Contemporary Soil Fertility Issues

Rigas Karamanos

Have I given a presentation like this before?

47 times!

21 times in Manitoba

1998 Winnipeg, Brandon, Dauphin, Stonewall, Arborg, Dunrea

1999 in Morden, Gross Isle, St. Jean, Brandon, The Pas

2001 in Dufrost

2007 in Winnipeg, Oak Hummock Marsh

2012 in Starbuck

2013 in Franklin and Dauphin

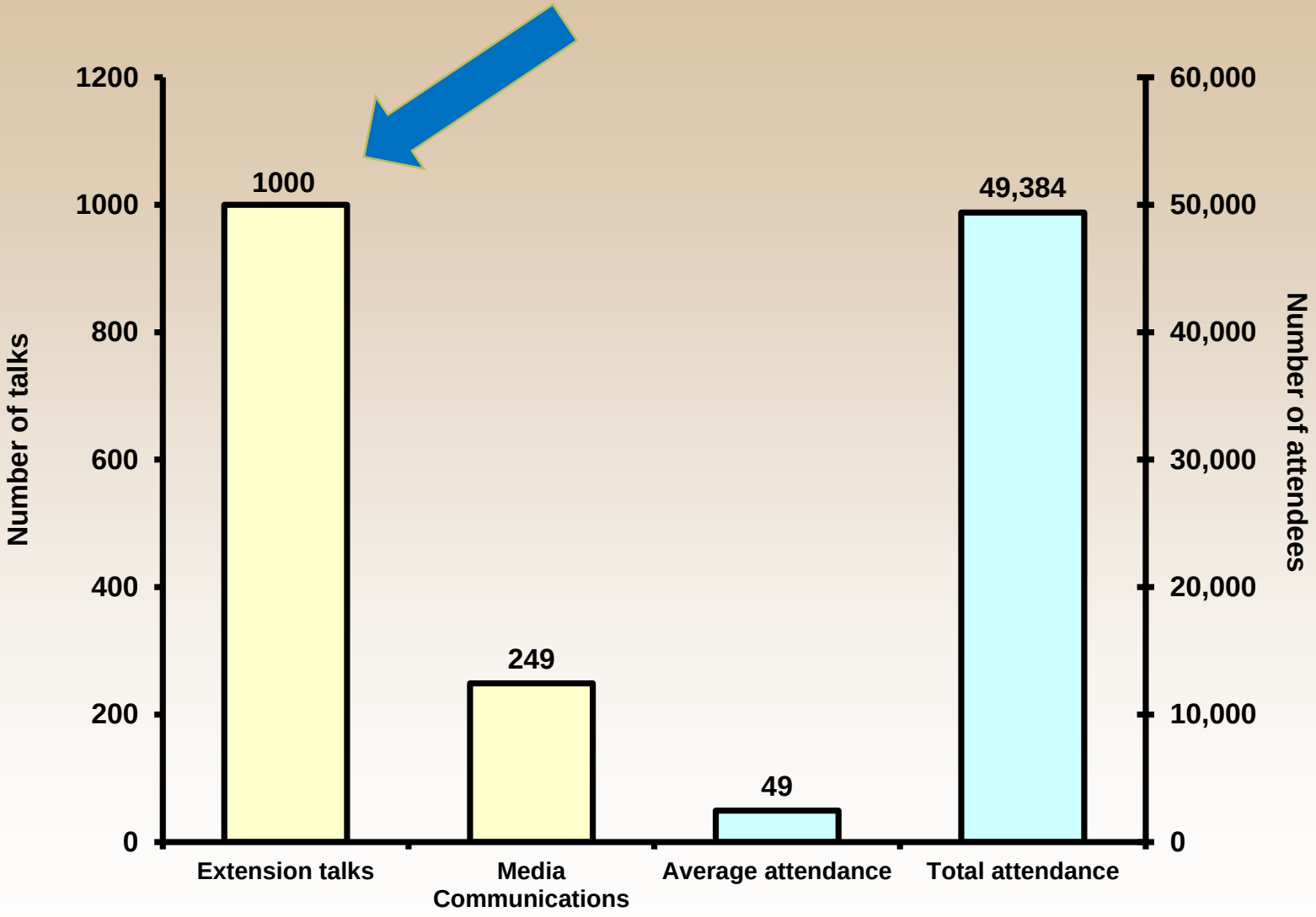
2016 in Meadows and Minnedosa

2017 in Winnipeg

2018 in Oakbank and Winnipeg

Then…

- Reducing risk in Agriculture with proper fertilization
- Soil Testing
- Agroeconomics
- Balanced Nutrition - What does it mean?
- Banding vs. Broadcasting my Nitrogen
- Phosphorus and Late Spring - Phosphate Efficiency
- Pro & Cons of Topdressing
- Sulphur - elemental S
- Micronutrients and Seed "primers"
- Potassium fertility of heavy clay soils
- Shallow banding of Nitrogen – potential for losses?
- The $5.50 product – will you buy it?
- Saline vs. sodic vs. alkaline soils – what is the difference?
- Variable Rate Fertilization
- Virtual Soil Test
- Forage Fertility


Number of talks
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1000
800
600
400
200
0
60,000
50,000
40,000
30,000
20,000
10,000
0
Number of attendees
1000
249
49
49,384
Extension talks
Media Communications
Average attendance
Total attendance

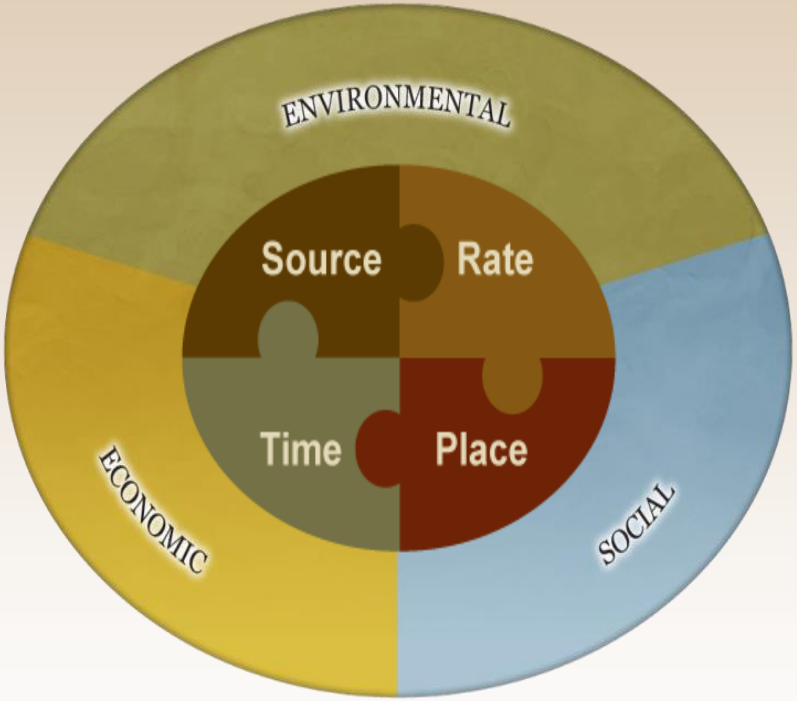
Today's most common questions

- Pros and cons of topdressing
- Phosphorus fertility - balancing need to application rates
- Surface application of Nitrogen – potential for losses?
- Boron

Our guiding principle: 4R Nutrient Stewardship

Right Source @ Right Rate, Right Time & Right Place

- Linking practices to science for sustainability performance



Courtesy IPNI

Pros & Cons of Topdressing

Topdressing N wheat

Questions:

Are post-emergent applications of N agronomically viable to achieve:

- **Higher grain protein levels?**
- **Higher grain yields?**

If so, what are the appropriate:

- **Rates?**
- **Time of application?**
- **N products?**

Effect of Soil and Post-Emergent N Rates
Overall N response

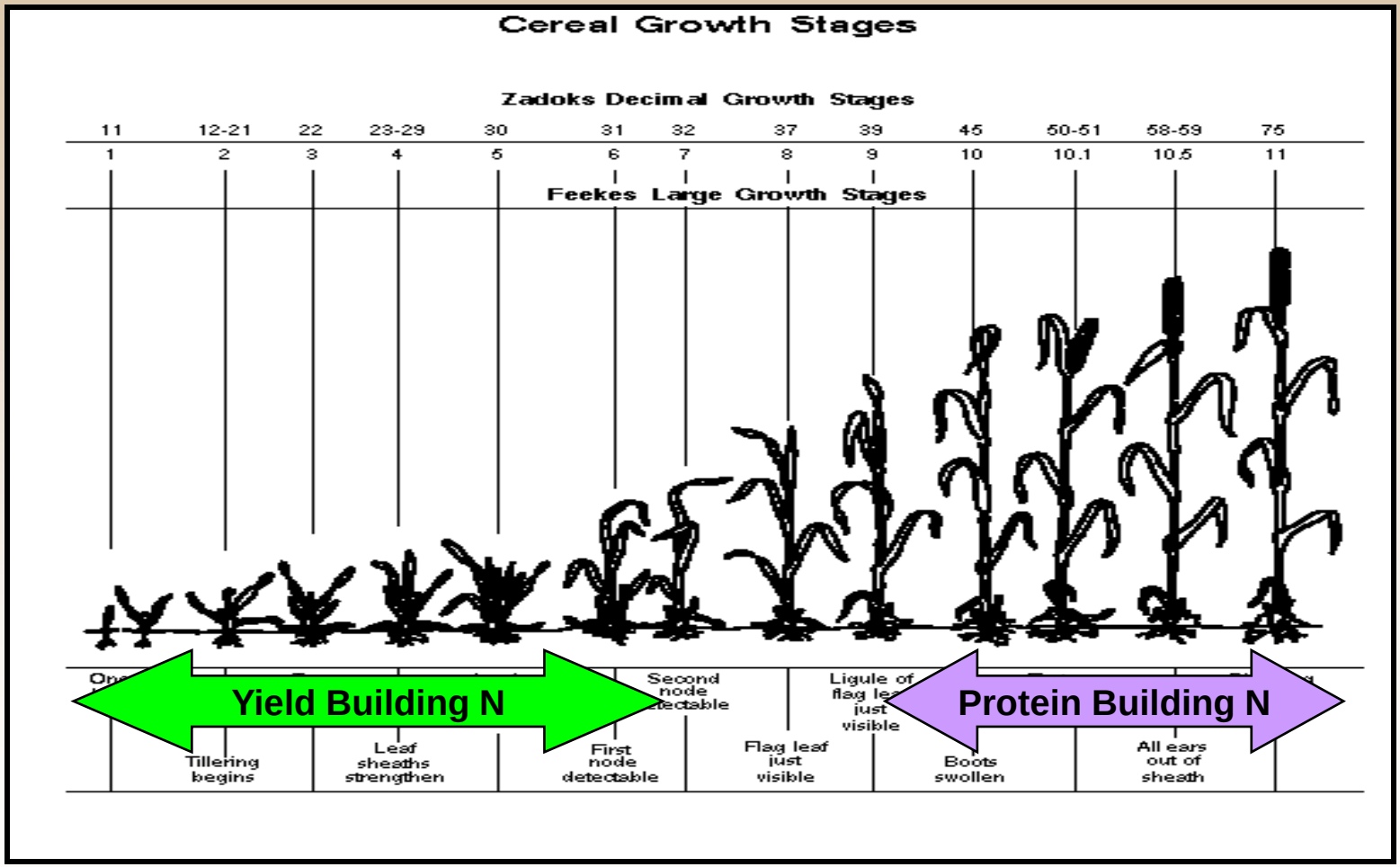
Own research*: Soil test N and growing season precipitation explained 78% of the yield increase due to N application

Other research (Selles et al. 2003**):

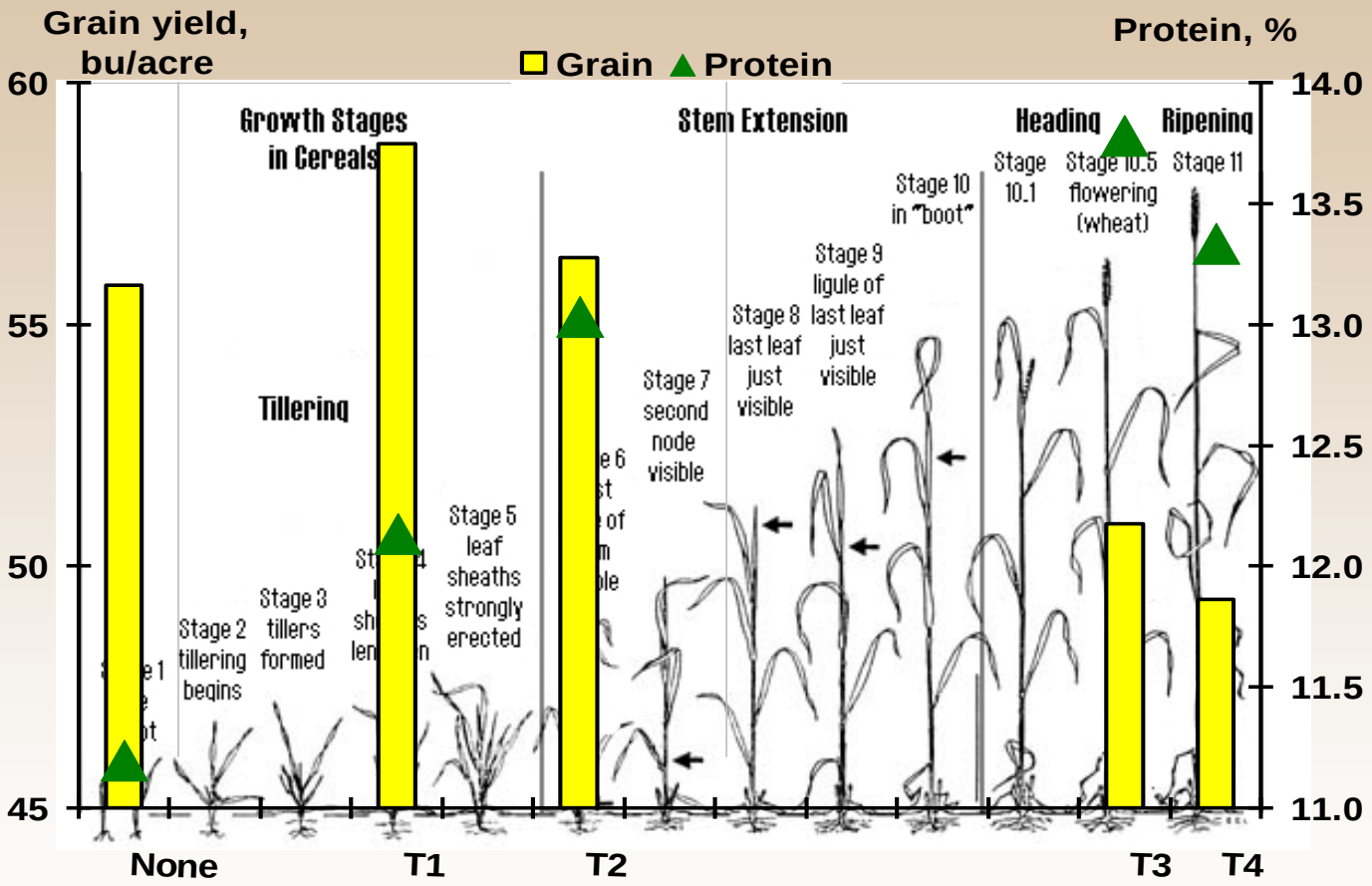
Factor	Contribution to Protein Variation
Cultivar (protein yield)	3%
N Fertility	70%

*** Karamanos et al. 2005. Can. J. Plant Sci. 85: 327–342.**

Plant Growth Stage and N Uptake

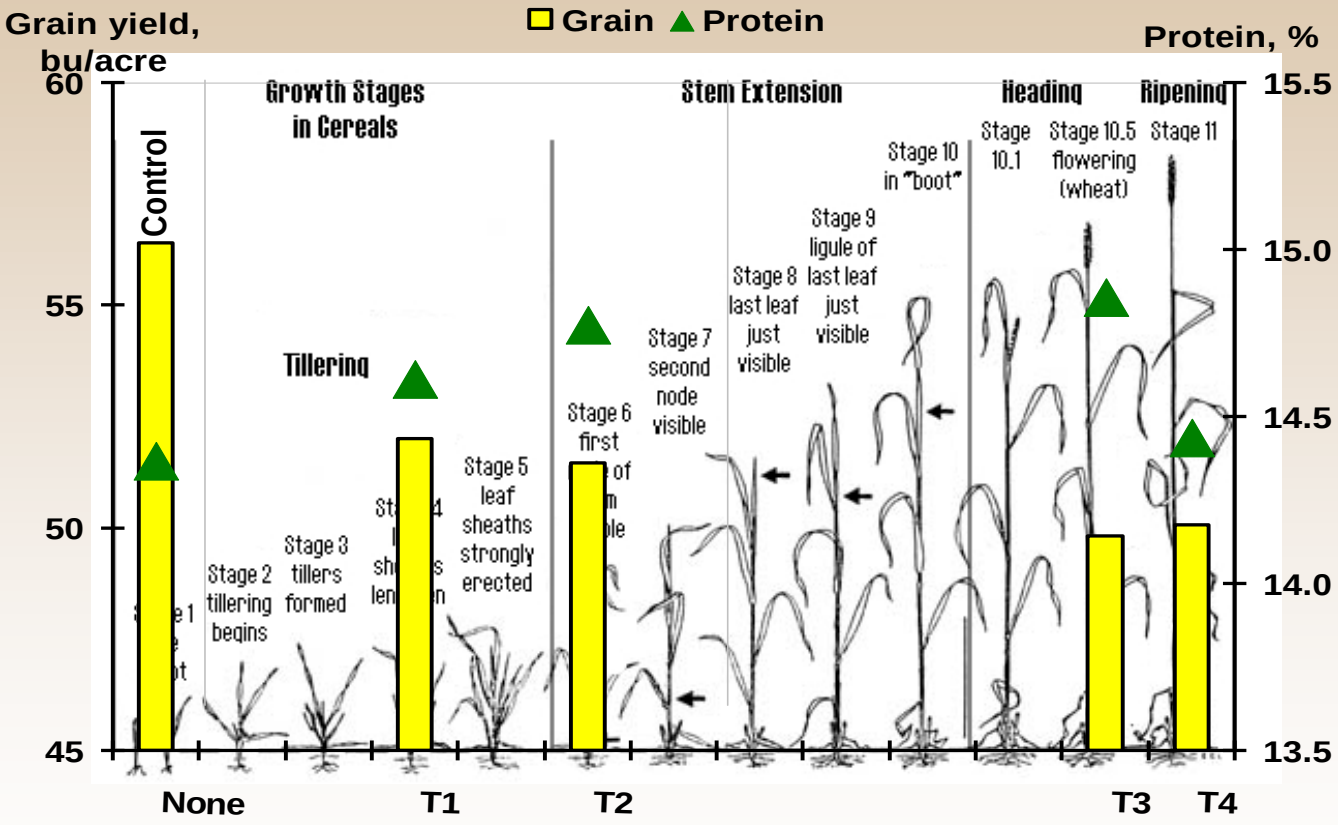


Take away 20 lb N/acre



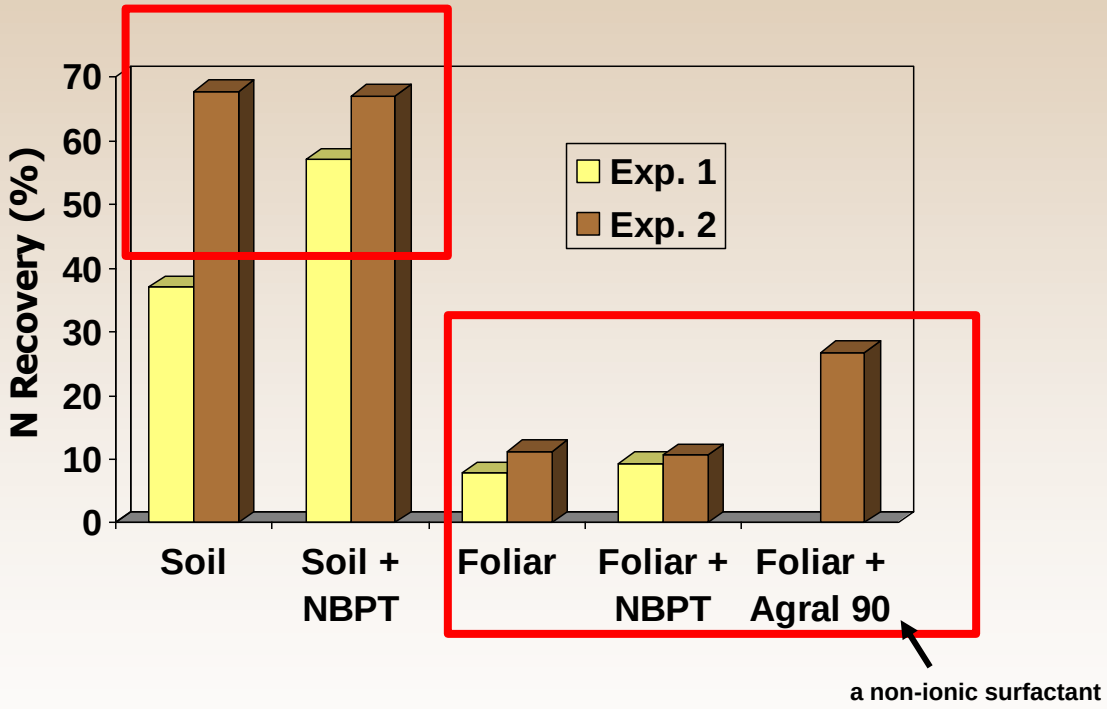
Karamanos et al., 2005. Can. J. Plant Sci. 85, 327-342.

Take away 40 lb N/acre



Karamanos et al., 2005. Can. J. Plant Sci. 85, 327-342.

Uptake of foliar-applied UAN by wheat is very low compared to soil application



*Rawluk, Grant and Racz . 2000. Can. J. Plant Sci. 80: 331–334

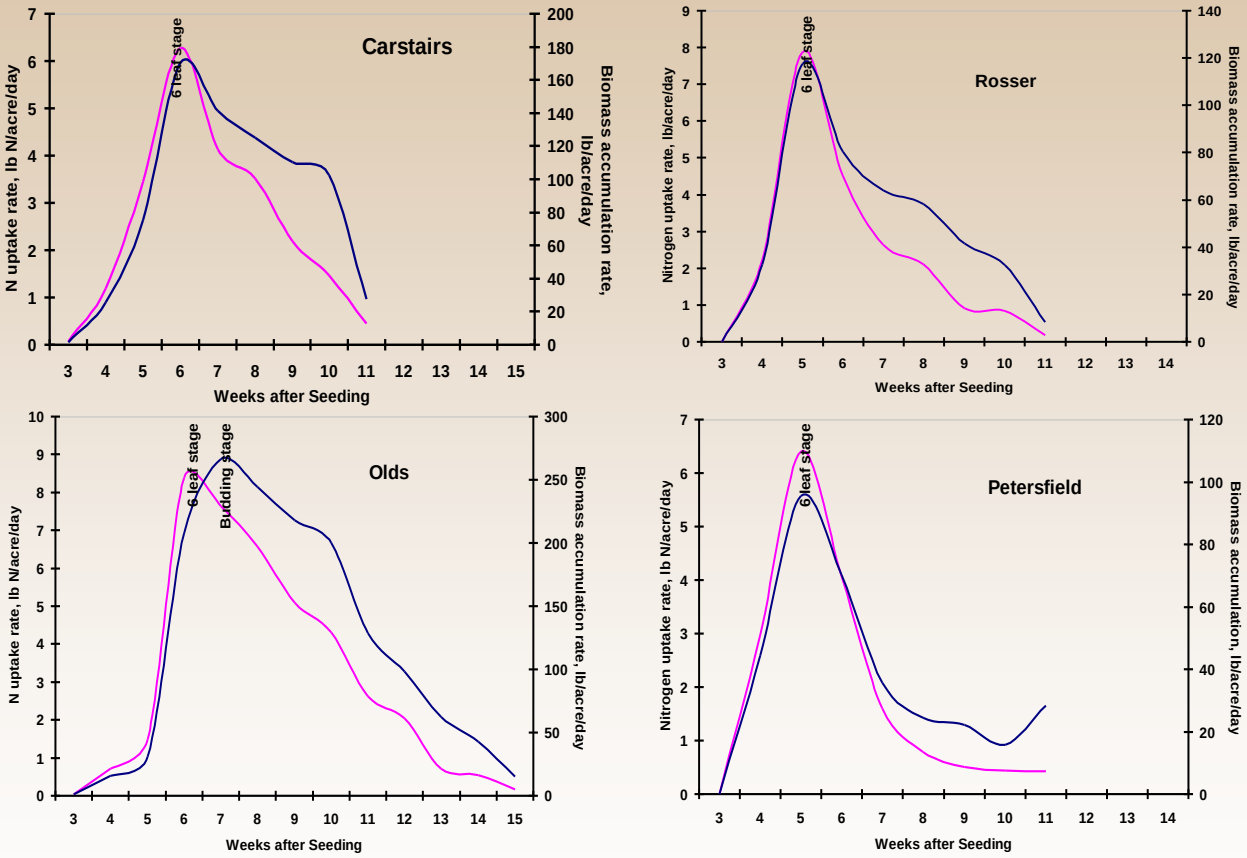
Conclusions for wheat in w. Canada

- Effect of topdressing:
  - N deficiency corrected by N application at or prior to seeding -> increase in grain protein but overall no economic benefit
  - N deficiency not corrected by N application at or prior to seeding -> increase in grain protein but loss in yield and no economic benefit (actually loss)
- **Post emergent application of N to enhance either grain yield or grain protein of dryland wheat in western Canada is a high risk practice.**

R.E. Karamanos, N.A. Flore and J.T. Harapiak, 2005. Effect of post-emergence nitrogen application on the yield and protein content of wheat. Canadian Journal Plant Science 85, 327-342.

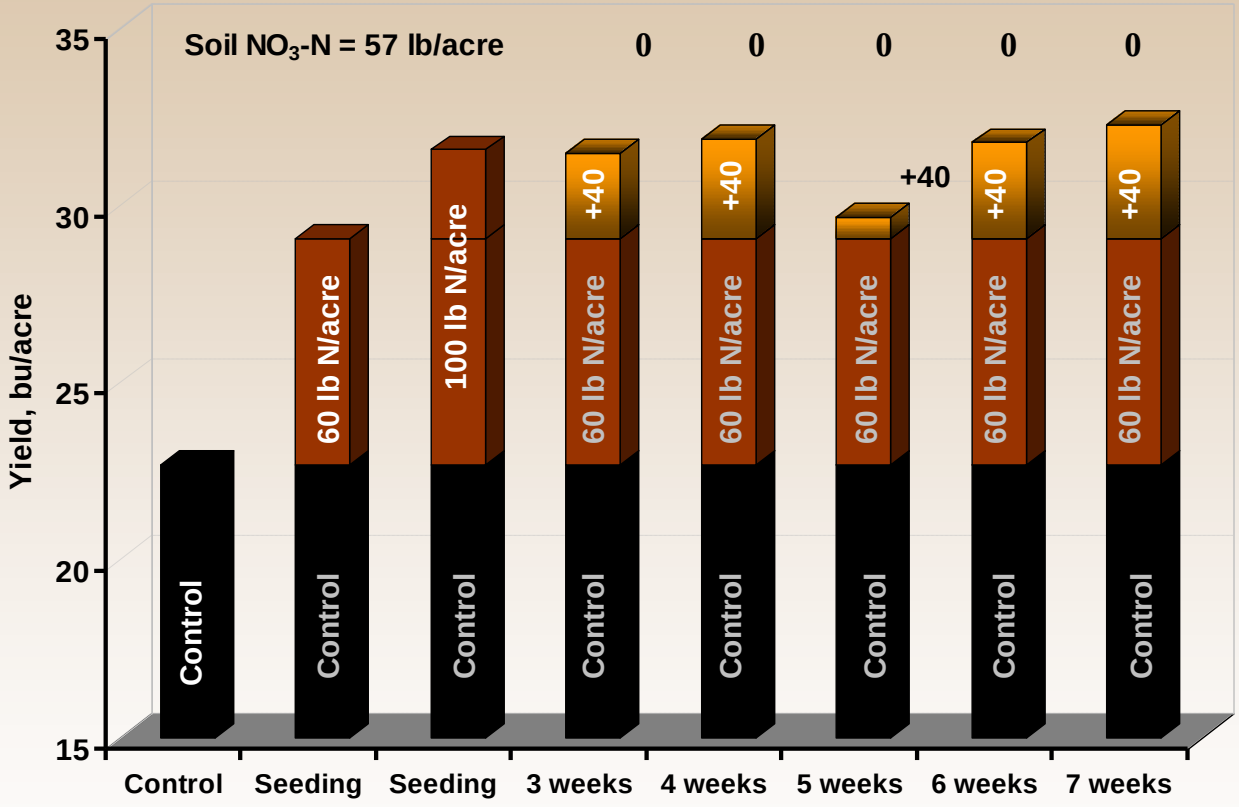
Topdressing N canola

Daily N uptake*



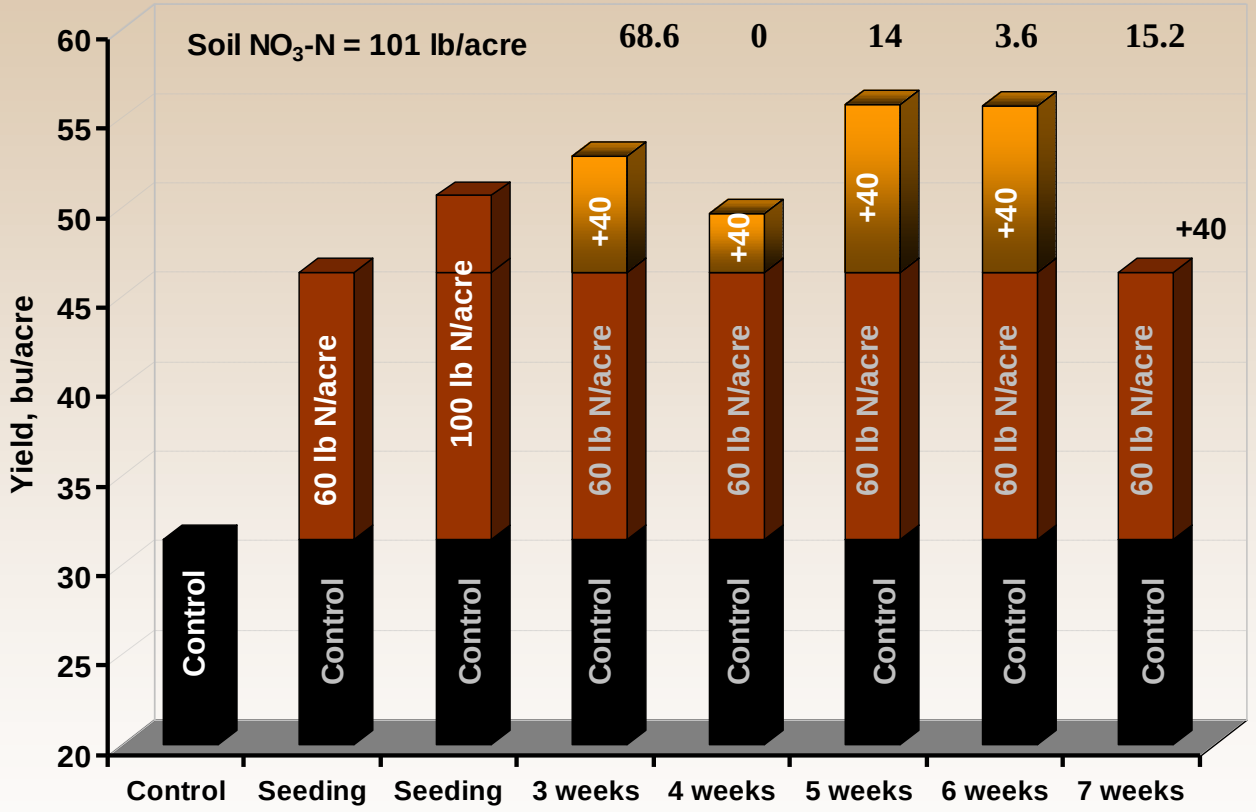
*Karamanos et al. 2004. Soils and Crops 2004

Topdressing - Rosser



*Karamanos et al. 2004. Soils and Crops 2004

Topdressing - Petersfield



*Karamanos et al. 2004. Soils and Crops 2004

Conclusion*

Post emergent application of N to enhance grain yield of canola has to occur prior to the 6th leaf stage and is predicated on the crop receiving adequate rainfall.

Splitting N applications could be an advantage if it remains dry and there is no need for additional N

It can be uneconomical because of:

- **extra cost of application**
- **damage to standing crop**

It is considered a "high risk" practice

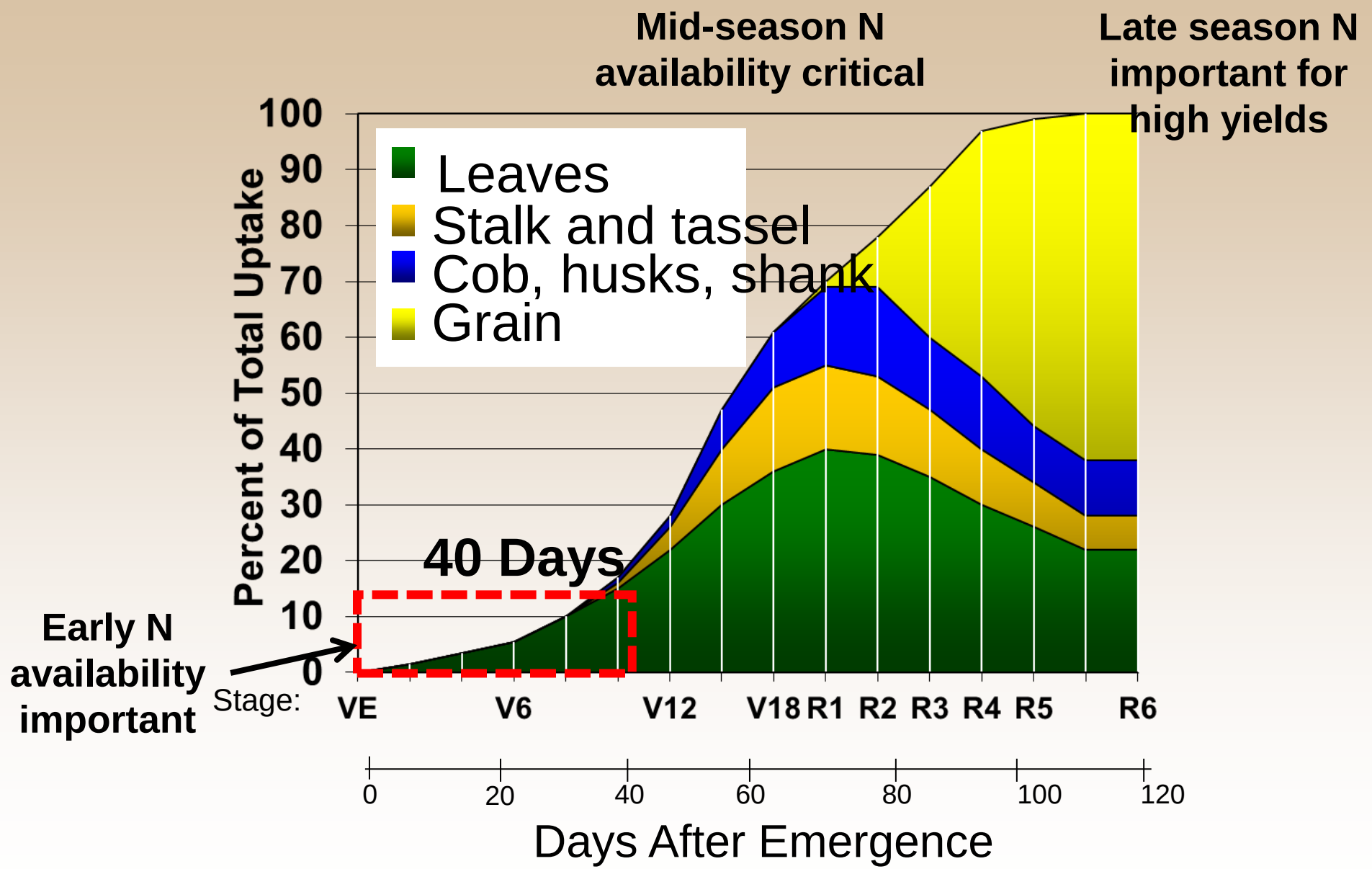
Emergency practice ONLY

*Karamanos et al. 2004. Soils and Crops 2004

Exception!

Corn

Nitrogen Uptake in Corn



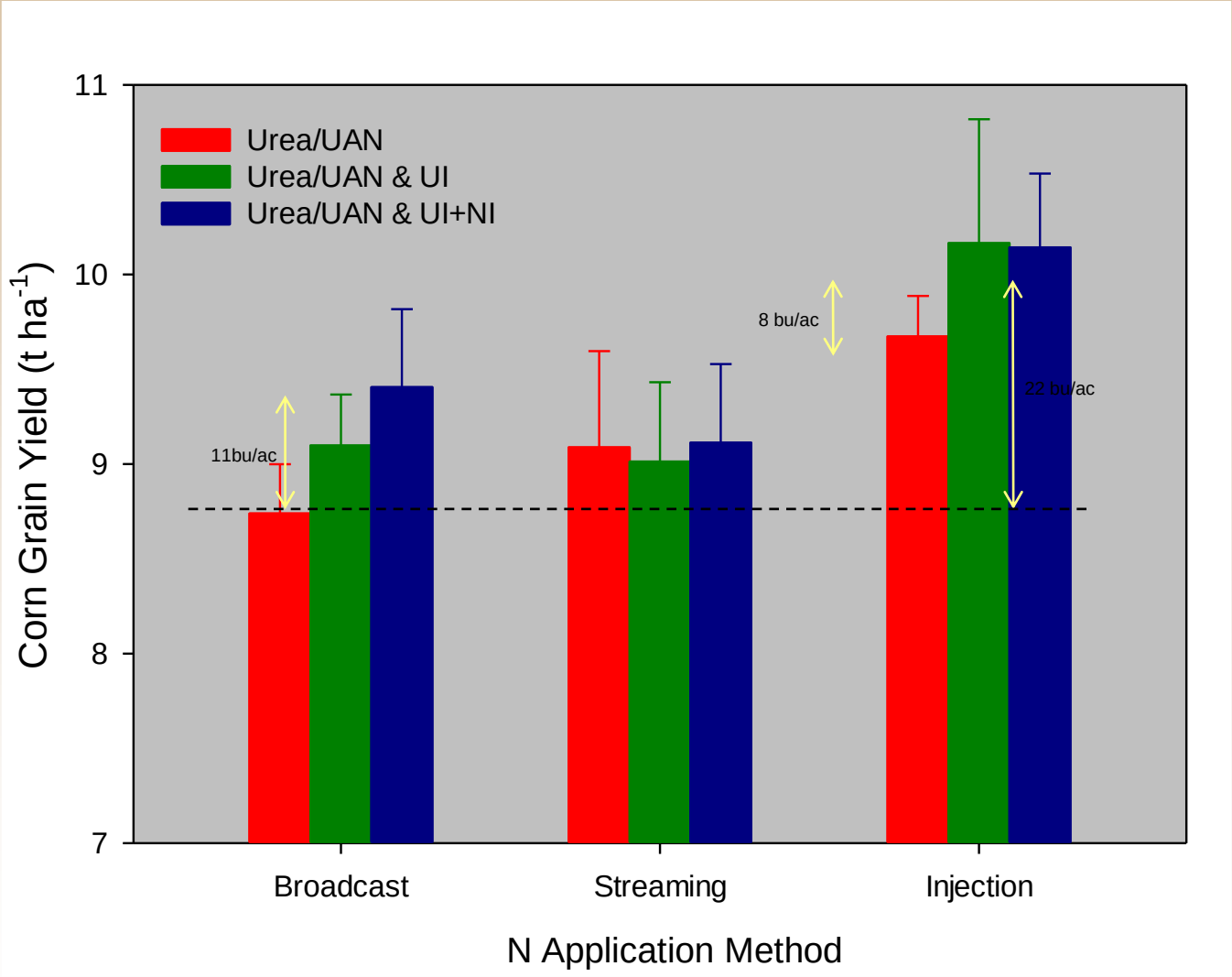
Source: Adapted from How a Corn Plant Develops, Special Report 48 Iowa State University

How Do We Insure Adequate N Availability for Corn?

Apply early and a lot! **NO!!**

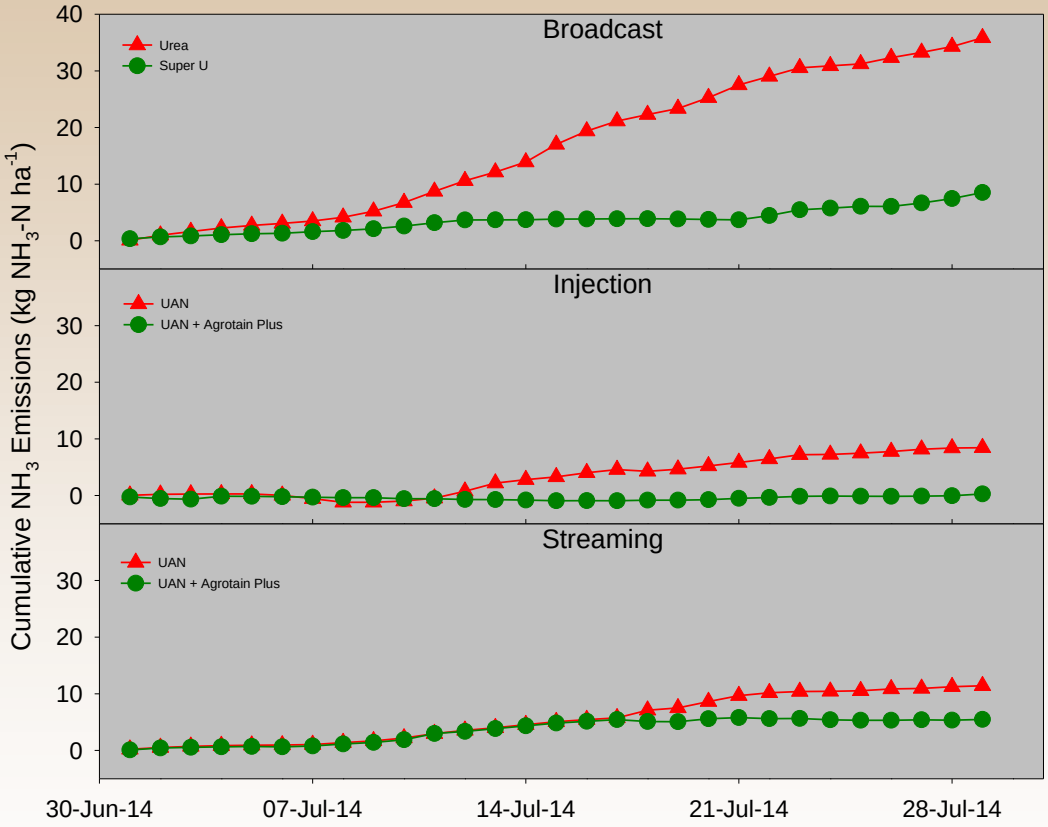
- **Economics**
- **Environment**

Corn Grain Yields



Courtesy: Craig F. Drury, Agriculture & Agri-Food Canada, Harrow, Ontario

Cumulative Ammonia Volatilization



Courtesy: Craig F. Drury, Agriculture & Agri-Food Canada, Harrow, Ontario

Phosphorus fertility

balancing need to application rates

Fertilizer P Efficiency

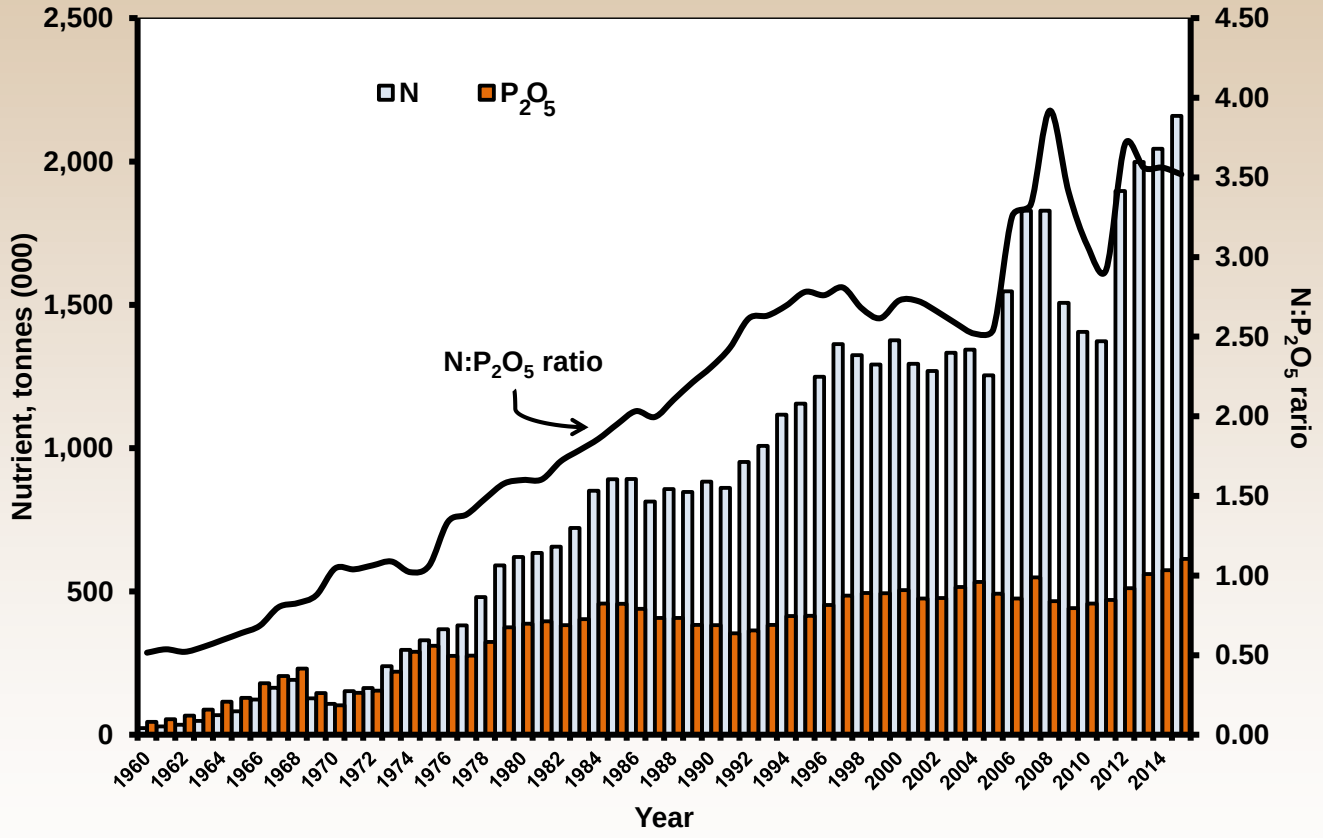
15 to 30 % the first cropping year after application

WHY?

roots only explore 1-3% of the soil volume

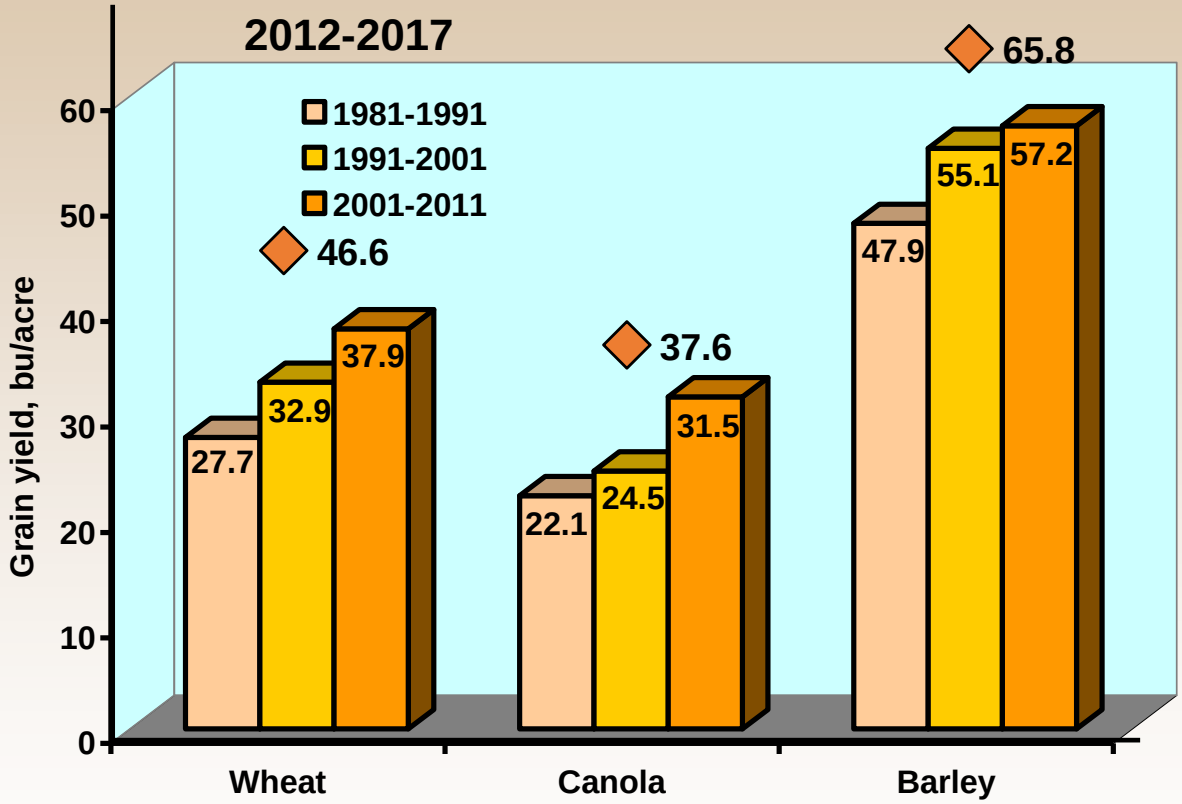
diffusion is a slow and short-range process

$N:P_2O_5$ ratio in western Canada



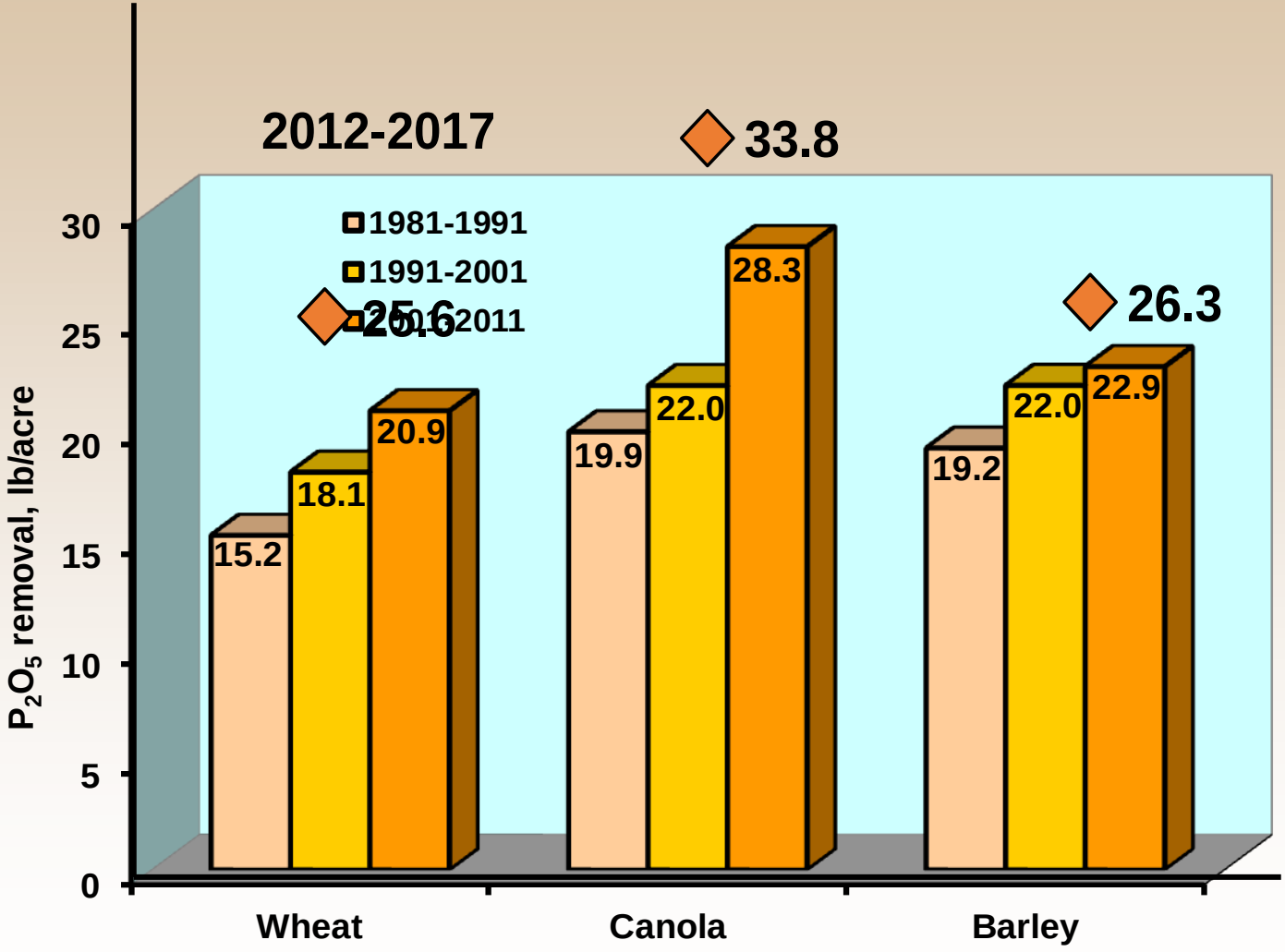
Based on data from: http://www5.statcan.gc.ca/cansim/a26

Yields of crops over the last three decades



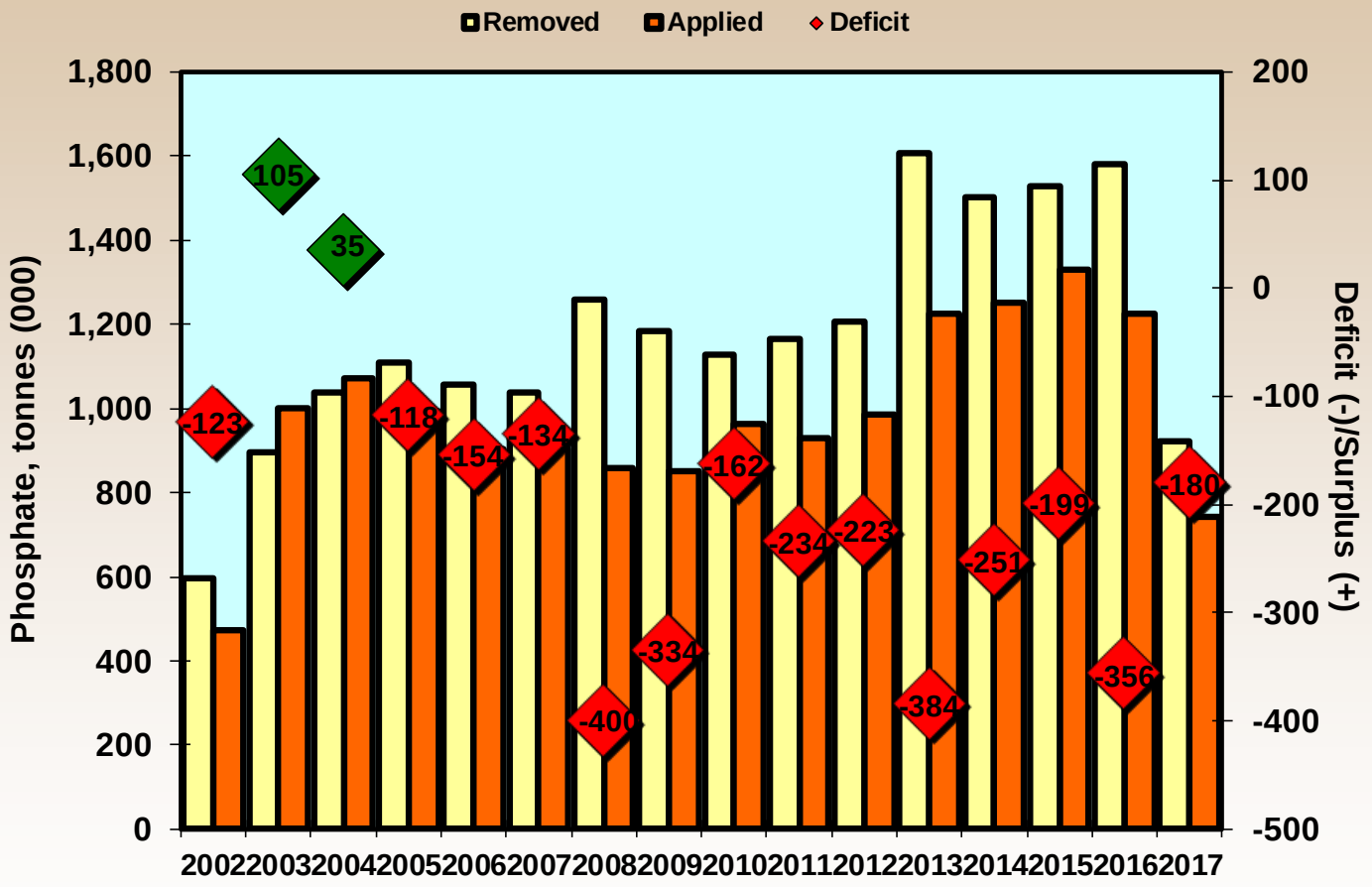
Based on data from: http://www5.statcan.gc.ca/cansim/a26

Phosphate removal based on average yields



Crop	P removal
Wheat	0.55
Canola	0.9
Barley	0.4

Phosphorus – The forgotten macronutrient?



*Canadian Fertilizer Institute: http://www.cfi.ca/publications.cfm, or
International Plant Nutrient Institute: http://www.ipni.net/article/IPNI-3296

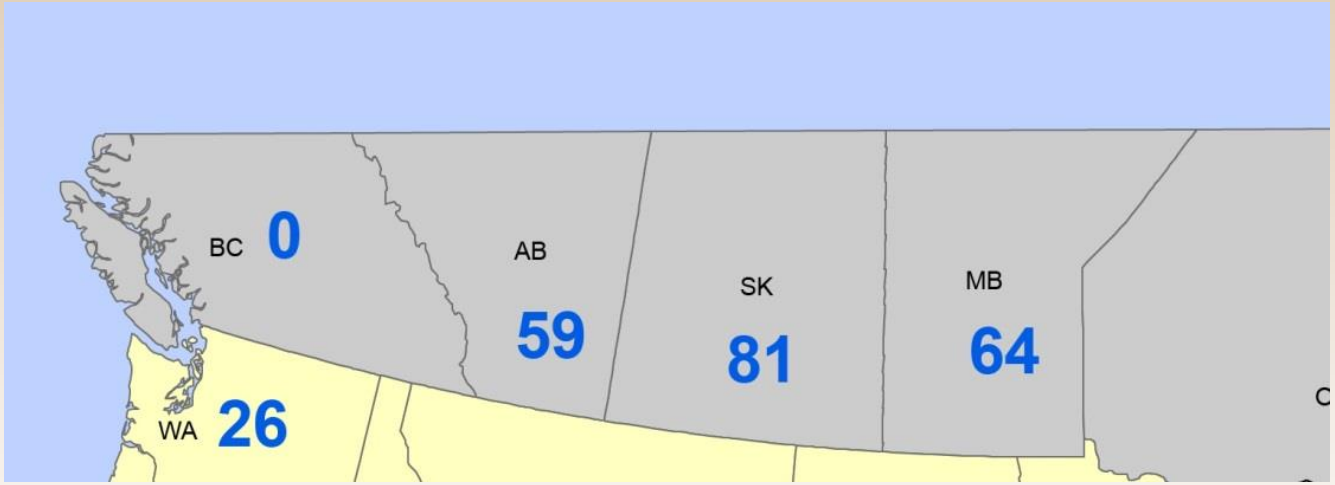
IPNI*

A general rule of thumb is: 12 to 28 pounds of P_2O_5 above crop removal are required to raise the soil test phosphorus level one part per million.

The amounts of P_2O_5 (and K_2O) required will depend on the initial soil test level, the rate of crop removal, the soil texture, clay minerals present, organic matter level, and tillage system.

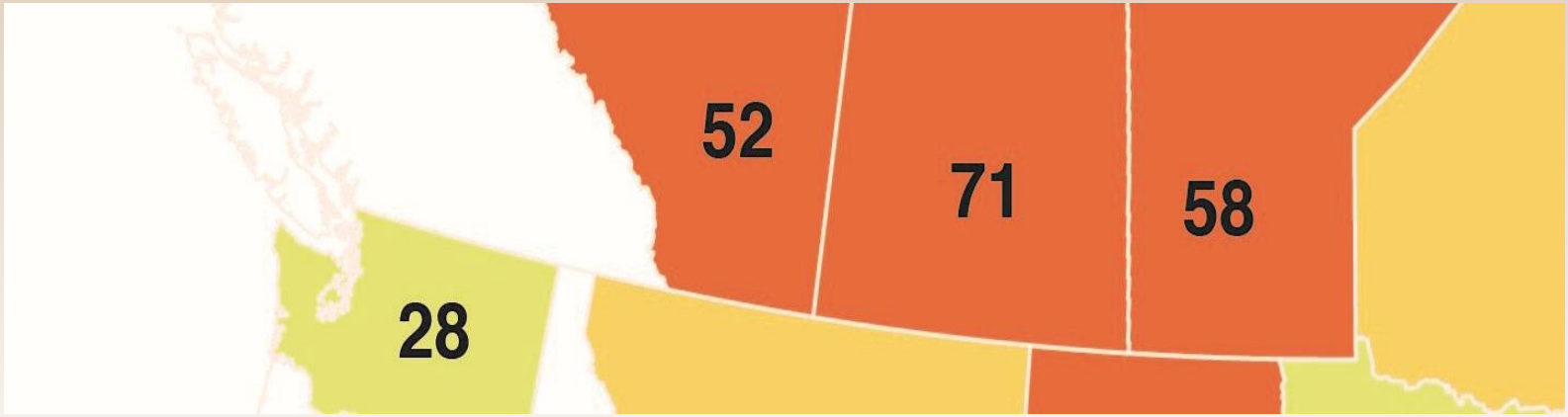
https://www.ipni.net/ppiweb/agbrief.nsf/$webindex/article=47A7A85E852569670056EC4A3057B332

Percent of samples testing below the critical level, 2015



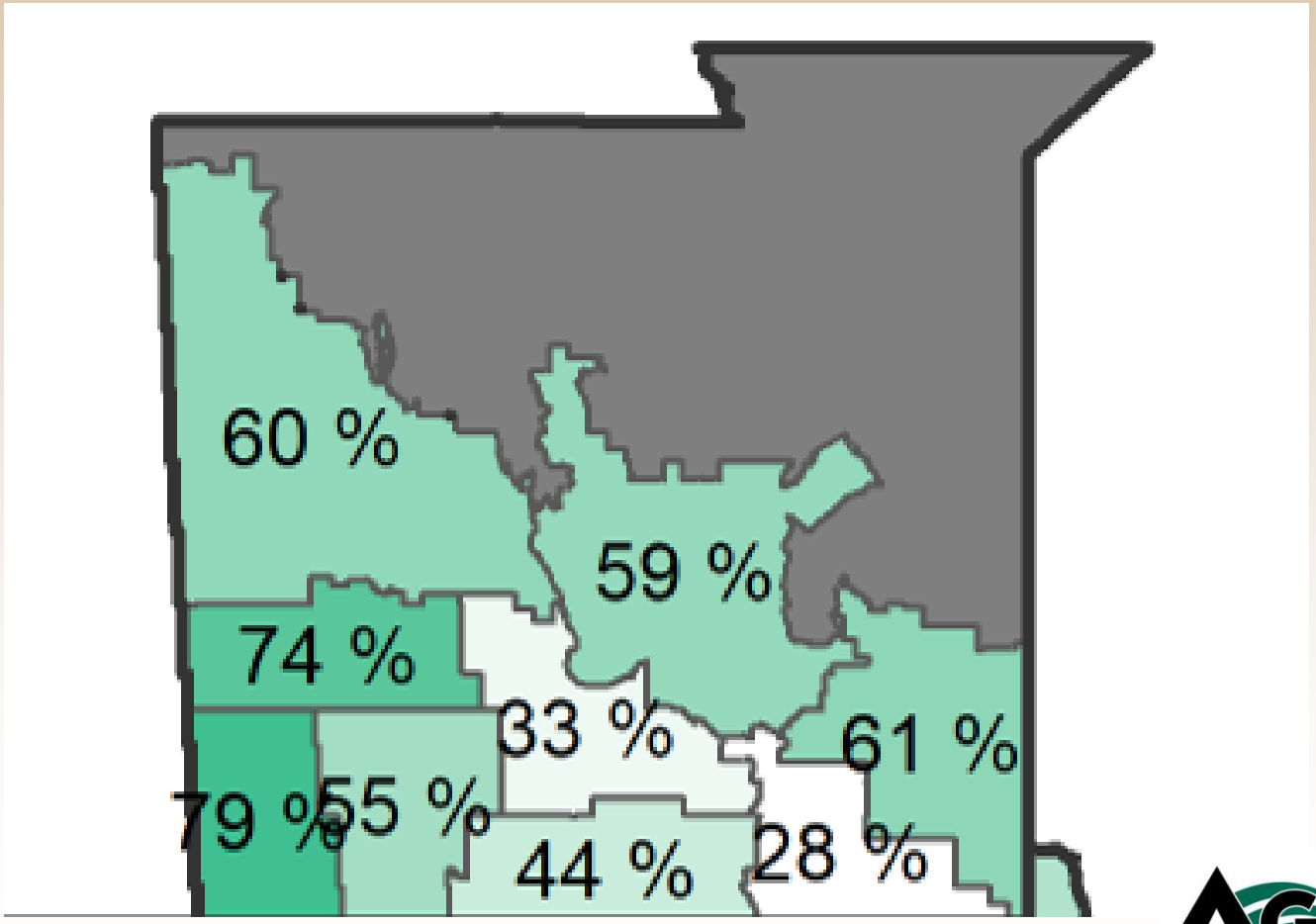
Source: http://soiltest.tfi.org/

Percent of samples testing below the critical level, 2020



Source: http://soiltest.tfi.org/

Percent of samples testing below the critical level, 2021



AGVISE LABORATORIES

Balancing need to application rates

Please, see the Manitoba Ag site:

- Phosphorus Fertilization Strategies for Long Term Agronomic and Environmental Sustainability

http://www.gov.mb.ca/agriculture/crops/soil-fertility/pubs/phosphorus-fertilization-strategies-for-manitoba.pdf

Also: Phosphorus balance calculator

http://www.gov.mb.ca/agriculture/crops/soil-fertility/phosphorus-balance-calculator-for-a-rotation.html

… and then there is the cost

Phosphate Rate of Return Calculator
Wheat, Barley, Peas & Canola
western Canada

Crop and Soil data	
Expected prices ($/bushel):	
CWRS wheat	$12.60
Barley	$9.15
Canola	$18.00
Peas	$20.00
Soil Test (0-6")	20
Texture*	Clay Loam
Area (NFRZ)*	Humic Parkland
Irrigation*	No
*CAUTION: these entries are drop down lists	
Yellow Cells Can be Modified	

Fertilizer P_2O_5 data	
Fertilizer Type	MAP
Cost/tonne	$1,350
%P_2O_5	5
Price of UREA	$1,360
Cost/Unit of P_2O_5	$0.89
Fertilizer P_2O_5 increment	5
Crop price increment, $	$0.4
Fertilizer price increment, $	$93

https://www.agvise.com/resources/helpful-links/ → Western Canada

Strategies to sustain P levels

Sideband at planting to match P rate to crop removal without risk of seedling injury

Maximize seedrow P in crops such as cereals that tolerate more than their removal

Apply manure, where available, to meet crop N requirements supplies P for several years

Broadcast large rates of P – not always a desired option

- **High cost**
- **Environmental concerns**
- **Interaction with other nutrients, e.g., Zn**

Surface Application of N

AGROMANAGER™ forum

Risks of Applying Urea on Snow or on Very Wet Soils

John T. Harapiak, P.Ag. Agronomy Department

#196

Risks of Applying Urea on Snow or on Very Wet Soils

A very significant component of the yield potential of grass forage stands and fall planted crops such as winter wheat is established early in the season during the first few weeks of good growth. A shortage of nitrogen (N) at this critical time means that maximum yield potential will be adjusted downwards in accordance with the N supply available to the plants. A late application will help the plants recover, but not to the extent that would be possible with an earlier application. Of course, precipitation is required after application to move the N into the root zone and this can be a problem in a drier spring, especially in the "chinook belt" of the southwestern prairies.

Light, fluffy, freshly fallen snow on a dry soil followed by thawing conditions provide the best situations for applying urea on snow. These conditions favour rapid movement of the urea through the snow and into the soil.

Favourable Conditions

In the "chinook belt" an option effectively used by farmers is the application of urea N on snow. Under very specific conditions, Westco has demonstrated that application of urea to a light, fresh snow cover can in fact improve the performance of this fertilizer. However, this practise is only effective under a very specific set of soil and climatic conditions. Favourable conditions include:

Broadcasting on snow

Under very specific conditions, Westco had demonstrated that application of urea (not fertilizers containing nitrate, e.g., UAN) to a light, fresh snow cover can in fact improve the performance of this fertilizer. However, this practice is only effective under a very specific set of soil and climatic conditions.

eutectic point* -11^{o}C

practical working temperature of around -4^{o}C

* From Greek “ευτηκτικό”; the temperature at which a particular eutectic mixture freezes or melts

Broadcasting on snow

Favorable conditions include:

a 2 - 4" layer of newly fallen, fluffy snow on a previously snow-free field

a period of mild weather following the snowfall at which time the urea is broadcast applied

urea pellets should dissolve and move completely through the snow cover in a droplet of melted snow and also penetrate through any thatch layer to establish good soil contact.

These ideal conditions for applying urea on snow will seldom if ever exist outside of the "chinook belt." Therefore, for most of the prairie region, application of urea on snow is not recommended by Westco.

Broadcasting on snow

Conditions to avoid include:

fields that are very wet (i.e., surface saturated with water)

fields in which the soil froze in a wet condition

fields with compacted, drifted or crusted snow

fields with more than 4" of fresh snow cover

extremely cold weather conditions that will prevent urea from penetrating the snow cover rapidly.

Westco trials conducted under the above unfavorable conditions consistently resulted in poorer performance than if the urea was broadcast applied under snow-free conditions.

Application of urea on snow and frozen soil* (1995-96)

Application timing	Yield, bu/ac	Protein, %
Fall applied, incorporated	45.4	14.5
Soil frosted, not deeply frozen, November	45.8	13.8
Soil deeply frozen, December	27.6	12.7
Soil deeply frozen, March	33.3	13.0
Applied prior to seeding, April incorporated	49.6	14.6
LSD<0.05	5	0.5

*Endres, Schatz and Franzen, 1996; Franzen, 2003. North Dakota soil and fertilizer handbook. NDSU Extension Service, North Dakota State University, Fargo, ND.

Ammonia Volatilization Loss in Cold Weather

Engel 2011 MAC. Volatilization losses from surface-applied urea during cold weather months

https://umanitoba.ca/faculties/afs/agronomists_conf/media/Dec_14am_1_Engel_presentation.pdf

Campaign	Fertilization date	Urea	Urea+AGROTAIN® stabilizer
		% nitrogen lost	
1	3 Apr.	8.4	4.4
2	8 Oct.	3.1	1.4
3	14 Nov.	31.3	3.8
4	25 Mar.	35.6	18.0
5	26 Mar.	39.9	18.1
6	6 Oct.	11.6	4.3
7	13 Oct.	10.4	4.8
8	19 Oct.	15.7	3.4
9	27 Jan.	24.3	9.3
10	26 Feb.	44.1	11.9
11	29 Mar.	6.3	1.7
12	20 Apr.	14.7	1.8
Average		**20.5**	**6.9**

Source: Engel et al., 2011. Montana State University

Improving Nitrogen Use Efficiency in Forage Seed Production*

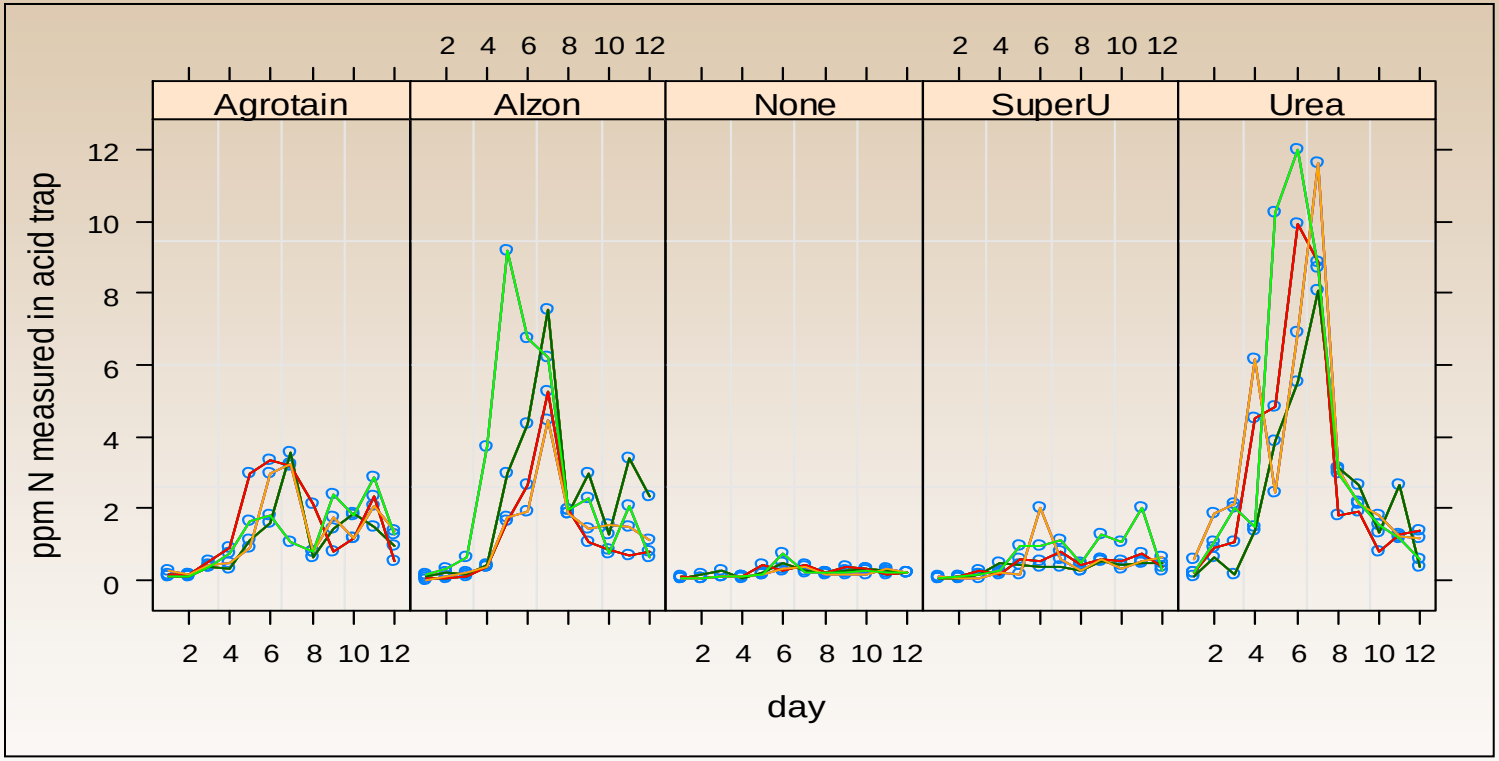
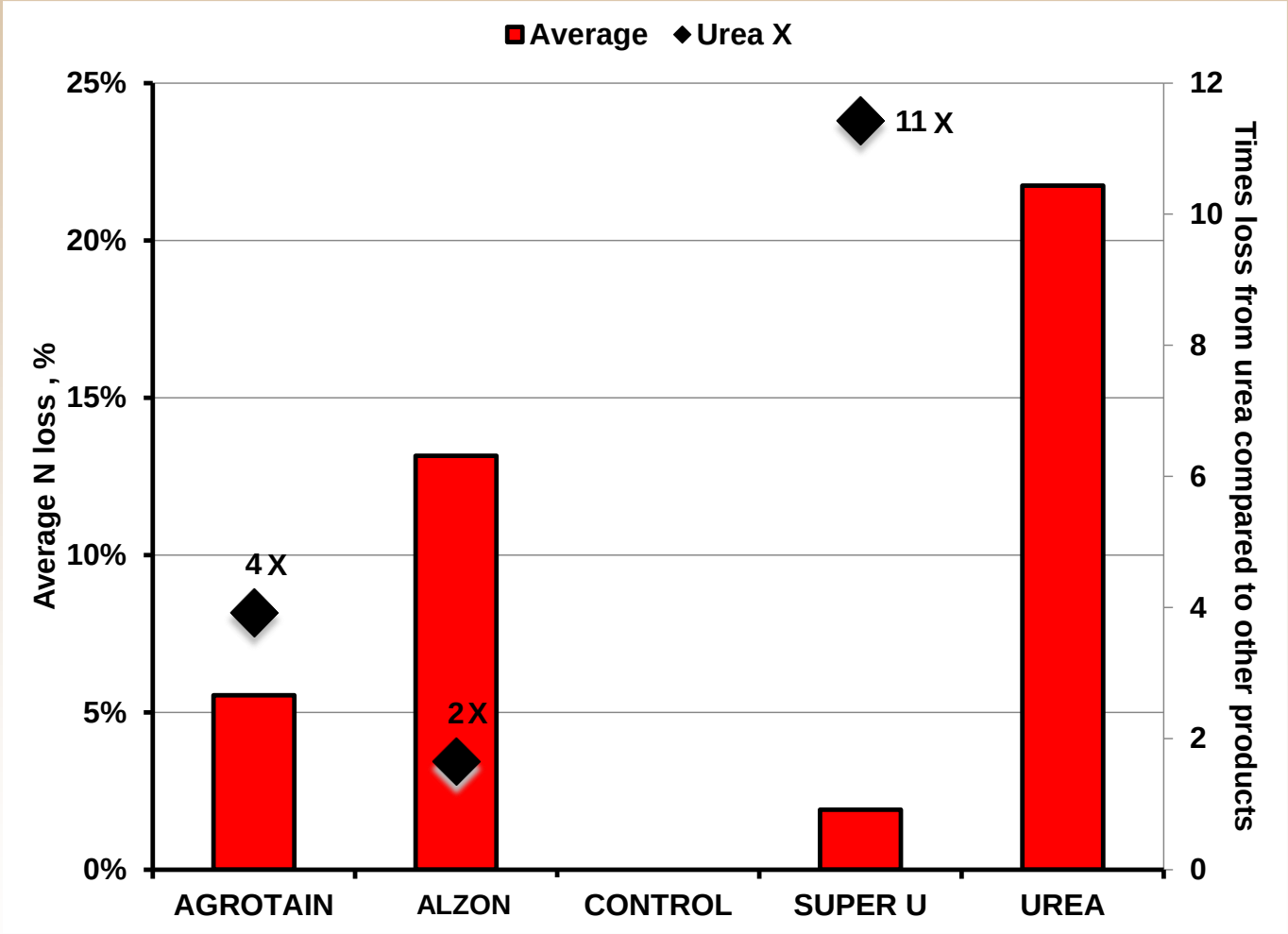


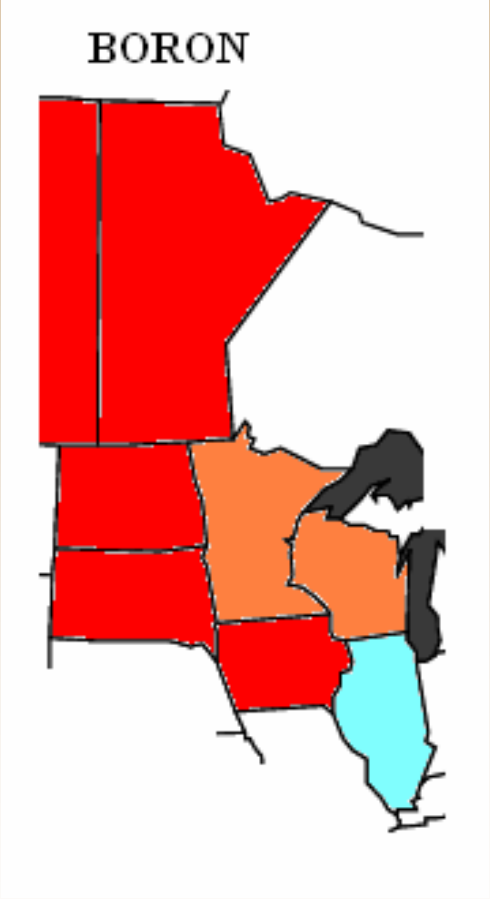
Figure 1: Amount of N captured per day from four fertilizer types and a non-fertilized control (None)

*Nils Yannikos, James Woodhouse, Fran Walley(fran.walley@usask.ca) and Rich Farrell (r.farrell@usask.ca), Department of Soil Science, University of Saskatchewan

At maximum loss per product



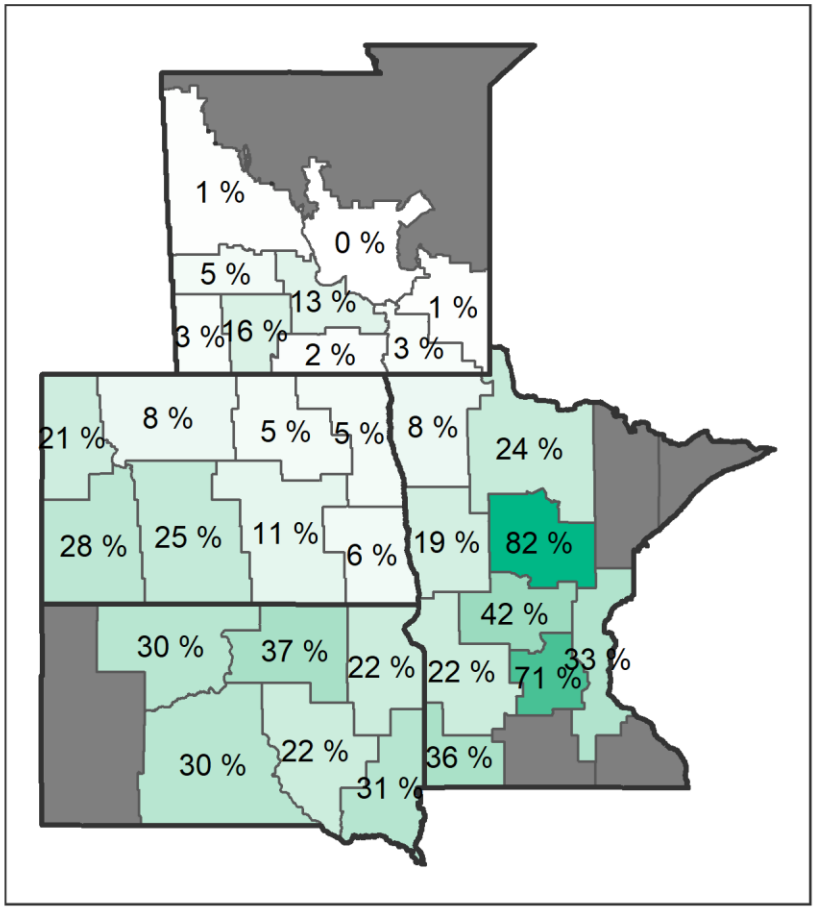
Boron



- In Minnesota, a response to B is expected on soils that have a sandy loam, loamy sand, or sand texture and low organic matter content.
- Boron deficiencies have been identified in Illinois and Michigan on light textured soils especially when alfalfa and specialty crops are grown
- Boron deficiencies are considered the most common micronutrient deficiencies in Wisconsin

% Soil Samples with Boron less than 0.4 ppm

Soil samples with soil test boron below 0.4 ppm in 2021

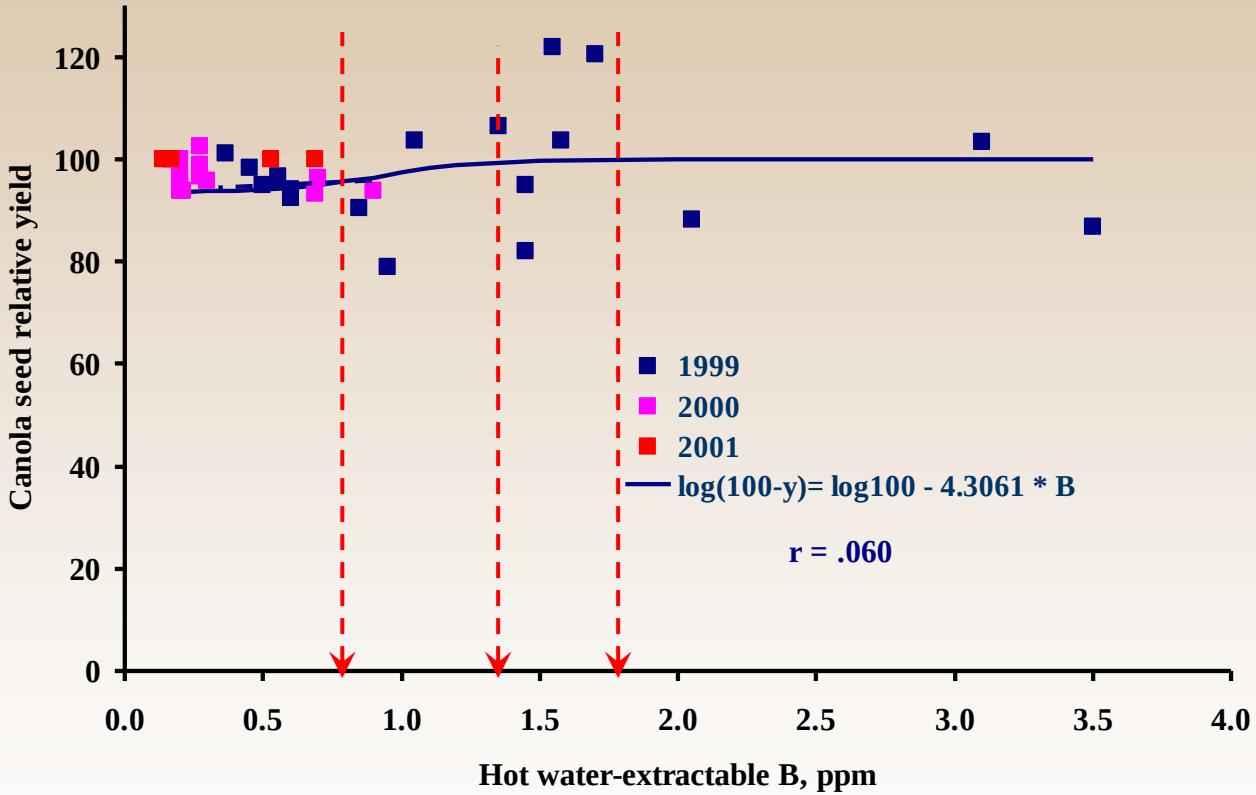


Data not shown where n< 100
AGVISE Laboratories, Inc.

AGVISE LABORATORIES

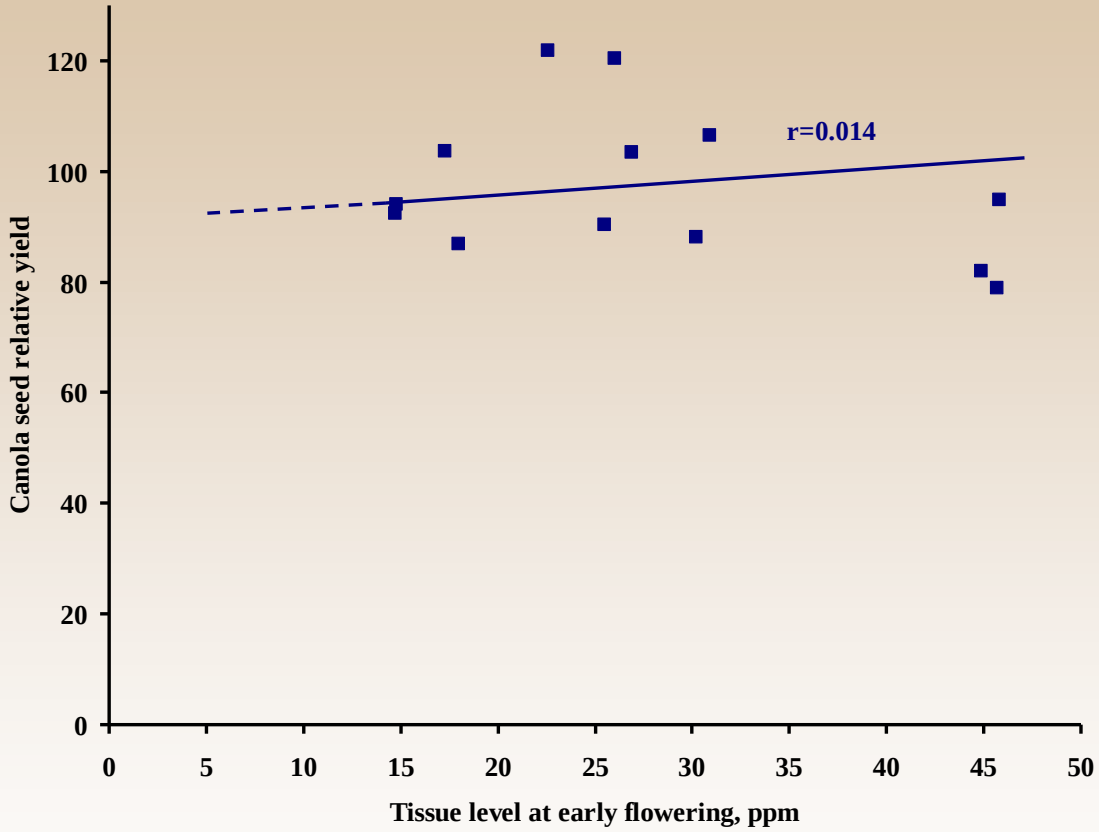
Interpretation of Soil Tests

w. Canada 40 sites (including Carberry, Elm Creek, Miami and Neepawa; yield 18-63 bu/ac



Karamanos et al. 2003. Can. J. Plant Sci. 83: 249–259.

Interpretation of Plant Tissue Tests



Karamanos et al. 2003. Can. J. Plant Sci. 83: 249–259.

Which crop to be concerned about?

Boron in alfalfa

Boron for alfalfa

0.8 lb B/ac removed with 4t/ac

Deficient soils

high pH

sandy texture

low organic matter

“DRY WEATHER DISEASE”

Boron for alfalfa

Visual signs

stunted regrowth

yellow-purplish tips

reduced flowering

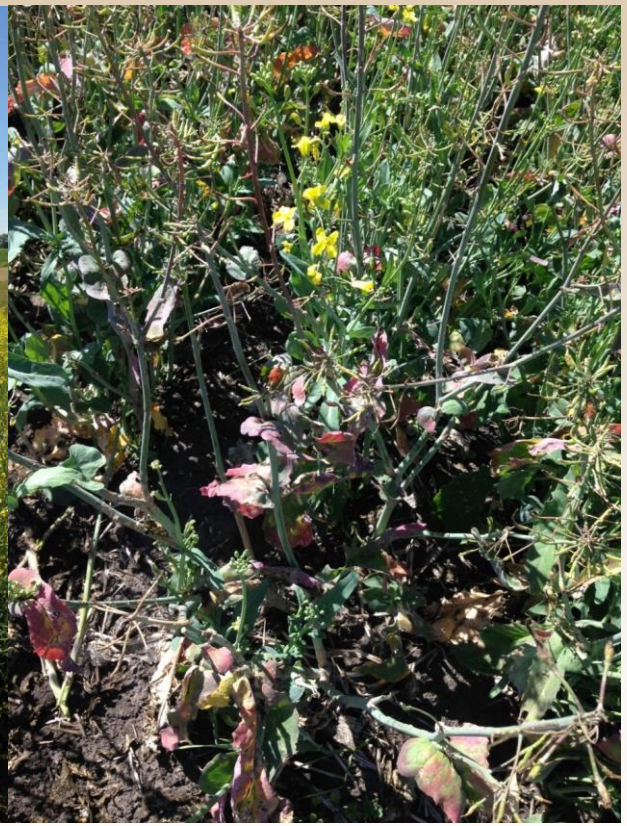
Tissue test < 20 ppm B

Soil test <0.3 ppm

Apply

1-2 lb B/ac to soil or 0.2-0.5 lb B/ac foliar

The “other side” of Boron application



Thank you

rkgeoponica@gmail.com