Soil Fertility and Fertilizers - Timing and Management

Crop Opportunity Update
North Battleford, SK
March 6, 2014

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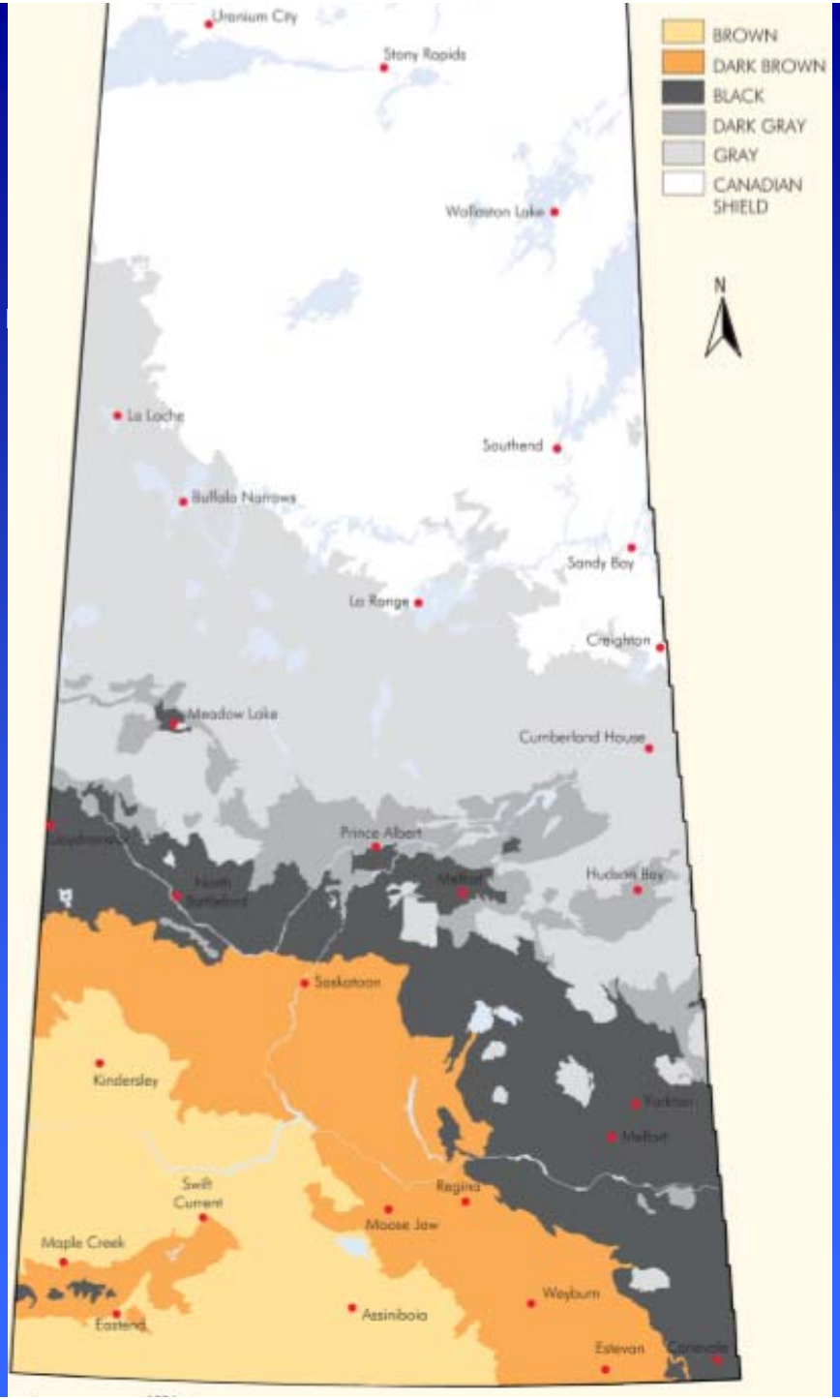
Outline:

- Assessing soil fertility - Soil Testing
- Understanding soil nutrients
  - Nitrogen in soil / Fertilizer Nitrogen / Losses
  - Phosphorus, Potassium, Sulfur
- Fertilizer placement & timing
- Crops – Canola, Wheat, Malt Barley
- New fertilizer products – pro's and con's

SK Soil Map

- What soil zone are you in?
- What is your typical growing season precipitation?



Essential elements for plant nutrition:

Carbon (C), **Hydrogen** (H) and **Oxygen** (O) are primary nutrients taken up as carbon dioxide and water.

Category	Name	Symbol	Mobile	Avail Form
Macro-nutrients	Nitrogen	N	Y	NO_3^-
	Phosphorus	P	N	$H_2PO_4^-$, HPO_4^{-2}
	Potassium	K	N	K^+
	Sulfur	S	Y	SO_4^{-2}
	Calcium	Ca	N	Ca^{+2}
	Magnesium	Mg	N	Mg^{+2}
Micro-nutrients	Boron	B	Y	H_3BO_3, $H_2BO_3^-$
	Chloride	Cl	Y	Cl^-
	Copper	Cu	N	Cu^{+2}
	Iron	Fe	N	Fe^{+2} , Fe^{+3}
	Manganese	Mn	N	Mn^{+2}
	Molybdenum	Mo	Y	MoO^{-2}
	Zinc	Zn	N	Zn^{+2}

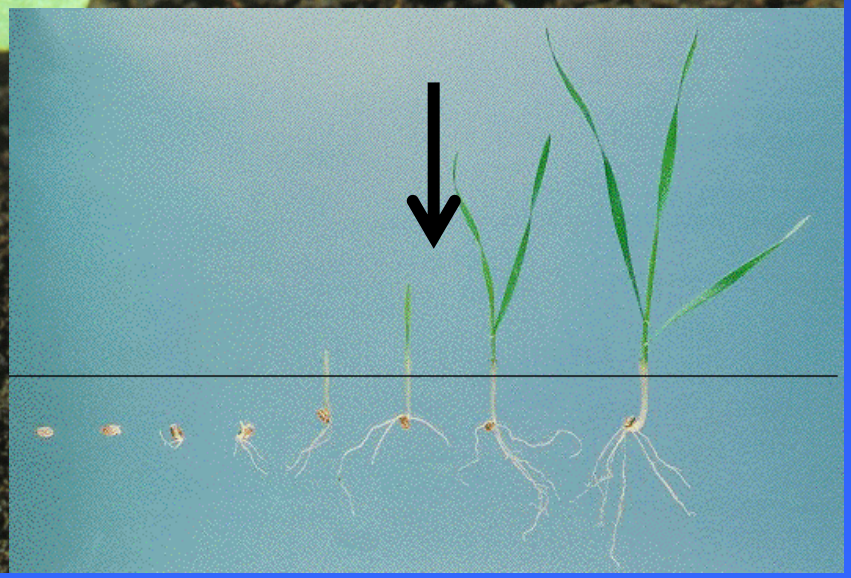
Nutrient Requirements

- How much of each nutrient is required?
- When is each nutrient required?

Nutrient Uptake and Removal

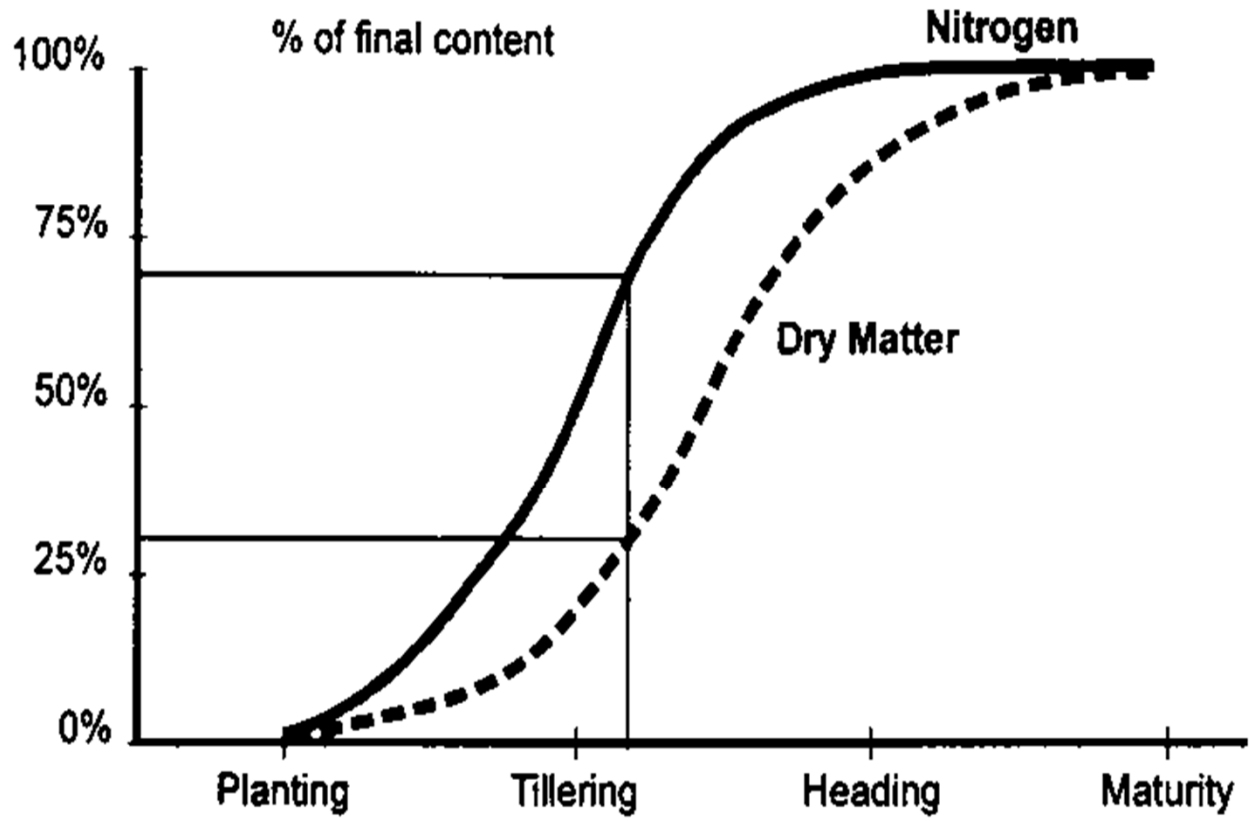
	N	P_2O_5	K_2O	S
	----------(lb/ac)----------			
Wheat (60 bu/ac)	110-135 (80-100)	45 (30-35)	90-120 (25-28)	12-15 (6-8)
Barley (80 bu/ac)	100-120 (70-85)	45 (30-35)	95-115 (23-28)	12-14 (6-8)
Canola (50 bu/ac)	140-170 (85-100)	55-65 (40-45)	95-120 (20-30)	23-30 (14-17)

Nutrients supplied by the seed run out at this stage
Adequate supply of soil nutrients are needed!




At this stage canola will have taken up about
50 % of its N, P and K requirements
Canola
Bolting

Cereal Crop – Nitrogen Uptake



Required Nutrients

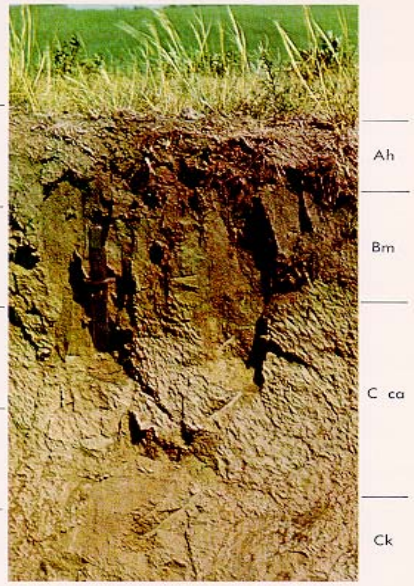
- How much can the SOIL provide of each nutrient?
- How much of each nutrient DO YOU need to apply – to ensure optimum yield potential?

Soil Test

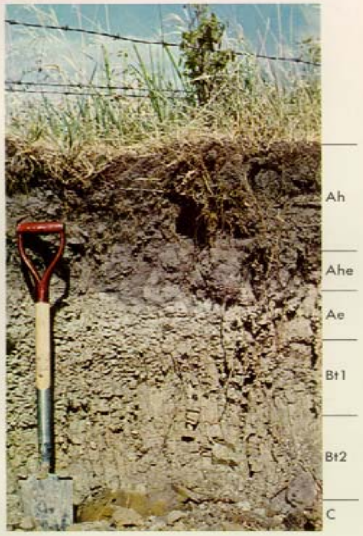
- Gives an excellent inventory of:
  - Plant available nutrients
- Provides a basis for recommending additional nutrients for crop production on an individual field basis.

Soil Sampling

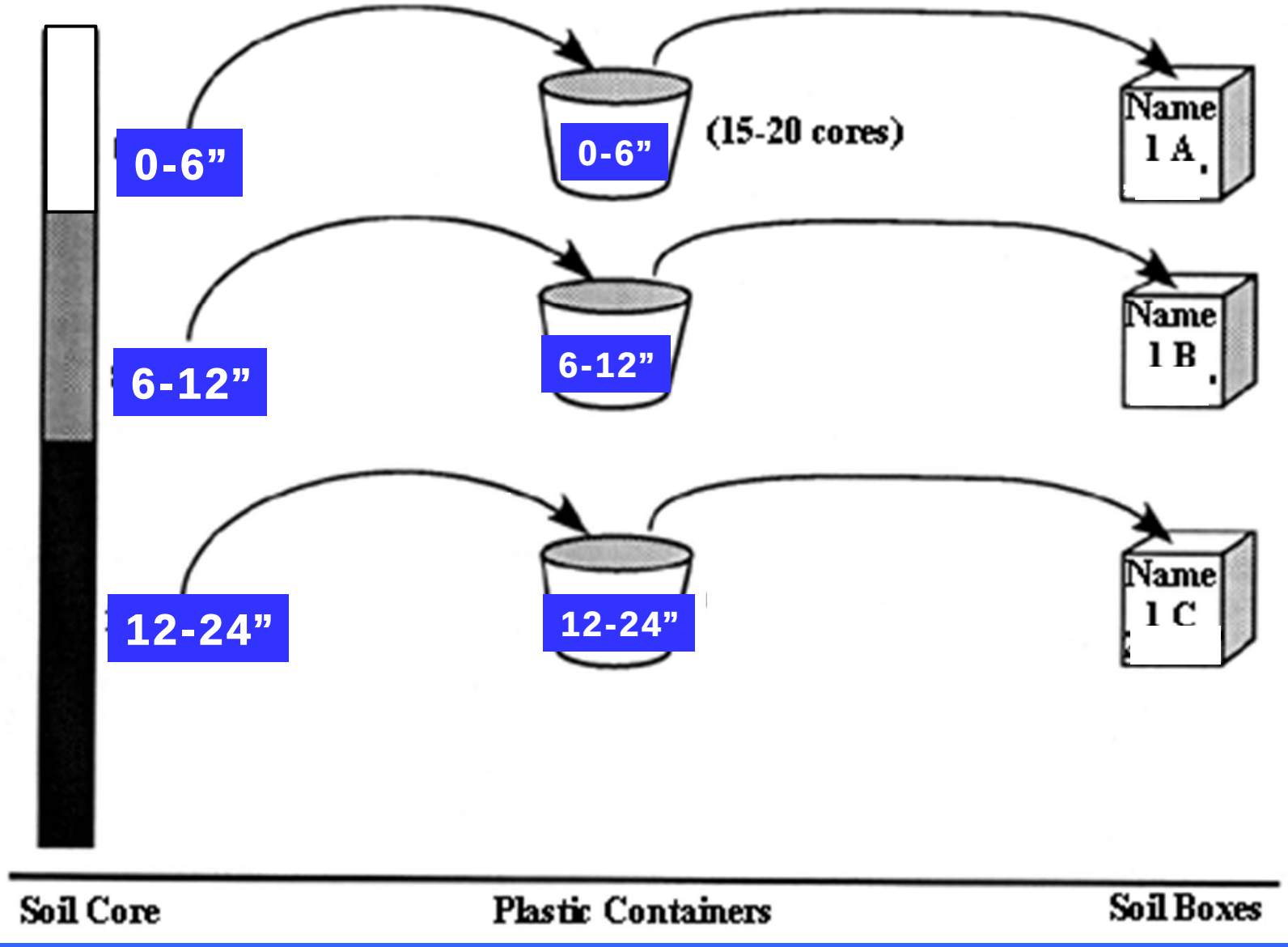
- Most important limitation is taking representative soil samples.
- Test data is worthless if the sample is not representative of the area to be fertilized.
- In variable fields - Separate soil samples for each soil type or slope position within a field.



Orthic Dark Brown



Eluviated Black

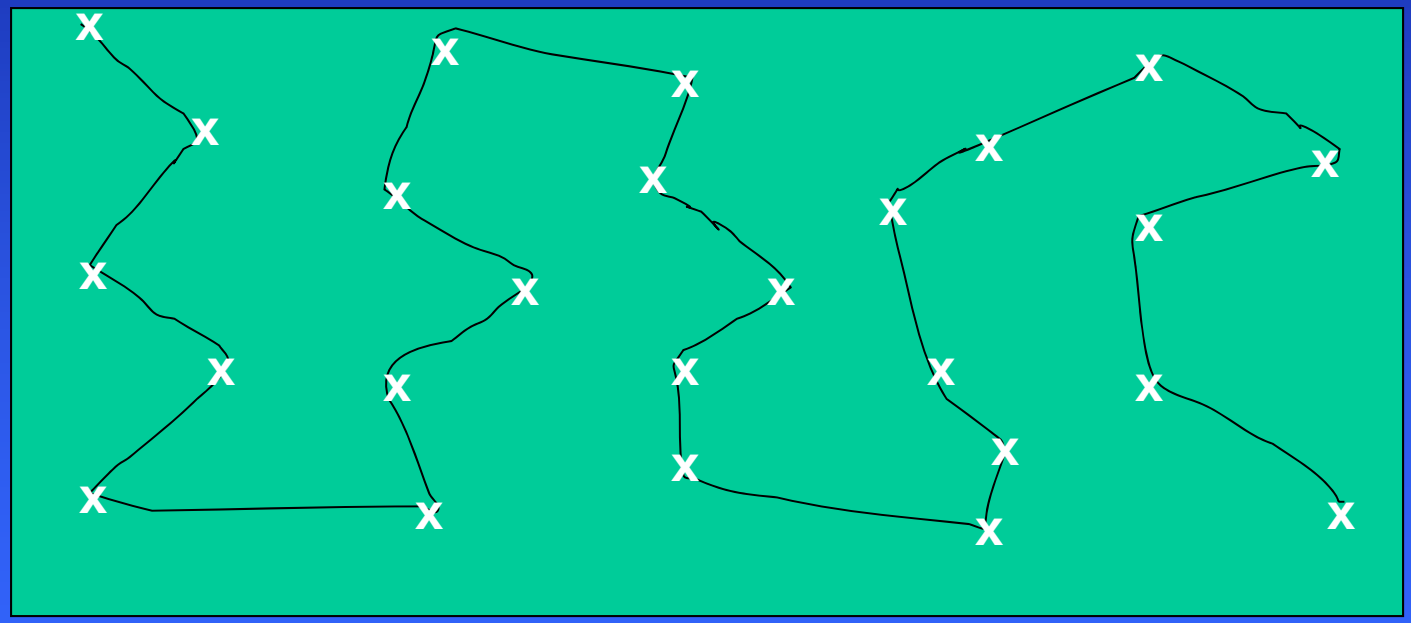


Number of Soil Samples:

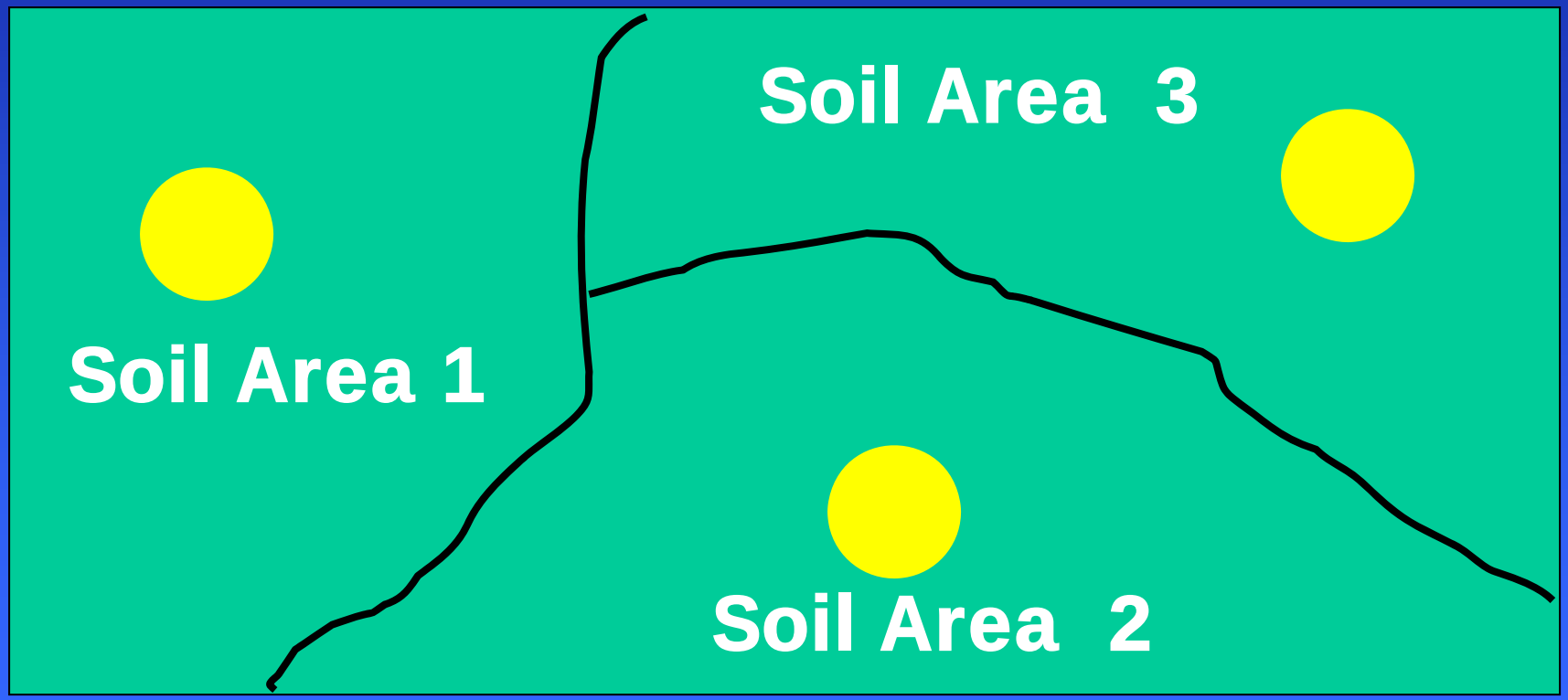
- Sample a minimum of 20 samples per field.
- Why??
- 1 ac – 6” depth = 2,000,000 lbs
- 160 ac – 6” depth =320,000,000 lbs
- A 2 lb soil sample must represent 320,000,000 lbs or 0.0000006% of field!!

Methods of Sampling:

- **Random sampling – 20 to 25 samples per field**



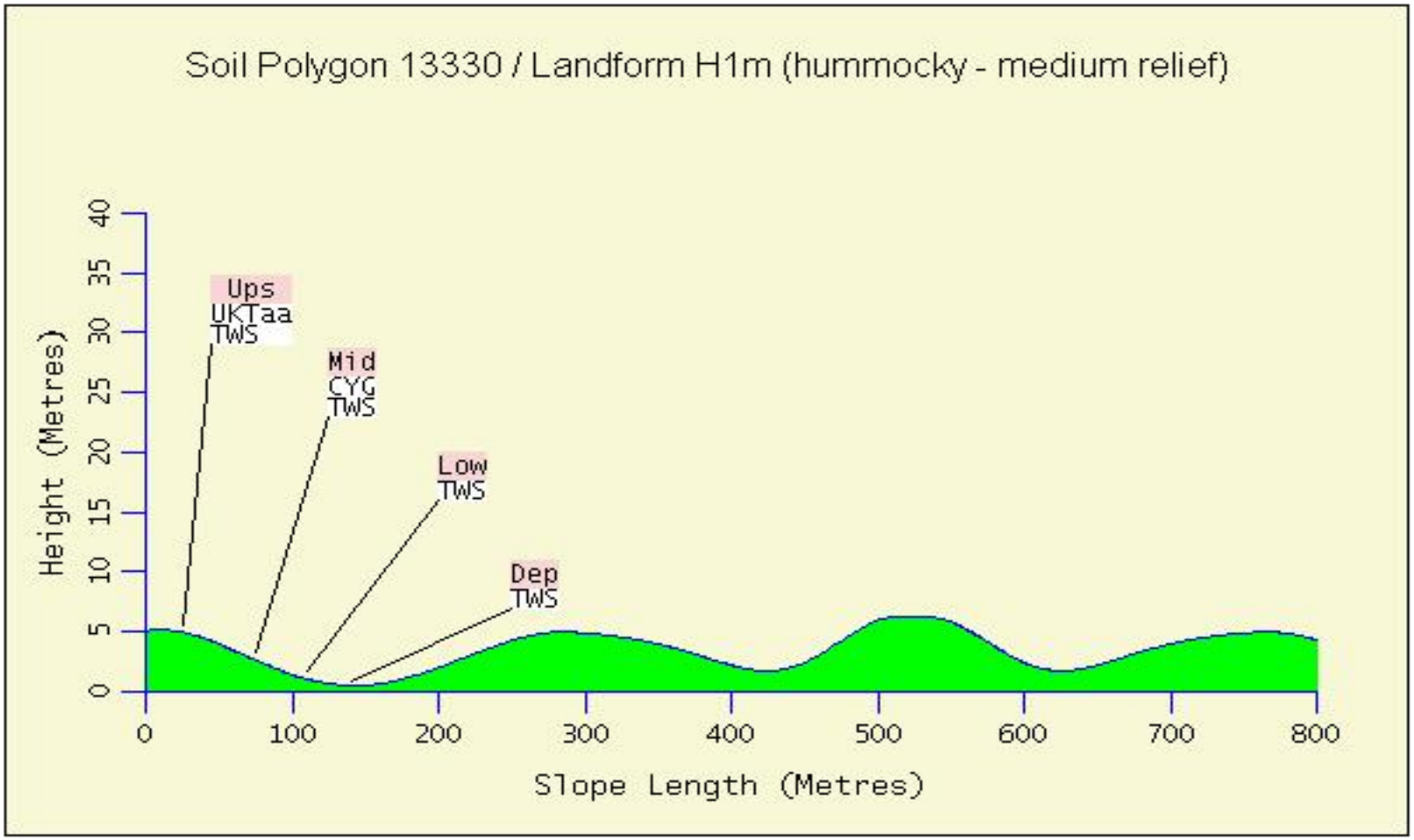
Site Specific Benchmark
– sample same site locations each yr



Soils vary with topography

Landform Report - Microsoft Internet Explorer

Landform profile and soil distribution



Print | Close Window


MacMillan Landform Classification
Mercer Site
N
0 60 120 240 360 480 600 Meters
1: Upper Slope
2: Mid Slope
3: Lower Slope
4: Depression Area

Handle Soil Samples Properly

- **Handing:**
  - **Take care to avoid contamination.**
  - **Dry completely**
  - **Fill the soil sample cartons**
  - **Label each carton correctly**

- **Send to a reputable soil testing laboratory.**

ALS Laboratory Group Agricultural Services

Phone:
1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

Client Information:
DOUG BROWN

Sample / Field Information:

Crop Year	2013
Field Name	
Legal Location	
Soil Climatic Zone	
GPS Reference	
Acres	440
Previous Crop	Canola, h.y.
Yield	30
Stubble Management	Spread
Rotation	Continuous

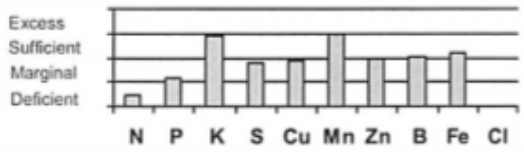
Sample ID 979633 Date Sampled 29-APR-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca	Mg	K	Na	Base Saturation Ca	Mg	K	Na
									ppm				% of CEC			
0-12	Loam	6.2	0.1	0.2	Non Saline											

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N	P	K	SO_4-S	Cu	Mn	Zn	B	Fe	Cl
	lb/ac									
0-12	17	39	915	26	3.1	63.7	2.2	2.7	141	



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NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 1.8 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
73 bu/ac 6.1 in. of ppt - 50% chance of this ppt. 13.5% Protein. 12.0 in. of Irrigation	130-140	25-30	0 or 15	5-10	0-3	0-0	0-0	0-0	0-0	
64 bu/ac 6.1 in. of ppt - 50% chance of this ppt. 13.5% Protein. 10.0 in. of Irrigation	110-120	25-30	0 or 15	0-10	0-3	0-0	0-0	0-0	0-0	
56 bu/ac 6.1 in. of ppt - 50% chance of this ppt. 13.5% Protein. 8.0 in. of Irrigation	90-100	25-30	0 or 15	0-10	0-3	0-0	0-0	0-0	0-0	
90 bu/ac 6.1 in. of ppt - 50% chance of this ppt. 13.5% Protein. 16.0 in. of Irrigation	170-180	25-30	0 or 15	5-10	0-3	0-0	0-0	0-0	0-0	

User Specified: Target Yield of 90 bu/ac User Specified: 13.5% Protein ☑ Irrigation

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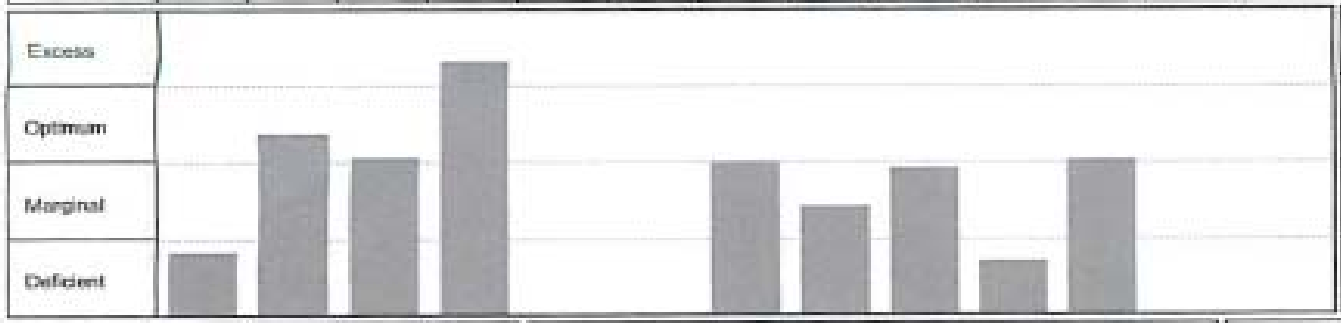
Farm Soil Analysis

Nutrient analysis (ppm)

Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP
0" - 12"	12	27	173	20			23	0.5	1	0.3	3.4		
12" - 24"	4			72			10	0.6	<0.5	0.3	2.0		

Soil Quality

pH	EC(dS/m)	OM(%)	Sample#
8.0	0.54	1.2	3513245
8.2	0.77		3513246



Alkaline	*Very Toxic*	*High*
Neutral	*Toxic*	*Normal*
Acidic	*Caution*	*Low*
Very Acidic	*Good*	*Very Low*

Total lbs/acre	67	109	690	372
Estimated lbs/acre	67	76	346	372

Texture *n/a* Hand Texture *n/a*

Sand n/a Silt n/a Clay n/a

Ammonium n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

BS n/a

Ca n/a Mg n/a Na n/a K n/a

TEC n/a Na n/a

*Nitrate-N **Sulfate-S n/a = not analysed

Comments:

Converting ppm to lb/ac

- One ac of soil 6” deep = 2,000,000 lb
- Therefore a 6” depth in ppm x 2 = lb/ac
- A 12” depth in ppm x 4 = lb/ac
- An 18” depth in ppm x 6 = lb/ac

To maximize fertilizer efficiency:

- Which nutrients are marginal or deficient?
- Which fertilizers do you really need?
- What fertilizer forms would be best?
- How and when would you apply each fertilizer?

- You should ask various sources for advice!!

Soil Nitrogen and Nitrogen Fertilizer

What is the cost of your Nitrogen Fertilizer:

- Anhydrous ammonia (82-0-0) and Urea (46-0-0) are usually the least expensive.
- Liquid (28-0-0) and ESN (45-0-0) are usually more expensive.
- Do you calculate the price of your N fertilizer?

If Urea (46-0-0) cost is $600/tonne; Liquid (28-0-0) is $450/tonne, What is the price of nitrogen/lb?

One tonne of 46-0-0 has 460 kg of N/ tonne

$$\frac{\$600}{460\ kg} \sim \frac{x}{1\ kg} = \$1.30/kg\ of\ N \quad (59\ ¢/lb\ of\ N)$$

One tonne of 28-0-0 has 280 kg of N/ tonne

$$\frac{\$450}{280\ kg} \sim \frac{x}{1\ kg} = \$1.61/kg\ of\ N \quad (73\ ¢/lb\ of\ N)$$

Cost of N fertilizer:

- If urea N fertilizer is 59¢ /lb and you apply 70 lb/ac onto 4000 acres = $165,200

- If liquid N fertilizer is 73¢ /lb and you apply 70 lb/ac onto 4000 acres = $204,400

- Difference in cost: $39,200

Sources of Nitrogen:

- Soils will mineralize 20 to 40 lb N/ac
- Legume crops can contribute 20-50 lb N/ac
- N received in precipitation is about 4-8 lb/ac/yr.
- Livestock manure will contribute significant N

- Remaining N must come from commercial fertilizer –
  - Need to understand N fertilizer dynamics!!

Nitrogen Transformations:

Terms you need to know and understand:

Mineralization

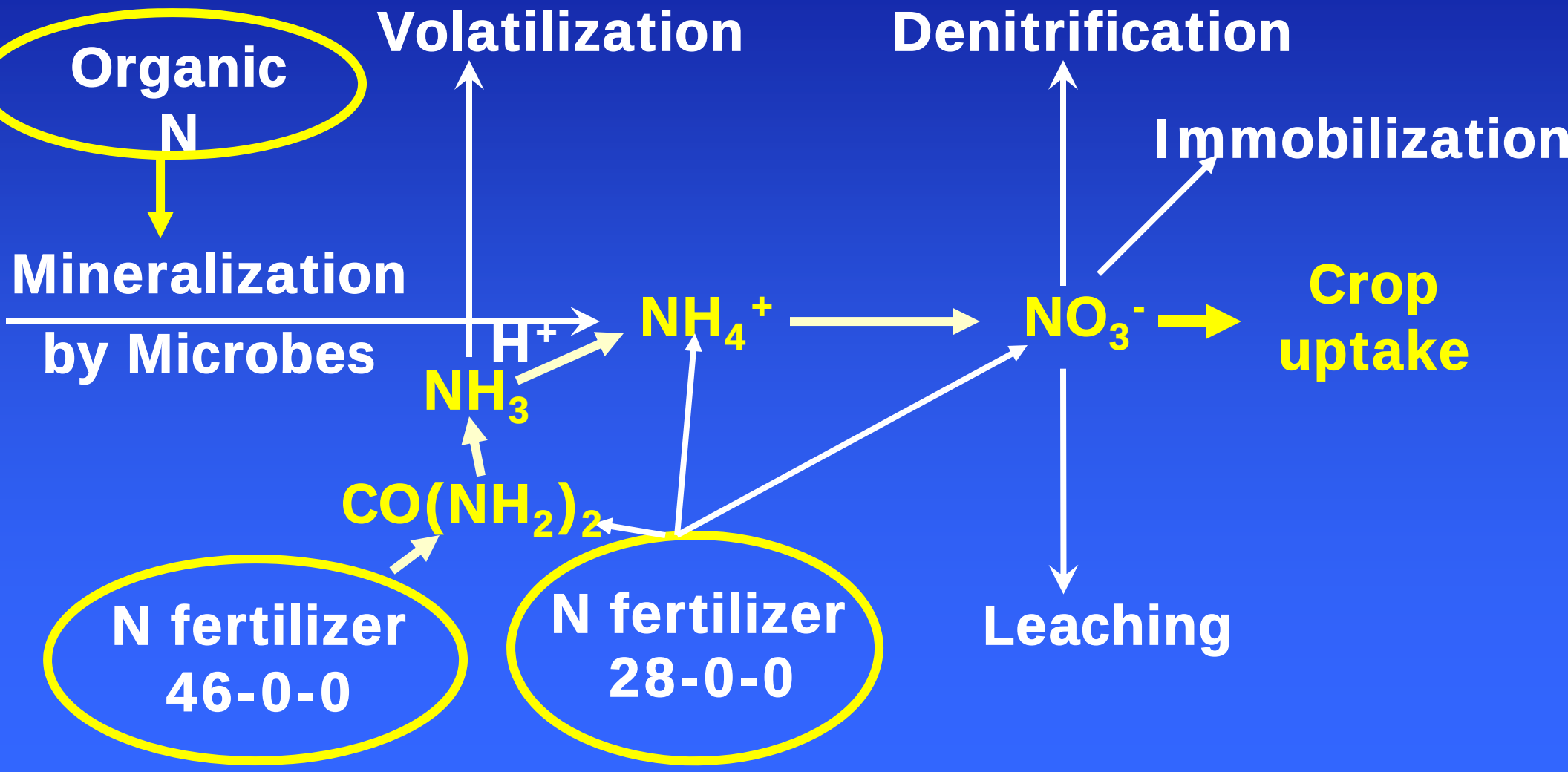
Volatilization

Denitrification

Immobilization

Leaching

Nitrogen Dynamics:



Remember how soil and fertilizer N can be lost from soil!

- **Volatilization** – gaseous loss of broadcast urea when soil & air temperatures are warm!
- **Leaching** – under excess moisture –BUT usually only a concern with Sandy soils!
- **Denitrification** – is a problem when soils are very wet for more than 2-3 days and soils are warm.
- **Immobilization** – when soil nitrate-N is inadequate to meet crop and soil microbe requirements – greater problem with increased crop residue levels.

When you understand soil N dynamics

- better understand BMP's of N fertilizer

N Fertilizer - BMP Choices??

- **Choice 1**
  - **Mid row or side band N at seeding**

    or
  - **Seed-place N – <u>BUT</u> only at safe rate!**

Cereals – Nitrogen Fertilizer Safe Seed-placed Rates

	Urea- Cereals		ESN - Cereals	
Seed Bed Utilization	Course Texture	Medium to Fine Texture	Course Texture	Medium to Fine Texture
	----------N (lb/ac)----------		----------N (lb/ac)----------	
5%	0	10 (0)	0	
10%	15 (0)	25 (15)	60	75
25%	25 (15)	35 (25)	75	100
33%	30 (20)	40 (30)		

Assumes 30 lb/ac P_2O_5 is seed-placed but no K or S fertilizer is placed with seed.

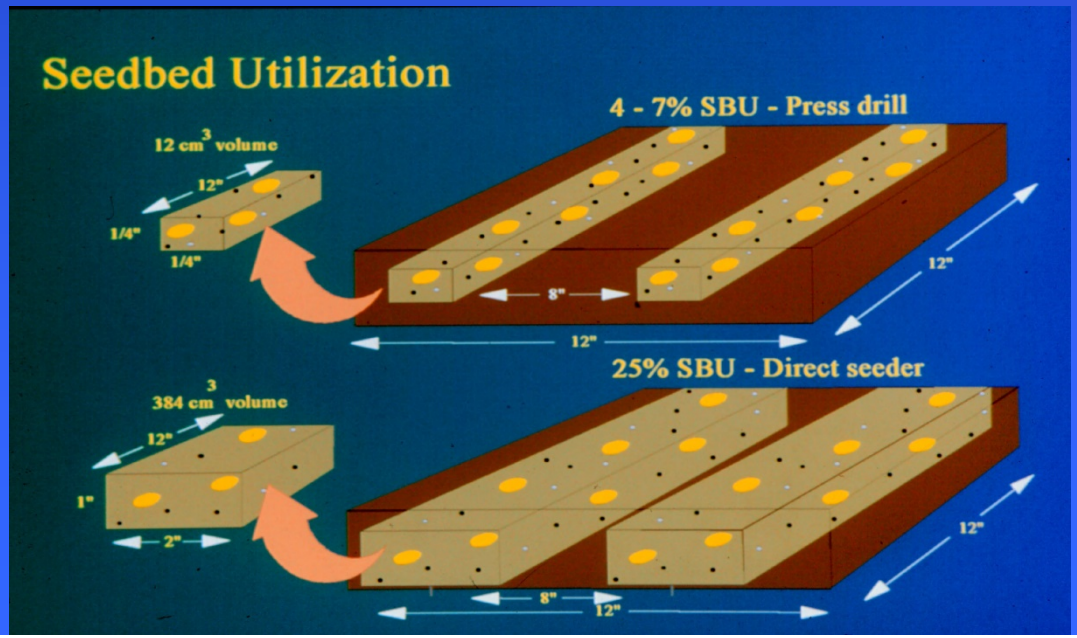
Canola – Nitrogen Fertilizer Safe Seed-placed Rates

	Urea		ESN	
Seed Bed Utilization	Course Texture	Medium to Fine Texture	Course Texture	Medium to Fine Texture
	----------N (lb/ac)----------		----------N (lb/ac)----------	
5%	0	5 (0)	0	
10%	5 (0)	10 (0)	15	30
25%	15 (0)	20 (10)	45	60
33%	20 (10)	30 (20)	60	90

Assumes 15 lb/ac P_2O_5 is seed-placed but no K or S fertilizer is placed with seed.

Main Injury Factors

- **Salt Effect**
  - Makes it difficult for the seedling to imbibe water and grow.
  - 21-0-0-24 and 0-0-60 have a high salt index.
- **Toxicity**
  - When Urea N converts to NH_3 (ammonia).



N Fertilizer - BMP Choices??

- **Choice 2**
  - Band N in early spring
  - Concerns: seed bed is compromised plus loss of critical seed bed soil moisture

- **Choice 3**
  - Band N in late fall - at Soil Temp < 5˚C
  - Concern: N must remain in NH_4^+ form over winter to minimize losses

BMP Choices

- **BMP Choice 4**

  Broadcast 46-0-0 before or just after seeding – Concerns:

  - **Moderate to Very Inefficient – subject to gas off**
  - **Depend on rain to move fertilizer into soil**
  - **DON'T Broadcast ESN – release is too slow**

BMP Choice 5 – In-crop N

- In-crop N using 28-0-0
  - In-crop N with spray jet nozzles: - < 40% efficient
  - Concern: need moisture to move N into soil and then must convert to an available form
  - Must apply in early crop stage to be effective

BMP Choice 6 - Foliar N application

- Very inefficient – only 5% N uptake via leaves!
- Leave burn at > 20 lb N/ac
- Leaves are designed to capture the energy of the sun – NOT to absorb nutrients

BMP Choice 7 - ESN – Environmentally Smart Nitrogen

- Polymer coated urea fertilizer - protects the Urea N from rapid release
- Releases over a 10 to 60 day period – peaking at 30 days
  - Soil temperature and moisture conditions
- Under wet soil conditions ESN fertilizer is protected by releasing slowly to reduce denitrification losses!
- Using a Urea:ESN blend can replace need or in-crop N application

How Much N Fertilizer is Optimum?

- As rainfall increases yield potential increases

- BUT – HOW MUCH N is OPTIMUM!!
- Optimum N fertilizer is a function of:
  - soil moisture
  - growing season precipitation
  - soil test N level

Nitrogen Fertilizer for Wheat

Soil N Level (lb N/ac) 0 to 24 inches		Soil Moisture + Growing Season Precipitation (inches)					
		8”	10”	12”	14”	16”	18”
		Recommended N Fertilizer (lb N /ac)					
Very Low	0-20	60	75	90	105	120	135
Low	20-40	45	60	75	90	105	120
Medium	40-60	30	45	60	75	90	105
High	60-80	15	30	45	60	75	90

Nitrogen Fertilizer for Canola

Soil N Level (lb N/ac) 0 to 24 inches		Soil Moisture + Growing Season Precipitation (inches)					
		8”	10”	12”	14”	16”	18”
		Recommended N Fertilizer (lb N /ac)					
Very Low	0-20	70	85	100	115	120	140
Low	20-40	55	70	85	100	115	120
Medium	40-60	40	55	70	85	100	115
High	60-80	25	40	55	70	85	100

Phosphorus Nutrition

Phosphorus (P)

Phosphate (P_2O_5)

Ortho Phosphate (H_2PO_4)

- **About 80 % of soils are P deficient!**

New Agdex has up-to-date information and recommendations

Revised January 2013 Agdex 542-3

Phosphorus Fertilizer Application in Crop Production

Phosphorus (P) is an essential plant nutrient required for optimum crop production. Phosphorus deficiencies can be corrected with phosphate fertilizer (P_2O_5). Generally, P is the second most limiting soil nutrient in crop production in Alberta. With respect to fertilizer use, it is second only to nitrogen (N) in Alberta.

Effect on crop growth

Plants need phosphorus for growth, utilization of sugar and starch, photosynthesis, nucleus formation and cell division. Phosphorus compounds are involved in the transfer and storage of energy within plants. Energy from photosynthesis and the metabolism of carbohydrates is stored in phosphate compounds for later use in growth and reproduction.

Phosphorus is readily translocated within plants, moving from older to younger tissues as the plant forms cells and develops roots, stems and leaves.

Adequate P results in rapid growth and early maturity, which is important in areas where frost is a concern. Frequently, P will enhance the quality of vegetative crop growth.

An adequate supply of available P in soil is associated with increased root growth, which means roots can explore more soil for nutrients and moisture. Phosphorus occurs in most plants in concentrations between 0.1 and 0.4 per cent, on a dry weight basis. A deficiency of P will slow overall plant growth and delay crop maturity.

Content and crop requirements

In young, actively growing plants, P is most abundant in the actively growing tissue. By the time plants have attained about 25 per cent of their total dry weight, they may have accumulated as much as 75 per cent of their total phosphorus requirements. Therefore, most crops require significant quantities of P during the early stages of growth. For example, cereal crops will often take up to 75 per cent of their P requirements within 40 days after crop emergence.

Phosphorus requirements for optimum yields vary with different crops (see Table 1). For example, wheat requires less P than canola due to the lower protein content of the seed. A 2,700 kg/ha (40 bu/ac) wheat crop requires about 33 kg/ha (29 lb/ac) of phosphate as indicated in Table 1.

Table 1. Approximate range of phosphate requirements of wheat, barley, canola and pea

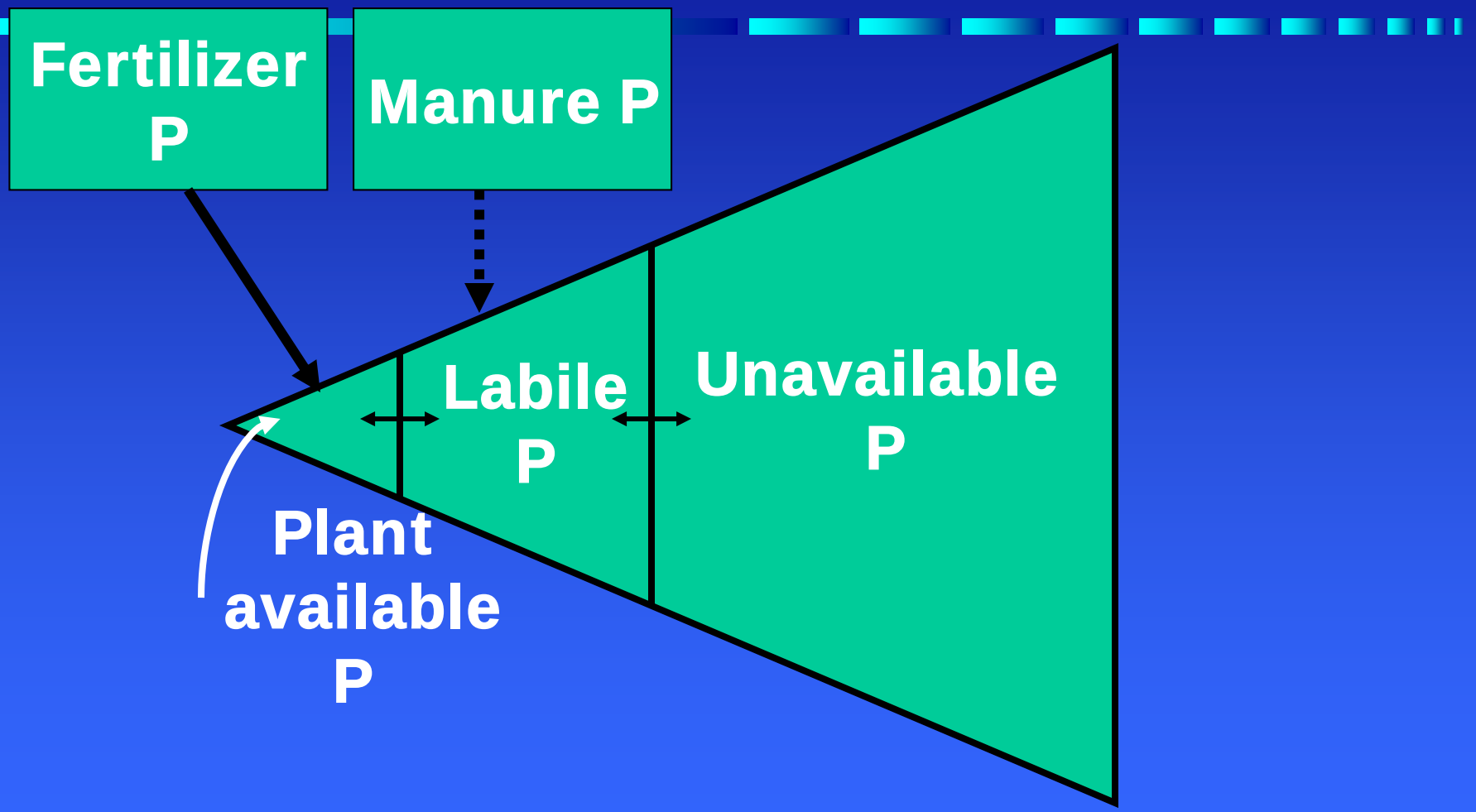
Crop	Crop part	Phosphate kg/ha	Phosphate lb/ac
Wheat 2,690 kg/ha (40 bu/ac)	Seed	23 - 28	21 - 26
	Total Uptake	32 - 38	29 - 35
Barley 3,226 kg/ha (80 bu/ac)	Seed	33 - 40	30 - 37
	Total	44 - 53	40 - 49
Canola 1,960 kg/ha (35 bu/ac)	Seed	36 - 44	33 - 40
	Total	50 - 61	46 - 57
Pea 3360 kg/ha (50 bu/ac)	Seed	34 - 41	31 - 38
	Total	41 - 50	38 - 46

Deficiency symptoms

A mild P deficiency results in somewhat stunted crop growth, which can be difficult to see. In severe cases of P deficiency, symptoms include characteristic stunting, purpling or browning, appearing first on the lower leaves and base of the stem and working upward on the plant, particularly on cereal crops. The effect is first evident on leaf tips, and then progresses toward the base. Eventually, the leaf tip dies. However, visual diagnosis of

Alberta Government

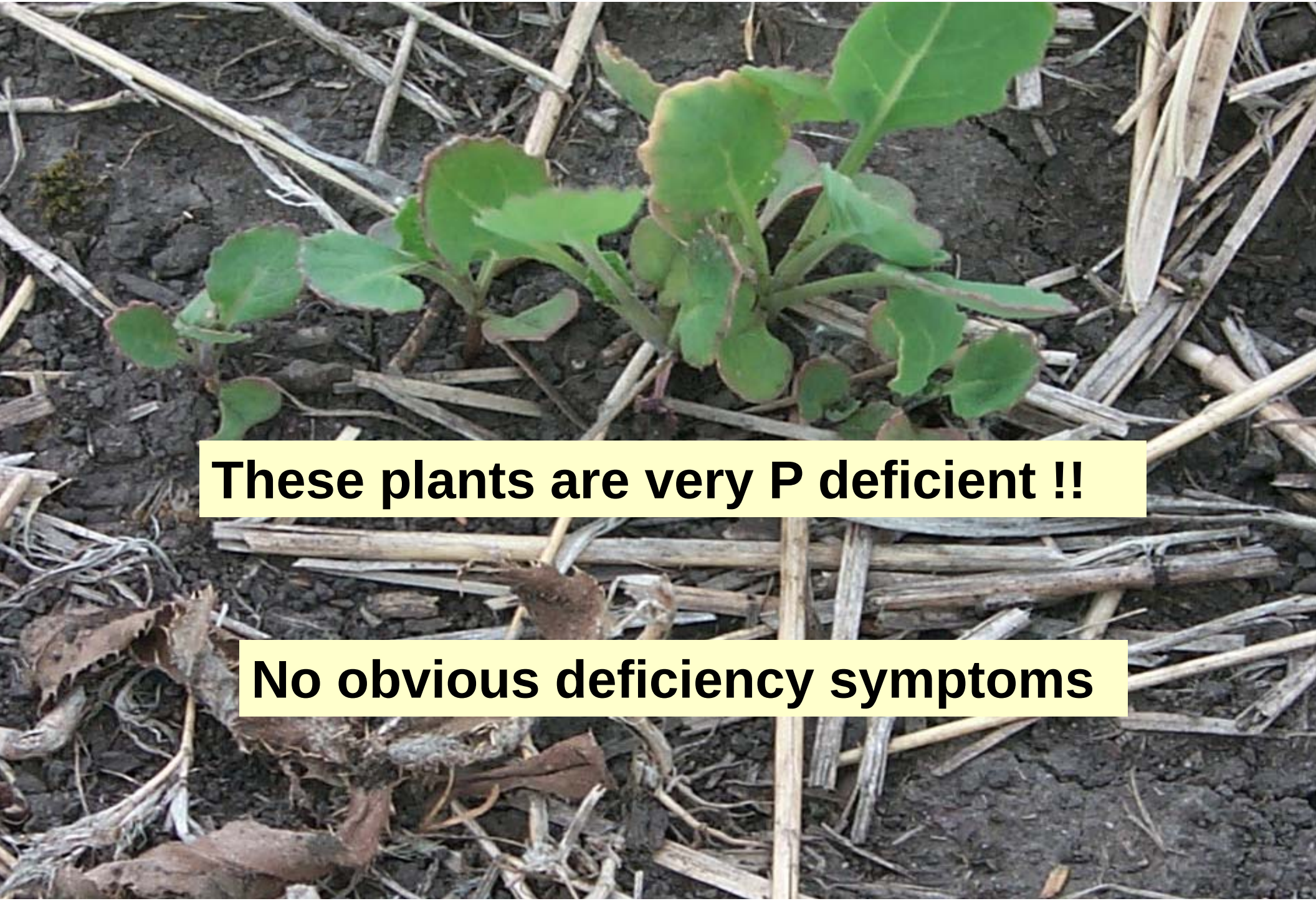
Soil Phosphorus Fractions



Determining Plant Available Soil P

- Preferred method for Alberta and Saskatchewan soils:
  - Modified Kelowna: NH_4F + HOAc + NH_4OAc

- Other methods that used:
  - Olson (Bicarb method): $NaHCO_3$
  - Bray-1
  - Mehlich-3


These plants are very P deficient !!
No obvious deficiency symptoms


U of A P Plots
1979 Est
Mid Row P
No P
11 kg/ha
June 1999

Alberta Data:

Response to seed-placed versus banded phosphate fertilizer

	Wheat Stubble	Barley Stubble	Canola Stubble
No. of sites	17	19	15
P responsive sites	10	13	14
Seed-placed > banded	6	8	6
Banded > seed-placed	3	0	2
Seed-placed = banded	1	5	7

Remember:

Soil and Fertilizer P are immobile – therefore – placement near the seed is best!

Seed-placed P:

- Most effective when soil P level is low
- Placement of P with the seed can provide a starter or pop-up effect – especially in cool, wet soils
- Will stimulate early root growth
- Is often the more effective placement method – except when soils are drier!
- Small seeded crops are more sensitive to seed placed P (canola, mustard, flax)

N-P Dual Band Placement:

- Roots proliferate in the area of the band results in higher nutrient uptake
- N tends to move out of the band and P remains – if N levels are higher than ~70 lb/ac
  - the N in the band will prevent roots from penetrating the band to efficiently taking up P
- Dual N-P banding:
  - It is a good method for applying N-P fertilizer but
  - Starter P is still very important

Soil test rating for plant available P

Soil test level rating*	Phosphorus (P) (lb/ac)	
Very low	0 – 15	High probability of crop response to P
Low	15 – 30	
Medium	30 – 60	Moderate probability
Medium to Adequate	60 - 90	
High	>90	Low probability of crop response to P

* Modified Kelowna Method

Phosphate fertilizer recommendations for canola in the Dark Brown soil zone

Soil P (lb P/ac)	Dry	Moist	Wet	
0-10	35	40	45	Apply P_2O_5 at ~30-40 lb/ac
10-20	30	35	40	
20-30	25	30	35	
30-40	20	25	30	Apply 20-25 lb/ac
40-50	15	20	25	
50-60	15	20	25	Apply maintenance rate of 15-20 lb/ac
60-90	15	15	15	
>90	0			

New Products
What are the Benefits?

MicroEssentials™ S15

A New Vision in Phosphate from Mosaic

MicroEssentials S15 Typical Analysis:
(not guaranteed)

Total Nitrogen	13%
Total P_2O_5	33%
Total Sulfur	15%
Sulfate Sulfur	7.5%
Elemental Sulfur	7.5%
Bulk Density	54-60 lbs/ft³ packed 50-55 lbs/ft³ loose

MicroEssentials™ S15 provides nutrients that are combined in a patented production process. Every MicroEssentials S15 granule contains three vital nutrients — nitrogen (13%), phosphorus (33%) and sulfur (15%) — all more evenly distributed than separate applications. Phosphorus and sulfur are in a proper ratio that benefits most crops, due to key nutrient interactions, and makes them more available and easier for plants to use throughout the growing season. High analysis means less volume than the equivalent blend of MAP and ammonium sulfate.

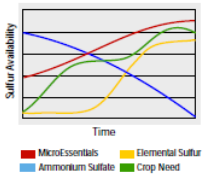
MicroEssentials S15 — delivers higher yields!

MicroEssentials S15 is a more uniform product that, when applied correctly, gives every single plant a better shot at getting essential nutrients it needs to grow, thrive, and produce the best results.

A Unique Crop Nutrient System!

MicroEssentials S15 nutrients are accessible to plants throughout the season. It is designed to supply phosphorus and sulfur in the right ratio and at the right time to a developing crop. Key nutrient interaction between phosphorus and sulfur helps plants take up more nutrients and P content increases10 to 30%.
It delivers an optimal rate of sulfur in two forms: the sulfate form (50%), which is available immediately to developing roots, and the elemental form (50%), which becomes available later in the growing season. The two forms combined provide season-long release of sulfur for the crop.

Sulfur Availability & Uptake



Plants start out faster because MicroEssentials S15 delivers nitrogen the way research proves young plants prefer it — in the ammonium form. About 40% of N is in the ammonium sulfate form and 60% is in the mono-ammonium phosphate form. This means plants are less dependent on weather and get off to a faster start!

Mosaic

Key benefits of MicroEssentials S15

- Ammonium phosphate based product
- Balanced nutrition – nitrogen, phosphorus, sulfur
- All nutrients in each granule
- Improved distribution of nutrients compared to blended product
- Eliminates component segregation that is possible with a blend
- More uniform spreading in the field
- Two forms of sulfur - 50% sulfate and 50% elemental
- Season-long sulfur availability
- Improved nutrient uptake due to chemistry of the granule
- Convenient/easy to use: direct application, blends, and starters
- Saves a bin – nitrogen, phosphate and sulfur in the same bin

Patented process

During the manufacturing process, sulfur is added and forms partial layers around a developing granule.

Sulfur appears as veins in this cut-away illustration. Elemental sulfur is not very mobile in soil solution. When added as granules in bulk blends, much of their benefit is lost as plants must seek out the sparse sulfur granules across large areas.

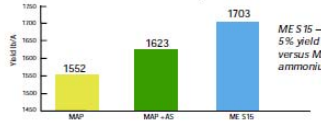
Sulfur distribution comparison in broadcast applications

Typical Sulfur Blend
Sulfur as granules in bulk blend through broadcast application (15 lb/A).

MicroEssentials S15
Sulfur incorporated in phosphate fertilizer (33 lbs/A P_2O_5 and 15 lb/A sulfur).

Better yields are more than just a possibility!

Canola Yield Results — Five-Year Study



ME S15 — showed a 5% yield advantage versus MAP + ammonium sulfate!

Spring Wheat Yield Results — Five-Year Study

ME S15 — showed a 5% yield advantage!

Corn Yield Results — Five-Year Study

ME S15 — showed a 6% yield advantage versus DAP!

Mosaic

www.microessentials.net

MicroEssentials S15 single granular nutrients get spread across the field more uniformly because component segregation of these nutrients is eliminated!

New Products – Claims!

ALPINE

the starter fertilizer company®

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TESTIMONIALS

Below are just a few of ALPINE's satisfied customers. If you are interested in sharing your testimonial, please email us at info@alpinepfl.com or call (800) 265-2268. We love to hear from our farmers!

Kevin Sparrow Farms
4200 acres - Fairfax, Manitoba

"I have used alpine for three years now going on four; I really like the vigour of the plants in cold early springs. we are noticing fast emergence and large root development compared to the fields around us using dry phosphate. I have been using micronutrients with our ALPINE in the seed row and find that a very efficient way to apply the micronutrients I need. when we first set up the ALPINE equipment we found it very easy to install on the drill and ALPINE being a highly available product with low use rates we do not need a lot of liquid storage. The product stores well over winter and ALPINE's Early Booking Program works quite well."

Kevin seeds 4200 acres with one 42 foot Seedhawk air drill with a 1200 gallon liquid tank on board, carrying enough ALPINE to seed 350 acres per fill.

Owen Cairns (Hillcrest Enterprises Ltd.)
13,000 acres - Coronach, SK

"After being in no-till for over 20 years we were seeing no response to phosphate fertilizer. After being introduced to ALPINE I liked the theory so we tried it for the first time in the spring of 2007. We instantly noticed the quicker crop emergence and had substantial yield increases compared to our checks with up to 25% yield increase on yellow peas. We also like the ease of handling the product."

Murray and Scott Wilson
4,500 acres - Melville, SK

"ALPINE Liquid Phosphate has been our source of phosphate for the past 24 years. 15 years in Eastern Canada and now 9 years in Western Canada. It has given our canola plants a better root system which has lead to higher yields. We also follow up with a foliar application of ALPINE and liquid Ammonium Sulphate which has also helped push yields. ALPINE has also been very convenient to use in our operation."

Phosphorus Product Comparison

10-34-0

(14.0 lbs/gal) x (0.34) = 4.76 lbs P_2O_5/gallon
times 5 gal/A
Equals 23.8 lbs P_2O_5/A

30% Ortho-phosphate
7.14 lbs/A in the Ortho-phosphate form

70% Poly-phosphate
16.66 lbs/A in the Poly-phosphate form

Even after 30 days, with a soil pH of 7.2, 50% of the phosphate will still be in the Poly-Phosphate form, being unavailable for the crop to utilize. TVA Research

—High impurities
—High viscosity, hard to meter evenly

Alpine

(12.7 lbs/gal) x (0.22) = 2.86 lbs P_2O_5/gallon
times 3 gal/A
Equals 8.5 lbs P_2O_5/A

70% Ortho-phosphate
5.95 lbs/A in the Ortho-phosphate form

30% Poly-phosphate
2.55 lbs/A in the Poly-phosphate form

—Includes Micro package
—No urea
—Low salt index, guaranteed seed safe
—Low impurity level
—Product storability
—Low viscosity
—Non-corrosive

Source: TVA Research

the starter fertilizer company

ALPINE

Remember:

- Take promotional material & testimonials with caution!
- Find out as much about the testing of the product or practices – does it measure up to the claims?
- Ask others for a second opinion!

- **USE CRITICAL THINKING!!**

Potassium

Soil test K determined as: **Potassium – K+**

K fertilizer recommendation: **K_2O**

K fertilizer sold as: **K_2O**

Potash fertilizer K form: Potassium Chloride (KCl)

New Agdex has up-to-date information and recommendations

Revised January 2013 Agdex 542-9

Potassium Fertilizer Application in Crop Production

Potassium (K) is required by all plant and animal life. While potassium is not a commonly limiting soil nutrient in crop production in Alberta, about 15 per cent of Alberta soils used for annual crop production are estimated to have slight to moderate potassium deficiency.

Adequate potassium results in superior quality of the whole plant due to the improved efficiency of photosynthesis, increased resistance to some diseases and greater water use efficiency. Potassium helps maintain a normal balance between carbohydrates and proteins.

Sufficient potassium results in stronger straw of cereal crops and assists in seed filling. Potassium deficiency in cereal crops results in reduced growth, delayed maturity, lodging caused by weaker straw and lower bushel weight.

Potassium deficiencies are most common on well drained, coarse-textured soils. These deficiencies can be corrected with potassium (potash) fertilizer (K_2O).

Potassium (K) is required by all plant and animal life.

Soil potassium

The majority of soils in Alberta contain sufficient plant-available potassium to satisfy crop growth. The total amount of potassium in soil often exceeds 40,000 kg/ha (36,000 lb/ac) in the top 15 cm (6 in) of soil. However, only 1 to 2 per cent of the total K in soil is in a form available to plants.

The parent geologic material on which Alberta soils developed generally contains considerable potassium-bearing clay minerals. Potassium becomes available to crops through weathering of these soil minerals.

There are three forms or pools of potassium in soil:

1. **Unavailable K:** About 90 to 95 per cent of the total soil potassium is contained in clay minerals. This pool of soil K is locked within the structure of the layered clay sheets and is not available to plants.
2. **Slowly available K:** About 5 to 10 per cent of the total soil potassium is slowly becoming available to plants. Weathering of the clay minerals occurs on the surface of the minerals and results in a very slow release of K from the unavailable K pool locked within the clay minerals. The weathering of clay minerals gradually releases K from the minerals to recharge the K removed from the available soil K pool.
3. **Available and exchangeable K:** The K in soil available to plants is dissolved in soil water while exchangeable K is loosely held on the exchange sites on the surface of clay particles. Typically, this K pool or fraction represents about 1 to 2 per cent of the total soil K. A portion of this pool is plant-available K dissolved in the soil water. The exchangeable K, which is positively charged (K+), is loosely held on the negatively charged exchange sites on the surface of clay minerals and is referred to as exchangeable K. As the available K dissolved in the soil water is taken up by plant roots, exchangeable K is released into the soil solution to maintain an equilibrium between the two forms. Soil tests attempt to measure the available and exchangeable K in soil to determine the K-supplying power for the soil K for crop production. Available and exchangeable levels of K generally range between 300 and 1,000 kg/ha (270 - 900 lb/ac) in Alberta soils in the top 15 cm (6 in) of soil. A very small percentage of Alberta soils have as little as 100 kg/ha (90 lb/ac) of available potassium. A minimum of 200 kg K/ha (180 lb/ac) in the top 15 cm (6 in.) of soil is generally required for adequate growth of most crops grown in Alberta.

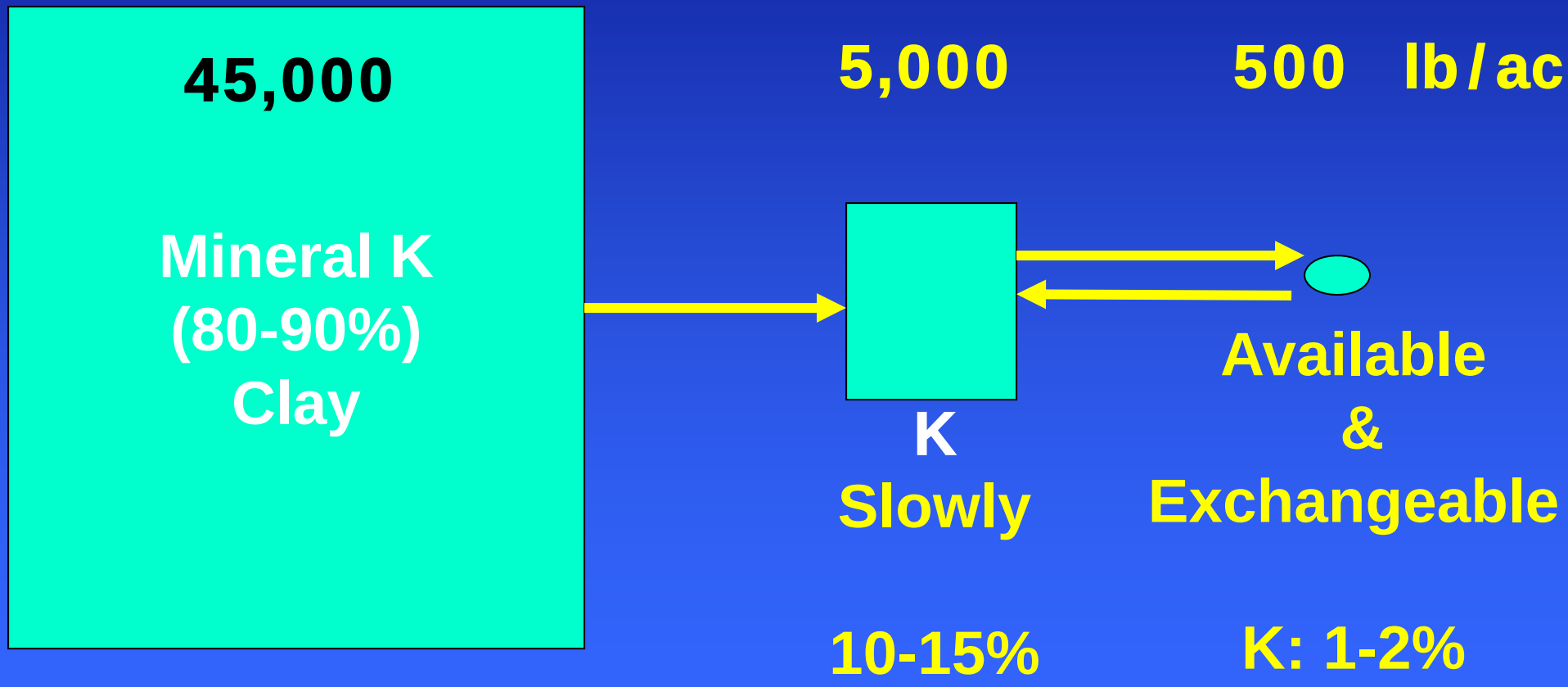
Potassium only occurs in soils in inorganic form and does not make up part of the soil organic matter. Potassium in soil solution and in exchangeable form occurs as a positively charged ion, K+.

Alberta Government

Potassium (K) in Soil:

- Soils high in clay have higher levels of K
- Sandy soils tend to have lower K levels
- Forage crops have the highest K requirements
- Sandy soils that are intensively cropped to high K requirement crops .
- Recommend K fertilizer when soil K is < 250 lb/ac.

Soil Potassium:



Application of K Fertilizer:

- K has limited movement in soil – therefore placement near the seed will improve uptake.
- KCl fertilizer has a high salt index - too much seed-placed K will decrease germination and emergence
- Seed-placed K should not exceed 15-20 lb/ac when SBU is <10% for cereal crops
- Higher rates must be banded or side-banded to reduce potential damage

Potash Fertilizer: Potassium Chloride (KCl)

- Majority of Alberta and Saskatchewan soils are not K deficient (>75%) & do not need K fertilizer!
- However, there are times when barley will response to KCl fertilizer.
- It is believed that the Cl at times (15% based on Penney & Robertson) will aid in reduced incidence of root diseases, particularly take-all root rot.

Response of Barley to K in Alberta

Soil test level (lb K/ac)	No. of Responsive sites (%)
<50	100
50-100	75
100-150	66
150-200	24
200-250	18
>250	3

Potassium recommendations for canola in Alberta (lb/ac):

Soil K: 0-6” (lb/ac)	K_2O (lb/ac)	
<100	100	K IS Recommended
150-100	80	
200-150	40- 60	
250-200	20- 40	
300-250	20	K maintenance applic.
>300	0	K NOT Required unless K is variable in field

Sulfate Sulfur (SO_4^{-2} – S)

Elemental Sulfur (S)

New Agdex has up-to-date information and recommendations

Revised February 2013 Agdex 542-10

Sulphur Fertilizer Application in Crop Production

Sulphur (S) is an essential plant nutrient required by all crops for optimum production. Plants take up and use S in the sulphate (SO_4-S) form, which like nitrate (NO_3-N), is very mobile in the soil and is prone to leaching in wet soil conditions, particularly in sandy soils.

Sulphur deficiencies are becoming increasingly common in Alberta. Deficiencies can be easily corrected with fertilizers containing sulphate (SO_4). Generally, S is the third most limiting soil nutrient in cereal, oilseed and forage crop production in Alberta. It is third only to nitrogen (N) and phosphorus (P) in fertilizer use in Alberta.

Background

Oilseed crops, particularly canola, and forage crops, have a higher S requirement than cereal crops. Table 1 provides examples of nutrient uptake and removal by wheat, canola, pea and alfalfa. Sulphur is required in the development of fertile canola flowers and must be present for good nodule development on legume forages such as alfalfa and pulse crop roots such as pea and faba bean.

In Alberta, an estimated 6 to 8 million acres are considered potentially S deficient for optimum canola production, and the potentially deficient areas are increasing due to increased crop yields and increased canola production, which is drawing down S soil reserves.

Soil organic matter is the primary source of plant-available SO_4-S in surface soil. Soils that are sandy, low in organic matter and found in upper to mid-slope field positions are particularly prone to S deficiency since only a small amount of SO_4-S is released from organic matter and is susceptible to leaching loss.

The subsoil of Brown and Dark Brown soils in southern and south central Alberta often have an abundance of gypsum, which is calcium sulphate ($CaSO_4$). This mineral is an important source of plant-available S in these soils.

Table 1. Nutrient levels taken up and removed by average yields of canola, wheat and alfalfa in Alberta

Crop	Yield	Crop Part	Nitrogen N	Phosphate P_2O_5	Potassium K_2O	Sulphur S
			(lbs/acre)			
Canola	35 bu/ac	Seed	60-75	30 - 35	15 - 20	10 - 12
		Seed/straw	100 - 115	45 - 50	75 - 85	17 - 20
Wheat	50 bu/ac	Seed	60 - 75	24 - 28	70 - 85	10 - 12
		Seed/straw	85 - 110	32 - 36	15 - 22	5 - 6
Pea	50 bu/ac	Seed	100 - 120	30 - 35	30 - 35	6 - 7
		Seed/straw	130 - 150	35 - 45	120 - 140	10 - 14
Alfalfa	5 tons/ac	Total	260 - 320	60 - 75	270 - 330	27 - 33

Alberta Government

Sulfur in Soil:

- S in surface soil (0 to 6”) is often low at the end of the growing season.
- But S is often adequate to high in sub soil
  - SO - do you need S fertilizer
- If surface soil is LOW– need S fertilizer to get crop through vegetative growth until roots are into sub-soil!

Yellowing of newly emerging leaves is an indicator of sulphur deficiency in wheat, other cereals and forage grasses.

Sulphur deficiency symptoms in canola: leaf cupping.

Soil Test Results (0-6 and 6-12”)

- A **deficient** result means the field is deficient.
  < 10 lb/ac
- A **marginal** result means the field could be either marginal and/or deficient.
  10 to 20 lb/ac
- An **adequate** result means the field may be a combination of adequate, marginal and/or deficient.
  > 20 lb/ac

Sulfur Fertilizer Recommendations

- When soil is marginal or deficient in sulfate apply 10 to 20 lb/ac of sulfate sulfur.
- Use sulfate fertilizer (21-0-0-24) when soil is deficient.
- Only use elemental S (0-0-0-90) in a building program - it will not correct a problem in the year of application.

Micronutrients:

Essential vs Non-essential

Essential	Non-essential (Essential in some respects)
Boron	Cobalt
Chlorine	Nickel
Copper	Selenium
Iron	Silicon
Manganese	Sodium
Molybdenum	
Zinc	

Table 2. Range levels of micronutrients in soils.

	Deficient	Medium	Adequate
Boron (Hot Water Extracatable - ppm)	0.0 - 0.4	0.5 - 1.2	>1.2
Chlorine (Water Extractable - ppm)	0.0 - 8.0[a]	-	-
Copper (DTPA Extractable - ppm)	0.0 - 0.2[b]	0.3 - 1.0	>1.0
	0.0 - 0.5[c]	0.6 - 1.0	>1.0
	0.0 - 2.5[d]	-	>2.5
Iron (DTPA Extractable - ppm)	0.0 - 2.0	2.0 - 4.5	>4.5
Manganese (DTPA Extractable - ppm)	0.0 - 1.0	-	>1.0
Zinc (DTPA Extractable - ppm)	0.0 - 0.5	0.5 - 1.0	>1.0

[a] This level is used by some labs as a critical level for recommending Cl for disease suppression in cereals.
[b] Brown and Dark Brown soil areas.
[c] Black and Grey Wooded soil areas.
[d] Organic soils.

Melanosis - wheat

Irregular shaped areas within a field

Whip Tailing and Pig Tailing

Copper deficiency

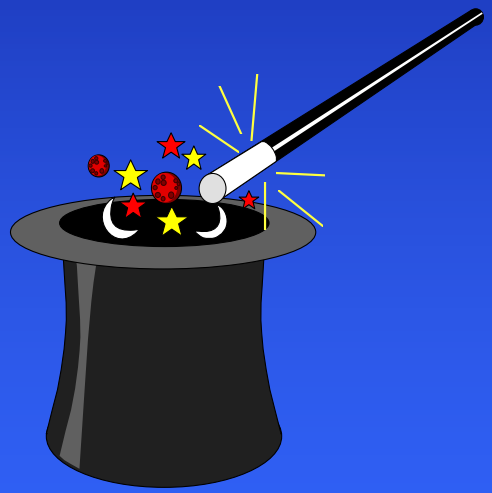
↓

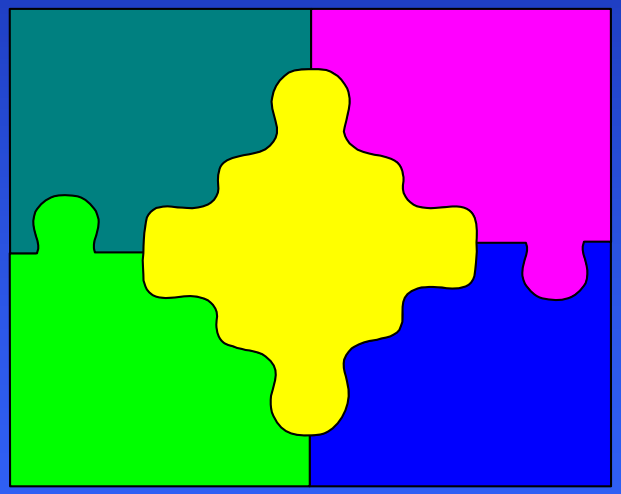
Open florets

↓

ERGOT

Micronutrients: Are important for crop nutrition but are not magical and will not make up for poor crop management!





Summary:

1. With continued cropping, soil micronutrient levels will slowly decline

   -However, in most regions - most crops still do not require micronutrient fertilizers.

2. Need to constantly watch micronutrient soil test results and observing fields for signs of potential micronutrient deficiency problems.

3. If potential problems are observed – contact your Regional Crop Specialist

   - start with on-farm trialing

Soil Fertility and Plant Nutrition

- Canola, wheat and barley respond well to N, P, K and/or S, when soil levels are deficient.
- N and P are frequently deficient
- K is occasionally deficient (<25%)
- S is occasionally deficient but frequently recommended for Canola (~40-60%)

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Cation Exchange Capacity (CEC)
Base Saturation (%BS)

% Base Saturation:

Base saturation is the % of exchange sites occupied by basic cations

Basic cations: Ca + Mg + K + Na

Acidic cations: H and Al

$$\%\ \text{Base Sat (\%BS)} = \frac{Ca + Mg + K + Na}{Ca + Mg + K + Na + H + Al} \times 100$$

When all soil exchange sites are occupied by base cations, the % BS = 100%

Seed Recommendations

Crop Type	Variety	Germ.	Mortality	TKW	Plants/Ft^2	Rate	Comments

Soil Test Report

Depth	OM	P	P1	P2	K	Mg	Ca	pH	pH B	CEC	% K	% Mg	% Ca	% H	% Na
0-6" - 1-A	3.9	18	24	0	265	930	4290	7.2	0	32	2.1	24.2	67	4.8	1.9
6-12" - 1-B	2.3	6	9	0	173	1605	7200	7.6	0	51.6	0.9	25.9	69.7	0	3.5
12-24" - 1-C	1.2	0	0	0	157	1645	7130	7.9	0	53	0.8	25.9	67.2	0	6.2

Depth	S	N	Zn	Mn	Fe	Cu	B	Mo	SS	Sat P%	Al	K/Mg	Cl	Na	Base Sat.
0-6" - 1-A	76	12	1.8	69	51	2	1.3	0.472	0.6	9	340	0.09	16	137	
6-12" - 1-B	1103	5	0	0	0	0	0	0	1.7	7	161	0.03	0	420	
12-24" - 1-C	1364	12	0	0	0	0	0	0	2		0	0.03	0	751	

Soil Placement Recommendations

Comment	Placement	Type	N	P	K	S	Mg	Ca	Cl	B	Cu	Fe	Mn	Zn
Spring 37.25 gals/acre	Side band	Liquid	24.2	51	38	12	0	0	0	0	0	0	0	0
Spring Urea 154 lbs/acre	Mid-Row Band	Dry	71	0	0	0	0	0	0	0	0	0	0	0
Early Season 8.2 gal /acre	Fertigate	Liquid	24	0	0	0	0	0	0	0	0	0	0	0
	Application Total		119.2	51	38	12	0	0	0	0	0	0	0	0

Other/Foliar Recommendations

Comment	Product	Rate	Stage
Early-season	Zinc	1 lb/ac	A few strips in this field at seeding
Midseason	Fungicide	lb/ac	Early flag leaf stage if required
Midseason	Copper	500 mL/ac	Early flag leaf stage if required

Potassium soil test levels in this field shows some variability through the years of testing, slightly stronger this year. Degree of stratification is very similar. The percent K. base saturation level slightly below target. Whereas the K. to MG ratio has well below target because of the very strong magnesium levels.

Sulphur (S)
Sulfur soil test levels in this field shows some fairly extreme variability through the years of testing. Due to the mobility of sulfur a general application is recommended to ensure there are no areas of deficiency.

Magnesium (Mg)
Magnesium soil test levels in this field are very strong. Magnesium soil test levels are even slightly higher in this year sample as compared the last year sample. The very strong percent Mg base saturation level indicates some issues, like a soil that tends to seal of wondering conditions. Or a soil that works up in huge clumps when dry, or a soil that has wide cracks in it when dry. Applications of gypsum in seed row could be very positive.

Calcium (Ca)
Calcium soil test levels in this field shows some variability, generally levels appear to be adequate

Basic Cation Saturation Ratio (BCSR):

- Originally used in eastern USA (Bear et al. 1948) to recommend K, Ca & Mg based on BCSR
- Only used on 1:1 clay (kaolinite) soils with very low CEC in the range of 1 to 5 with a low base saturation
- It does not work for 2:1 clay (smectite) soils with high CEC capacity.
- Is not used for N, P, S or micronutrients
- It is a flawed approach to making K , Ca or Mg fertilizer recommendations on soils with higher CEC and % BS on the Canadian prairies!!