Soil Sampling and Highlights of a Soil Test Report

Birgit Martin

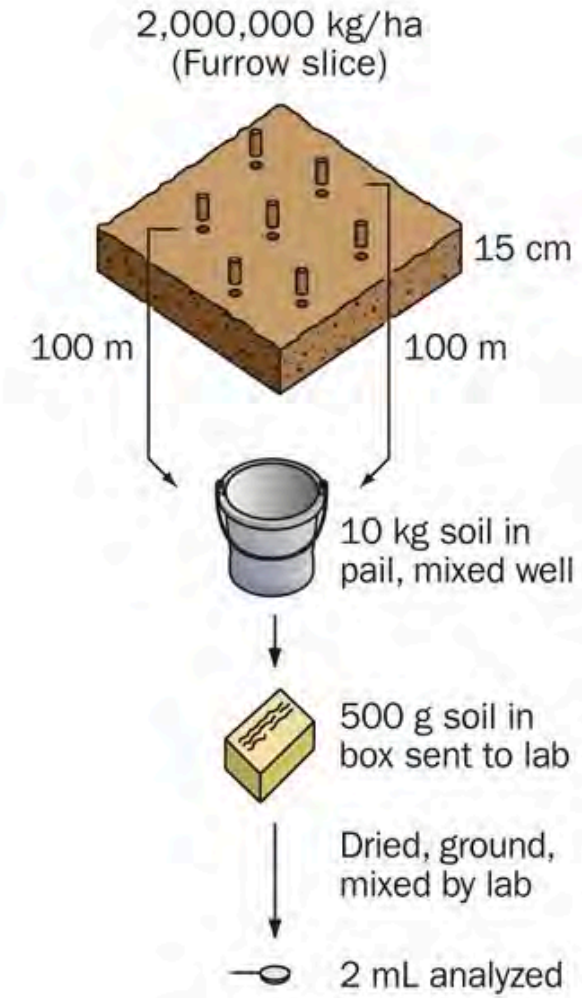
Crop production starts with a good soil sample...

Soil Sampling Procedures

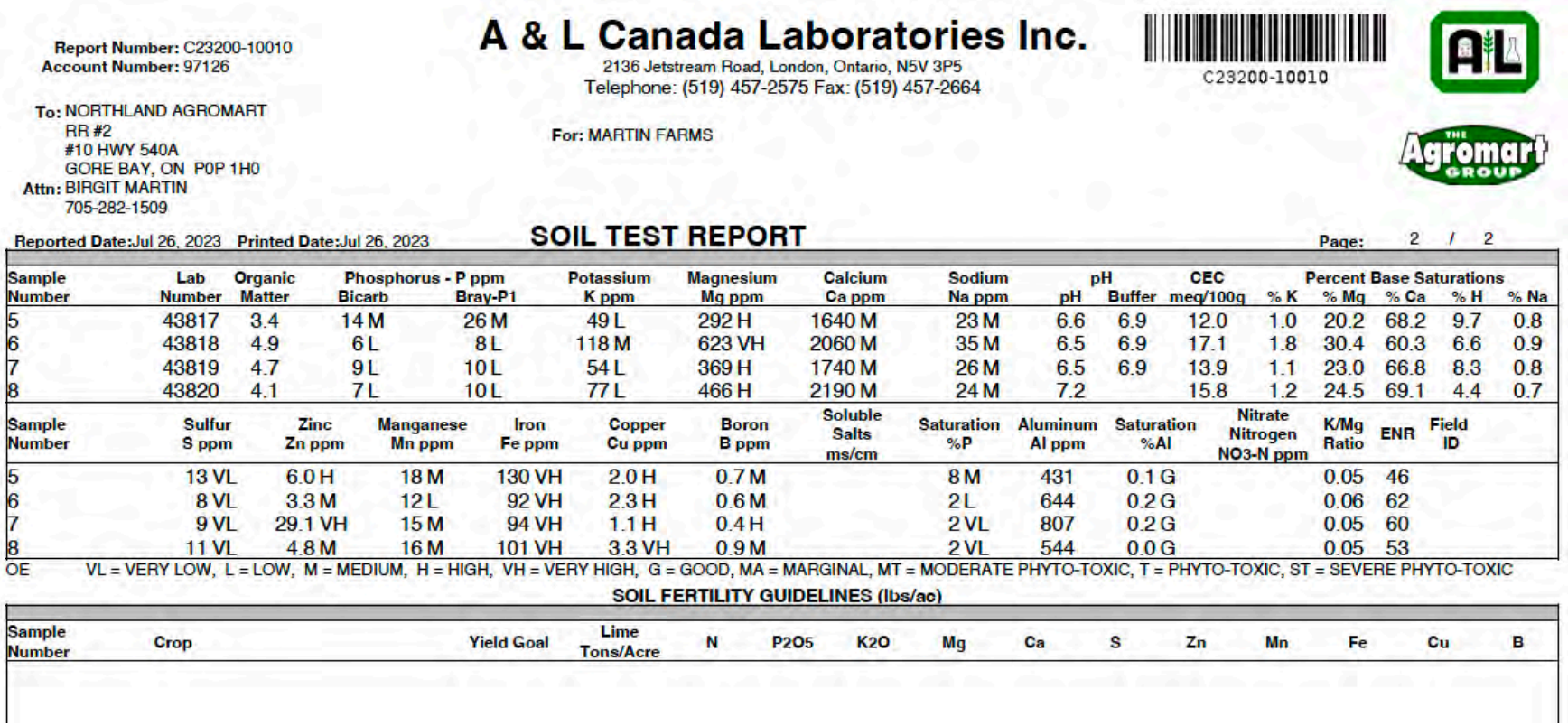
- Take separate samples from fields planted to different crops, different soil types
- Avoid headlands, treed field edges, roadside field edges, dead furrows, eroded knolls, old building sites etc.
- Avoid residue and thatch
- Sample to the depth that the soil would normally be tilled or 6”
- Use a stainless steel probe and plastic pail
  - Galvanized probes and pails can contaminate the sample especially when testing for micronutrients

Soil Sampling Procedures

- Composite sampling
  - Minimum 20 cores from maximum 25 acres
  - Even in small fields or areas, minimum 20 cores to average out small-scale variations
- Sample every 3-4 years to track changes and change management
- The goal of soil sampling is to direct the optimal rate of soil amendments
  - this directing of crop inputs will only be as good as the soil sample taken



Understanding your soil test report …



Report Number: C23200-10010
Account Number: 97126

To: NORTHLAND AGROMART
RR #2
#10 HWY 540A
GORE BAY, ON P0P 1H0
Attn: BIRGIT MARTIN
705-282-1509

A & L Canada Laboratories Inc.

2136 Jetstream Road, London, Ontario, N5V 3P5
Telephone: (519) 457-2575 Fax: (519) 457-2664

C23200-10010

For: MARTIN FARMS

Reported Date: Jul 26, 2023 **Printed Date:**Jul 26, 2023

SOIL TEST REPORT

Page: 2 / 2

Sample Number	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
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6	43818	4.9	6 L	8 L	118 M	623 VH	2060 M	35 M	6.5	6.9	17.1	1.8	30.4	60.3	6.6	0.9
7	43819	4.7	9 L	10 L	54 L	369 H	1740 M	26 M	6.5	6.9	13.9	1.1	23.0	66.8	8.3	0.8
8	43820	4.1	7 L	10 L	77 L	466 H	2190 M	24 M	7.2		15.8	1.2	24.5	69.1	4.4	0.7

Sample Number	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts ms/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	Nitrate Nitrogen NO3-N ppm	K/Mg Ratio	ENR	Field ID
5	13 VL	6.0 H	18 M	130 VH	2.0 H	0.7 M		8 M	431	0.1 G		0.05	46	
6	8 VL	3.3 M	12 L	92 VH	2.3 H	0.6 M		2 L	644	0.2 G		0.06	62	
7	9 VL	29.1 VH	15 M	94 VH	1.1 H	0.4 H		2 VL	807	0.2 G		0.05	60	
8	11 VL	4.8 M	16 M	101 VH	3.3 VH	0.9 M		2 VL	544	0.0 G		0.05	53	

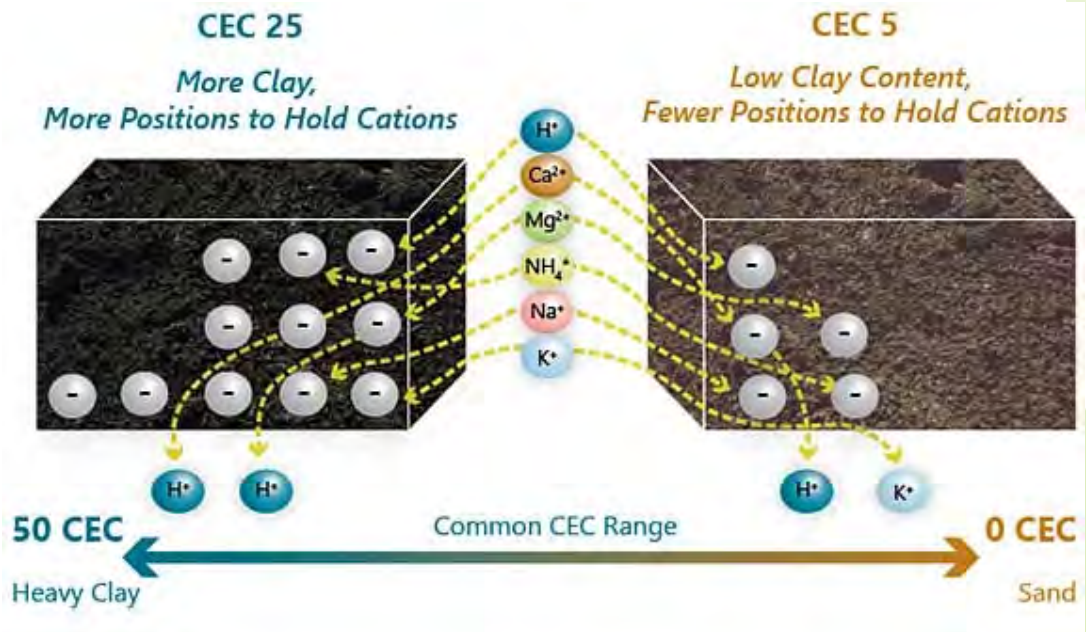
OE VL = VERY LOW, L = LOW, M = MEDIUM, H = HIGH, VH = VERY HIGH, G = GOOD, MA = MARGINAL, MT = MODERATE PHYTO-TOXIC, T = PHYTO-TOXIC, ST = SEVERE PHYTO-TOXIC

SOIL FERTILITY GUIDELINES (lbs/ac)

Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P2O5	K2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B

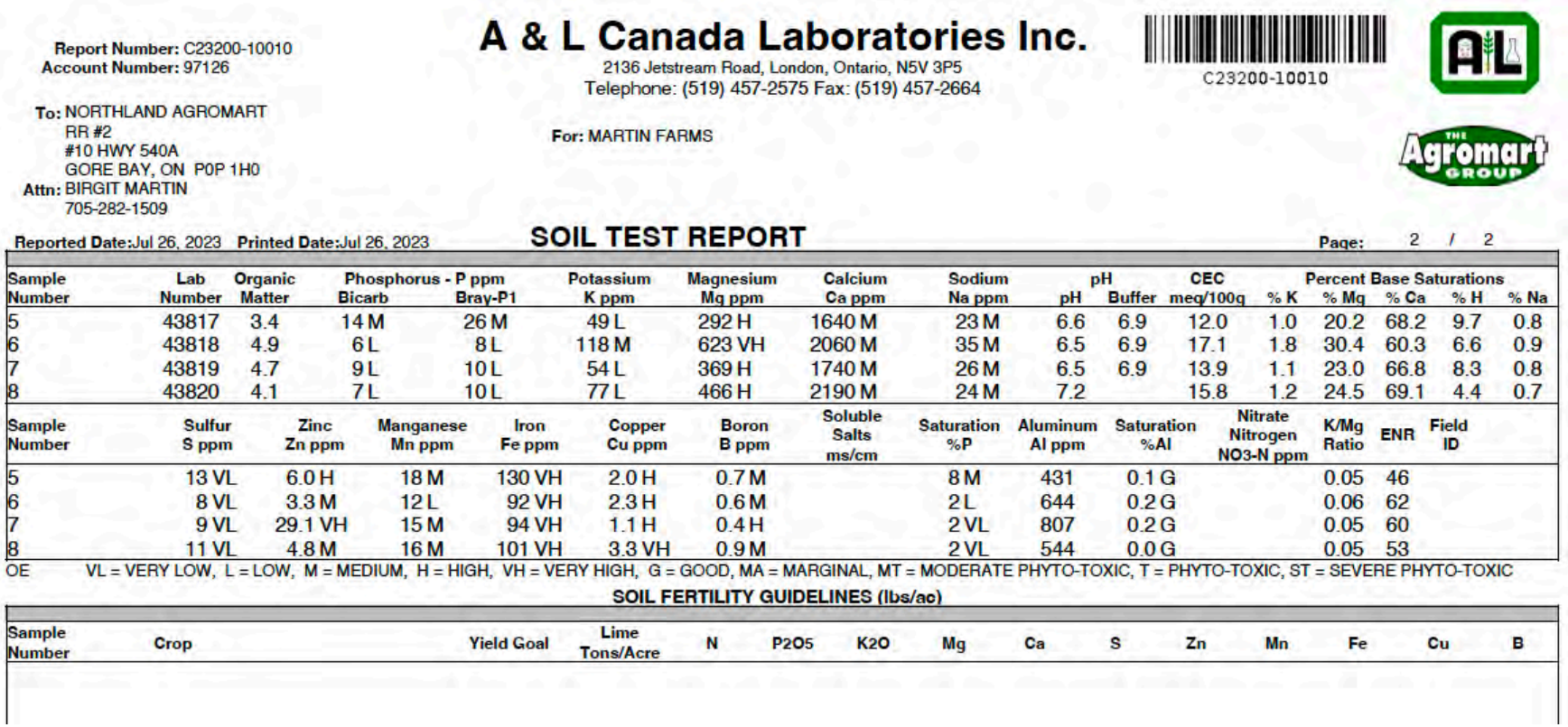
- There is a lot of information!
- Start with CEC

CEC: Cation Exchange Capacity



- Clay and organic matter are negatively charged
- Many nutrients are positively charged (cations)
  - K, Ca, Mg, NH4
- So CEC is simply a measure of the soils ability to hold and exchange these cations
  - It represents the equilibrium between the soil solution and the soil surfaces
- CEC is a good indication of texture
  - 2-10 sandy
  - 7-25 loam
  - 20-40 clay
- A higher CEC means that more of a nutrient is needed to fill those exchange sites but more is in reserve then for plant nutrition

Understanding your soil test report …



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Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P2O5	K2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B

- Look at Percent Base Saturations next to give an idea of the nutrient status of your soil
- Optimum ranges:
  - Ca 60-80
  - Mg 10-20
  - K 2-6
  - H 10-15

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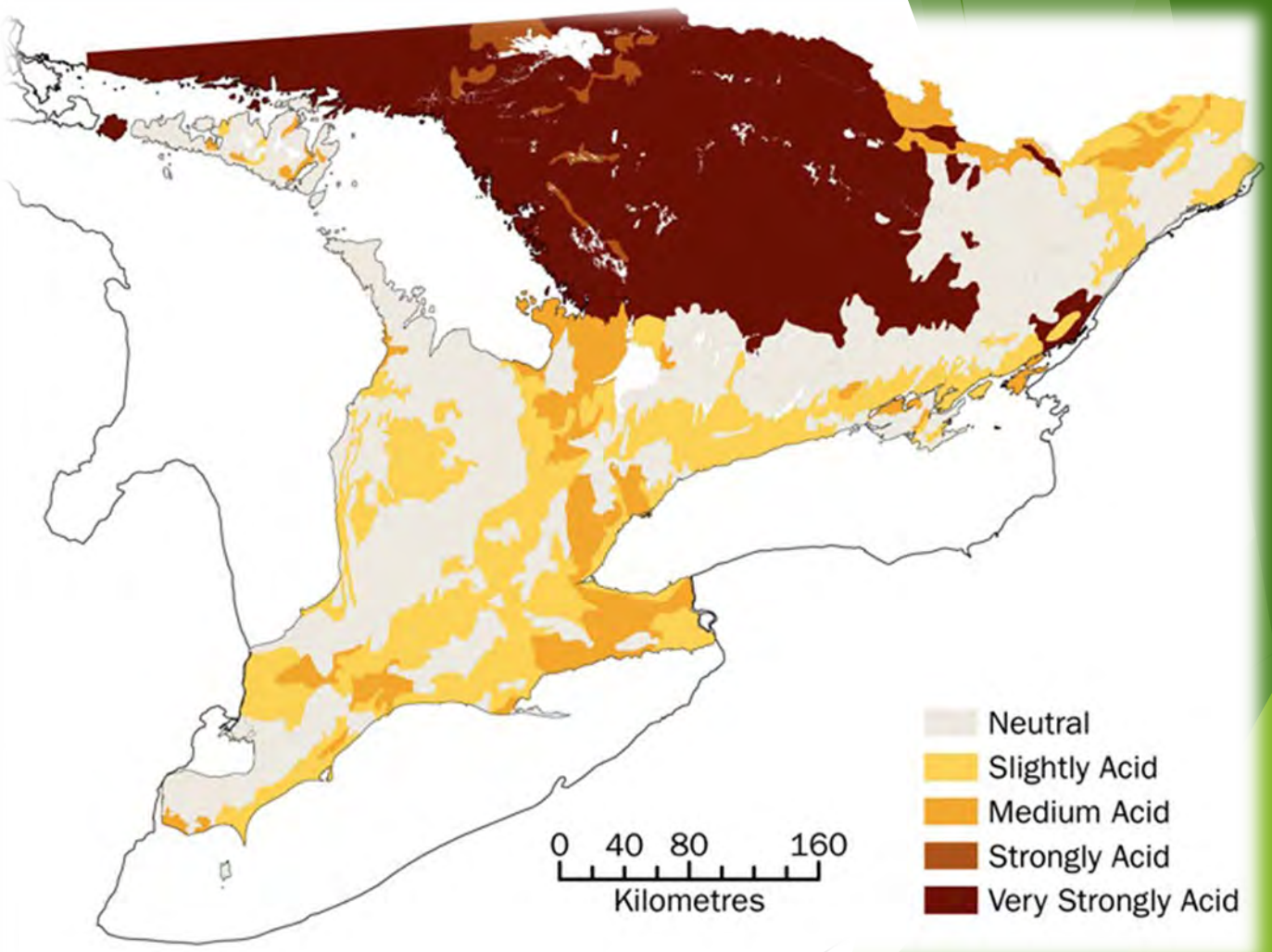
- **Next, look at pH and Buffer pH**



Northern Ontario soils influenced by Canadian Shield's igneous bedrock

But even Manitoulin's Escarpment base has pockets of acidic soils

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1	43813	4.0	14 M	20 L	64 L	299 H	1680 M	24 M	6.4	6.9	12.3	1.3	20.2	68.1	9.5	0.8
2	43814	3.5	12 L	20 L	72 L	244 H	1340 M	25 M	6.2	6.8	11.4	1.6	17.8	58.8	20.8	1.0
3	43815	3.6	9 L	15 L	77 M	322 H	1680 M	22 M	6.6	6.9	12.5	1.6	21.4	67.0	9.3	0.8
4 Barrie Island	43816	4.9	14 M	19 M	167 H	505 H	1530 VL	30 M	6.1	6.5	18.4	2.3	22.9	41.7	32.4	0.7

Sample Number	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts ms/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	Nitrate Nitrogen NO3-N ppm	K/Mg Ratio	ENR	Field ID
1								3 VL	815	0.3 G		0.06	52	
2								3 VL	732	0.4 G		0.09	47	
3								3 VL	666	0.2 G		0.07	48	
4								2 L	970	0.4 G		0.10	62	

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SOIL FERTILITY GUIDELINES (lbs/ac)

Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P2O5	K2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B

The results of this report relate to the sample submitted and analyzed. All results are released based on acceptable QC data.
* Crop yield is influenced by a number of factors in addition to soil fertility.
No guarantee or warranty concerning crop performance is made by A & L.

Results Authorized By: Beth Wood, Agronomist

A&L Canada Laboratories Inc. is accredited by the Standards Council of Canada for specific tests as listed on www.scc.ca and by the Canadian Association for Laboratory Accreditation as listed on www.cala.ca

Soil pH	Plant Growth
>8.3	Too alkaline for most plants
7.5	Iron availability becomes a problem
7.2	
7.0	6.8 to 7.2 – near neutral
6.8	6.0 to 7.5 – acceptable for most plants
6.0	
5.5	Reduced soil microbial activity
<4.6	Too acid for most plants

- Ca is limited in acid soils which inhibits root development
- H+ ions are toxic to root development
- Rhyzobia become less productive and even die
  - Clover rhizobia killed at pH 4.7
  - Alfalfa rhizobia killed at pH 5.0

pH affects crop growth

Symptoms of low pH

- Poor nodulation of forage legumes and resulting N deficiency
- Poor persistence in perennial forages despite adequate drainage and fertility
- Oats predominant in a mixed grain stand
- Presence of mosses and certain weeds:
  - Wild strawberry
  - Devil's paintbrush
  - Sheep sorrel

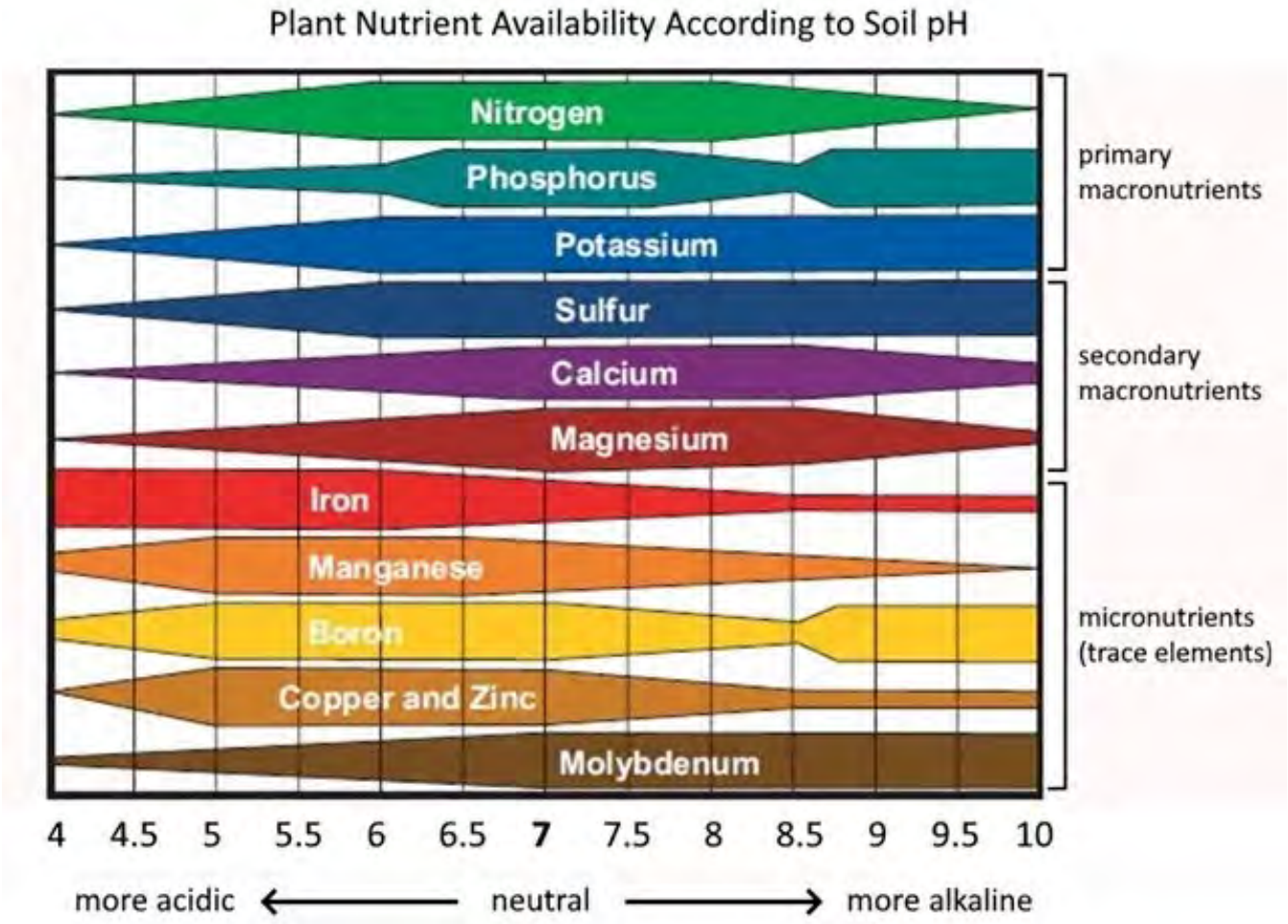
Ideal pH ranges for plants

Plant	Soil pH
Alfalfa	6.5–7.5
Barley	5.5–7.0
Blueberries	4.5–5.5
Carrots	6.0–6.8
Corn	5.8–6.8
Potato	5.0–5.5

Crop	Normal Growth pH Range	Recommend pH Range
alfalfa	6.5 - 7.5	6.6 - 7.0
barley	6.3 - 7.0	6.3 - 6.5
dsfoot trefoil	6.0 - 7.0	6.3 - 6.5
clovers	5.8 - 7.0	5.8 - 6.2
corn	5.8 - 7.0	5.8 - 6.2
grasses	5.8 - 7.0	5.8 - 6.2
oats	5.8 - 7.0	5.8 - 6.2
soybeans	6.5 - 7.5	6.6 - 7.0
wheat	6.3 - 7.0	6.3 - 6.5

There is an ideal pH range for all crops

pH affects nutrient availability



- Generally, plants take up nutrients only if they are dissolved in water
- Soil pH influences the solubility of plant nutrients
- Fixation of nutrients can occur at low or high pH
  - P fixes with Ca and Mg at high pH
  - P fixes with Al at low pH
    - Levels of dissolved Al may reach toxic levels for intolerant species at pH 5.5 and below

Correcting acidic soils

- Lime requirements are based on BUFFER pH
  - pH is a measure of H+ in the soil solution
  - Buffer pH is a measure of H+ and other cations on the CEC … it is ‘reserve acidity’
  - The greater this reserve, the more lime is required

Table 1: Lime Requirements to Correct Soil Acidity (based on OMAFRA Pub 611, OMAFRA Soil Fertility Handbook)				
Buffer pH	Ground Limestone Required (t/ha)*			
	Target soil pH = 7.0[1]	Target soil pH = 6.5[2]	Target soil pH = 6.0[3]	Target soil pH = 5.5[4]
7.0	2	2	1	1
6.9	3	2	1	1
6.8	3	2	1	1
6.7	4	2	2	1
6.6	5	3	2	1
6.5	6	3	2	1
6.4	7	4	3	2
6.3	8	5	3	2
6.2	10	6	4	2
6.1	11	7	5	2
6.0	13	9	6	3
5.9	14	10	7	4
5.8	16	12	8	4
5.7	18	13	9	5
5.6	20	15	11	6
5.5	20	17	12	8
5.4	20	19	14	9
5.3	20	20	15	10
5.2	20	20	17	11
5.1	20	20	19	13
5.0	20	20	20	15
4.9	20	20	20	16
4.8	20	20	20	18
4.7	20	20	20	20
4.6	20	20	20	20

*Based on Agricultural Index of 75.

[1] Liming to pH 7.0 is recommended only for club-root control on cole crops.

[2] Add lime if soil pH is below 6.1.

[3] Add lime if soil pH is below 5.6.

[4] Add lime if soil pH is below 5.1.

Ontario Lime recommendations

- Calcitic vs Dolomitic lime??
- Max 2-3 tonnes per acre/season
- Reassess every soil sampling cycle

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ORGANIC MATTER:

- Adds greatly to CEC
- Microbes at work and create a reservoir of slowly available nutrients
- Soil tilth
- Water holding capacity

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Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P2O5	K2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B

A FEW CONSIDERATIONS FOR P and K:

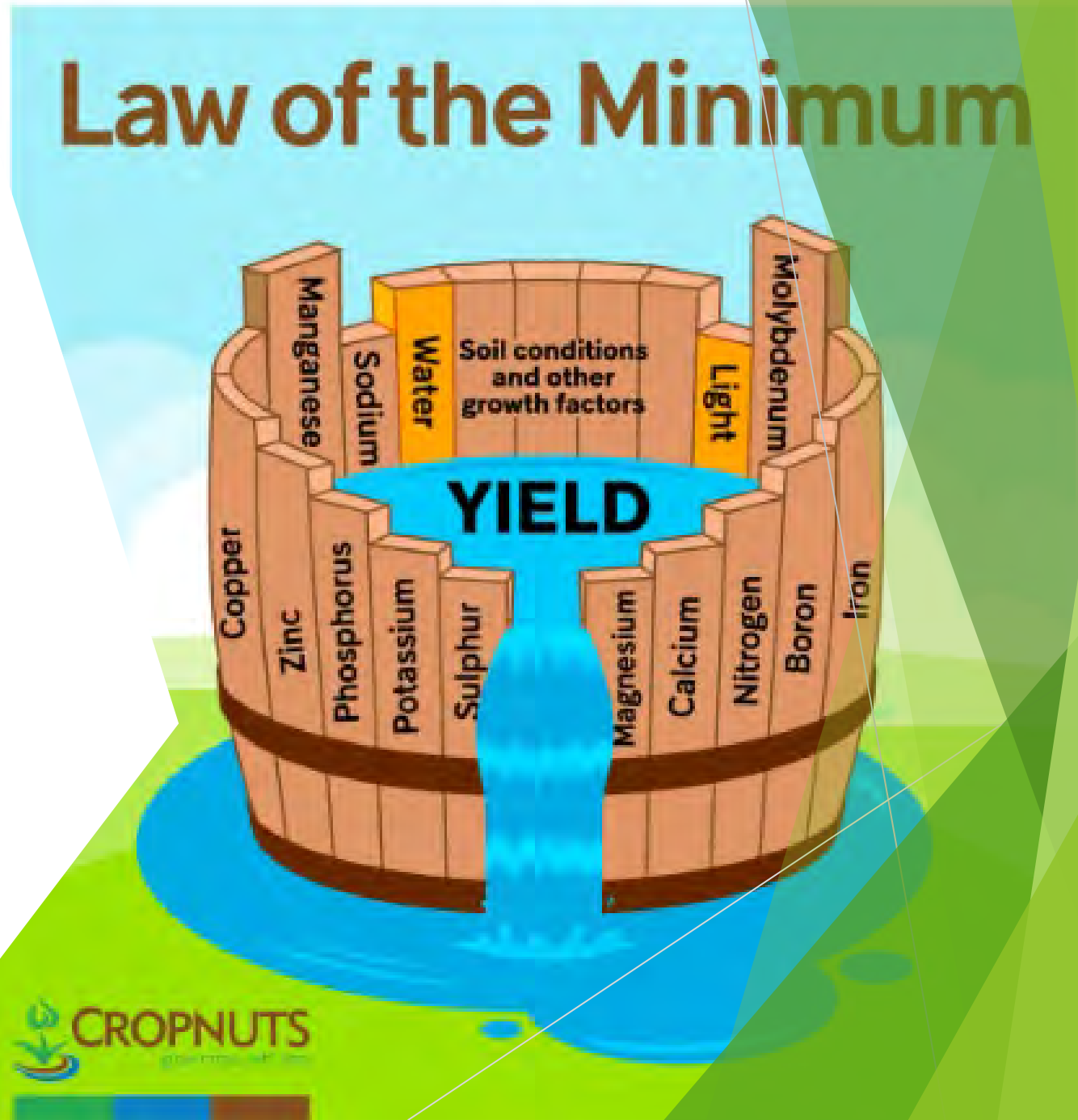
- Crop to be grown?
- Owned or rented?
  - ”soil build” or “crop removal”
- Rely on soil reserves only if levels are high
- Be mindful of “mining”

Owning vs renting may determine nutrient applications

- Own: Build Soil to M levels for macros
  - P: 12-18 ppm (Olsen)
  - K: 100-130 ppm
  - TAKES TIME: our farm…
    - 1998 K levels 36 ppm (VL)
    - 2023 K levels 92 ppm (M)
    - P almost doubled but just in M
      - In hindsight we underestimated P removal with our higher yielding crops and overestimated P content in our beef cow manure
- Rent:
  - short term – crop removal
  - Long term – soil building approach
- Changes your investment but also your yield potential

Soil report points you in the direction of what nutrient might be limiting yield potential

If soils are lacking and all other factors are met, crop potential will not be realized



- Build the soil to medium + crop requirements
- Soil building takes time and investment in organic amendments or commercial fertilizer
- 35 lb actual P fertilizer to increase 1 ppm
  - = 68 lbs MAP 11-52-0
  - = 6 tons/ac cow-calf manure
- 19 lb actual K fertilizer to increase 1 ppm
  - = 32 lbs potash 0-0-60
  - = 1.5 tons/ac cow-calf manure

Crop Requirements

- Requirements for primary, secondary and micronutrients vary by crop
- Requirements vary with yield
- Requirements for ‘whole plant’ crops significantly higher, especially in K removal
  - Cereals when straw is harvested
  - Forages
  - Corn silage

Field Crop Nutrient Removal in Ontario (lbs/ac)

CROP	YIELD/ac	N	P	K	Ca	Mg	S
Grain Corn	180	153	73	50	1.3	15.7	12.6
Corn Silage	8 ton	206	91	188	37.6	24	14.4
Winter Wheat	100 bu	120	59	36	2.7	16	8
WW + straw	2 ton	148	71	106	26	17.5	18.8
Oats	130 bu	93	33	25	3.5	5.2	8.7
Oats + straw	2 ton	117	46	101	13	7.8	17.7
Soybeans	45 bu	173	38	63	9	7.2	1.5
Canola	60 bu	126	73	37	14	18	19.8
Legume hay	2 ton	111	26	111	51	11	9.2
Mixed hay	2 ton	89	24	93	43	9.6	6.8
Grass hay	2 ton	71	23	84	32	8	6.8

Report Number: C23200-10010
Account Number: 97126

To: NORTHLAND AGROMART
RR #2
#10 HWY 540A
GORE BAY, ON P0P 1H0
Attn: BIRGIT MARTIN
705-282-1509

A & L Canada Laboratories Inc.

2136 Jetstream Road, London, Ontario, N5V 3P5
Telephone: (519) 457-2575 Fax: (519) 457-2664

C23200-10010

For: MARTIN FARMS

SOIL TEST REPORT

Reported Date: Jul 26, 2023 Printed Date: Jul 26, 2023

Sample Number	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
5	43817	3.4	14 M	26 M	49 L	292 H	1640 M	23 M	6.6	6.9	12.0	1.0	20.2	68.2	9.7	0.8
6	43818	4.9	6 L	8 L	118 M	623 VH	2060 M	35 M	6.5	6.9	17.1	1.8	30.4	60.3	6.6	0.9
7	43819	4.7	9 L	10 L	54 L	369 H	1740 M	26 M	6.5	6.9	13.9	1.1	23.0	66.8	8.3	0.8
8	43820	4.1	7 L	10 L	77 L	466 H	2190 M	24 M	7.2		15.8	1.2	24.5	69.1	4.4	0.7

Sample Number	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts ms/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	Nitrate Nitrogen NO3-N ppm	K/Mg Ratio	ENR	Field ID
5	13 VL	6.0 H	18 M	130 VH	2.0 H	0.7 M		8 M	431	0.1 G		0.05	46	
6	8 VL	3.3 M	12 L	92 VH	2.3 H	0.6 M		2 L	644	0.2 G		0.06	62	
7	9 VL	29.1 VH	15 M	94 VH	1.1 H	0.4 H		2 VL	807	0.2 G		0.05	60	
8	11 VL	4.8 M	16 M	101 VH	3.3 VH	0.9 M		2 VL	544	0.0 G		0.05	53	

OE VL = VERY LOW, L = LOW, M = MEDIUM, H = HIGH, VH = VERY HIGH, G = GOOD, MA = MARGINAL, MT = MODERATE PHYTO-TOXIC, T = PHYTO-TOXIC, ST = SEVERE PHYTO-TOXIC

SOIL FERTILITY GUIDELINES (lbs/ac)

Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P_2O_5	K_2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B

Secondary nutrients S, Ca, Mg

Ca and Mg heavily influenced by parent material

Secondary nutrients Ca, Mg, and S

- S is mobile in soils so soil test an estimate at best
- sulfur in the environment has declined markedly over past decades and fertilizers are purer

- Mg deficiencies more likely in coarse, acidic soils
- Important in chlorophyl
- Interveinal yellowing

- Ca deficiency rare when soil pH in adequate range
- Ca important in cell wall stabilization so new growth lacks integrity

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SOIL TEST REPORT

Reported Date: Jul 26, 2023 Printed Date: Jul 26, 2023 Page: 2 / 2

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SOIL FERTILITY GUIDELINES (lbs/ac)

Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P_2O_5	K_2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B

Crops vary in their response to micronutrients

Micronutrients can't be overlooked…

- All micronutrients combined account for <0.1% of plant DM
- But are equally important to plant function and yield
- Yields in Ontario climbing so micros becoming evident
- In Ontario, most common deficiencies are:
  - Zinc
  - Manganese
  - Boron

Response to micronutrient							
Crop	Mn	B	Cu	Zn	Mo	Fe	Cl
Alfalfa	low	high	high	low	medium		
Asparagus	low	low	low	low	low	medium	
Barley	medium	low	medium	low	low	medium	high
Blueberry	low	low	medium				
Broccoli	medium	high	medium		high	high	
Cabbage	medium	medium	medium	low	medium	medium	
Carrot	medium	medium	medium	low	low		
Cauliflower	medium	high	medium		high	high	
Celery	medium	high	medium		low		
Clover	medium	medium	medium	low	high		
Corn	medium	low	medium	high	low	medium	
Cucumber	high	low	medium				
Dry edible bean	high	low	low	high	medium	high	
Grass	medium	low	low	low	low	high	
Lettuce	high	medium	high	medium	high		
Oats	high	low	high	low	low	medium	medium
Onion	high	low	high	high	high		
Parsnip	medium	medium	medium		low		
Pea	high	low	low	low	medium		
Pepper	medium	low	low		medium		
Peppermint	medium	low	low	low	low	low	
Potato	high	low	low	medium	low		
Radish	high	medium	medium	medium	medium		
Rye	low	low	low	low	low		
Snapbean	high	low	low	high	medium	high	
Sorghum	high	low	medium	high	low	high	
Soybean	high	low	low	medium	medium	high	
Spearmint	medium	low	low	low	low		
Spinach	high	medium	high	high	high	high	
Sudangrass	high	low	high	medium	low	high	
Sugar beet	high	medium	medium	medium	medium	high	
Sweet corn	high	medium	medium	high	low	medium	
Table beet	high	high	high	medium	high	high	
Tomato	medium	medium	high	medium	medium	high	
Turnip	medium	high	medium		medium		
Wheat	high	low	high	low	low	low	high

Crops vary in their response to micronutrients

Final thoughts:

- Manure supplies secondary and micronutrients in addition to NPK
- Soil fertility is about the big picture – it's ALL important!
- Soil fertility is technical and complicated so fall back on resources:
  - Soil Fertility Handbook Pub 611
  - Local agronomist

Questions?