MEASURE AND MANAGE

Organic Soils

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Organic soils are usually differentiated on the basis of the state of their decomposition. Deposits which are slightly decayed are called peat soils. In peat soils it is easy to identify the original plant materials as they are only slightly decayed. Muck soils, however, are so completely decayed that it is virtually impossible to identify any of the original materials. Peat soils can be fine or coarse textured depending on the nature of the deposit. Well-decomposed mucks are finely divided and when dry, are quite powdery and subject to wind erosion. For practical purposes, the terms ‘organic’, ‘muck’ or ‘peat’ are interchangeable.

Marshes, bogs and swamps provide conditions suitable for the accumulation of organic soils. The environment in the adjacent areas encourages the growth of many plants and trees. Numberless generations, over thousands of years grow and die and sink down into the water. The water shuts out the air and prohibits rapid oxidation and acts as a preservative. The breakdown is brought about by fungi and anaerobic bacteria which aids in the synthesis of humus. As one generation of plants follows another, different layers of organic residue are created. In some areas, different layers accumulate in profiles. Deep water plants may be succeeded by weeds and sedges, followed by mosses and shrubs and finally hardwoods or deciduous trees. In other areas, fluctuating water levels and climatic events have altered the accumulation and changed the sequence of the profiles.

Parent Material:

Sedimentary Peat
- Mixture of water lilies, pond weed and plankton

Fibrous Peat
- Sedges, mosses, sphagnum, reeds and cat-tails

Woody Peat
- Deciduous and coniferous trees and shrubs

Sedimentary Peat
- Accumulates in deep water
- Found well down in the profile
- Sometimes mixed with other layers higher in the profile
- Highly colloidal, compact with rubbery texture

- Holds 4 to 5 times its weight in water
- Dries out slowly
- Dries irreversibly
- Reabsorbs water very slowly
- Dried sedimentary peat remains hard and lumpy
- Undesirable soil
- Fortunately these layers appear below the plow line

Fibrous Peat
- High water holding capacity
- Varying degrees of decomposition
- Filamentous or fibrous nature used in greenhouse soils
- Reeds and cat-tails give it a coarse texture
- May contain moss peats which are very acidic and low in nitrogen
- Lies above the sedimentary layer
- May be layered with sedimentary peat

Woody Peat
- Usually at the surface
- Loose open texture
- A lower water holding capacity than sedimentary or fibrous peats
- Desirable characteristics for vegetable production
- Depending on fluctuating water tables during formation, it may be overlaid with fibrous peat.

Physical Characteristics:

Colour
- Dark brown on intensely black
- Dark humic compounds appear as decomposition continues

Bulk Density
- Light weight
- Bulk density compared with mineral soil is much less
- Bulk density in muck soil is 0.2 – 0.3
- Mineral soil is 1.2 – 1.45
- One cubic foot of organic soil contains 8 – 20 lbs dry matter.
- An acre furrow slice of muck soil weighs approx. 400, 000 lbs
- A comparable layer in mineral soil weighs 2 million lbs
- This is an important consideration when interpreting soil test

Water capacity
- High water holding capacity
- Retains 2 to 4 times its weight in water
- Undecayed organic soil holds 20 times its weight in water
- Amounts of unavailable water are much higher than mineral soil
- Lower bulk density means less total water

- Therefore organic soils supply only slightly more water than mineral soils

Structure

- Good physical conditions
- Porous, open, easy to cultivate
- Lower profiles may not exhibit same textures as the surface
- Different parent materials and different stages of decomposition may result in laminated, vertical fibrous or rubbery layers.

Chemical Properties:

pH

- As with mineral soils, the colloidal complex control pH which is tied to the % of base saturation
- A base being elements of higher pH such as potassium magnesium and calcium
- The Colloidal complex of most organic soils is saturated with hydrogen ions resulting in low pH.
- At 50% base saturation, muck soils will have a lower pH than a mineral soil with the same saturation

Buffering

- Buffering is controlled by the cation exchange capacity (CEC)
- Organic soils resist changes due to the higher CEC
- Actual CEC readings are 70 –150 milliequivalents per 100 grams of dried soil
- It takes more lime and/or sulphur to raise or lower the pH in a muck soil due to the greater magnitude of the CEC
- There are more exchange sites to occupy than on a mineral soil at the same base saturation percentage

Exchange

Comparison of base saturation and CEC

	Muck Soil	Typical Mineral Soil (clay/loam)
Exchangeable Calcium (ppm)	6468	3000
Magnesium	504	300
Potassium	327	160
Actual CEC (meq)	84	20
% base saturation	45	90
pH	5.5	7.5
Exchangeable hydrogen (%)	55	9

The muck soil has much higher calcium, magnesium levels and much higher CEC than the mineral soil. The base saturation of the muck soil is 45% and the mineral soil is 90%. Both soils are very productive. Even with 55% of the exchange capacity saturated with hydrogen, the muck soil is very productive.

The percentage of available or exchangeable calcium and magnesium is much greater on the muck soil. Therefore we have ample calcium and magnesium available even though the pH is 5.5. One of the problems with muck soil is that magnesium is 100% exchangeable, resulting in lower availability over time with intensive cropping.

Nitrogen and Organic Matter

- Organic soils have very high carbon to nitrogen ratios, 20:1 or higher
- In mineral soils they are 8:1 or higher
- Organic soils have a high nitrification rate in spite of the high C:N ratios
- Organic soils carry large amounts of nitrogen
- The presence of large amounts of calcium and inactive carbon effectively lower the C:N ratio closer to that of a mineral soil
- As a result, the nitrifying bacteria are allowed to flourish and generate large amounts of nitrate nitrogen

Phosphorus and Potassium

- Even though a soil report may reveal high levels of available P and K, the lower bulk density lowers the total supply available to plants
- An acre furrow slice of a mineral soil weighing 2 million lbs may have a phosphorus reading of 40 ppm, while a similar reading in an organic soil will supply less total phosphorus because of the lower bulk density, therefore more phosphorus and potassium must be applied to organic soils

Calcium and pH

- Muck soils have a high calcium content
- Water entering swamps from the uplands has had ample time to dissolve calcium and magnesium in the sub strata
- The high CEC of the organic soil promptly absorbs large quantities of calcium and magnesium
- High exchangeable level of calcium is an outstanding characteristic of peat type soils.

Magnesium and Sulphur

- Intensively cropped organic soils usually develop a magnesium deficiency
- The highly exchangeable magnesium is readily consumed initially in young soils and declines over time
- Sulphur is abundant
- There is very little need for sulphur supplementation
- Under vigorous oxidation sulphates may accumulate to extremely high levels of 300 to 400 ppm

Total Salts

Organic soils under intensive cropping and fertilization can accumulate high salt levels. A salt reading is an electrical conductivity test which measure the relative amounts of ions in the soil solution. The more ions in solution, the higher the salt reading. It is necessary to maintain enough ions in solution to meet the needs of the crop, however, there are conditions where there are too many ions in solution causing crop loss. Excessive nutrients may burn back the root system, slow plant growth or in extreme cases result in plant death.

Depending on the method use, salt readings and the corresponding crop tolerances are noted.

Soil Conductivity Reading Interpretation

Saturated Paste	2:1 Conductivity "salt" reading millisiemens/cm	Rating	Plant Response
0.75	0 –0.25	L	Suitable for most plants if recommended amounts of fertilizer used.
0.75 –2.0	0.26 –0.45	M	Suitable for most plants if recommended amounts of fertilizer used.
2.0 –3.5	0.46 –0.70	H	May reduce emergence and cause slight to severe damage to salt sensitive plants
3.5 -5.0	0.71 –1.00	E	May reduce emergence and cause slight to severe damage to salt sensitive plants
5.0 +	1.00	E	Expected to cause severe damage to most plants

Some of the ions that cause the high salt readings are: nitrate nitrogen, potassium, magnesium, calcium, chloride, sulphate, and sodium. The following results were taken from the Cookstown, Ontario area.

	Total Salt	NO3	K	Mg	Ca	Cl	SO4	Na
High Salt Soil	3.32* 5.8**	194	1180	621	5626	474	150	101
Low Salt Soil	1.33* 2.03**	95	327	504	6468	94	20	27

* Total salts by 2:1 method
** Total salts by saturated paste

The high salt soil will probably cause plants to develop unevenly, exhibit signs of drought even in a wet soil, grow very slowly with a dwarfed appearance and some plants may even die.

Base Saturation and Cation Exchange Capacity in Organic Soils

Traditionally the CEC from mineral soils has been calculated from the extracted values of potassium, magnesium and calcium. Soils which are void of “free lime” have calculated CEC’s very close to the actual. The actual CEC is determined in the laboratory by stripping the soil of all of its cations with ammonium acetate resaturating the soil with barium then re-extracting with ammonium acetate causing the barium to go in solution. Then we determine the barium concentration in the solution and calculate the exchange capacity. Barium will only sit on the negative sites and therefore gives a truer picture of the exchange capacity.

In organic soils, the organic matter greatly increases the exchange capacity. The exchange capacity can have as much as 50 - 60% saturation with hydrogen. If we calculate the CEC based strictly on potassium, magnesium and calcium extractions we grossly underestimate the CEC. Illustrated below in the following table are the results of 5 soil samples from the Cookstown area that show both calculated and actual CEC’s.

Cation Exchange Capacities of Organic Soils (CEC) (meq/100 grams)		
Sample #	Calculated CEC	Actual CEC
#1	38	84
#2	44	82
#3	37	70
#4	46	75
#5	44	82

You can readily observe the difference in the CEC ratings. These particular soils have been cropped for many years. The difference between calculated and actual CEC’s would be much greater on virgin soils. Newly formed soils may have CEC’s of 150 – 200 meqs.

Lime:

- Lime is often necessary for acidic mineral soils, less so on organic soils.
- There are conditions which may benefit from limestone additions:

o Muck soils which have high clay contents and low pH
o These soils may also have excessive aluminum, iron and manganese dissolved in them at toxic levels
o Liming will reduce the solubility and lessen the toxicity

Summary:

Muck Soils

- ☐ Are porous
- ☐ Open texture
- ☐ Low bulk density
- ☐ Need high levels of phosphorus and potash
- ☐ Magnesium is highly exchangeable and will need to be added as soils ages
- ☐ Have high rates of nitrification
- ☐ High levels of calcium present
- ☐ Have high CEC's with a significant saturation of hydrogen
- ☐ Low pH
- ☐ 40 – 50% base saturated
- ☐ Copper levels should be maintained at 15 ppm
- ☐ May need zinc and boron additions
- ☐ As organic deposits subside the lower profiles of sedimentary peat, clay and sand become evident causing an increase in pH and high salt readings
- ☐ The use of low salt fertilizers and timely irrigation may be necessary to control salts during plant establishment