipment Ltd.
203 Waggoners Lane
Fredericton, N.B. Canada
E3B 2L4
1-800-561-3600
<http://www.bapequipment.com/>

Spectrum Technologies Inc.
23839 W. Andrew Road
Plainfield, Illinois
USA
60544
1-800-248-8873
www.specmeters.com

Universal Field Supplies
1540 Trinity Dr. Unit 4
Mississauga, Ontario
L5T 1L6
905-795-1610
1-800-387-4940
www.ufsupplies.ca

Appendix

Soil Texture Triangle (Canadian version)



Hand Texturing Flowchart

Guide to Texture by Feel

Modified from S.J. Thien. 1979. *A flow diagram for teaching texture by feel analysis.* Journal of Agronomic Education. 8:54-55.

