Spring 2020:
Approaching Soil Fertility in Saturated Soils

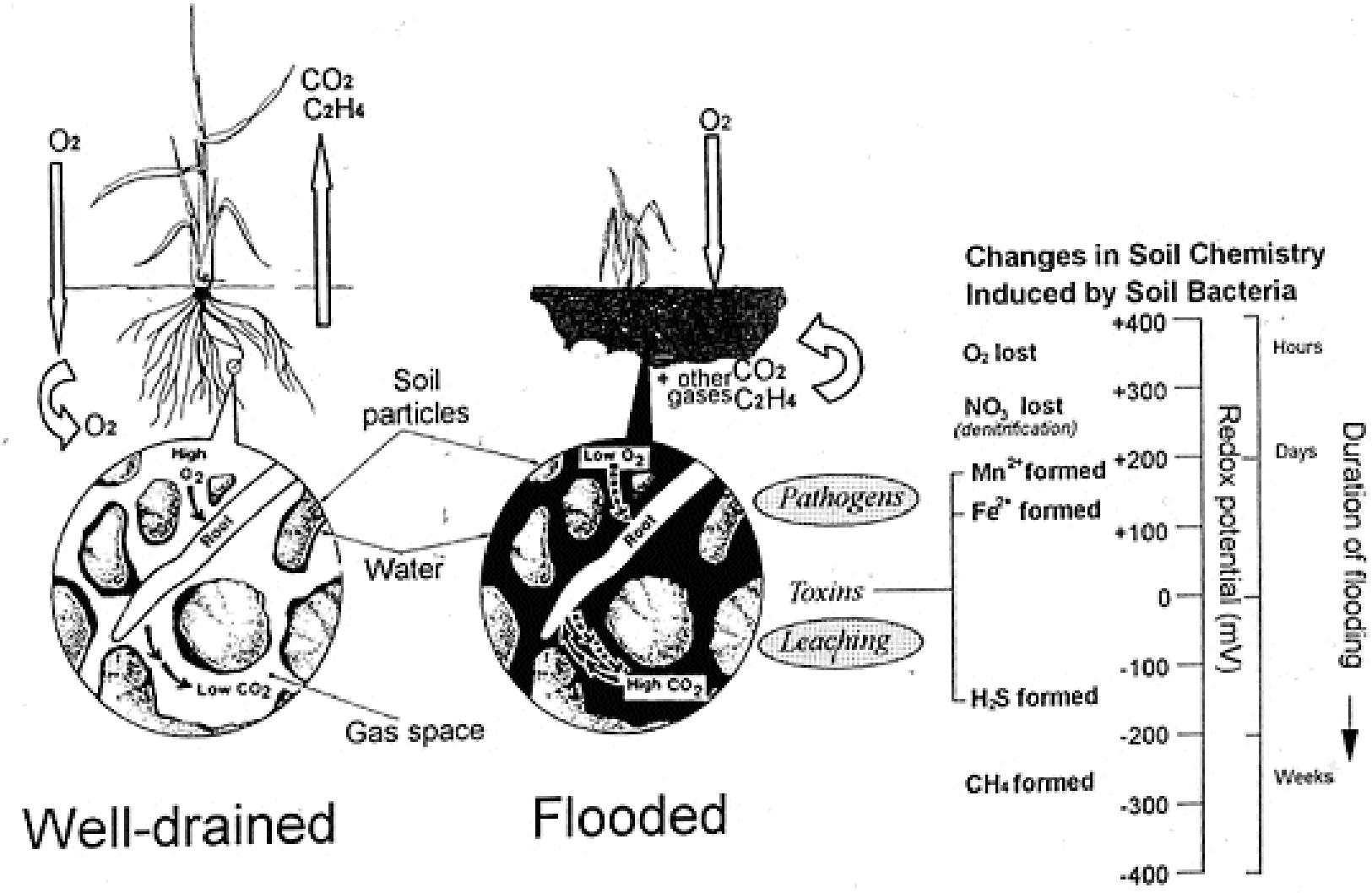
John Heard
Gittin' It Right
Crop Production Meeting
January 2020

Manitoba

Topics/Concerns

- Microbial survival (Rhizobium):
  - established populations or virgin ground
- IDC and salinity
- Fertilizer applications
- Ruts and compaction
- Crop residue and tillage
- Residual fertility of unharvested crops

Fig. 2. Effect of flooding on (i) the displacement and exclusion of aerial oxygen from the soil, entrapment of metabolically generated gases in the soil and (ii) the consequences, over time, of bacterial respiration for soil redox potential, loss of free nitrate and subsequent generation of chemically reduced end-products. (Developed from (Setter and Belford, 1990)



Flooded soil on soil chemistry - fertility

1. Nitrate lost to N_2O or N_2 gas
- Rate on saturated cold soils is 2-4 lb N/ac/day
- Some nitrate may have leached in sandy soils

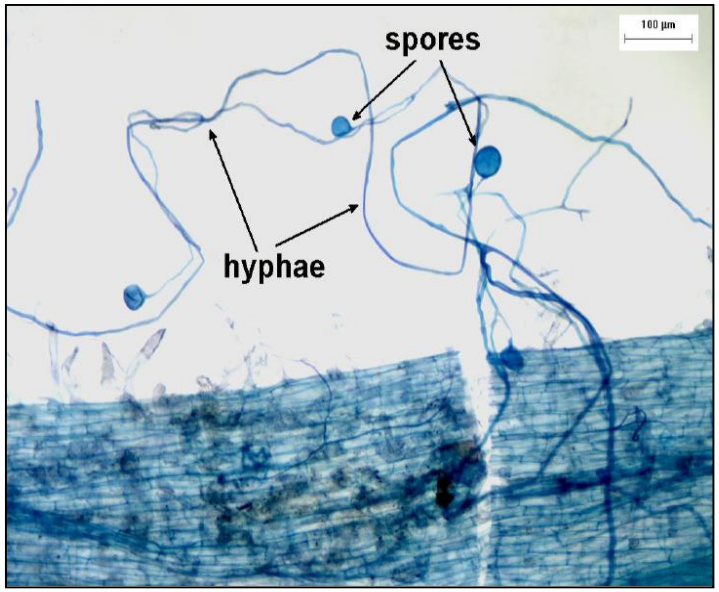
2. Mn and Fe increase in availability

3. Free lime + saturated soil = bicarbonate and interferes with Fe uptake leading to IDC

4.Inflates soil test P

Flooded soil on soil biology

- Well known “flooded or fallow” soil syndrome
- Due to collapse of mycorrhizae populations when land not cropped to host plants
- Eg corn and flax after canola



- Not the case with a wet fall

Will soil rhizobium survive the wet fall?

- Not suspected to be a problem with rhizobium species after a “wet fall” – for established soy fields

Stuttgard – Arkansas State Soil

``Grow soybeans after flooded rice, followed by flooding for duck hunting and saturated soil most of winter``
``Inoculate seed only 20% of the time.``
``No problems``
K. Nixon

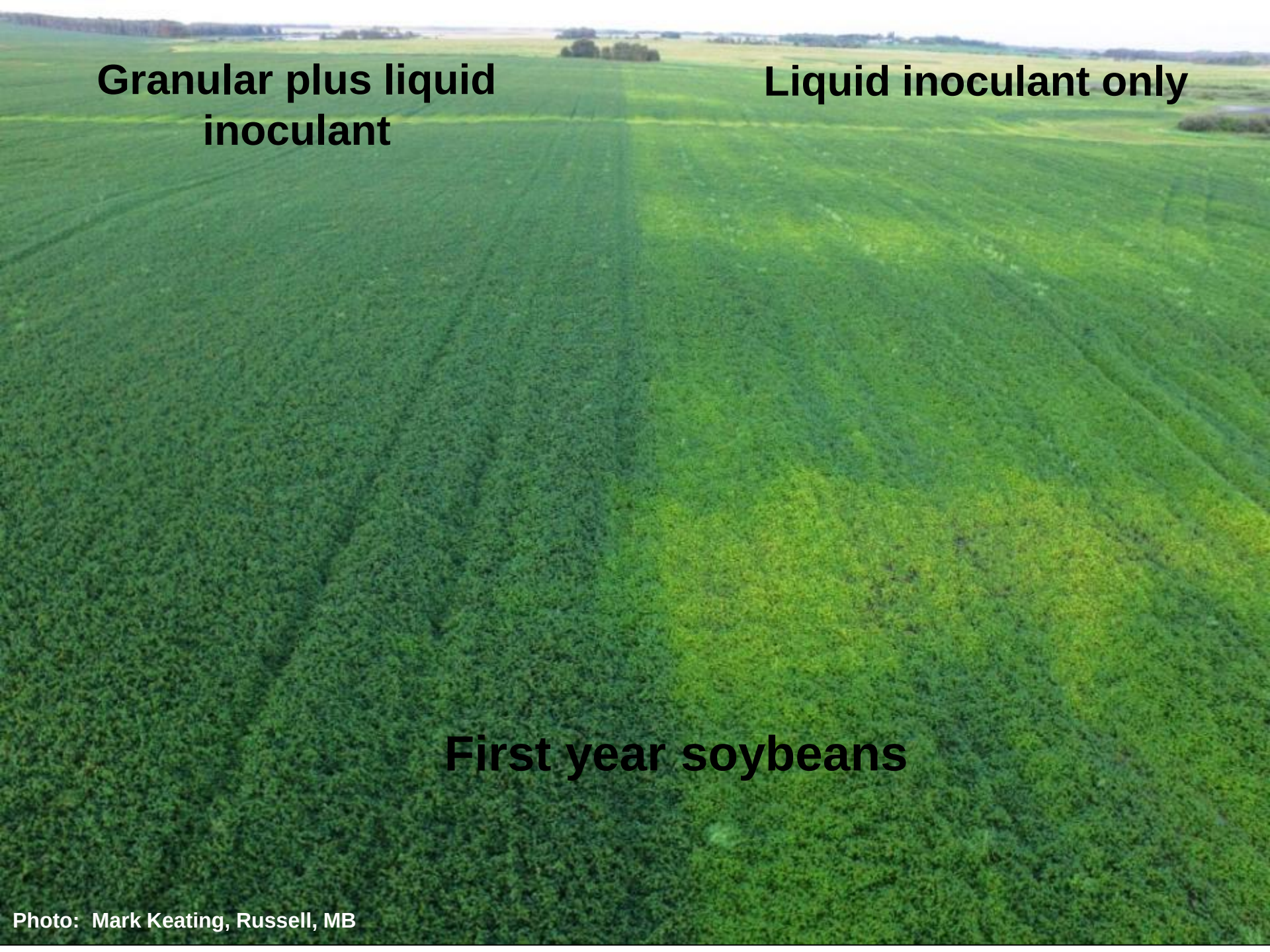


Photo: Mark Keating, Russell, MB

Do you still need granular or in-furrow liquid on "experienced fields"?

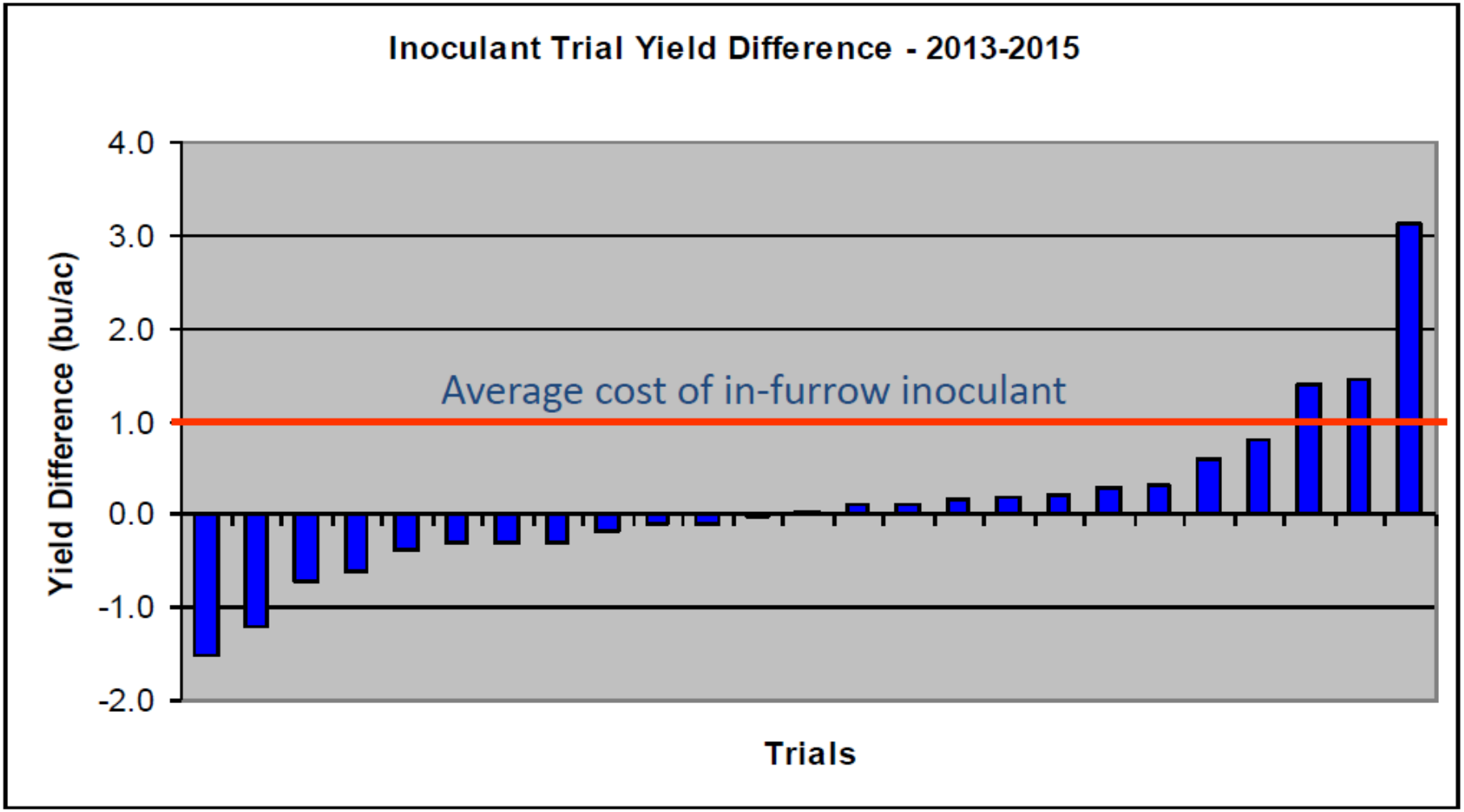


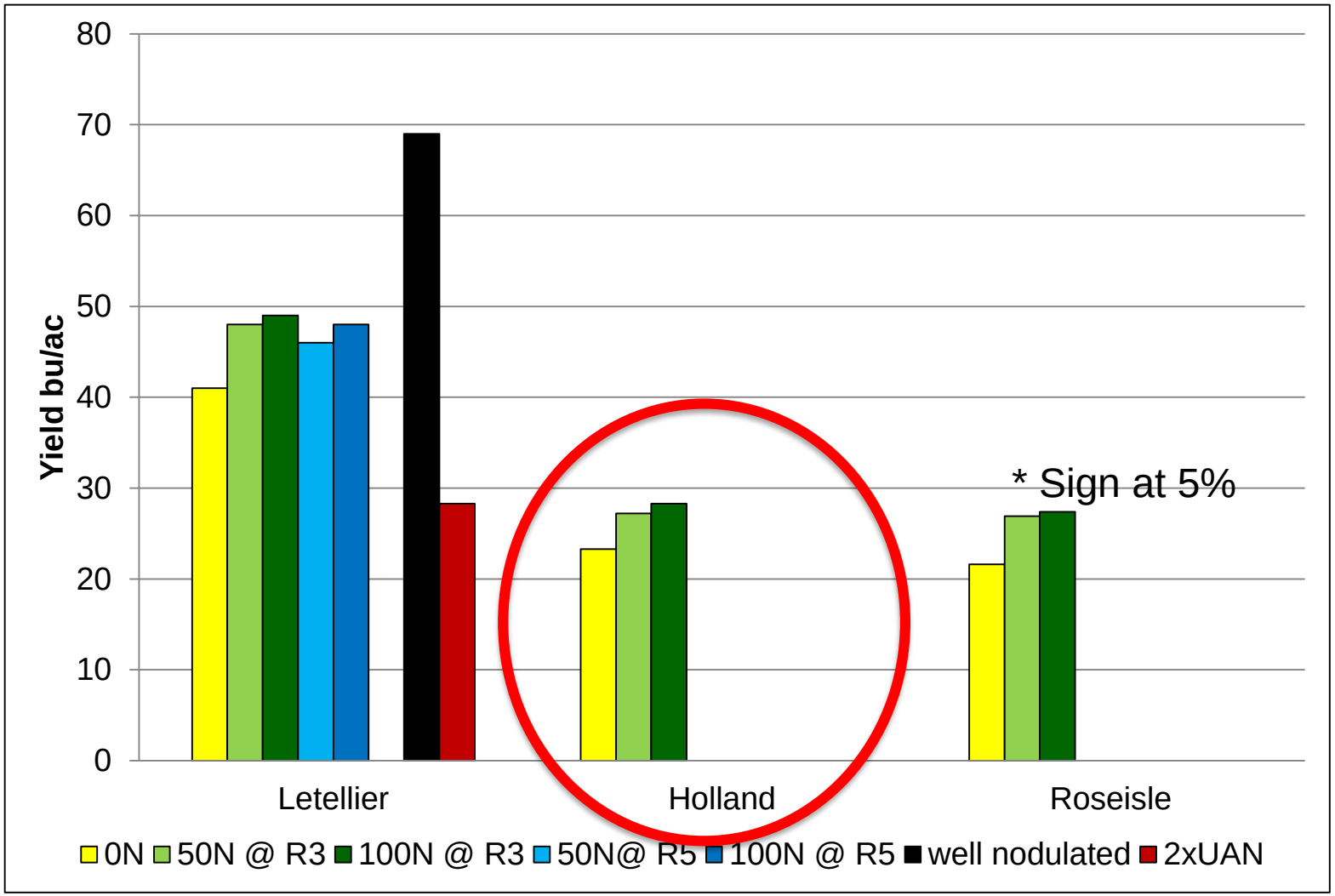
Figure 4 – Inoculant Trial Yield Difference 2013-2015

Tone Ag Consulting Ltd, 2015

In season flooding on soys. 2014

Leaf colour (SPAD chlorophyll)	**28.9** **(40.2)**
Leaf N content (%)	2.5% D (4.8%S)
Plant height ”	20.9” (30.1”)
Nodules / plant	13.4 (46.4)

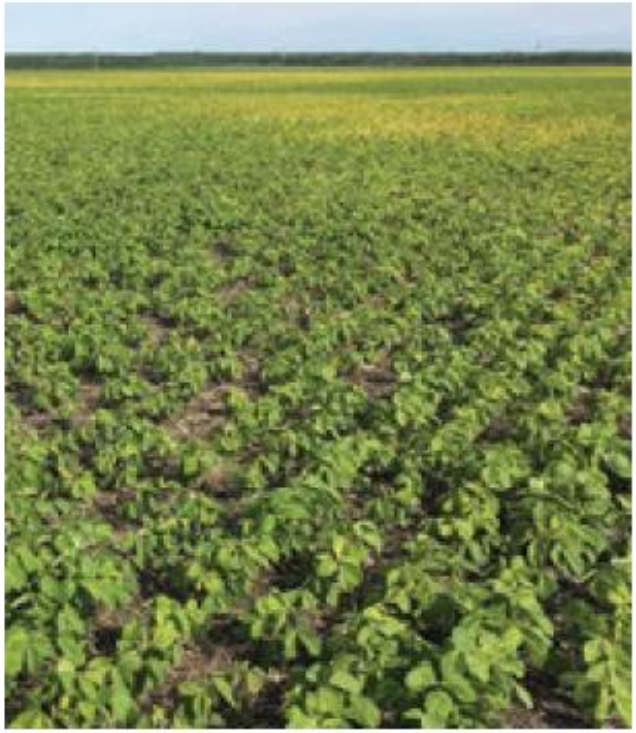
Soybean yield response to rescue N applications.



Yield Impact of Yellow Soybeans and Management Strategies

Kristen P. MacMillan, MSc, PAg, Research Agronomist, University of Manitoba

in Pulse Beat: Summer 2018



Soil test report

AGVISE LABORATORIES

Soil Analysis by Agvise Laboratories
(http://www.agvise.com)
Northwood: (701) 587-6010
Benson: (320) 843-4109

SOIL TEST REPORT

FIELD ID
SAMPLE ID
FIELD NAME
COUNTY
TWP RANGE
SECTION QTR ACRES 0
PREV. CROP Canola-bu

N / W / E / S

SUBMITTED FOR:
JOHN HEARD

SUBMITTED BY: LE0002
JOHN HEARD
MB AG
65 3RD AVE NE
CARMAN, MB R0G 0J0

REF # 17499669 BOX # 0
LAB # NW1521

Date Sampled | Date Received 01/23/2015 | Date Reported 1/26/2015

Nutrient In The Soil		Interpretation (VLow Low Med High)
Nitrate	0-6" 9 lb/ac; 6-24" 15 lb/ac	*****
	0-24" 24 lb/ac	
Phosphorus	Olsen 8 ppm	**********
Potassium	109 ppm	**********
Chloride	0-24" 76 lb/ac	**********
Sulfur	0-6" 44 lb/ac; 6-24" 360 +lb/ac	**********
Boron	1.2 ppm	**********
Zinc	1.03 ppm	**********
Iron	13.7 ppm	**********
Manganese	2.0 ppm	**********
Copper	0.27 ppm	*****
Magnesium	506 ppm	**********
Calcium	3921 ppm	**********
Sodium	31 ppm	***
Org.M.	2.0 %	********
Carbonate(CCE)	4.5 %	**********
Sol. Salts	0-6" 0.27 mmho/cm; 6-24" 0.33 mmho/cm	**********

1st Crop Choice			2nd Crop Choice			3rd Crop Choice		
Soybeans			Soybeans			Soybeans		
YIELD GOAL			YIELD GOAL			YIELD GOAL		
40 BU			40 BU			40 BU		
SUGGESTED GUIDELINES			SUGGESTED GUIDELINES			SUGGESTED GUIDELINES		
Band			Band/Maint.			Broadcast		
LB/ACRE		APPLICATION	LB/ACRE		APPLICATION	LB/ACRE		APPLICATION
N	***		N	***		N	***	
P_2O_5	32	Band *	P_2O_5	35	Band *	P_2O_5	54	Broadcast
K_2O	26	Band *	K_2O	60	Band *	K_2O	53	Broadcast
Cl	0		Cl	0		Cl	0	
S	0		S	0		S	0	
B	0		B	0		B	0	
Zn	0		Zn	0		Zn	0	
Fe	0		Fe	0		Fe	0	
Mn	0		Mn	0		Mn	0	
Cu	1	Band	Cu	1	Band	Cu	2	Broadcast
Mg	0		Mg	0		Mg	0	
Lime			Lime			Lime		

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
0-6" 7.7 6-24" 8.0		24.2 meq	(65-75) 81.0	(15-20) 17.4	(1-7) 1.2	(0-5) 0.4	(0-5)

General Comments: Soil Texture: Sand: 83.0 % Silt: 8.0 % Clay: 9.0 % USDA Textural class: Loamy Sand .

Iron Deficiency Chlorosis Risk Factors

Soluble salts (mmhos/cm)	Carbonate level CCE% 0-2.5	2.6-5	>5
0-0.25	Low	Low	Moderate
0.26-0.50	Low	Moderate	High
0.51-1.0	Moderate	High	Very High
>1.0	High	Very High	Extreme

Under wet/saturated soil conditions
Compounded by high soil nitrate, herbicide stress, compaction

Adapted from AGVISE Labs

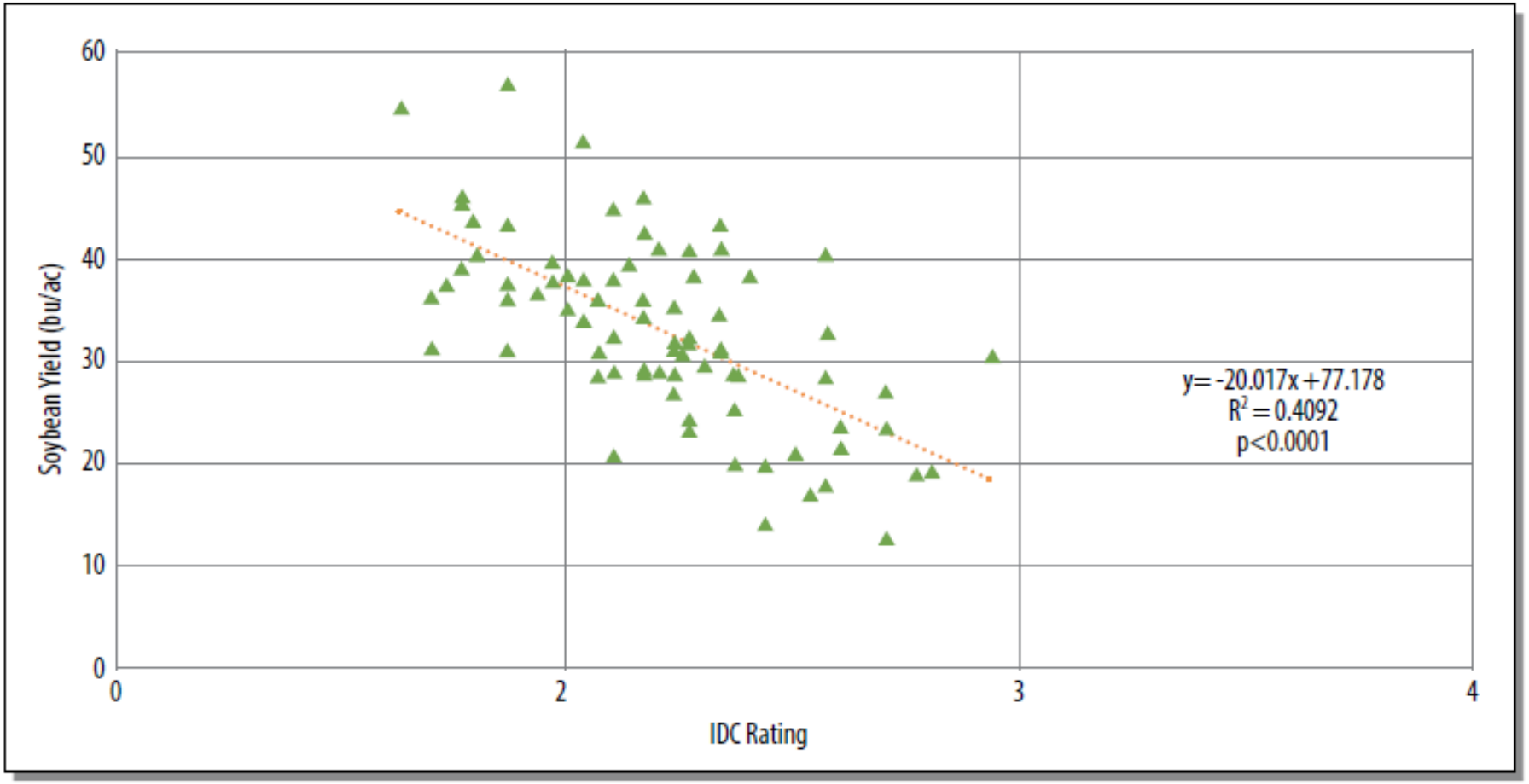
CCE – presence of ‘free lime”

- Fe-chlorosis or lime-induced chlorosis
- alkaline soils (pH > 7.4), high in free lime
- poorly drained and higher salinity areas.
- Limits soluble form of iron taken up by plants
- Managed through field and variety selection, drainage
- Compounded by N application

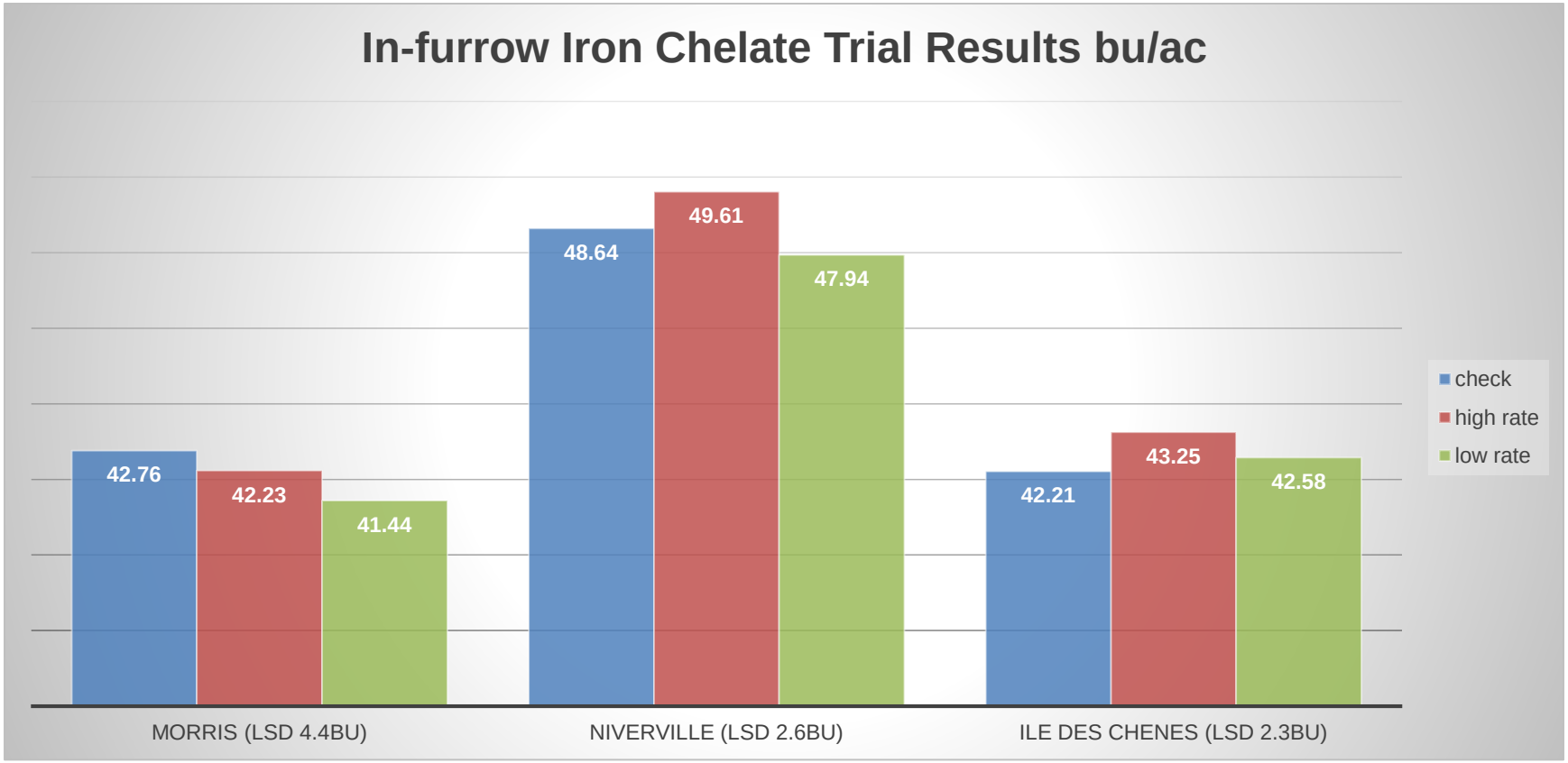
Yield Impact of Yellow Soybeans and Management Strategies

Kristen P. MacMillan, MSc, PAg, Research Agronomist, University of Manitoba

▼ *Figure 5b. Soybean yield decrease with increasing IDC rating as collected from the 2017 IDC trial.*



SoyGreen Evaluation for Prevention of Iron Deficiency Chlorosis. Antara Research



MPSG, 2017

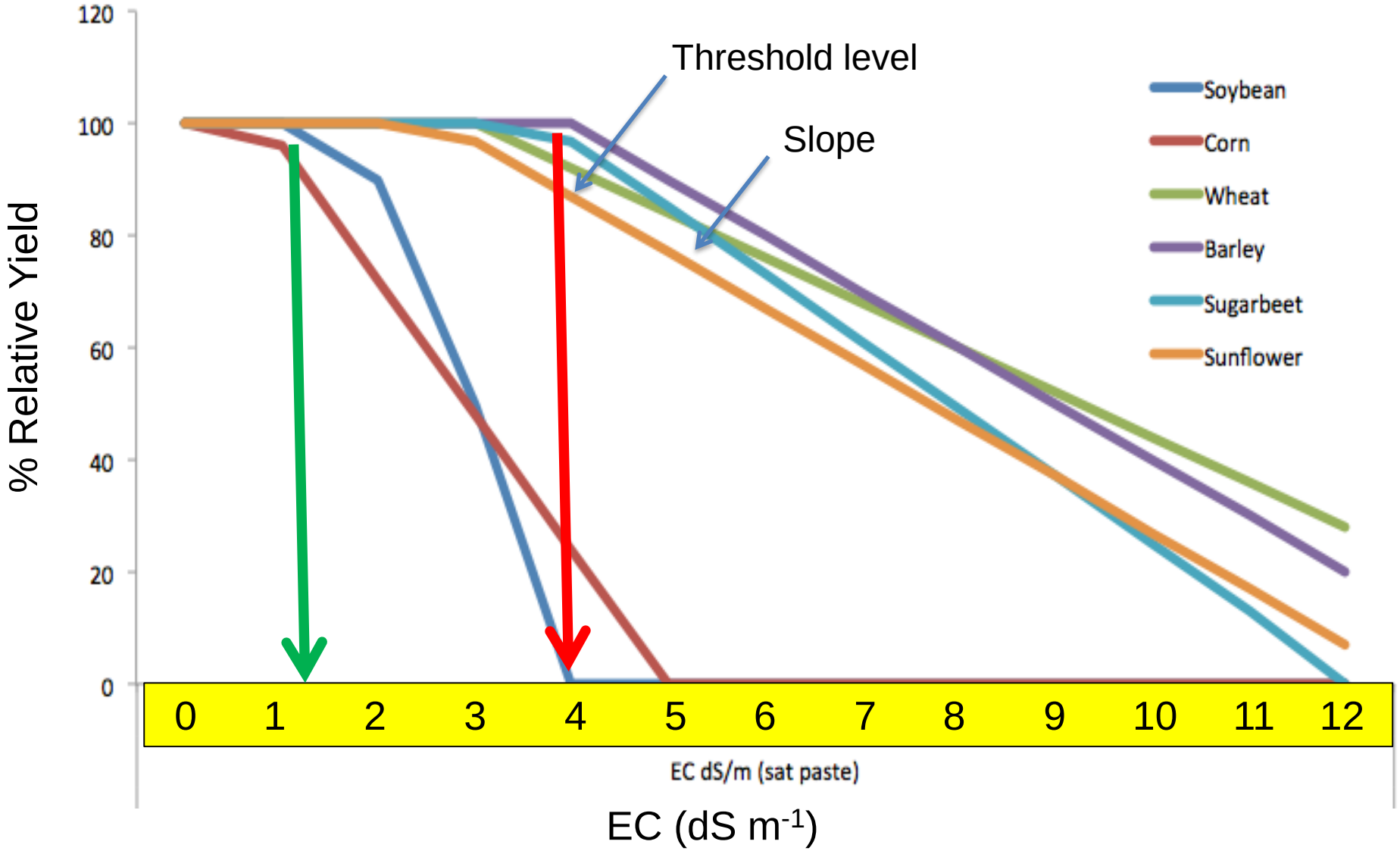
IDC Management

- Improve drainage, manage salinity
- Grow IDC tolerant varieties
- In furrow application of ortho-ortho-EDDHA Fe chelate (3 lb/ac dissolved in water)
- Biologically “dewater soil”
  - Plant in 15” or wider rows so there are more seeds per ft of row
  - Increase seeding rates
  - Seed a 1 bu/ac oat cover crop and spray out later

SALINITY

Salinity and IDC

Salinity Effects on Crops



Commercial lab approximation

Soybeans are sensitive also

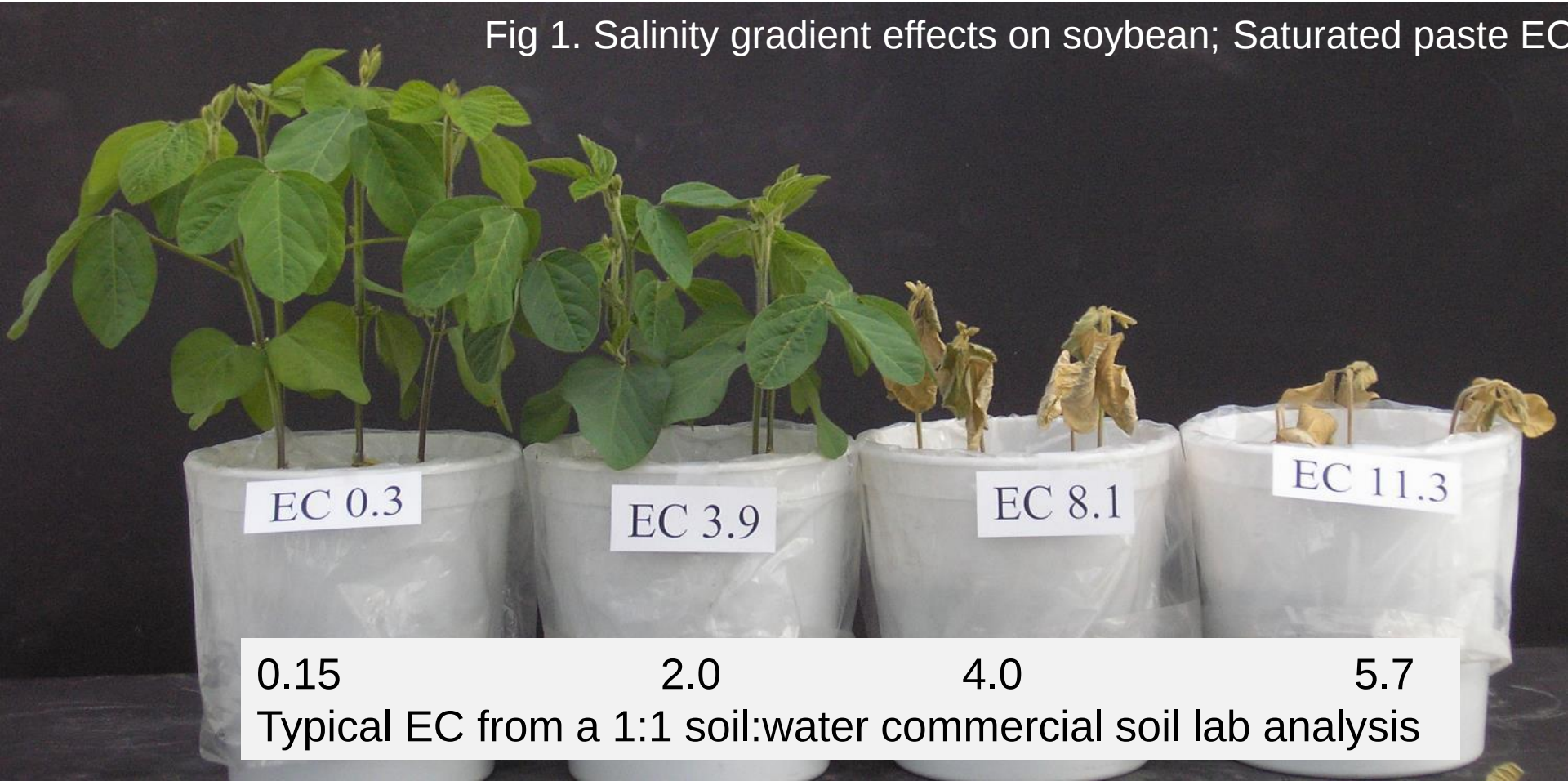
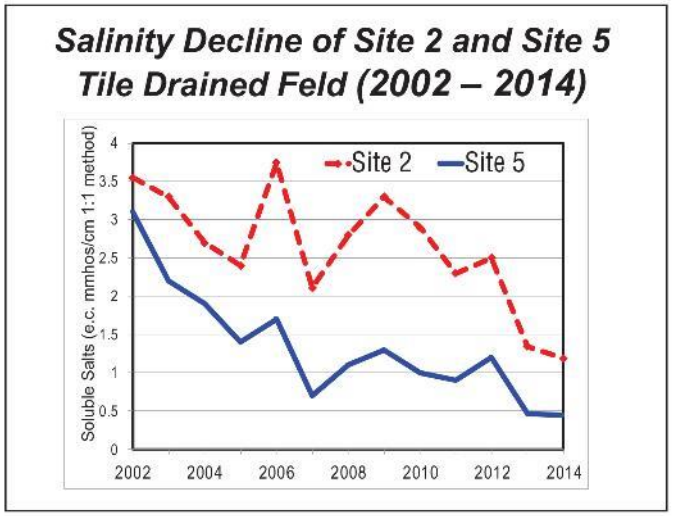


Fig 1. Salinity gradient effects on soybean; Saturated paste EC

0.15	2.0	4.0	5.7

Typical EC from a 1:1 soil:water commercial soil lab analysis

Waiting for salts to flush out of tiles? You need surplus water!



AgVise Tile project

Salinity in 2020

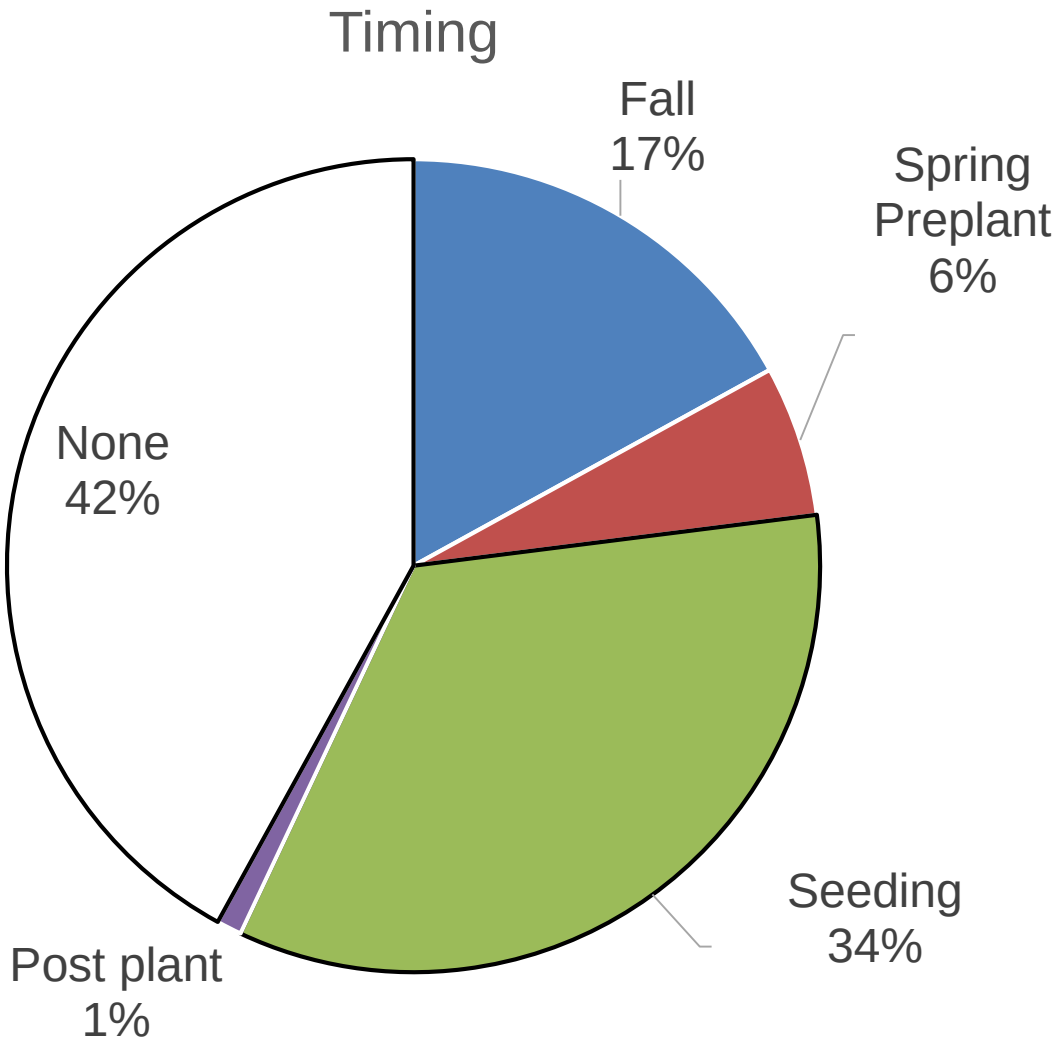
- Wet fall will likely have flushed salts deeper into the profile
- Will take some dry conditions for us to draw them back to the surface through tillage, etc.
- Or leave them there

Soybean Crop Fertility

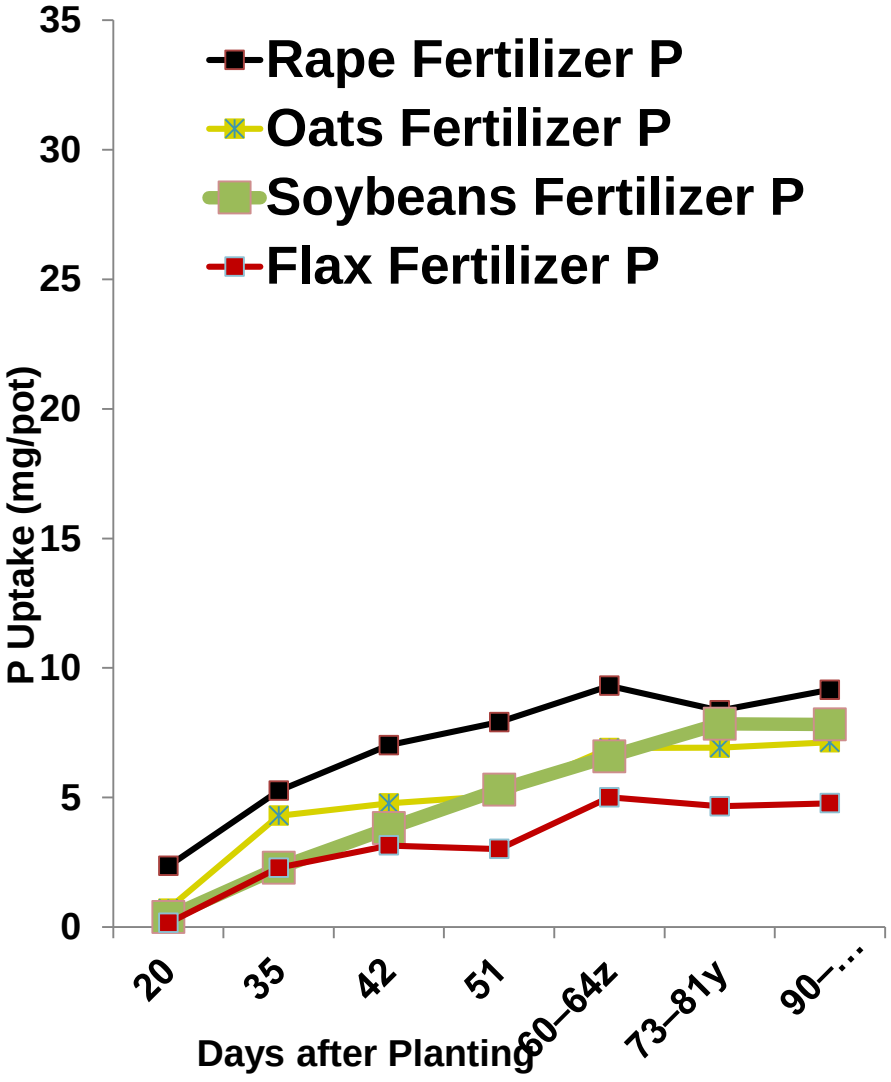
Table 2. Phosphorus fertilizer placement and timing in Manitoba for spring wheat, canola, soybeans and corn (STRATUS Research).

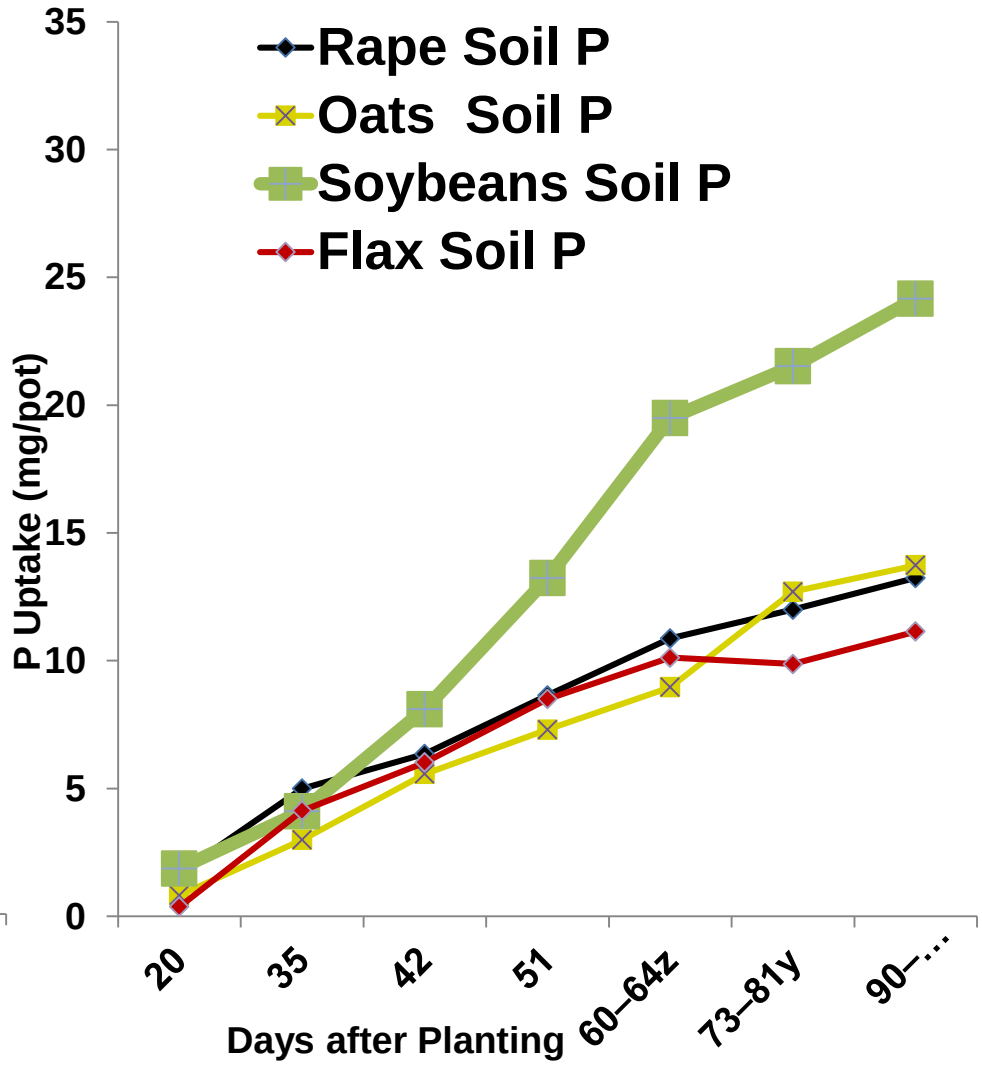
Practice	Wheat	Canola	Soybeans	Grain corn
	% of acres or volume applied			
PLACEMENT				
Broadcast , no incorporation	0	1	2	5
Broadcast and incorporated	3	9	14	35
Preplant banded	7	3	6	21
Sidebanded	23	13	13	19
Mid row banded	14	11	6	3
Seed placed	54	62	11	32
In crop applied	1	0	1	0
TIMING				
Fall	6	2	17	23
Spring, preplant	3	5	6	34
At seeding	91	92	34	55
Post seeding, in crop	0	0	1	0

Fertilizer P for soybeans in MB



Soybeans are efficient feeders for soil P





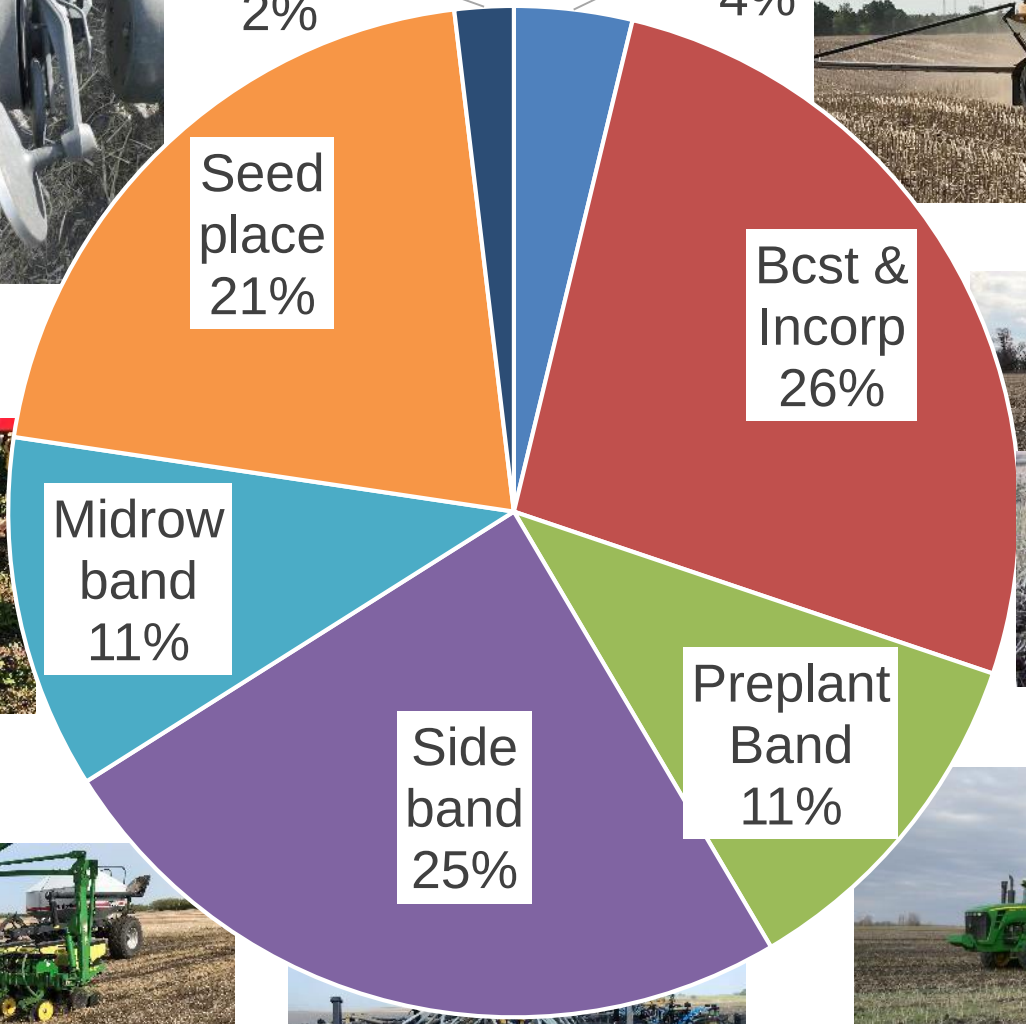
(Kalra and Soper 1968)

What about P?

Phosphorus Balance Calculation for a Rotation

Crop	Typical Yield (bu/ac)	P Applie	P Removed per bu	P Removed per acre	Annual Balance
		---------- (lb P_2O_5/ac) ----------			
HR Spring wheat	60	30	0.59	35	-5
Winter wheat	75	30	0.51	38	-8
Barley			0.43	0	0
Oats			0.26	0	0
Canola	54	20	1.00	54	-34
Soybeans	30	10	0.85	26	-16
Peas			0.68	0	0
Flax			0.65	0	0
Corn (grain)			0.44	0	0
Total for Rotation		90		153	-63

Fill in any of the blue cells for typical rotation, yields, and P appl'


In crop
2%
Bcst
4%
Seed
place
21%
Bcst &
Incorp
26%
Midrow
band
11%
Preplant
Band
11%
Side
band
25%

SFG Seedplaced P

Table 12. Maximum safe rates of actual seed-placed phosphate (P_2O_5) fertilizer as monoammonium phosphate†.

Crop	Actual P_2O_5 (lb/ac)‡
Cereals	50
Canola*, peas*, fababeans, buckwheat, flax[33]	20
Dry beans[34], soybeans (narrow rows**)	10
Dry beans, soybeans (wide rows**)	0

† Divide values in table by 0.51 or multiply by 1.96 to calculate lb of 12-51-0 per acre.

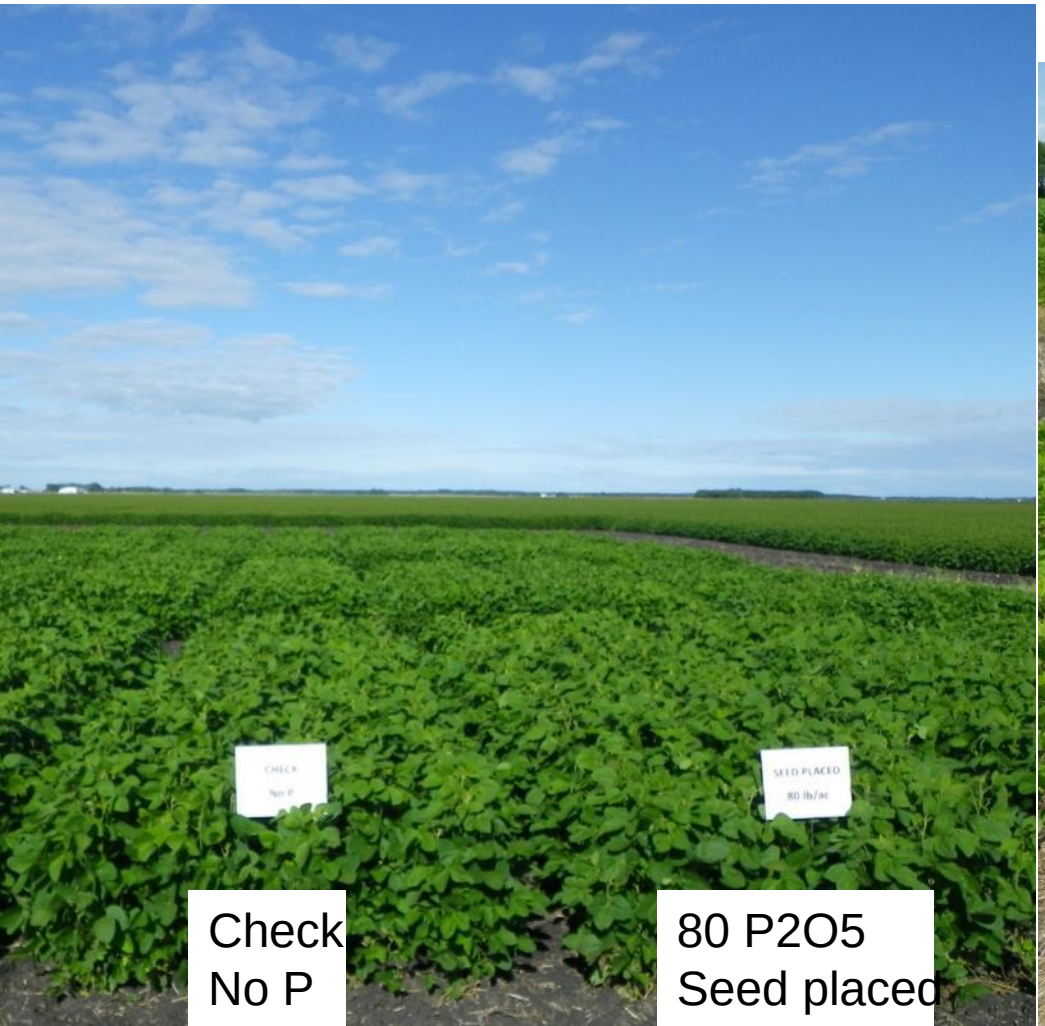
‡ Rates are based on disk or knife openers with a 1" spread, 6 to 7" row spacing and good to excellent soil moisture.

* When P soil test values are medium to high, no phosphorus should be placed with canola or pea seed.

** A low rate of seed-placed phosphorus is safe for beans and soybeans when seeded in row widths of 15" or less. Similar rates may cause unacceptable stand reductions in wider rows.

Beausejour

Clay – 8 ppm Olsen P



Melita

Loamy Sandy – 3 ppm Olsen P

Row crop application of liquid fertilizer

Risk factors:
Soil texture
Wide row spacing


05/16/2008


JOHN DEERE


Flexi coil
2320
JOHN DEERE

2020 Logistics:
Just in time delivery?
Or on-farm storage

Got Ruts?

Fertilization Challenges for 2020

- Fall 2019
  - Late harvest; little tillage or NH_3 application

Photos: Scott Corbett, Rosser

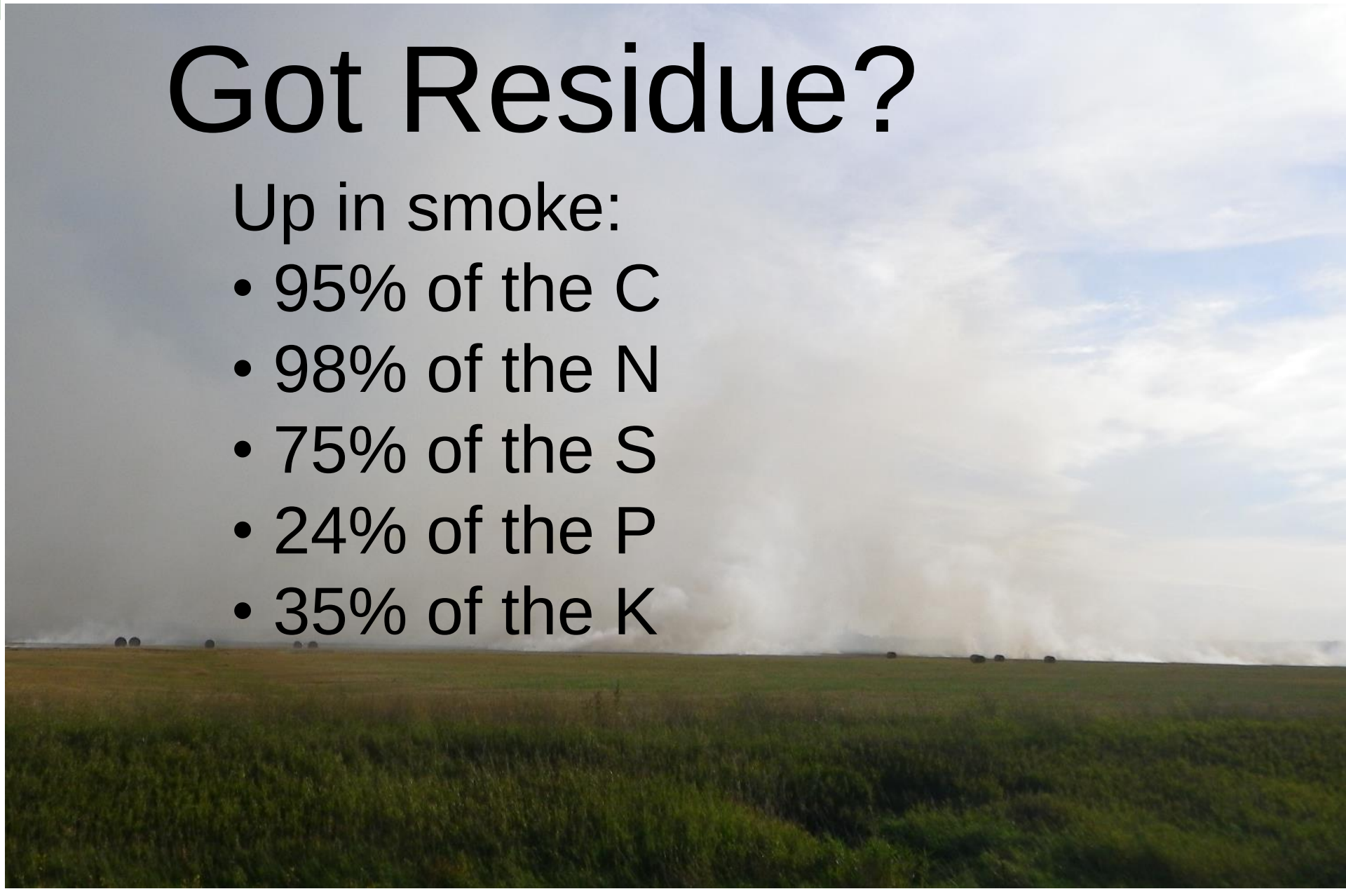
- Spring 2020
  - Mud & ruts are still there; N fertilizer still isn't
  - Low soil test N; high fertilizer costs
  - Dealer logistics

- Wetting/drying effect on soil

Got Residue?

Up in smoke:

- 95% of the C
- 98% of the N
- 75% of the S
- 24% of the P
- 35% of the K



How much tillage is needed to manage ruts and incorporate fertilizer?

- Is vertical till or heavy harrowing enough?

Traditional spring tillage

Field Cultivator

3-4” Depth

Even mixing of soil

Good fertilizer and herbicide incorporation

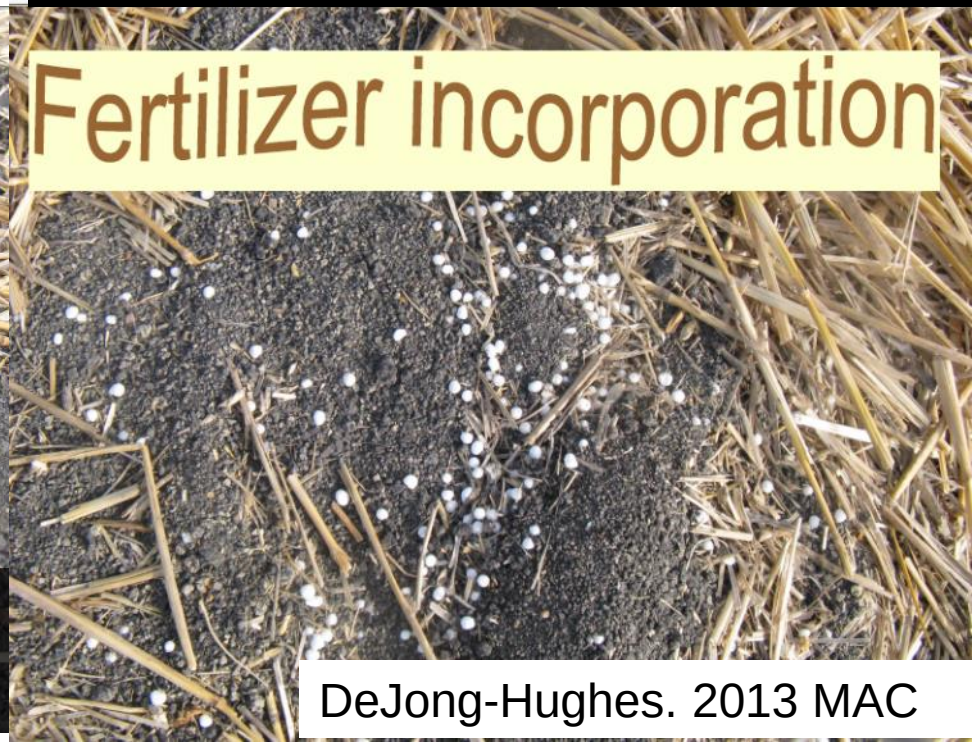
DeJong-Hughes. 2013 MAC

Vertical tillage

Speed - 7 to 10 mph

Challenges for VT

~ *Incorporation*



Fertilizer incorporation

DeJong-Hughes. 2013 MAC

Broadcast urea incorporation with 1 and 2 passes Vertical Till (Crop Diagnostic School 2014)

Application	Surface residue	N prills at surface	NH_3 loss ppm*
Surface N	93%	100%	300
Vertical till 1X	74%	20%	25
Vertical till 2X	54%	14%	25

* In 3 days before rainfall.


Strip till allows banding

Strip till allows fertilizer banding

B. Pritchard, 2019

Fall Disk

Zero till

Strip Till

How much tillage do you need for soybeans?

Fertility Value of Unharvested Crops

- Hailed soybeans
- Unharvested dry beans
- Unharvested potatoes (12K acres)

October 1, 2004

Soil Fertility Value of Immature Crops Returned to the Soil

back

Some agronomists are being asked to supply information to growers as to the fertility value of late seeded or long-season crops that may freeze before maturity. These crops may be worked into the soil as an unintentional green manure. What are the fertility implications for fall soil testing and planning the fertility needs for the 2005 crop?

Green manures are typically crops that are worked into the soil during maximum vegetative growth. A major objective is to increase organic matter of the soil to improve soil physical properties. In the case of legume or pulse crops, the return of nitrogen (N) may be considerable.

Three different approaches to estimate or predict N contributions:

1) Estimates calculated from expected N uptake of crops

Typical nitrogen uptake by the above-ground portion of crops at maturity.

Crop	Yield potential (if mature)	Harvest index*	Total DM biomass lb/ac	Total C** lb/ac	Total N *** lb/ac	C:N Ratio	N contribution based on release values of 30%	50%
Corn	100 bu/ac	50 %	11200	4480	156	29:1	47	78
Sunflower	2000 lb/ac	40 %	5000	2000	74	27:1	22	37
Canola	35 bu/ac	45 %	3900	1560	108	14:1	32	54
Soybeans	30 bu/ac	50 %	3600	1440	168	9:1	50	84
Dry beans	1500 lb/ac	40 %	3750	1500	93	16:1	28	47

*Harvest index is that percentage of total DM that is grain at full maturity. Values are from various research papers.
**Total C is carbon content, estimated to be 40% of DM based on past analysis of cereal straw
***Total N is total crop uptake adapted from the MB Soil Fertility Guide or Ontario Soil Fertility handbook.

Manitoba

Table 1. Plant nutrient equivalent content of dry beans, soybeans and potato tubers

Heard & Hay, 2006 MAC

Crop	**C:N Ratio**	**Total N content**	**Total P_2O_5 equivalent**	**Total K_2O equivalent**
Dry beans	13:1	3.5 lb/cwt	1.1 lb /cwt	1.9 lb /cwt
Soybeans	8.3:1	3.8 lb/bu	1.2 lb/bu	1.2 lb/bu
Potatoes	37:1	32 lb/100 cwt	16 lb/100 cwt	60 lb/100 cwt

If C:N < 20:1 mineralization = “release of N”

If C:N > 20-30:1 immobilization = “N is tied up”

Mineralization eventually follows after immobilization:

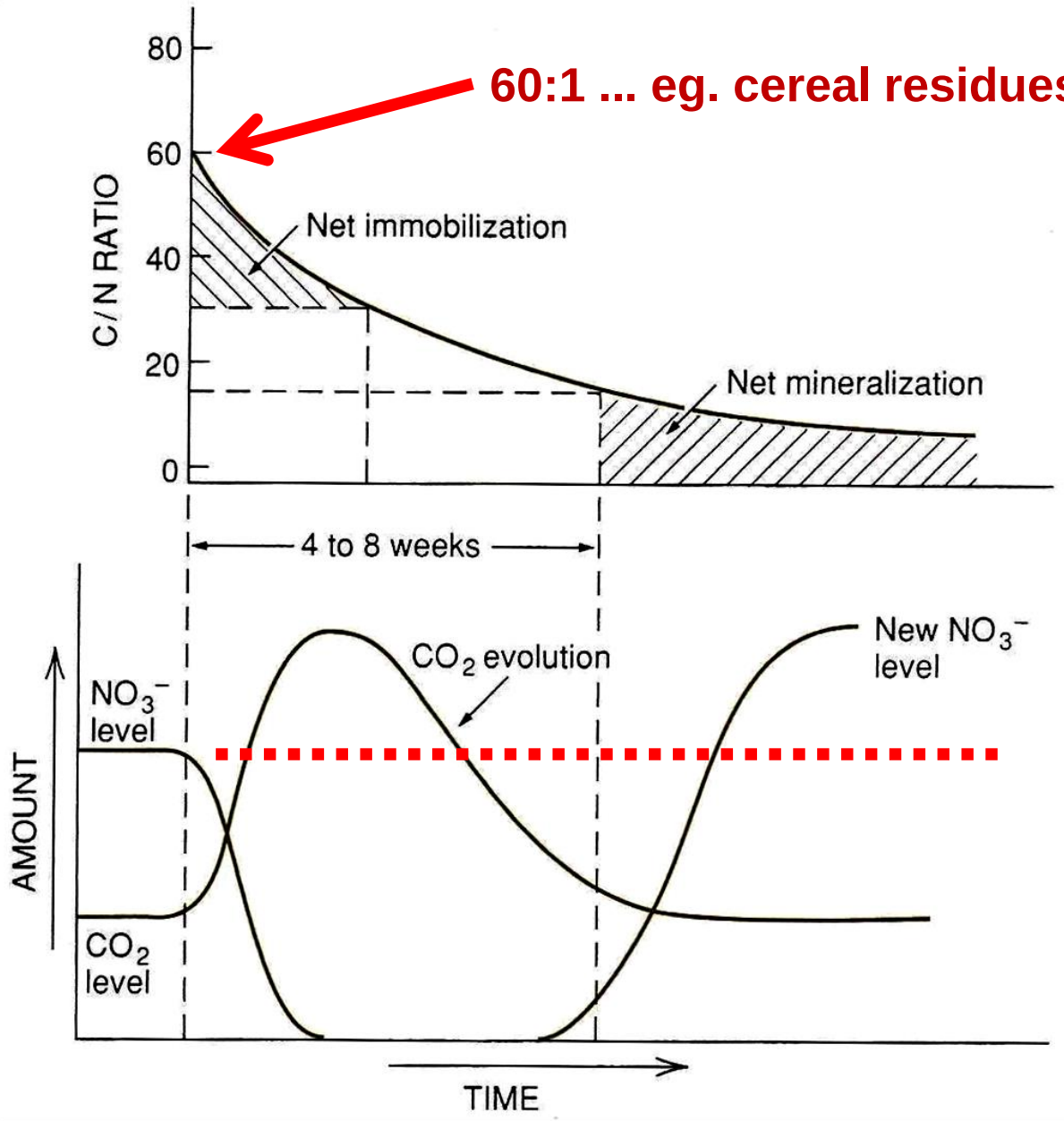


Figure 4-26
General description of N mineralization and immobilization following addition of residue to soil.
(Adapted from B. R. Sabey, Univ. of Illinois.)

37:1 potatoes

13:1 beans

8:1 soys

(Soil Fertility and Fertilizers 2014)

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Table 2. Estimated nutrient availability to 2020 crops from unharvested dry bean, soybean or potatoes.

Crop and estimated yield	Available N	Available P_2O_5	Available K_2O
	Lb/ac		
Dry beans 20 cwt/ac	70	18	34
Soybeans 30 bu/ac	114	29	32
Potatoes 300 cwt/ac	29 @ 30% available 48 @ 50% available	38	162

Modest to high N contribution.

P&K contribution is NOT “starter”, but consider as soil or maintenance supply.

Saturated Soil Summary

Manitoba

- Established fields - Soil bugs will take care of themselves. Use on-seed inoculant
- 1st time soils, granular inoculant offers protection
- Scout nodulation
- IDC – varieties, drainage, soil test, targeted SoyGreen?
- Salinity
- Fertility – stress of Placement & Timing for other crops
- Limit seed placement.
- Match P removals when able.
- Ruts – till them out
- Modest-high residual N from failed 2019 crops

Fall 2019 is behind us. Safari On!

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