The Agronomy Behind High Yielding Wheat

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Farmers Edge

Potential Yield

- **Potential yield** is the absolute capacity of a crop/genotype to produce economic yield under optimum production conditions. Under these conditions, the product of the yield components is expressed at the maximum possible for the genotype and production environment.
- Crop breeding improves genetic yield potential.

Actual Yield

- **Farm yield (actual yield)** is the economic yield attained at harvest under standard production conditions. Farm yield results from the interaction of the following factors:
    1. Genetic yield potential.
    2. Environment.
    3. Management practices.
    4. Pests.

What is Crop Yield?

- Crop yield is the product of the individual **yield components** (morphological characteristics) operating in the crop species in question.
- The yield components and the inherent physiological activities involved in their formation interact with the crop growth environment, management practices, and pests to affect yield.

Yield Components

- Crop yield is the biological and mathematical product of the components of yield.
- For example, yield of a grain crop can be expressed as:

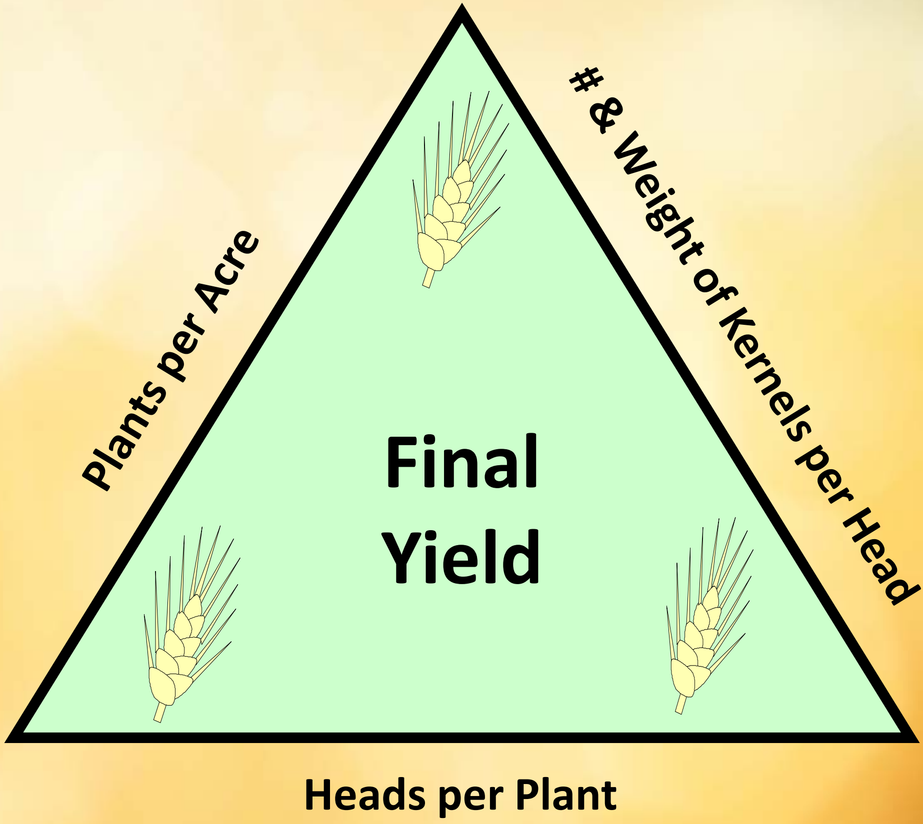
- Grain yield = Nf*Ns*Ws

where:

- Nf= number of florets.
- Ns = number of seeds.
- Ws= weight per seed.

Grain Yield Triangle

A triangle is a useful representation of how yield components interact to achieve a given yield . Number of spikelets per head and number of kernels per spikelet can be combined to create kernels per head.



- Each yield component has a period during which it is most sensitive to environmental and management conditions. These periods correspond to the developmental stages in which the potential of a component is set and then realized.

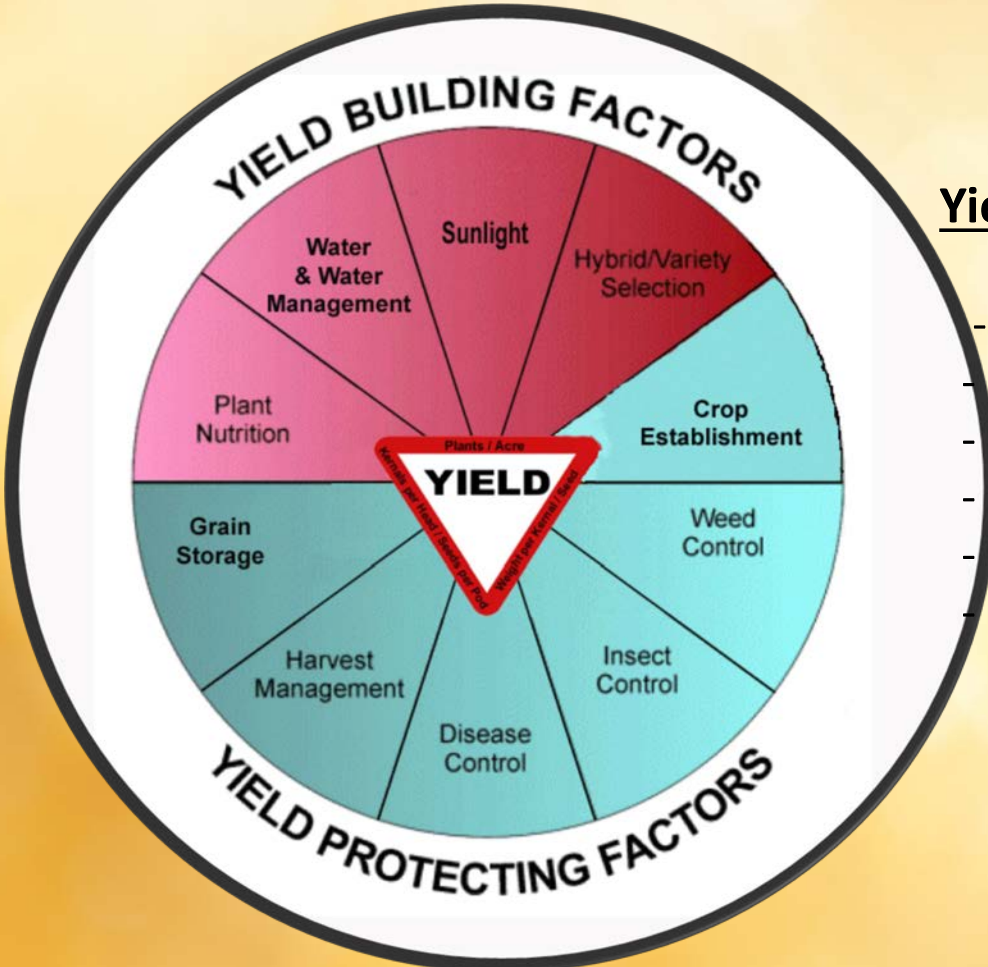
- In semi-arid production systems of the Great Plains, yield components related to number of plant parts (number of tillers per acre, number of kernels per head) generally are more important in determining yield than size of the parts (kernel size). This reflects the fact that the size of kernels tends to be more stable than number of heads or kernels.
- It follows that the number of heads per acre is the yield component most affected by environmental conditions, including management.
- In other words, management practices that promote good plant populations and tillering are critical for optimal yields

Environmental factors and management practices that determine yield

Yield component	Characteristic	Environmental factors	Management practices
Plants per unit area	Seedling density	NA	Planter adjustment, Seed number, size, and viability
	Soil seed contact	Soil water content, Seedbed condition	Planter adjustment, Planting speed, Tillage system and residue management.
	Germination	Soil temperature, Soil water content, Rainfall	Seeding depth, Tillage system
	Seedling survival	Soil temperature, Soil water content, Rainfall	Seeding depth, Irrigation, Tillage system
Tillers (heads) per plant	Tiller production	Air temperature, Soil water/nutrient content, Interplant competition, Rainfall	Planting date and rate, Plant nutrition, Soil cover/mulch, Irrigation
	Tiller abortion	Air temperature, Soil water/nutrient content, Interplant competition, Radiation	Planting date and rate, Plant nutrition, Soil cover/mulch, Irrigation
Spikelets per head	Spikelet production	Soil water/nutrient content, Interplant competition, Tiller age, Radiation/air temperature	Plant nutrition, Soil cover/mulch, Irrigation
Kernals per spikelet	Kernal set (i.e., pollination)	Soil water/nutrient content, Interplant competition, Tiller age, Radiation/air temperature	Plant nutrition, Soil cover/mulch, Irrigation
	Kernal production	Soil water/nutrient content, Interplant competition, Tiller age, Radiation/air temperature	Plant nutrition, Soil cover/mulch, Irrigation
Kernal size	Rate of grain filling	Soil water/nutrient content, Interplant competition, Tiller age, Radiation/air temperature	Plant nutrition, Soil cover/mulch, Irrigation
	Duration of grain filling	Soil water/nutrient content, Interplant competition, Tiller age, Radiation/air temperature	Plant nutrition, Soil cover/mulch, Irrigation

Yield Building Factors

- Sunlight
- Hybrid/Varietal Selection
- Plant Nutrition
- Water



Yield Protecting Factors

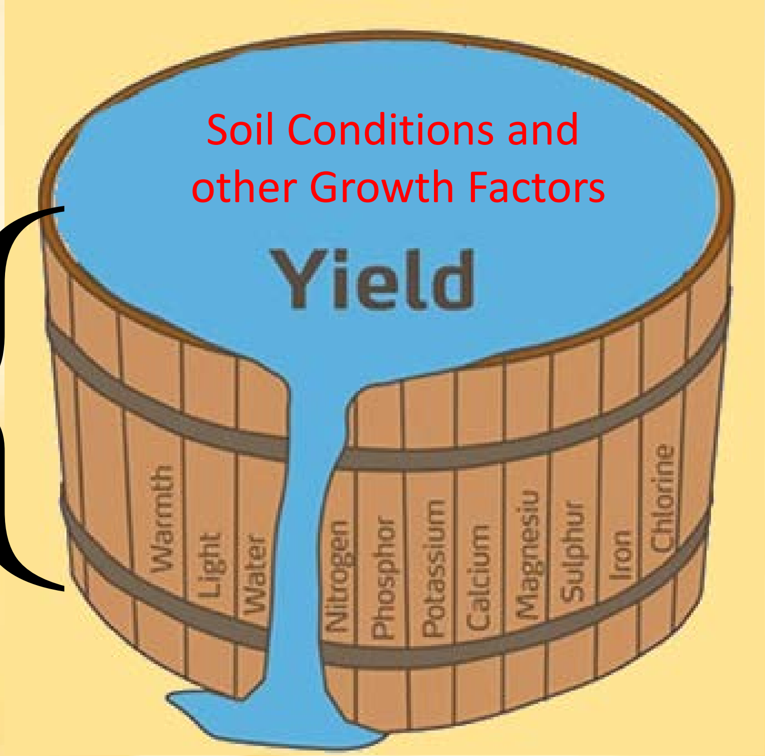
- Crop Establishment
- Weed Control
- Insect Control
- Disease Control
- Harvest Management
- Grain Storage

Cultivar / Variety Selection

Variety / Cultivar Selection

Yield Potential of
a Variety / Cultivar

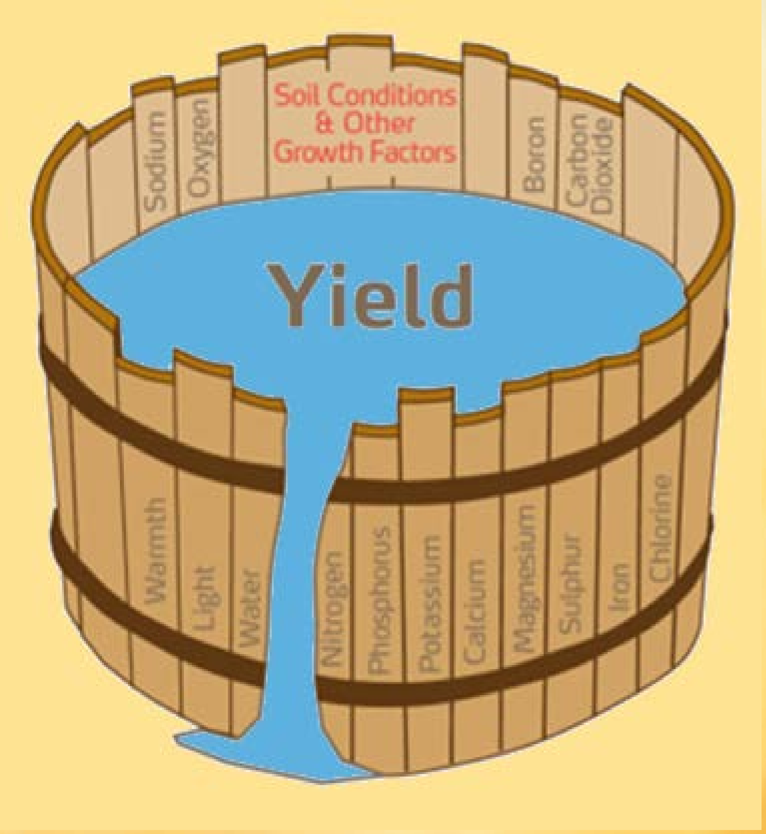
This can be looked at
As the ceiling!



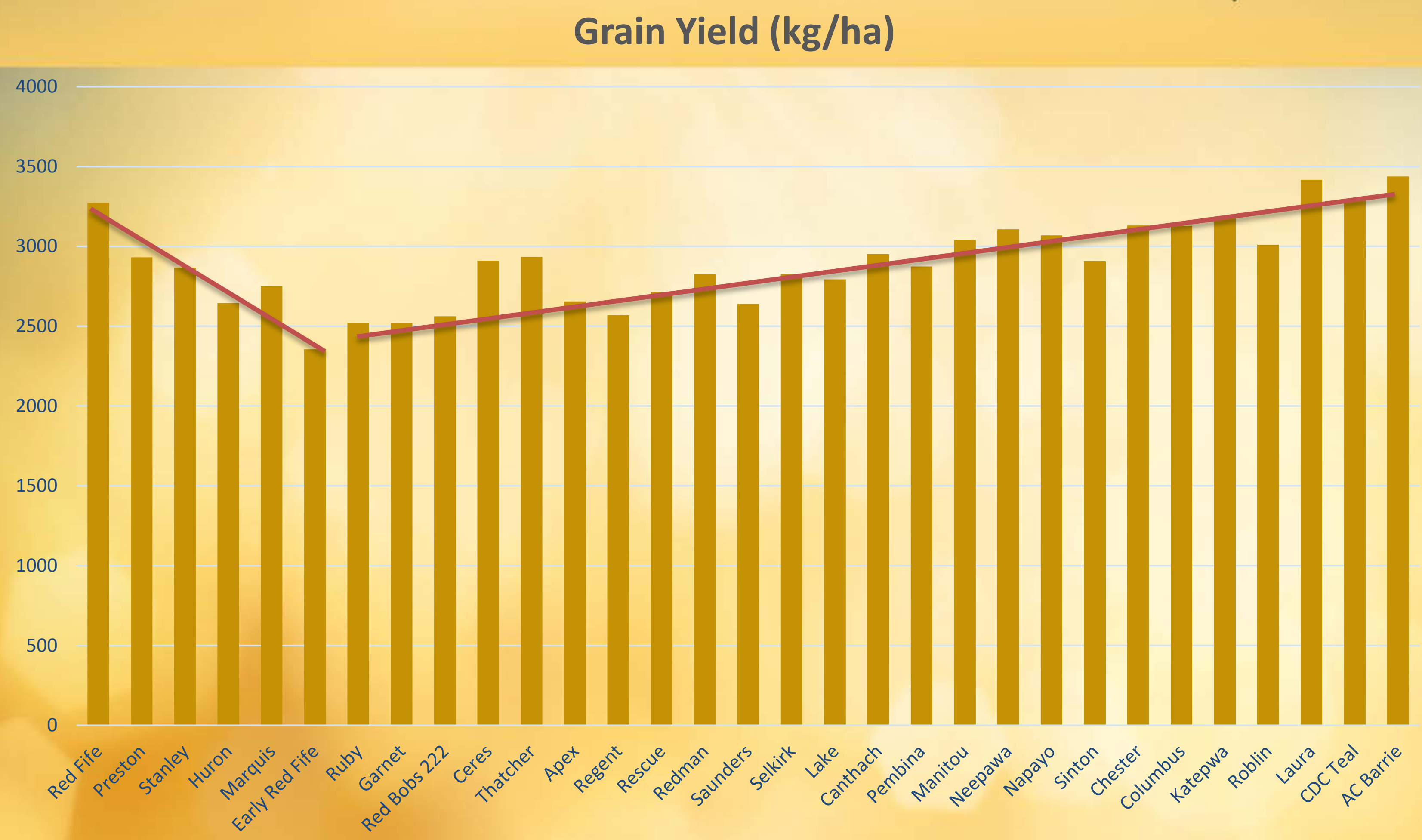
Variety / Cultivar Selection

Justus von Liebig's "Law of the Minimum" published in 1873

"If one growth factor/nutrient is deficient, plant growth is limited, even if all other vital factors/nutrients are adequate…plant growth is improved by increasing the supply of the deficient factor/nutrient"



Breeding – How well have we done?



Trials completed from 1989 – 2007 Saskatchewan

N=9

Average rate of yield gain = 15 kg/ha / year or 0.5% / year

It took us over 150 years to get back to where we started!

Hucl et al 2015

CEREAL CROPS

Wheat

Main Characteristics of Varieties

Category and Variety	Years Tested	Yield (%) Area 1 & 2	Yield (%) Area 3 & 4	Yield (%) Irriga-tion	Pro-tein	Resistance To[2] Lodg-ing	Sprout-ing	Stem Rust	Leaf Rust	Stripe Rust	Loose Smut	Bunt	Leaf Spot	FHB	Rel. Ma-turity (days)	Head Awned-ness	Seed Weight (mg)	Volume Wt.[3] (kg/hL)	Ht. (cm)
CWRS[1]		— Relative to Carberry —													——— Relative to Carberry ———				
Carberry	6	100	100	100	14.7	VG	F	MR	R	MR	MR	R	MS	MR	105	Y	36.0	80.3	84
AAC Bailey	5	98	100	—	+0.1	G	G	R	R	—	MS	MR	I	I	-3	N	+0.1	-1.7	+11
AC Barrie §	6	94	99	98	+0.1	G	G	MR	MS	S	MR	I	MS	I	-2	N	-1.3	-1.1	+12
CDC Bradwell	2	99	103	—	-0.1	G	F	MR	R	MS	MR	R	MS	I	-2	Y	-0.6	-1.7	+7
AAC Brandon	4	107	105	—	-0.5	G	P	R	R	MR	MR	S	I	MR	0	Y	-0.1	-0.2	-1
AAC Cameron VB	2	108	117	—	-0.6	G	F	MR	MR	S	S	R	I	I	-3	Y	+1.0	-1.2	+17
Cardale	5	99	101	—	-0.2	G	G	R	R	S	I	MR	MS	MR	-1	Y	-2.8	-1.2	+3
Coleman	3	96	96	—	-0.1	P	P	MR	R	MR	S	S	MS	MR	-3	Y	-1.1	-0.5	+15
AAC Connery	2	93	101	—	+0.5	VG	G	R	MR	R	MR	I	I	MR	-4	N	-0.7	-1.5	+2
AAC Elie	4	106	104	—	-0.3	G	F	R	R	MR	I	I	I	I	0	Y	+0.1	0	-2
Glenn	6	101	102	102	-0.4	VG	F	R	R	MR	I	I	I	I	-1	Y	-1.2	+3.3	+8
CDC Go	5	96	102	—	0.0	G	P	R	I	MR	MS	I	S	MS	-3	Y	+2.3	-1.4	+7
Go Early	2	94	100	—	+0.4	F	—	MR	MR	I	MS	MR	S	I	-4	Y	+3.3	-1.8	+16
Goodeve VB	6	101	107	—	0.0	VG	G	MR	MR	I	MR	S	MS	S	-4	N	-0.6	-2.0	+9
Harvest[4]	6	94	103	—	-0.3	VG	VG	R	MR	MR	MR	S	MS	S	-3	N	-2.8	-1.6	+10
Infinity	6	100	106	—	-0.1	G	G	MR	MR	MS	MR	MR	MS	S	-3	N	-4.0	-1.7	+12
AC Intrepid §	6	96	105	—	-0.2	G	P	MR	MR	MR	I	MR	MS	MS	-5	N	+3.2	-1.8	+11
AAC Jatharia VB	2	110	115	—	0.0	G	G	I	R	I	S	MS	I	I	-2	Y	+0.5	+0.3	+16
CDC Kernen	6	101	106	101	0.0	G	P	MR	MR	I	R	I	MS	I	-1	Y	+0.1	-1.3	+15
Lillian[4]	6	94	97	—	+1.1	F	G	MR	R	R	I	MR	MR	S	-2	N	0.0	-2.7	+12
CDC VR Morris	5	108	106	—	-0.2	G	P	MR	R	—	I	I	I	MR	-3	N	-2.8	-0.5	+10
Muchmore	6	102	98	102	-0.4	VG	G	R	R	MR	MR	R	MS	MS	0	Y	+0.1	-1.1	-3
CDC Plentiful	5	105	104	—	-0.2	VG	P	R	R	MR	R	I	I	MR	-3	N	-2.4	-1.5	+8
AAC Prevail VB	3	112	108	—	-0.6	G	VG	MR	R	R	S	S	MS	I	-1	N	-1.9	-0.9	+20
AAC Redwater §	4	102	101	—	+0.1	F	VG	R	R	MR	MS	I	MS	I	-5	Y	-2.8	-1.7	+7
Shaw VB	6	112	114	103	-0.7	G	G	R	MR	I	S	MR	MS	MS	-3	N	+0.1	-0.2	+17
CDC Stanley	6	103	107	100	-0.1	G	G	R	MR	I	MR	S	I	MS	-2	N	-3.4	-2.3	+10
Stettler	6	105	107	100	+0.2	G	G	MR	MS	MR	R	MR	MS	MS	-1	Y	-1.4	-1.1	+7
SY433	5	96	101	—	-0.3	G	VG	R	R	—	I	S	I	MR	-2	Y	+0.6	-0.3	+14
Thorsby	2	102	101	—	+0.2	G	F	MR	R	R	I	S	MS	I	-4	N	+1.0	-0.3	+10
CDC Thrive	6	102	102	103	-0.1	G	F	MR	I	I	MR	I	I	MS	-3	N	-1.8	-1.1	+13
CDC Titanium VB	3	106	111	—	+0.7	F	F	I	R	R	MS	I	MS	MR	-3	Y	+1.0	-1.1	+11
Unity VB[4]	6	111	115	—	-0.6	F	VG	MR	R	MS	MS	R	I	I	-2	Y	-1.7	+0.4	+14
CDC Utmost VB	6	108	112	107	-0.4	G	G	MR	R	I	MS	S	I	MS	-3	N	-1.7	-1.3	+10
Vesper VB	6	108	113	—	-0.7	F	F	MR	R	S	I	S	I	I	-3	Y	+1.5	0.0	+11
AAC W1876	2	96	98	—	+0.1	G	F	MR	R	I	I	I	MS	I	-1	Y	0.0	-0.3	+1
Waskada	6	108	107	108	-0.2	F	VG	R	I	MS	MR	R	MS	MR	-1	Y	-1.0	+0.3	+16
WR859CL	6	101	101	102	-0.1	G	G	MR	R	I	R	R	MS	MR	-2	Y	-2.6	-1.1	+7
5604HR CL	6	95	99	107	-0.4	G	G	R	R	—	MS	I	MS	I	-4	Y	-3.7	-1.5	+10
5605HR CL	3	103	105	—	+0.2	G	—	MS	R	MR	R	MR	MS	MR	-1	Y	-1.6	+0.5	+11

Summary

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- Be ware of testing results with limited locations and years.
- Pick the highest yielding variety for your area that has the most complete package of other attributes for your needs!

Solar Radiation

Solar Radiation & Crop Needs

- Plant leaves absorb sunlight and use it as an energy source in the process of photosynthesis.
- A crop's ability to collect sunlight is proportional to its leaf surface area per unit of land area occupied, or its "leaf area index (LAI)."
  - At "full canopy" development, a crop's LAI and ability to collect available sunlight are maximized.
- From full canopy through the reproductive period, any shortage of sunlight is potentially limiting to corn yield.
  - When stresses such as low light limit photosynthesis during ear fill, corn plants remobilize stalk carbohydrates to the ear. This may result in stalk quality issues and lodging at harvest.
- The most sensitive periods of crop growth (e.g., flowering and early grain fill) are often the most susceptible to stresses such as insufficient light, water or nutrients.

- Plants are able to use only a portion of the solar radiation spectrum. This portion is known as "photosynthetically active radiation (PAR)" and is estimated to be about 43% to 50% of total radiation.
- Amount of PAR available to a crop is reduced proportionately to cloud cover.
- As the next slide shows, PAR was reduced by 25% to 50% on partly cloudy to cloudy days, and by over 60% on rainy days at Johnston, Iowa.
- It is not surprising, then, that cloudy, rainy periods during susceptible stages of crop development can have significant effects on yield.

Effect of Cloud Cover on Photosynthesis

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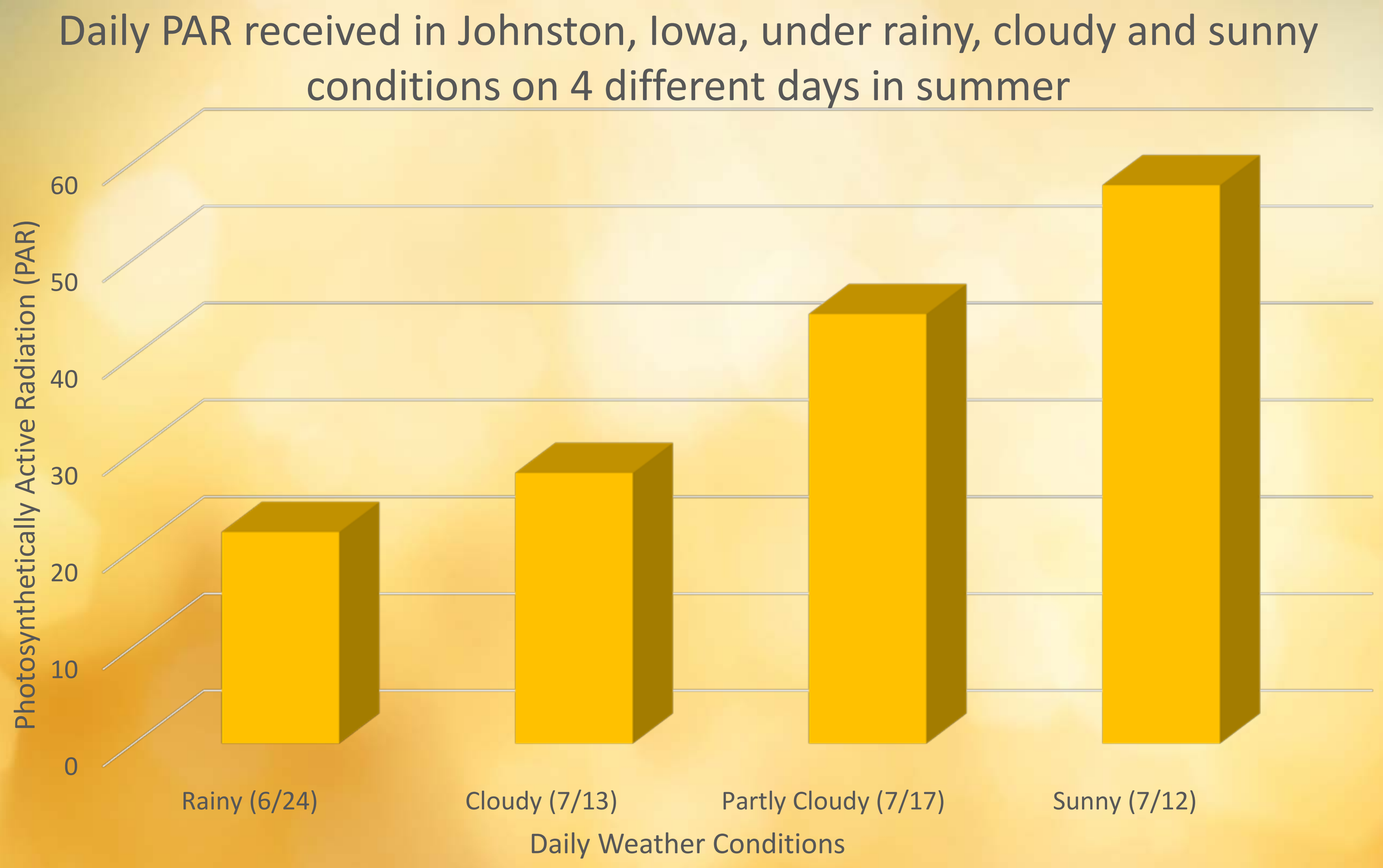
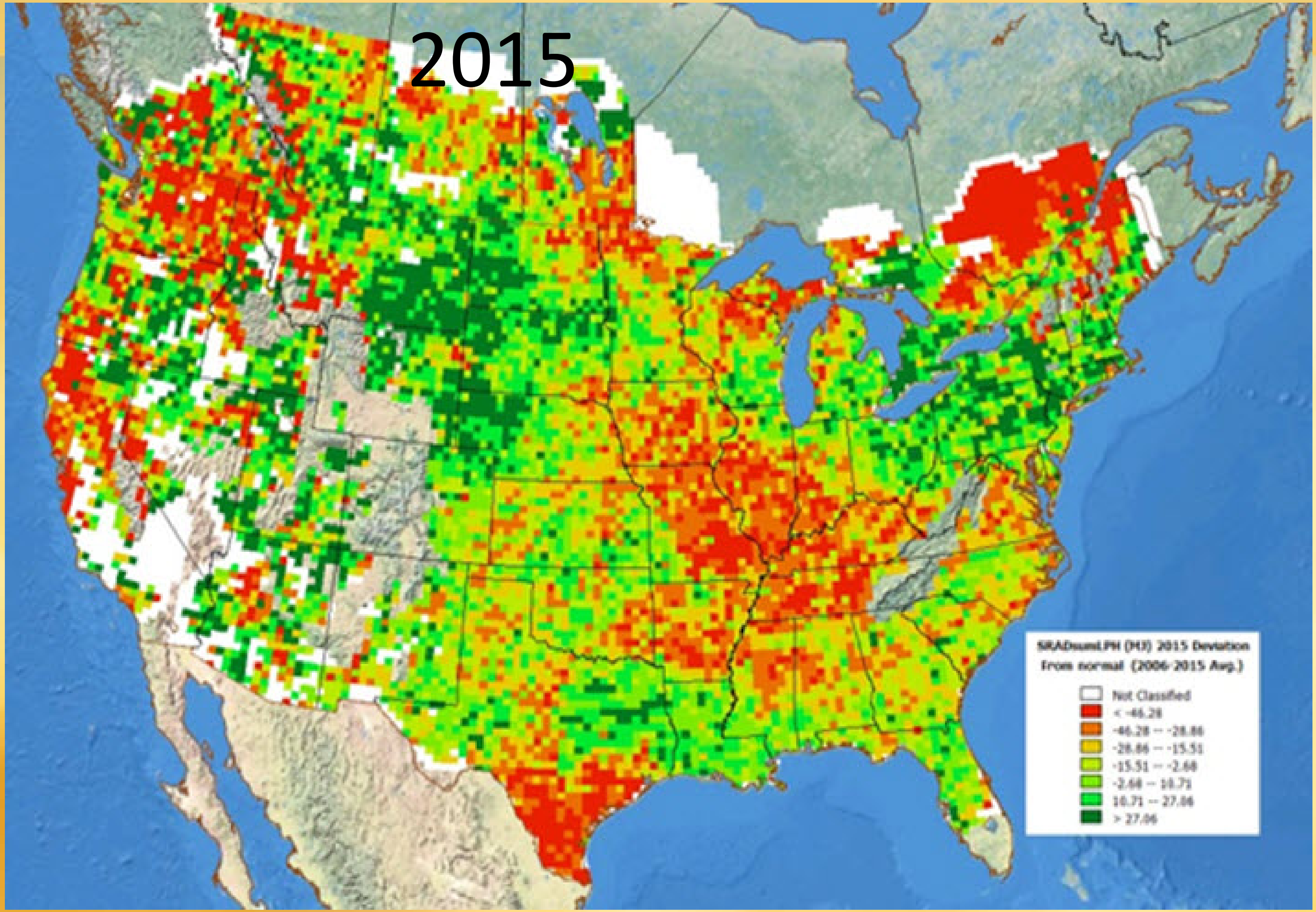


Growing Season Solar Radiation

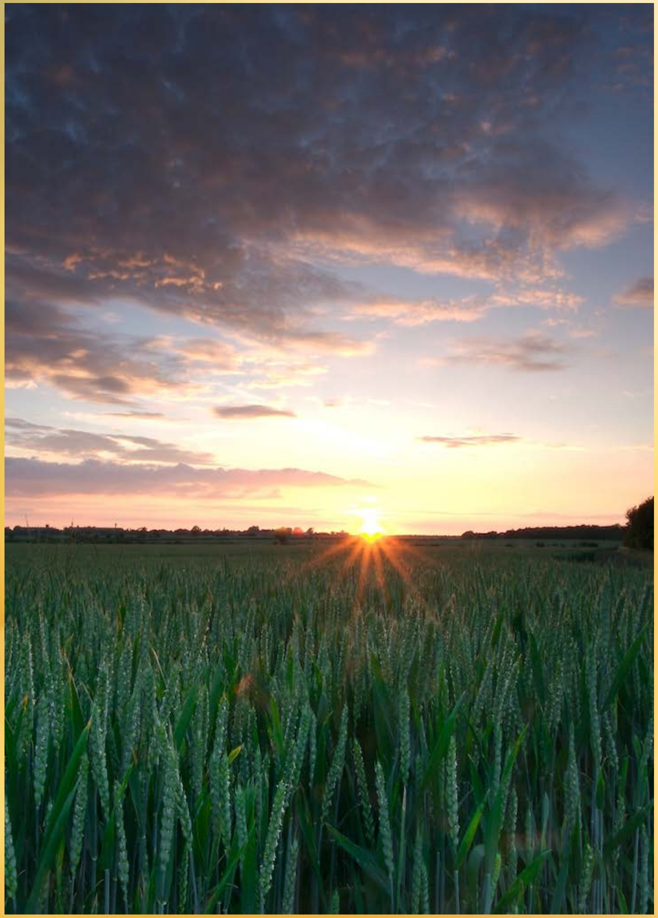
FarmersEdge

2015

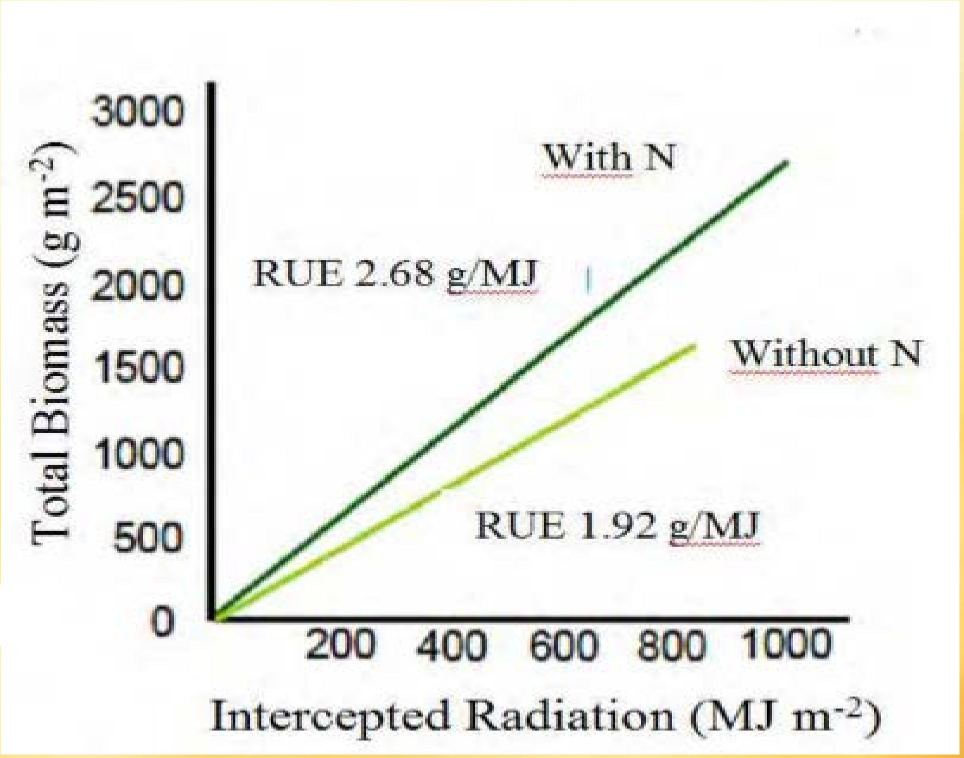


2015 deviation from normal (2006-2015 avg.) solar radiation during the "lag phase" of development. *Lag phase" is approx. the R1 (silking) through R2 (blister) stages of corn development.*

Interaction Solar Radiation and N Fertilizer

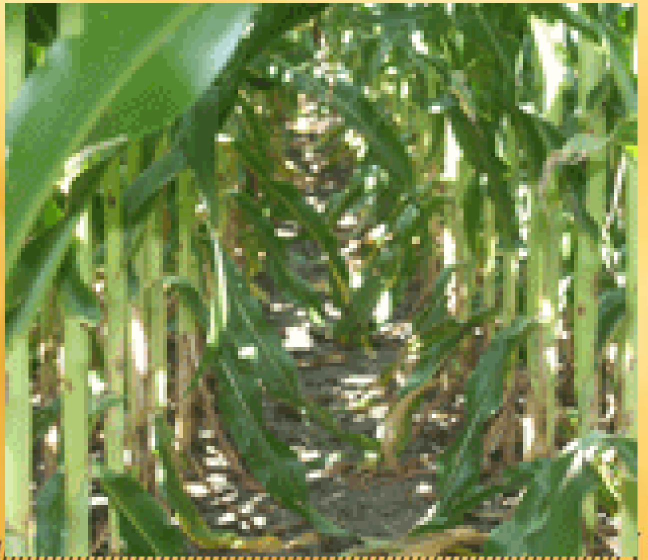


Effect of Nitrogen in corn on Intercepted Radiation

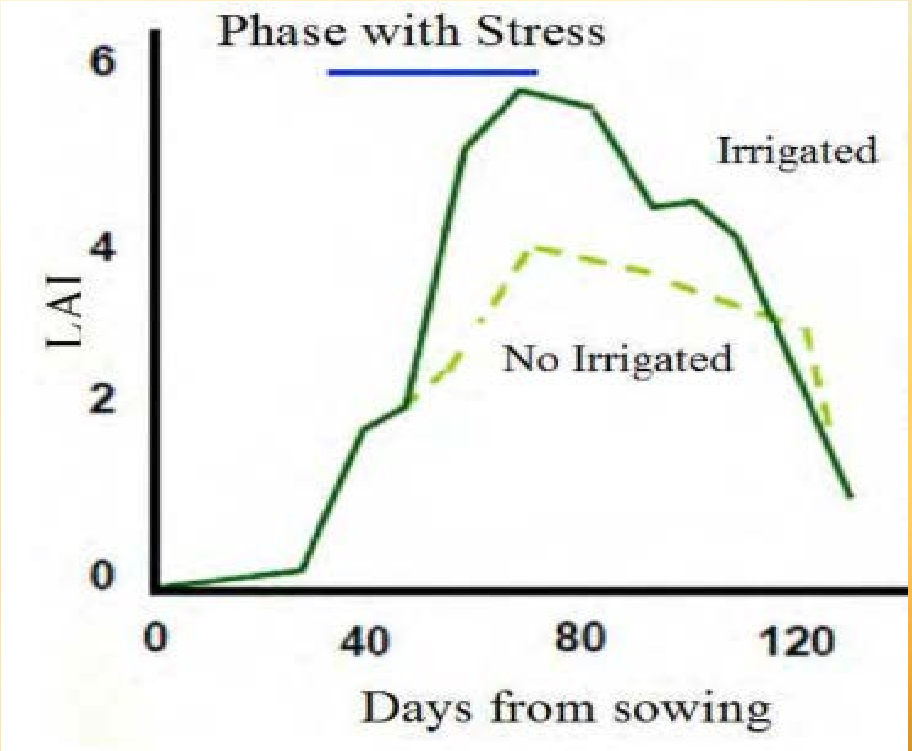


Adapted from Uhart & Andrade (1995)

Interaction Solar Radiation and Water



Effect of water stress on Leaf Area Index in corn



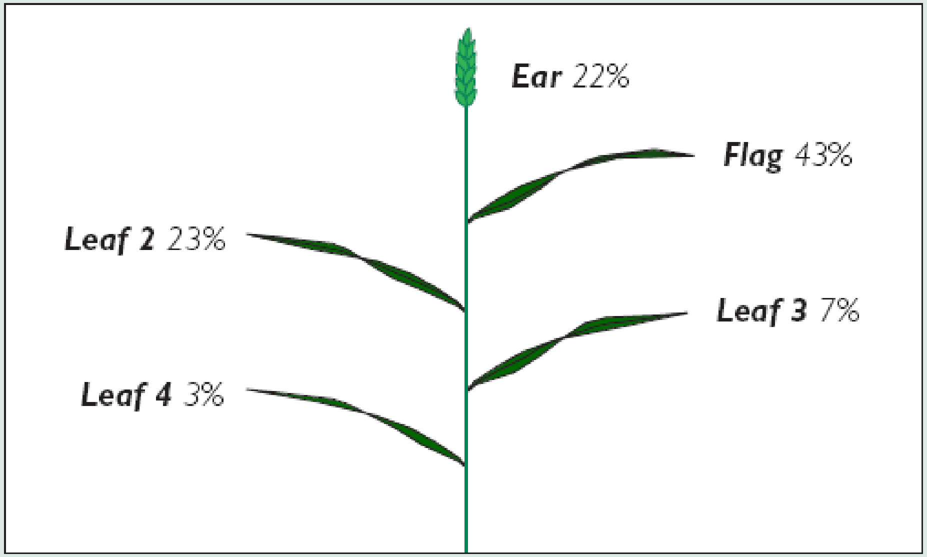
Adapted from Otagui (1992)

Contribution to yield from upper leaves of the cereal canopy

Cereal growth stages and their importance to fungicide application, 2003, Colin Hacking and Nick Poole, Hi-Grain Update

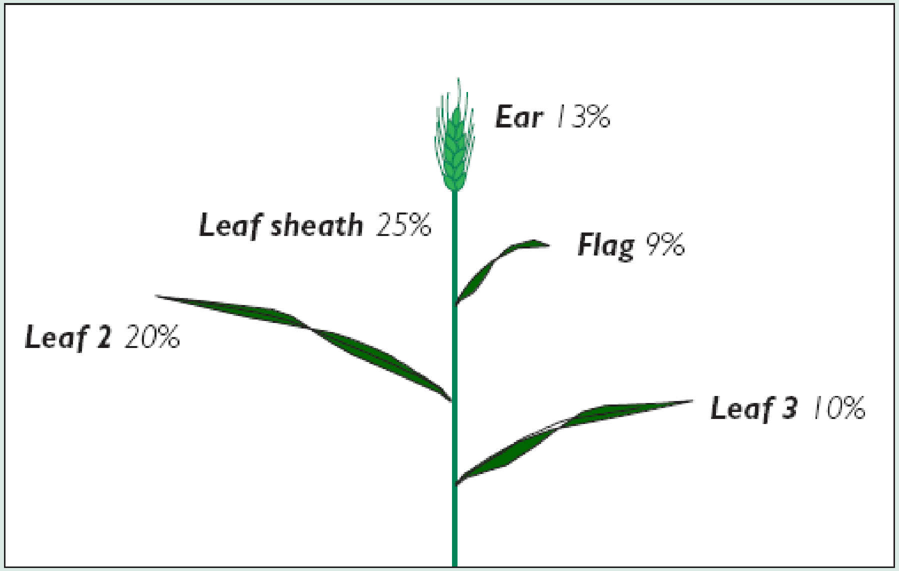
i) Winter Wheat

Diagram 3. Approximate contribution of top 3 leaves in winter wheat



ii) Winter barley

Diagram 4. Approximate contribution of top 3 leaves in winter barley



Summary

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- A plant's ability to utilize solar radiation can be improved by BMPs for wheat production!

Water….

Our Most Limiting Nutrient

How Much H_2O Do We Need For a Crop?

FarmersEdge

- **Four or five inches for any yield**

….to account for evaporative losses

Dark Brown Soil Zone

- **Maximum yield for wheat (80 bu) at about 20 inches**

Average Moisture Use Efficiency for Various Crops (bu/inch)

FarmersEdge

Soil Zone	HRS Wheat	Barley	Canola
Brown	3.75	5.7	2.6
Dark Brown	4.0	6.2	2.8
Black	4.25	6.4	3.2
Moist Black	4.5	6.7	3.4
Grey	4.75	7.2	3.6

So, for a 36 bu crop of wheat, we need about 9 inches per acre of water in the Dark Brown soil zone

…or, about 2 million gallons per acre

…from the stored soil moisture +
growing season precipitation,
less evaporation…..

All Rain is NOT Created Equal

FarmersEdge

Effect of Rainfall on Wheat Yield (Swift Current)

Time Period	Yield Increase (bu per inch)
May Rain	2.1
June Rain	1.3
July Rain	3.1
July Evaporation	-1.9

Available Moisture in Soil (inches)

Feet of moist soil	Sand	Loam	Clay
0.5	0.38	0.75	1.00
1.0	0.75	1.50	2.00
2.0	1.50	3.00	4.00
3.0	2.25	4.50	6.00
4.0	3.00	6.00	8.00

Example: Dark Brown Soil, Spring Wheat With 3 feet of moist clay soil….

Yield = (stored water + growing season water –1.75) X 4.0 bu/in

Wet year: (6” + 8” – 1.75) x 4.0 = 49 bu/acre

Dry year: (6” + 3” – 1.75) x 4.0 = 29 bu/acre

Water use, grain yield and WUE when averaged across years and crops direct seeded into stubble of various heights

Stubble*	Water use (mm)	Yield (kg ha^{-1})	WUE (kg ha^{-1} mm^{-1})
X-Tall (45+ cm)	215	1551a	8.5
Tall (30 cm)	215	1486ab	8.0
Short (15 cm)	215	1423ab	7.5
Cultivated	215	1329b	7.1

*stubble height imposed just before seeding

Cutforth and McConkey, 1995

Water use, grain yield and WUE of wheat at various N rates

FarmersEdge

Water Requirements Using Proper Fertilization

N rate (lb/A)	Total water use (in)	Yield (bu/A)	Water Use (in/bu)	Yield (bu/in)
0	11.4	27	0.41	2.4
20	12.0	36	0.33	3.0
40	12.9	45	0.29	2.4
60	13.4	50	0.27	3.4
80	13.2	54	0.24	4.2
100	14.3	64	0.22	4.5

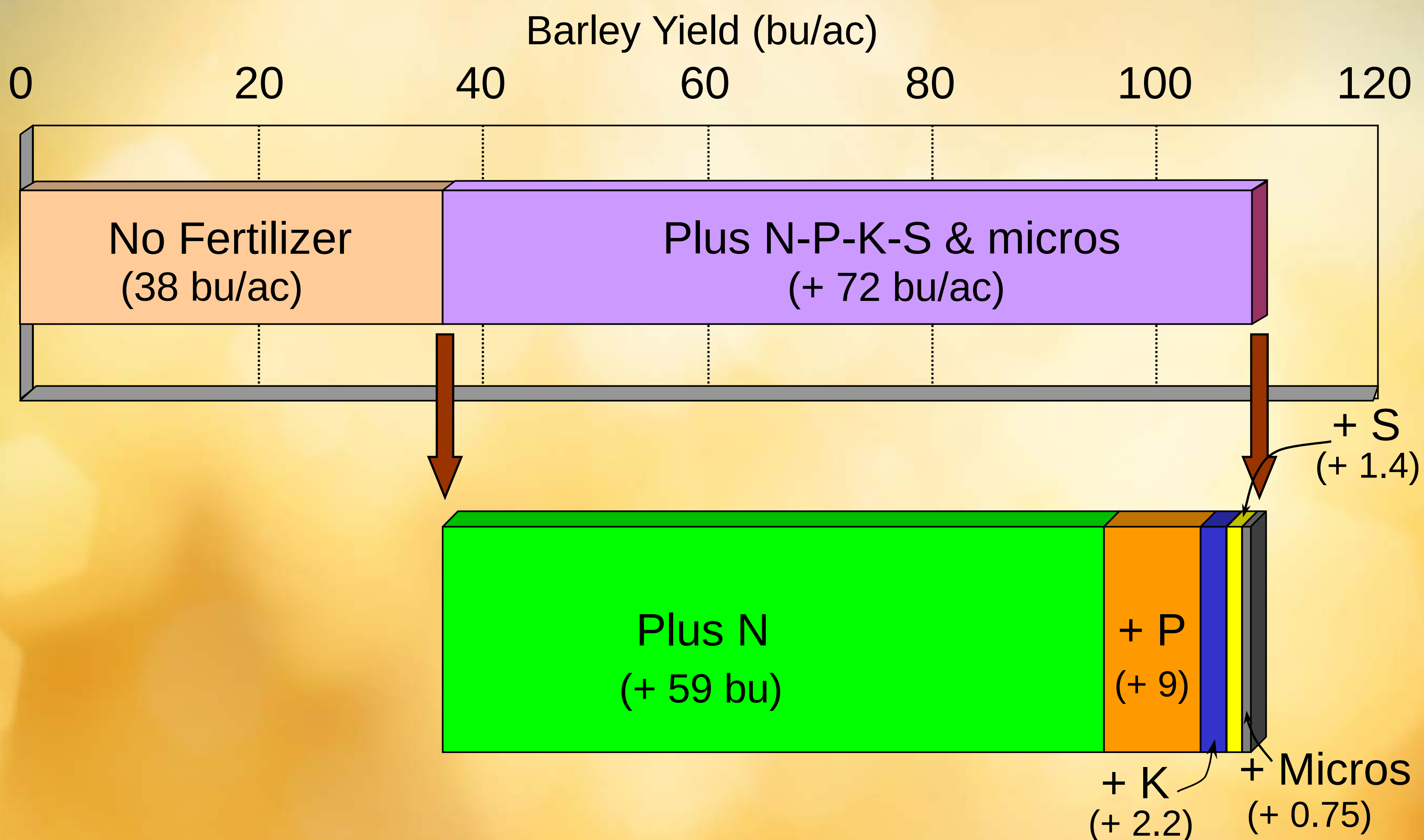
Research conducted by WESTCO has demonstrated that water use efficiency (WUE) can be very significantly improved with fertilizer management. Based on the results of several barley trials, application of broadcast fertilizer resulted in a WUE of 4.0 bushels per inch of water used on every acre compared to 3.0 for the unfertilized treatments. This represents a 33% increase in WUE due to the application of broadcast placed fertilizer. However, in the treatments where the fertilizer was deep banded, the WUE increased to 2.1 bushels per inch of water. This represents almosta 100% improvement over the unfertilized treatments.

Summary

- Water is the most limiting factor for wheat production in western Canada.
- Strategies to maximize a crop's access to water during key stages of crop production will optimize crop production.
- WUE can be improved by manipulating planting techniques, stubble height and fertilizer management.

FERTILIZER

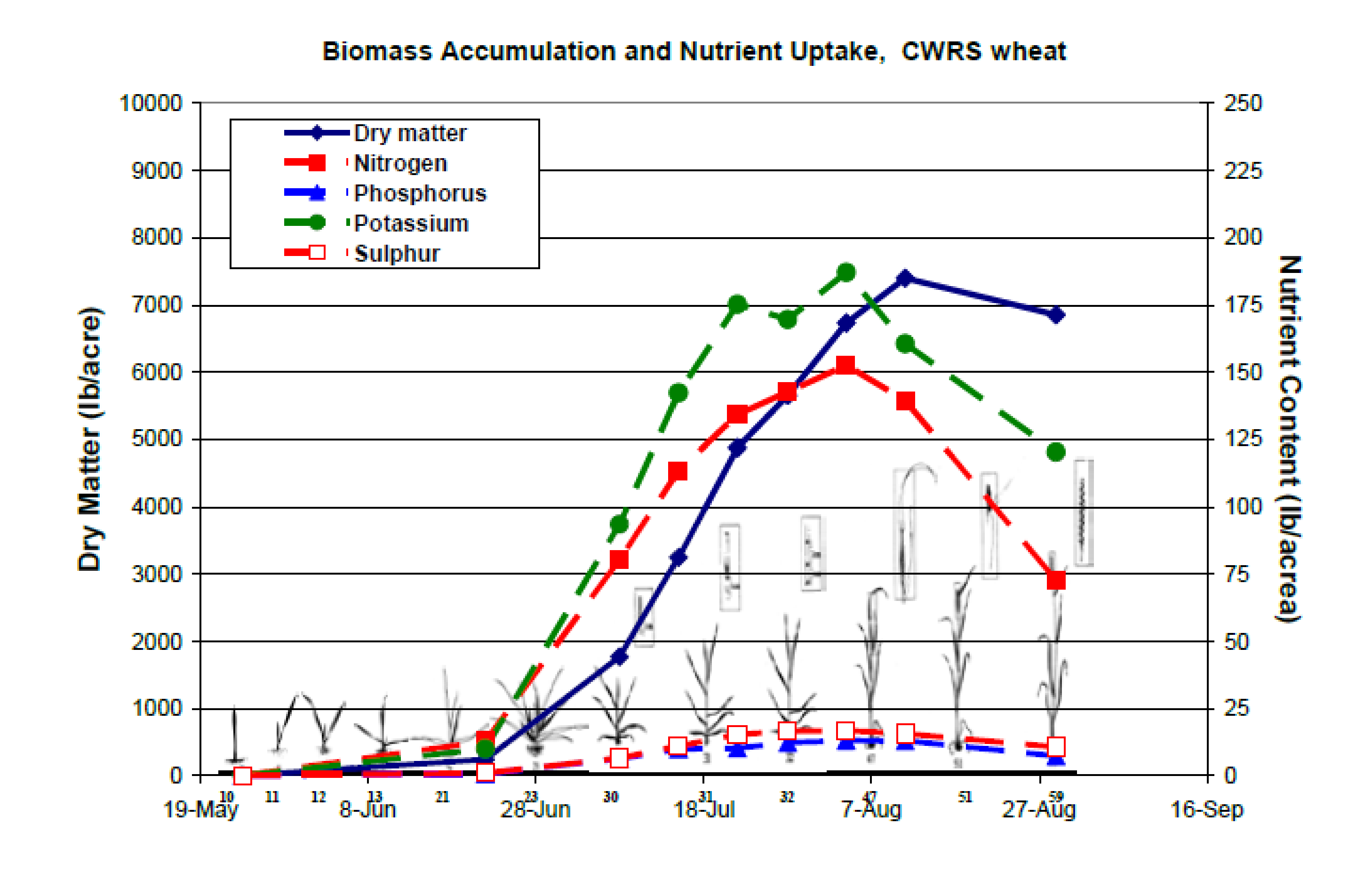
Contribution of Nutrients to Yield



Source: Westco

N = 41

Nutrient Uptake



Plant biomass and nutrient accumulation in wheat (adapted from Malhi et al.; growth stages shown on the graph are approximations).

Nitrogen

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Probability of a Yield Increase due to Nitrogen Fertilizer Application on N deficient soils

FarmersEdge

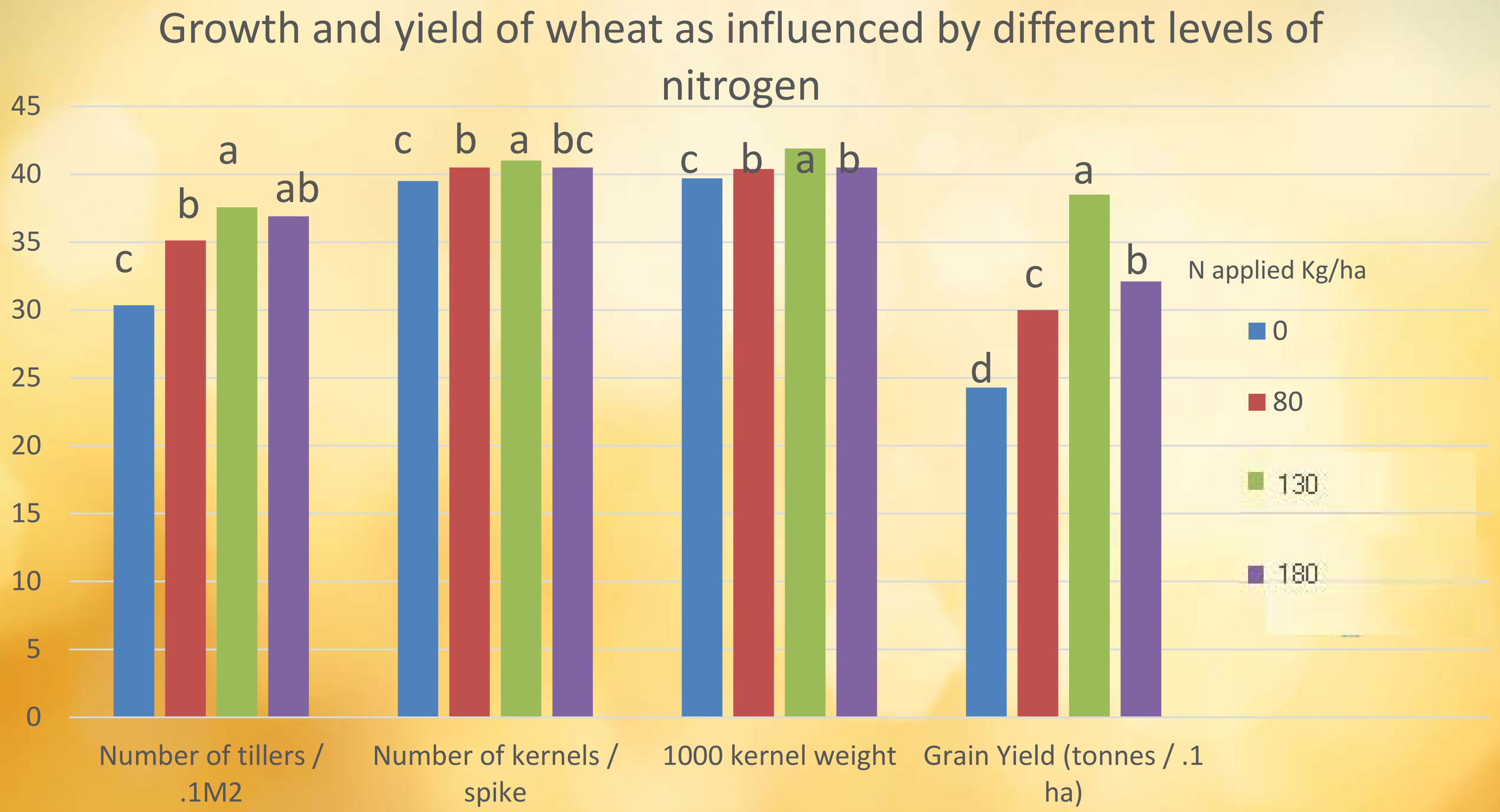
Crop	Probability of Overall positive Response	Probability of response by a yield increase of:		
		>10 bushels	>20 bushels	>30 bushels
Wheat	98.6%	70%	40%	<10%
Barley	99.3%	90%	80%	60%
Canola	100%	70%	25%	<10%

Average Yield Increases due to Nitrogen Fertilizer Application on N deficient soils

FarmersEdge

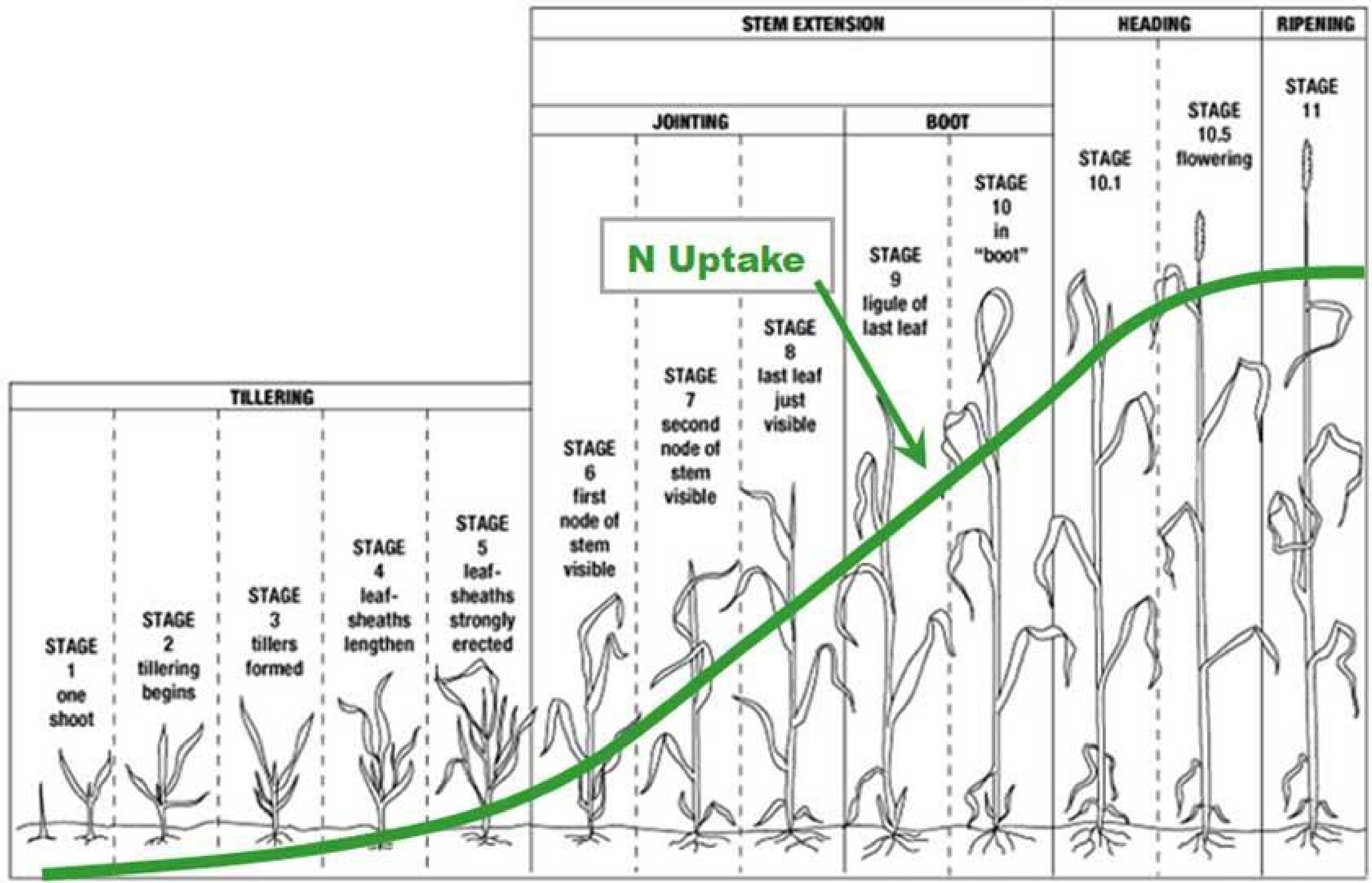
	Optimum Nitrogen fertilizer rate, lb N/acre				
Crop	<40	40-60	60-80	80-100	>100
Barley	18	22	38	45	53
Wheat	7	15	19	25	32
Canola	9	12	15	18	23

Impact of N on Yield



Note; means sharing common letters do not differ significantly from each other 5% probability level

Amjed Ali et.al.

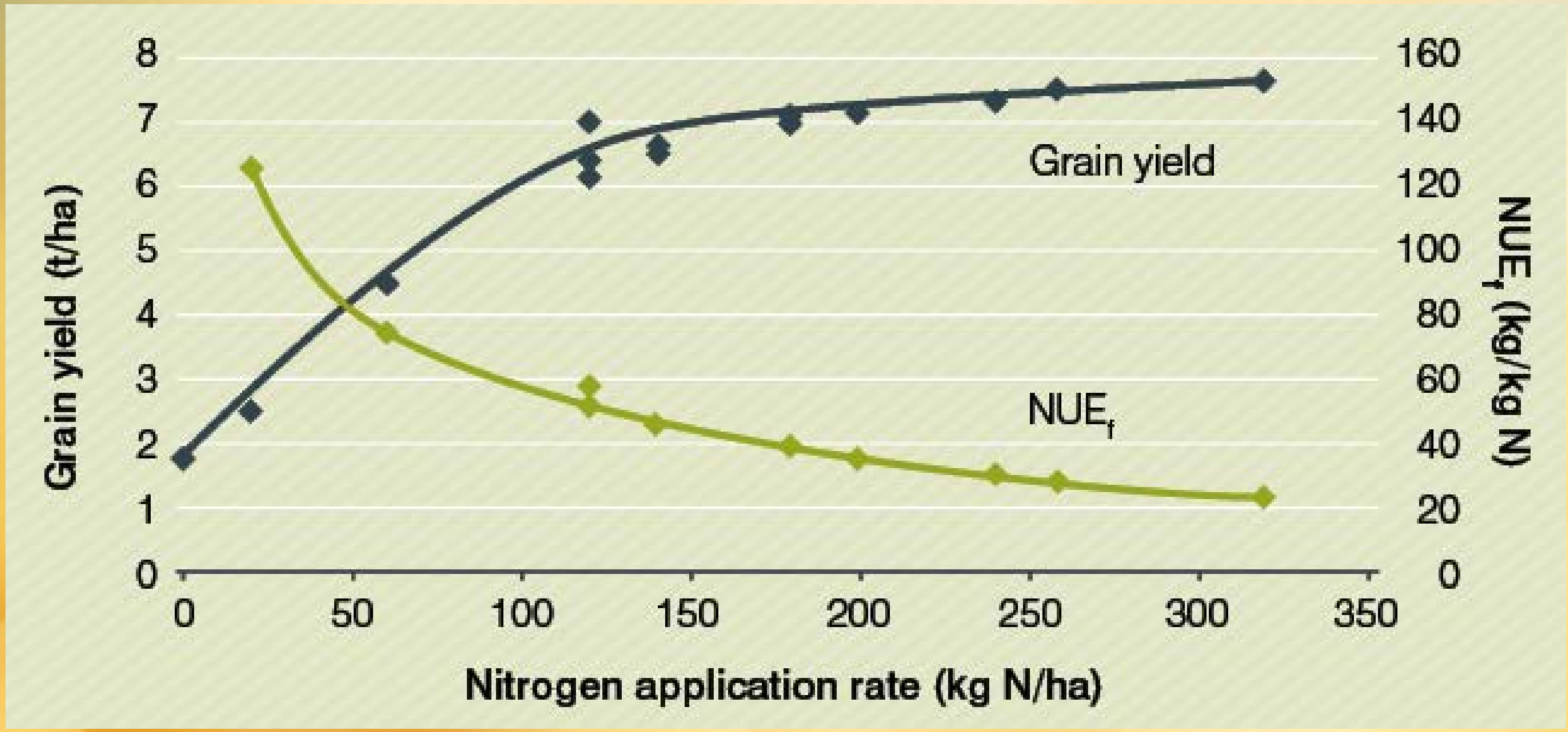


Source: S.A. Ebelhar, University of Illinois.

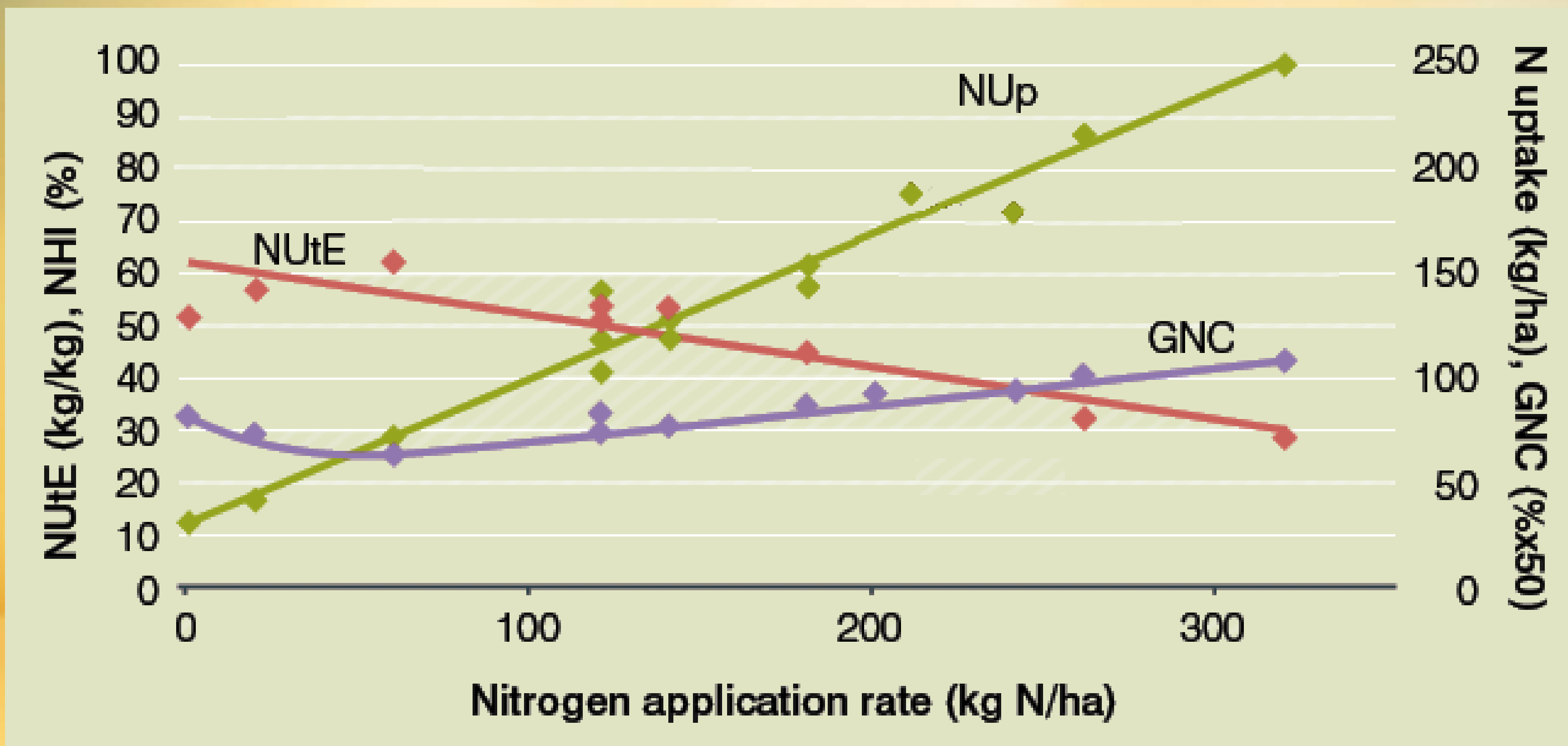
Nitrogen Use Efficiency

FarmersEdge

- Banded N - 50 – 70%
- Broadcast N - 40 – 50%
- Topdress N - 20 – 30%



NUE_f = Nitrogen Use Efficiency of applied fertilizer



NU_tE= total Nitrogen Use Efficiency

Nup = Nitrogen Uptake

GNC = Grain Nitrogen Concentration

Nutrient uptake in the straw and grain portion of wheat.

FarmersEdge

Yield	Plant Part	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Sulphur (S)
	Typical Nutrient Uptake (lbs/ac)				
40 bu/ac	Seed	55 – 65	25	17	4
	Straw	20 – 30	9	55	5
	Total	75 – 95	32	71	9
60 bu/ac	Seed	80 - 100	38	25	6
	Straw	30 - 45	14	83	8
	Total	110 - 145	52	108	14

Where does nitrogen come from?

- 3 sources
  - Soil nitrogen
  - Fertilizer nitrogen
  - Mineralized nitrogen

Where does nitrogen come from?

- 3 sources
  - Soil nitrogen
  - Fertilizer nitrogen 40 – 60% efficient*
  - Mineralized nitrogen 85 – 95% efficient

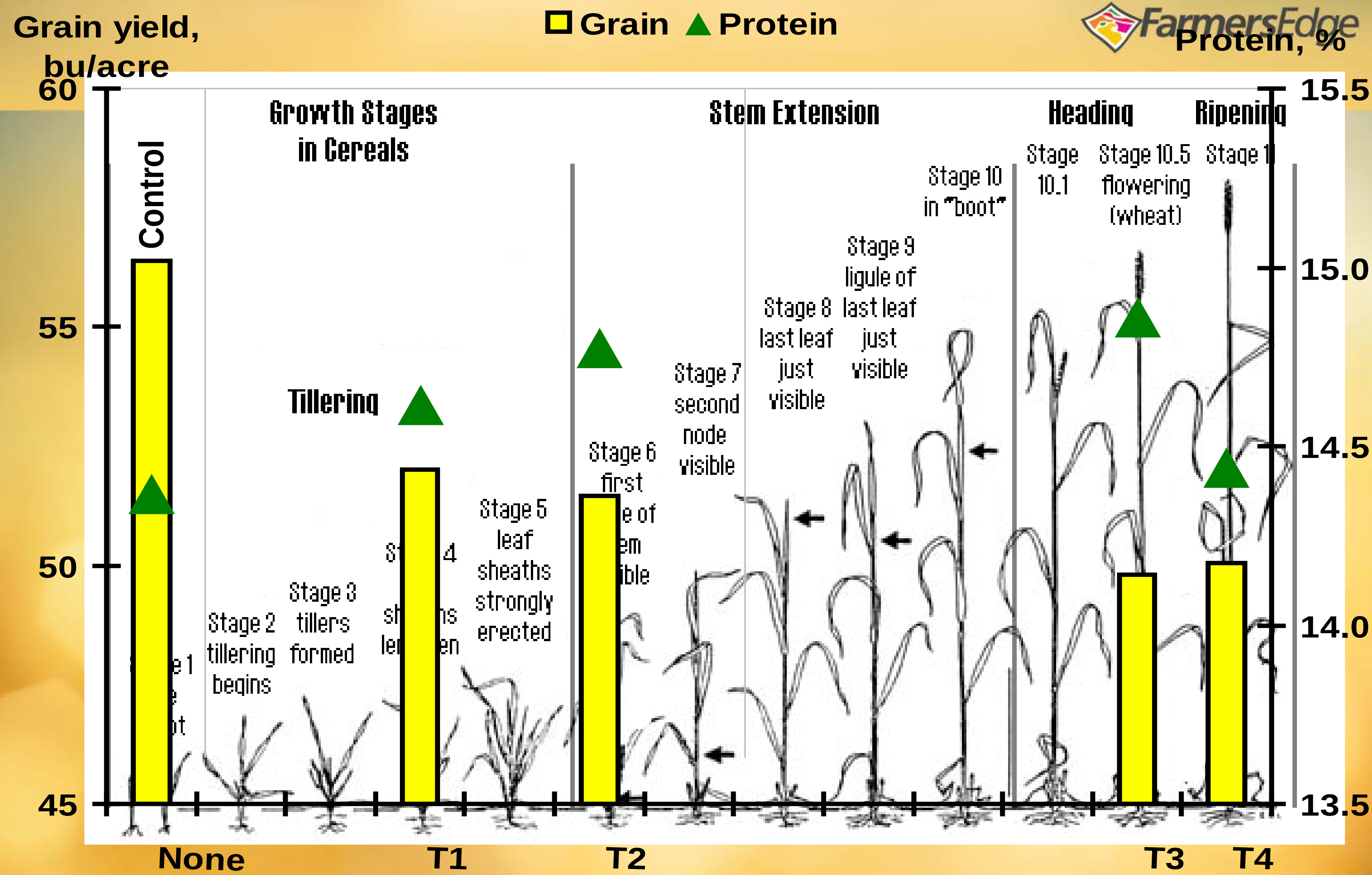
* in year of application

General Mineralization Rates during the growing season in western Canada

FarmersEdge

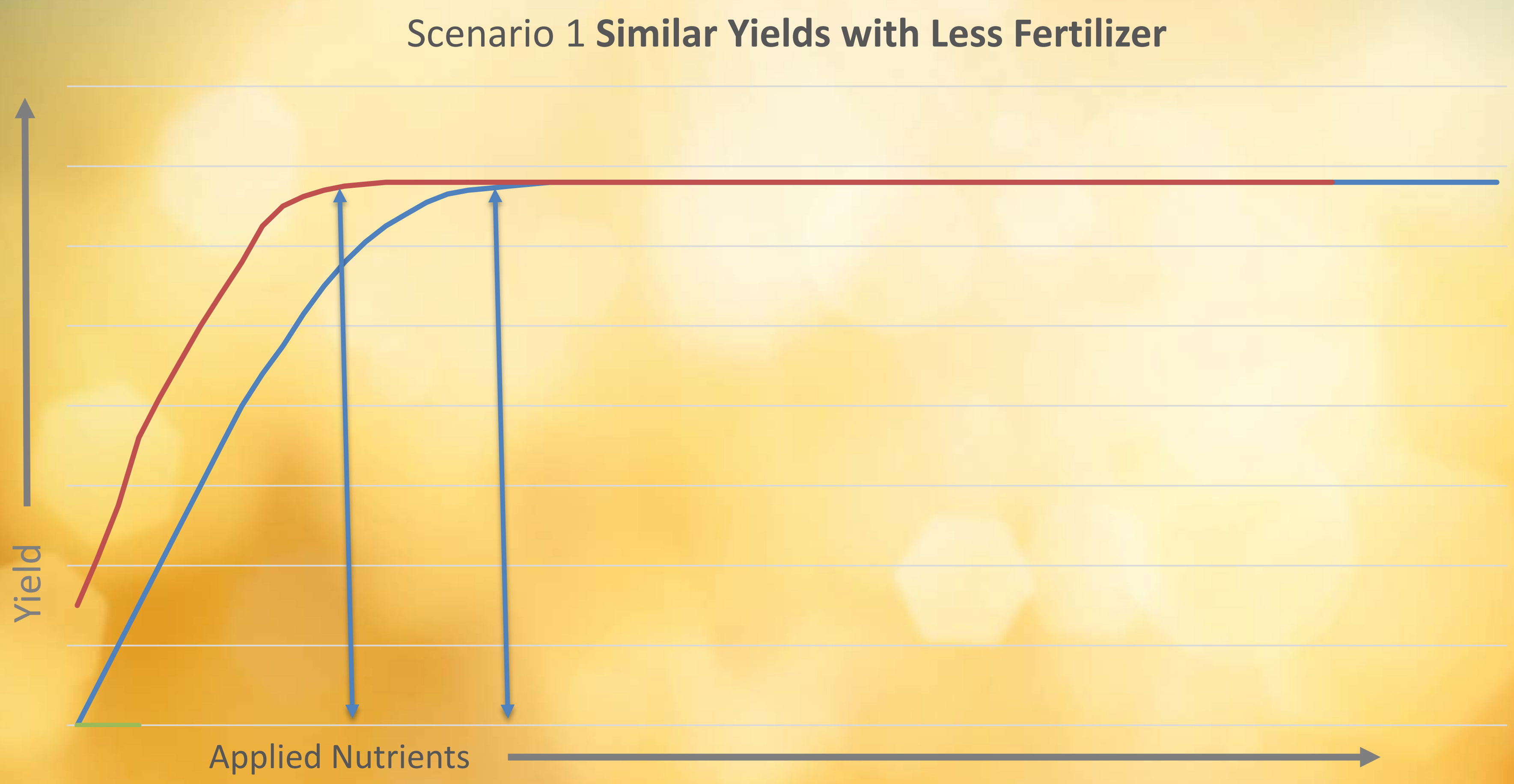
Soil Zone	Average organic matter (%)	Average Moisture Conditions (% of Normal)		
		25%	50%	75%
		lb N/acre (lbs N /% O.M.)		
Brown	2	15 (7.5)	27 (13.5)	32 (16)
Dark Brown	3.5	24 (6.9)	44 (12.6)	53 (15.1)
Thin Black	4	28 (7.0)	50 (12.5)	60 (15.0)
Thick Black	5.5	34 (6.2)	62 (11.3)	74 (13.5)
Gray Black	3.5	24 (6.9)	44 (12.6)	53 (15.1)
Gray	2.5	20 (8.0)	35 (14.0)	42 (16.8)
Average lbs N / % O.M.		(7.1)	(12.7)	(15.3)

Source: VST Handbook



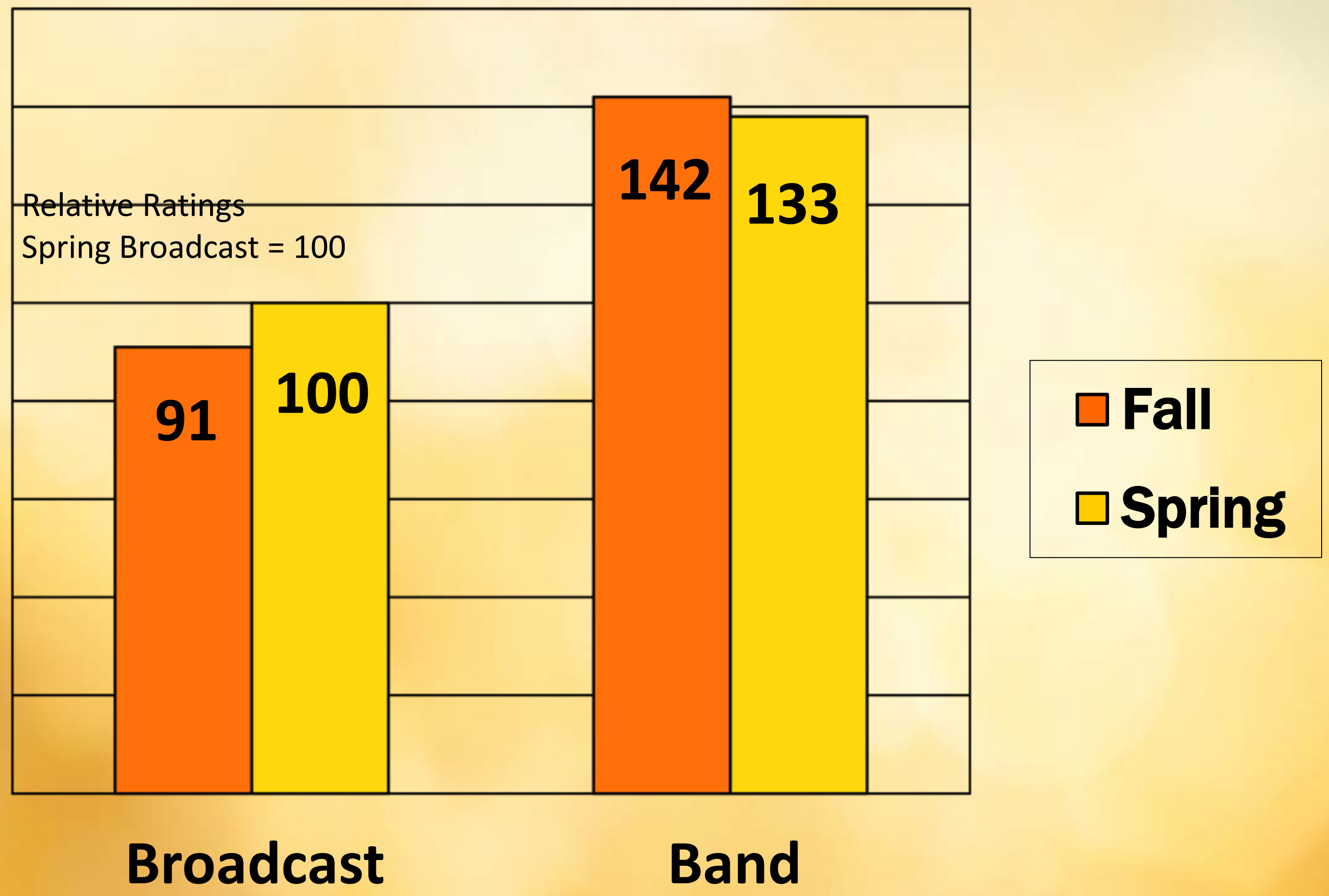
[GROW.MORE.PRECISELY.]

How Can Fertilizer Use Efficiency Be Improved??



Below et.al. 2007

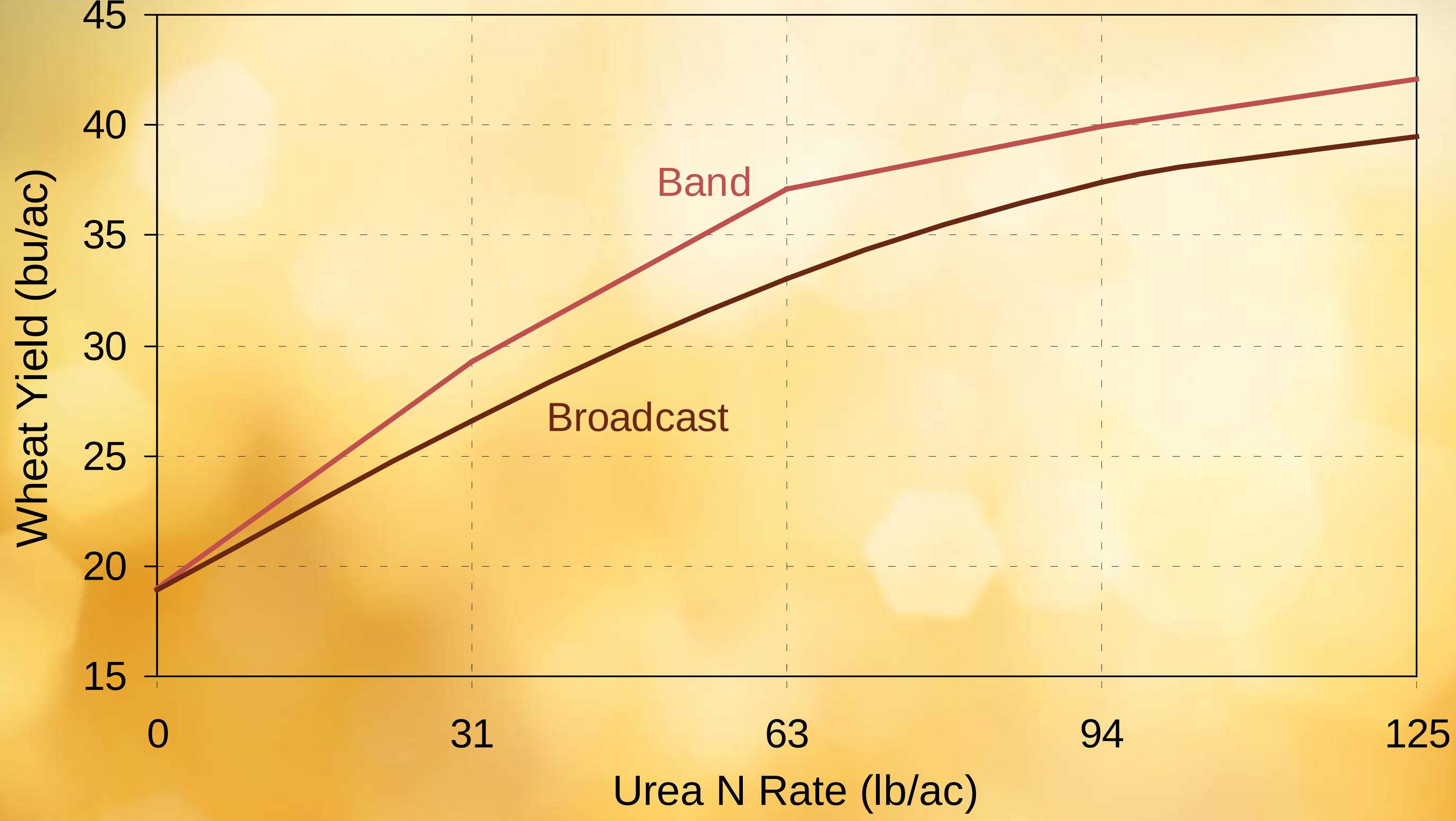
Rating Nitrogen Application Options
Manitoba / Saskatchewan 53 Site Years Data



N Response Curves for Wheat

FarmersEdge

9 Sites; Sask. and Man.



[GROW.MORE.PRECISELY.]

Source: Westco, 1993

Geospatial Harvest Summary and Variable Rate Comparison

Client:	###
Farm:	###
Field:	S 35
Date:	31/08/2012 - 08/09/2012
Crop:	Unity @ $6.00 /bu

Fertilizer Type	$/tonne or US gal.
46-0-0	$609.00
6-24-6	$0.00
0-0-60	$510.00
21-0-0-24	$390.00

Map Legend

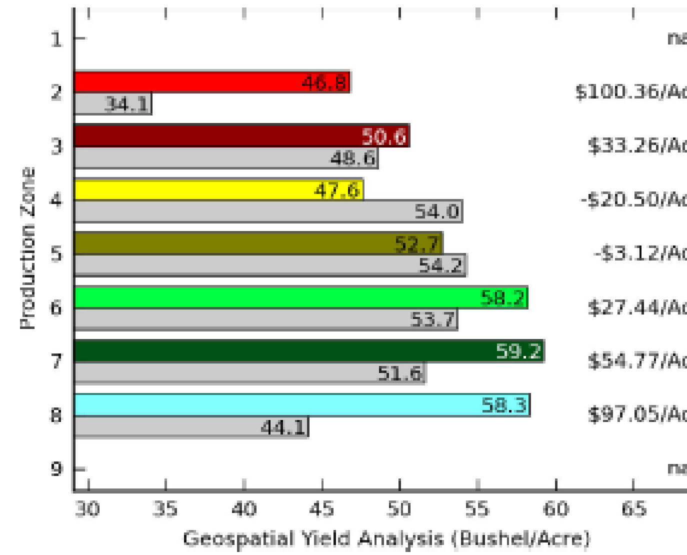
Estimated Volume by Production Zone (bu / ac)

- <= 38.8
- 38.8 - 44.0
- 44.0 - 49.3
- 49.3 - 54.5
- > 54.5

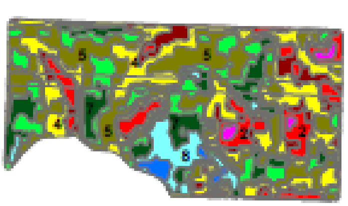
0 — 300 Meters

0 — 1,200 Feet

Variable Rate Fertility Advantage vs. Constant Rate Fertility



Production Zone Locator Map



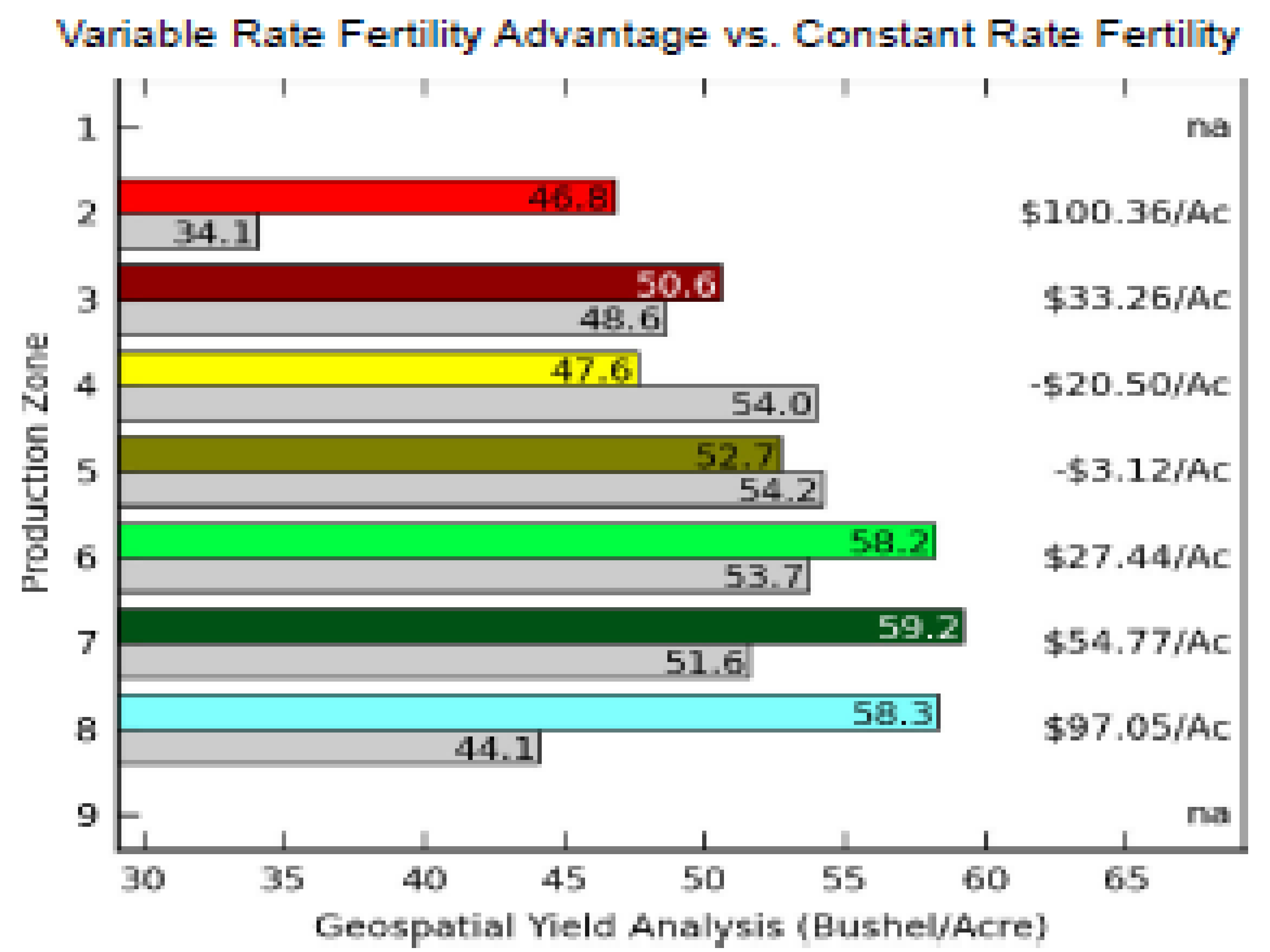
Production Zone	Zone Acres	VR Combine (bu / hour)	NON-VR Comb. (bu / hour)	Variable Rate Input (lb/ac) N - P - K - S	NON-VR Input (lb/ac) N - P - K - S	Variable Rate Advantage ($/ac)
1	2.9	--	--	--	--	--
2	27.2	595.0	511.7	50-8-0-0	85-8-5-9	$100.36
3	31.1	613.2	581.3	55-8-0-0	85-8-5-9	$33.26
4	57.8	551.0	630.7	60-8-0-0	85-8-5-9	-$20.50
5	73.1	599.2	606.7	80-8-0-0	85-8-5-9	-$3.12
6	42.0	632.7	594.5	90-8-0-0	85-8-5-9	$27.44
7	33.4	641.7	587.8	75-8-0-0	85-8-5-9	$54.77
8	15.2	673.9	538.5	70-8-0-0	85-8-5-9	$97.05
9	3.7	--	--	--	--	--
TOTAL / AVERAGE	286.4	599.6	603.5			

Variable Rate Fertility Field Summary

Production Zones present in checkstrip:
2, 3, 4, 5, 6, 7, 8

Estimated profit advantage with Variable Rate Fertility in this field ($ / acre):

$12.61



Variable Rate Fertility Advantage vs. Constant Rate Fertility
Production Zone
1
2
3
4
5
6
7
8
9
46.8
34.1
50.6
48.6
47.6
54.0
52.7
54.2
58.2
53.7
59.2
51.6
58.3
44.1
na
$100.36/Ac
$33.26/Ac
-$20.50/Ac
-$3.12/Ac
$27.44/Ac
$54.77/Ac
$97.05/Ac
na
30
35
40
45
50
55
60
65
Geospatial Yield Analysis (Bushel/Acre)

Yield Analysis Summary

FarmersEdge

Production Zone	Zone Acres	VR Combine (bu / hour)	NON-VR Comb. (bu / hour)	Variable Rate Input (lb/ac) N - P - K - S	NON-VR Input (lb/ac) N - P - K - S	Variable Rate Advantage ($/ac)
1	2.9	--	--	--	--	--
2	27.2	595.0	511.7	50-8-0-0	85-8-5-9	$100.36
3	31.1	613.2	581.3	55-8-0-0	85-8-5-9	$33.26
4	57.8	551.0	630.7	60-8-0-0	85-8-5-9	-$20.50
5	73.1	599.2	606.7	80-8-0-0	85-8-5-9	-$3.12
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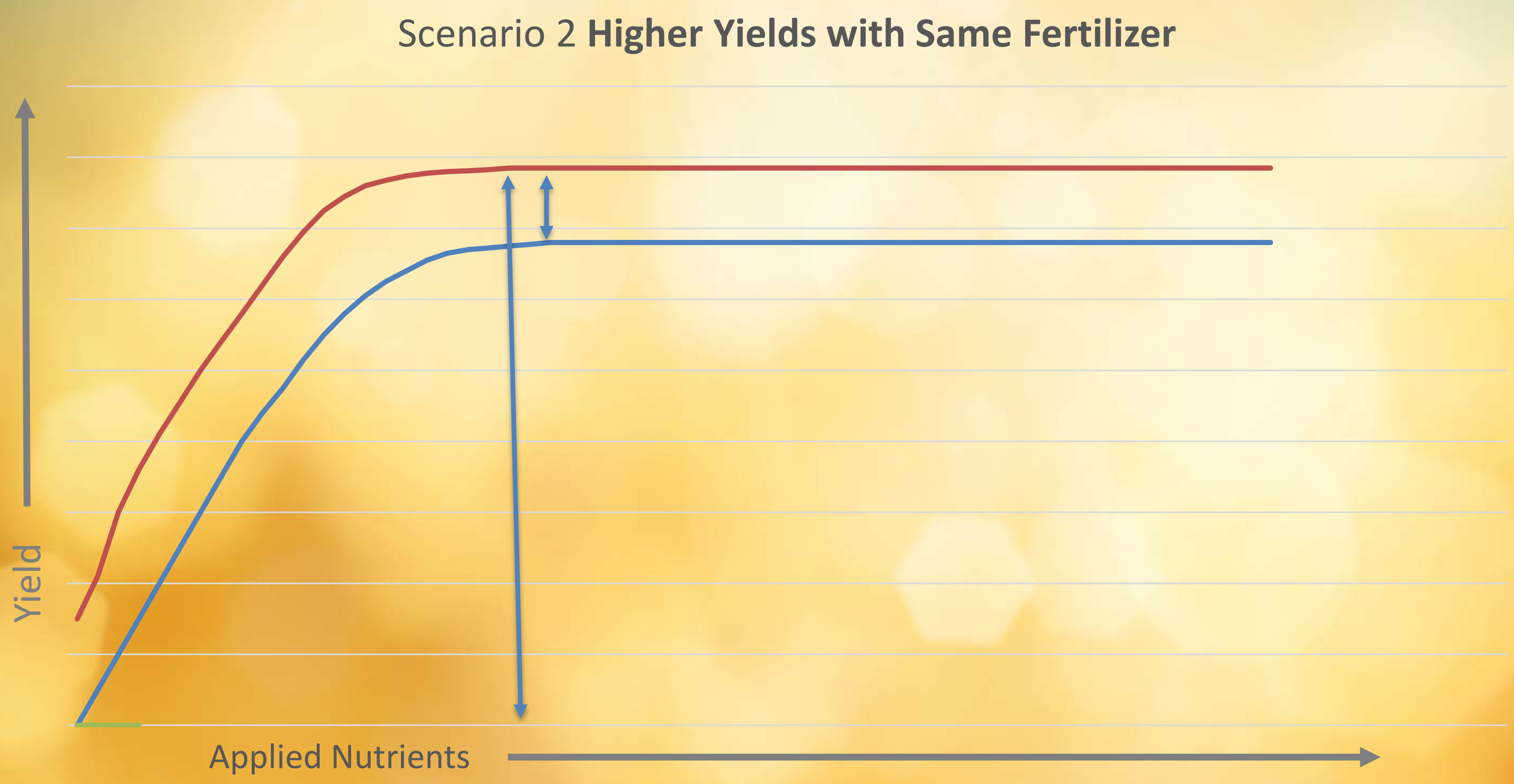
8	15.2	673.9	538.5	70-8-0-0	85-8-5-9	$97.05
9	3.7	--	--	--	--	--
TOTAL / AVERAGE	286.4	599.6	603.5			

Variable Rate Fertility Field Summary

Production Zones present in checkstrip:
2, 3, 4, 5, 6, 7, 8

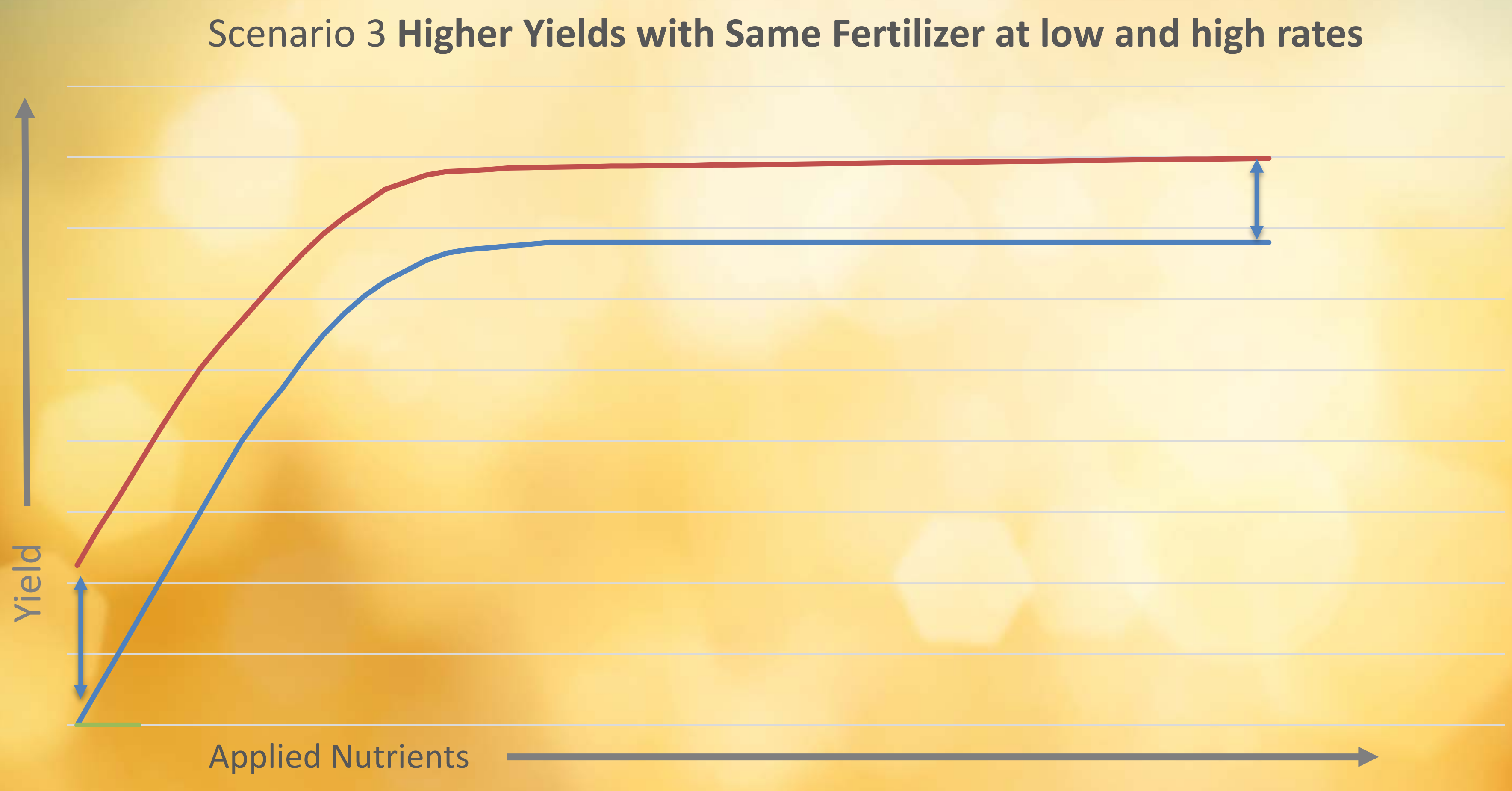
Estimated profit advantage with Variable Rate Fertility in this field ($ / acre):
$12.61

How Can Fertilizer Use Efficiency Be Improved??



Below et.al. 2007

How Can Fertilizer Use Efficiency Be Improved??

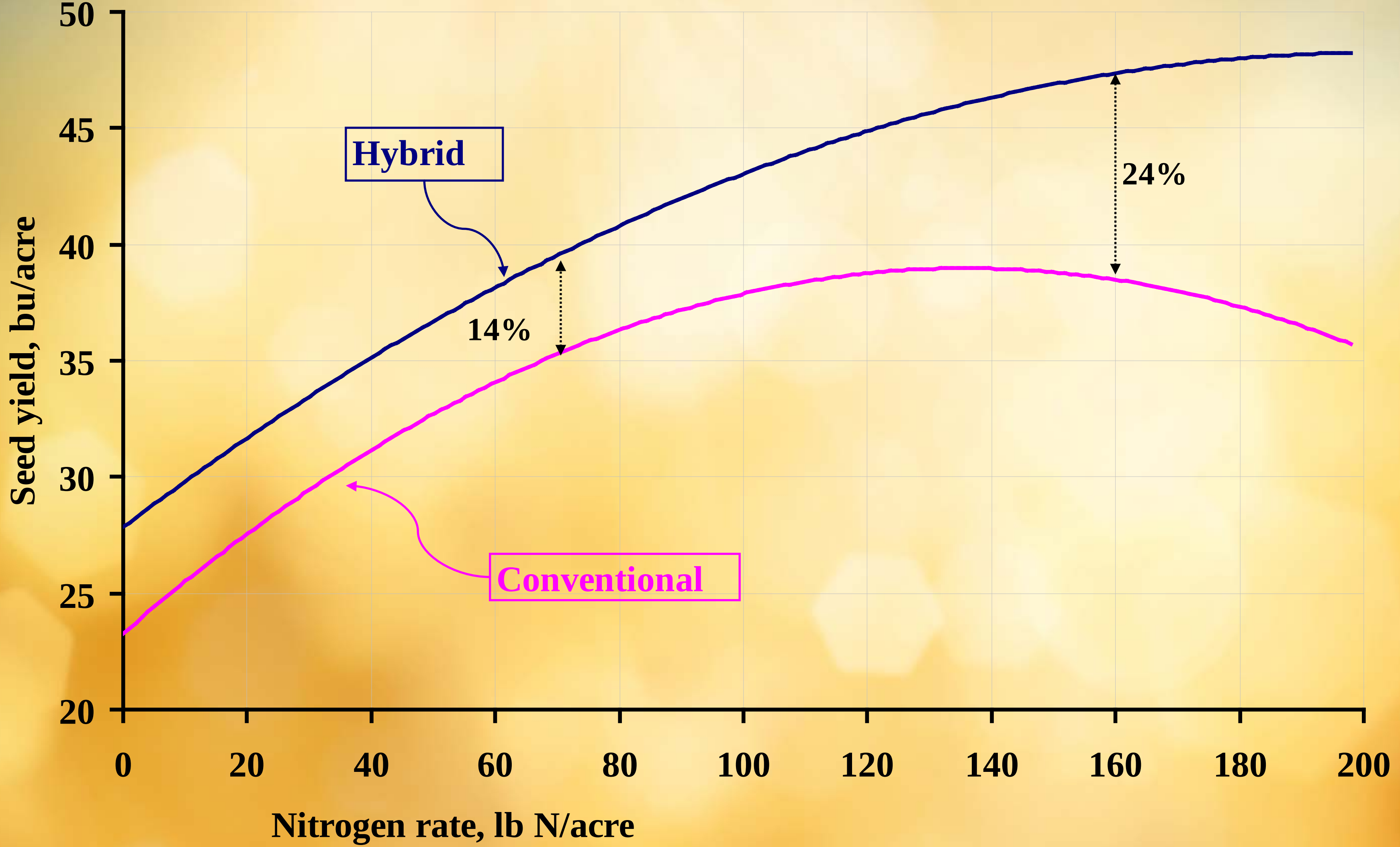


Below et.al. 2007

How Are Scenarios 2 & 3 Achieved?

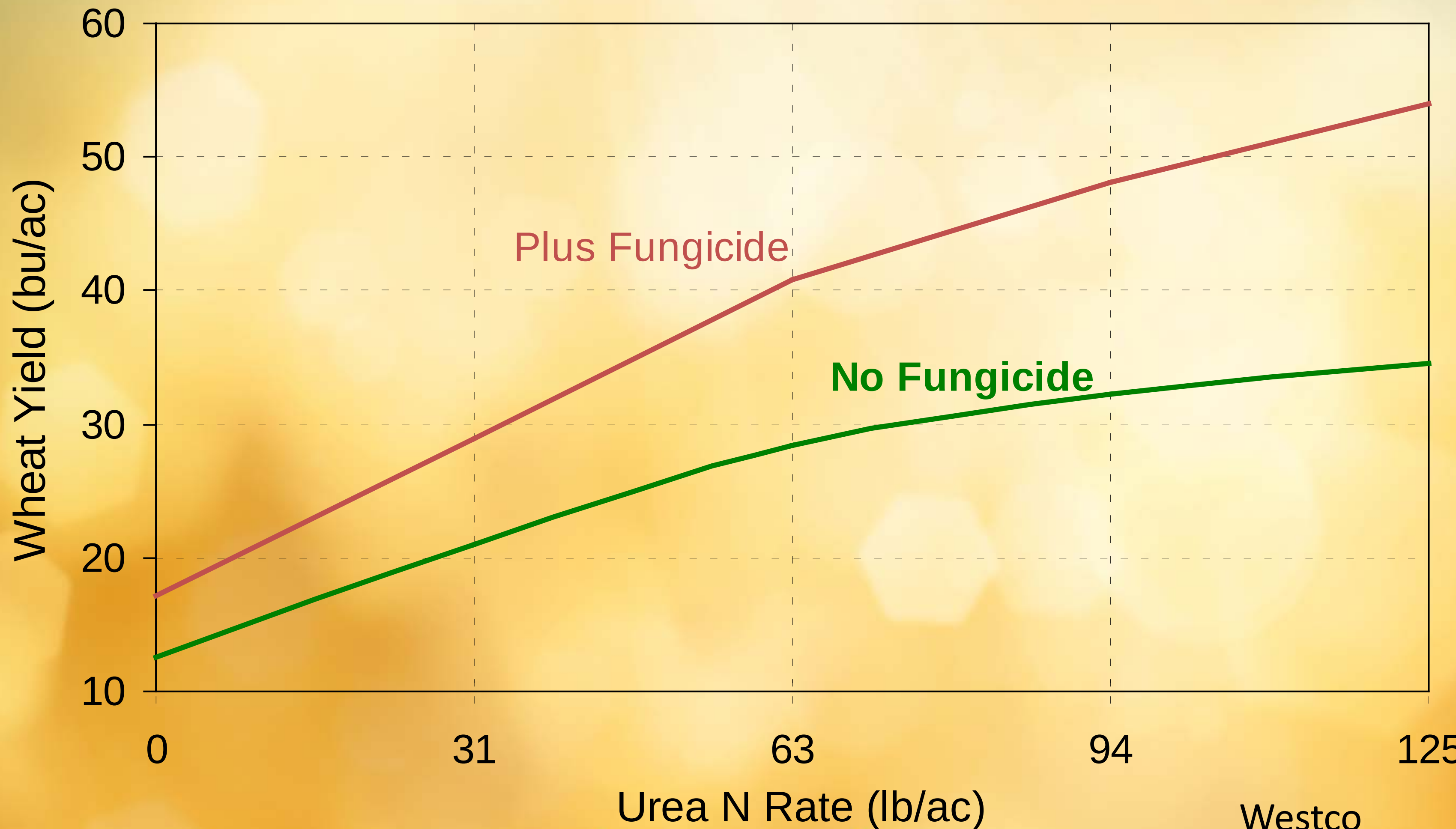
- Below says these scenarios are only achieved through genetic or technology improvements.

Hybrid vs. Conventional Canola
(17 site-years)



Improved FUE Due to Fungicide

2 Wheat Tests; Foxwarren, Man.

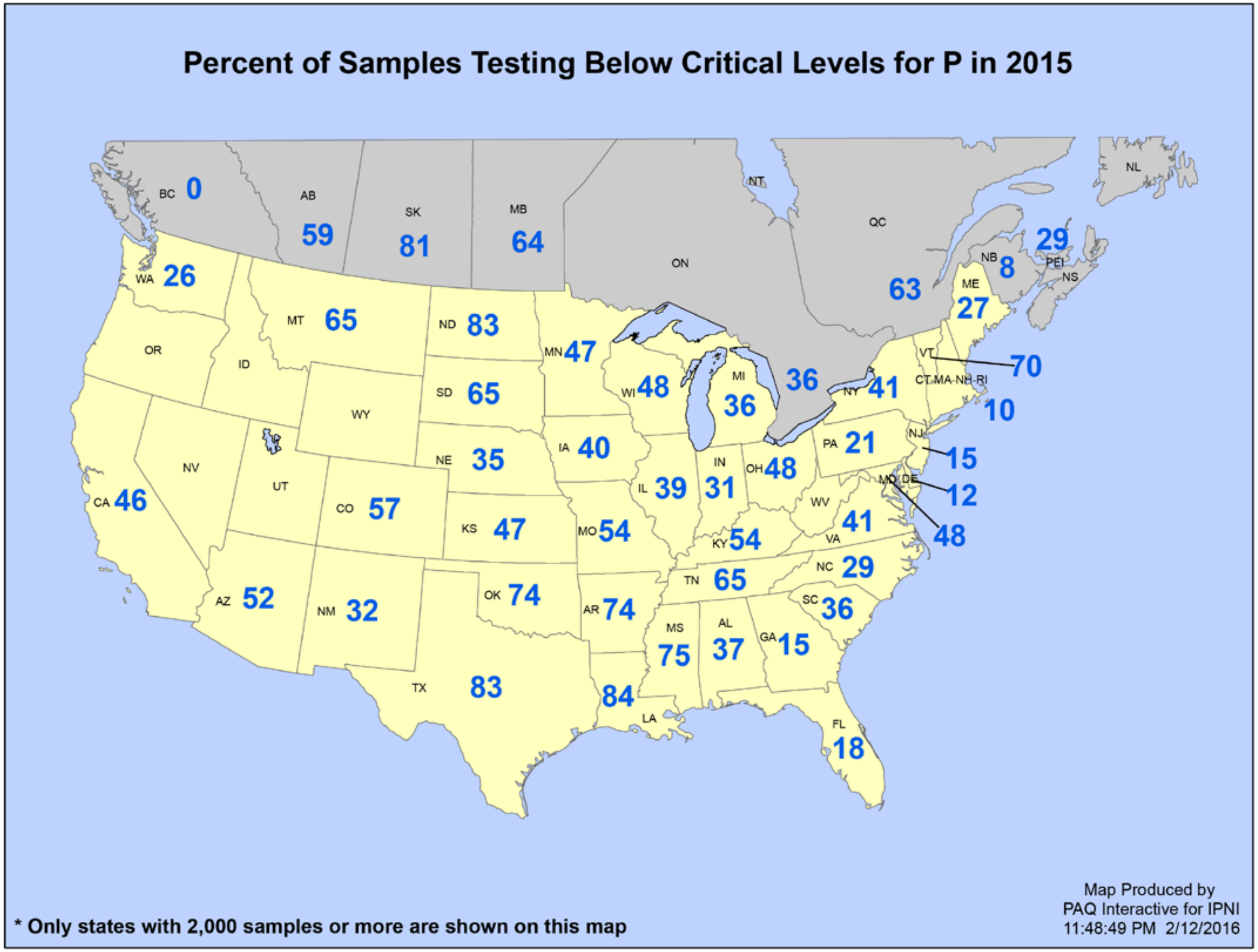


Westco

[GROW.MORE.PRECISELY.]

Source: Westco, 1993

Phosphate



[GROW.MORE.PRECISELY.]

Mercer - VRF - July 5, 2012
60 - N - - 60
0 - P_2O_5 - 25

Alberta Phosphate Data

FarmersEdge

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!

Soil test rating for plant available P

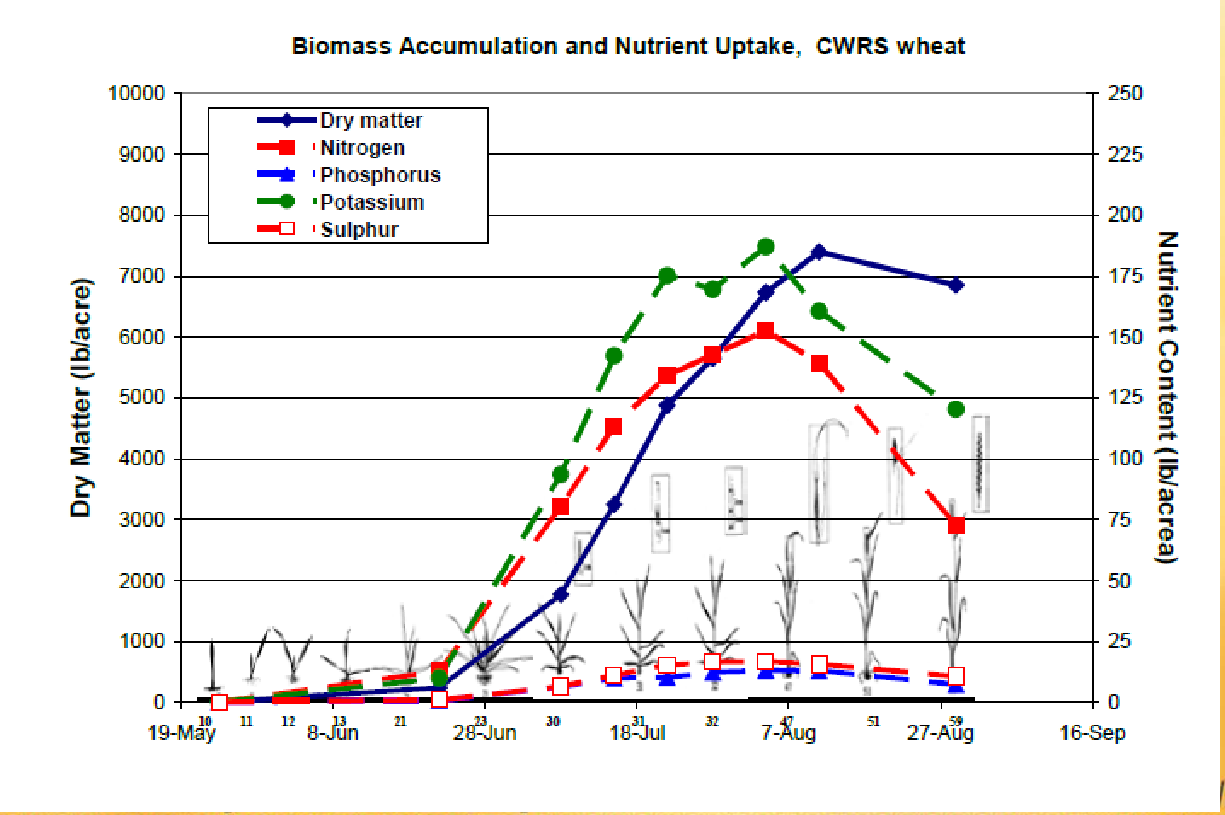
Soil test level rating* (lb/ac)			Phosphorus (P)
Very low	0 – 15	}	High probability of
Low	15 – 30		crop response to P
Medium	30 – 60	}	Moderate probability
Medium to Adequate	60 - 90		
High	>90	}	Low probability of

crop response to P

* Modified Kelowna Method

Phosphate

- Ortho – Phosphate or Poly-Phosphate
  - A lb of phosphate = A lb of phosphate

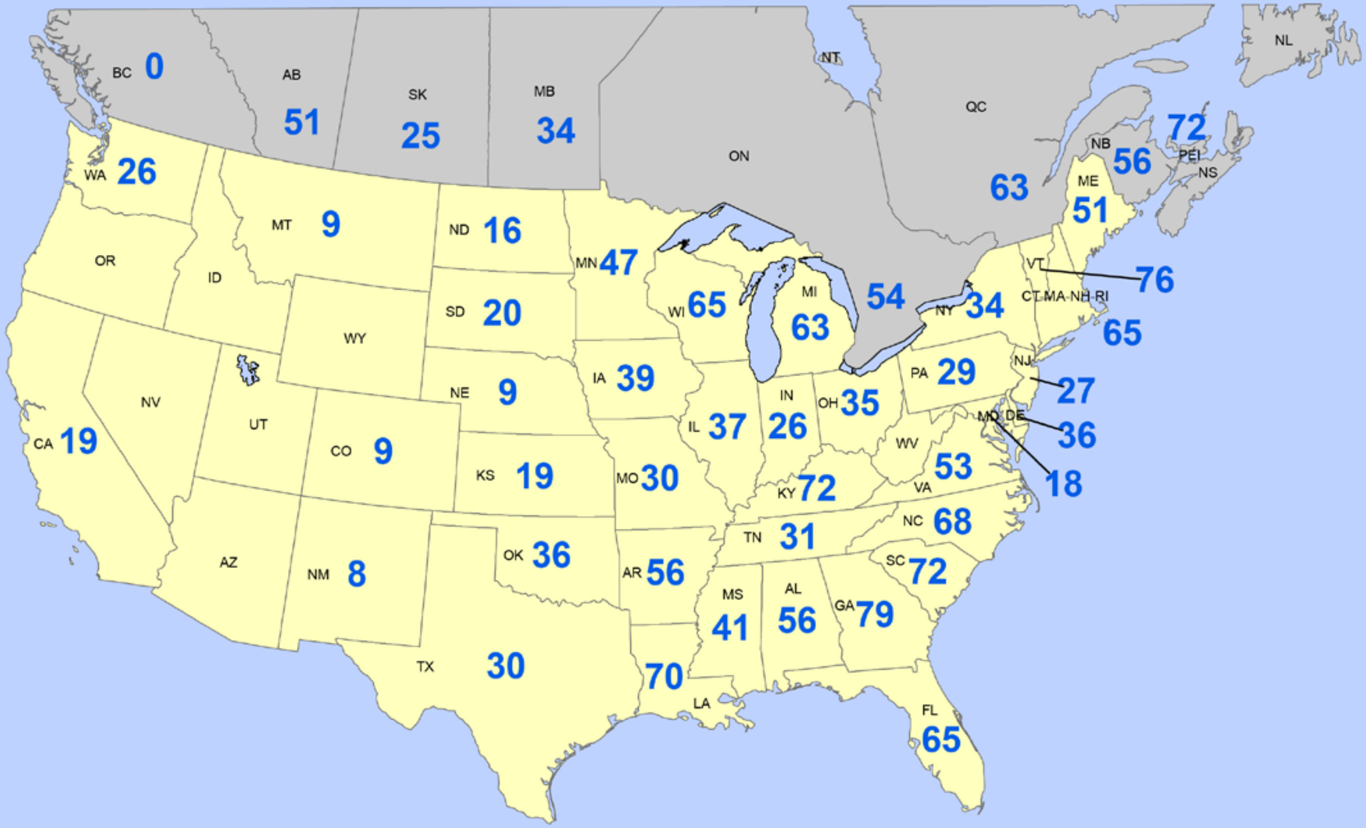


Potash Fertilizer: Potassium Chloride (KCl)

- Majority of 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.

FarmersEdge

Percent of Samples Testing Below Critical Levels for K in 2015



* Only states with 2,000 samples or more are shown on this map

Map Produced by
PAQ Interactive for IPNI
11:52:08 PM 2/12/2016

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

Characteristics of Sulphur Deficient Soils

- Black and Gray soils
- low organic matter soils
- sandy (coarse textured) soils
- historically high N
- hilltops or upland areas
- well drained areas
- eroded soils
- intensive cropping with S demanding crops
  - Canola
  - Alfalfa

Forms of Sulphur Fertilizer

- Sulphates (immediately available)
  - ammonium sulphate
  - potassium sulphate
  - calcium sulphate
- Thiosulphates (almost immediately available)
  - ammonium thiosulphate
- Elemental S Products (require conversion)
  - pure S (99-100% S)
  - bentonite S (0-0-0-90)
  - sulphur suspensions

Sulphur Deficiency in Wheat

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!!

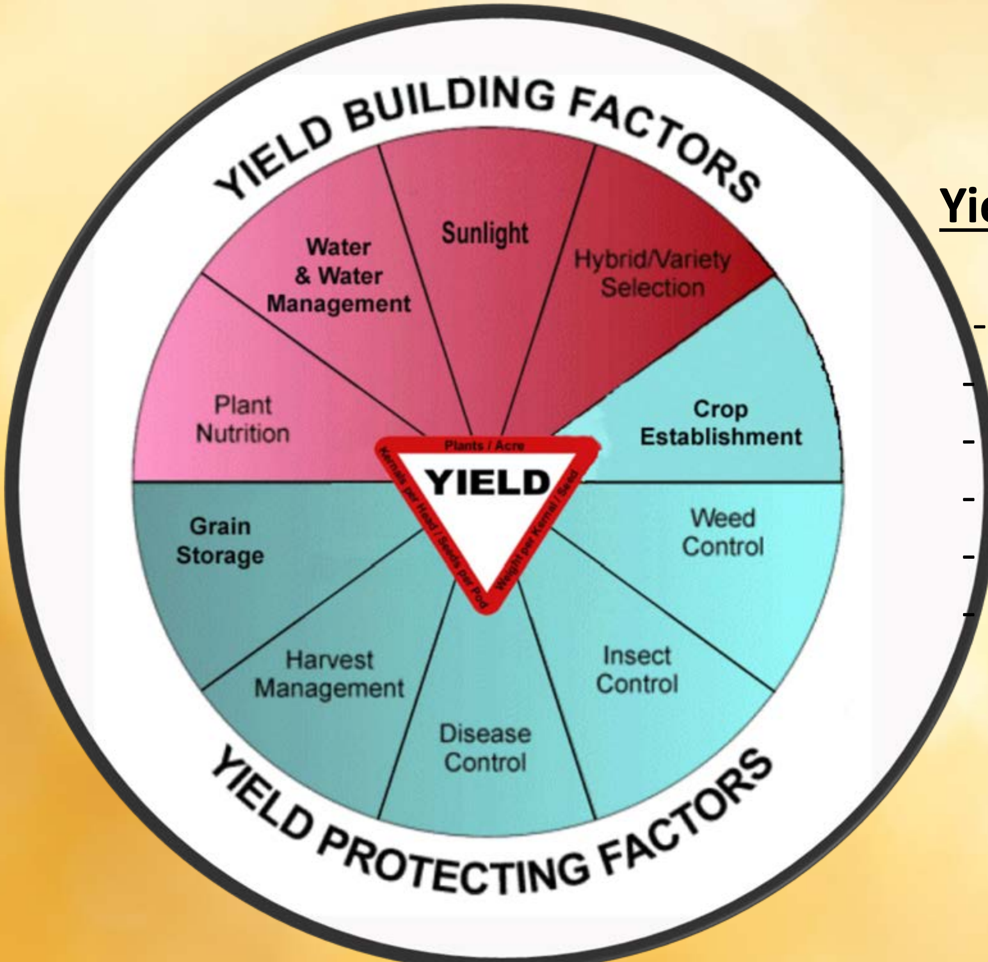
Summary

FarmersEdge

- Have **soil samples taken and analyzed for nutrient availability.** Adjust your fertilizer rates on each individual fields.
- **Time fertilizer applications** to minimize losses.
- Place **nitrogen fertilizers in the soil in bands** to reduce losses compared to broadcast applications.
- Use appropriate **starter fertilizer blends** precision placed near or for some crops in the seed-row when planting.
- Analyze your **return on the investment** before making your fertilizer decisions.
- Follow the **4Rs of Nutrient Stewardship**

Yield Building Factors

- Sunlight
- Hybrid/Varietal Selection
- Plant Nutrition
- Water



Yield Protecting Factors

- Crop Establishment
- Weed Control
- Insect Control
- Disease Control
- Harvest Management
- Grain Storage

Crop Establishment

FarmersEdge

- Seeding Rate
- Row Spacing
- Seeding Timing
- Other considerations

Crop Establishment – Row Spacing & Seeding Rate

Analysis of variance for seeding density, grain yield, harvest index, protein content, test weight, spike density, kernels per spike and kernel weight in 2004 and 2005. Adapted from **Hard Red Spring Wheat Response to Row Spacing, Seeding Rate, and Nitrogen** – Chen et. Al 2008

Source†	df	Seedling density	Grain yield	Harvest index	Protein content	Test wt.	Spike density	Kernels / spike	Kernel wt.
YR	1	**	**	**	**	**	**	ns	**
RS	1	ns	**	**	ns	ns	**	ns	ns
RS × YR	1	ns	ns	ns	ns	ns	ns	*	ns
FA	2	ns	ns	ns	**	ns	ns	ns	ns
FA × YR	2	ns	ns	ns	ns	ns	ns	ns	*
SR	3	**	**	*	**	**	**	**	ns
SR × YR	3	**	ns	**	*	ns	ns	ns	ns

* Significant at P = 0.05 ns not significant at P = 0.05

** Significant at P = 0.01

† YR – year; RS = row spacing; FA = fertilizer application; SR = seeding rate

Crop Establishment – Row Spacing & Seeding Rate

- Yield
  - RS – Row spacing 15 cm $\geq$ 30 cm
  - Seeding Rate 215 = 323= 430 > 108 seeds/m^2
- Test Weight
  - Seeding Rate 215 = 323=108 > 430 seeds/m^2

Crop Establishment – Row Spacing & Seeding Rate

The effect of row spacing on grain yield (bu/ac)

	Indian Head [1] (zero-till)						Indian Head [2] (conventional till - SF)			Brandon (zero-till)	
Row Spacing (cm)	1989	1990	1991	1992	1993 [3]	1994 [3]	1993	1994	1995	1993	1994
10	6.8	42.0	49.3	52.1	47.3	39.7	78.5	70.7	51.2	22.5	38.9
20	7.5	41.9	49.4	52.1	49.9	41.4	82.2	66.3	51.5	23.3	41.6
30	7.4	42.2	49.1	51.2	51.2	41.9	82.2	65.1	50.4	24.1	38.1

[1] *Lafond, 1994. Can. J. Plant Sci: 74:703-711*

[2] *Lafond and Derksen, 1996. Can. J. Plant Sci. 76:791-793.*

[3] *Bailey, Lafond and Domitruk. 1998. Can. J. Plant Sci. 78:145-150.*

Crop Establishment – Row Spacing

	Scott (1985,86) [1]		Melfort [1]
Row Spacing (inches)	Plants/m2	Grain Yield	Grain Yield
4.5	171	60.2	74.8
9.0	136	54.4	61.5
18.0	107	45.8	-

[1]*Averaged over the varieties Neepawa and HY320.*

	Melfort (1986) [1]	Carrot River (1986) [1]	Saskatoon 1986) [1]
Row Spacing (inches)			
3.5	35.3	35.0	40.1
7.0	35.1	31.1	43.2
10.6	34.7	30.4	40.5
14.2	33.2	27.8	38.3

[1]*Averaged over the varieties Neepawa and HY320.*

Taken from Brandt et al. 1987. Proceedings of the 1987 Soils and Crops Workshop, University of Saskatchewan, S'toon, SK.

Crop Establishment – Seeding Rates

FarmersEdge

Soil Region	CSWS wheat	CPS wheat	HRS wheat	Durum wheat
	Optimum seed rate range (seeds / m^2)			
Dark Brown	300 - 400	275 - 350	275 - 375	250 - 450
Thin Black	300 - 400	300 - 425	300 – 450	250 - 450
Black	300 - 400	350 - 450	350 - 450	-
Gray	300 - 400	300 - 425	300 – 450	-
Seeding Rate				
Dark Brown	80 - 110	80 - 105	75 - 100	85 - 155
Thin Black	80 - 110	90 - 125	80 - 120	85 - 155
Black	80 - 110	105 - 135	90 - 120	-
Gray	80 - 110	90 - 125	80 - 120	-

Summary of a variety of trials

Note: High variation of results in Brown Soil Zone due to high fluctuation in moisture regimes

Note: Comments often noted lodging at higher seeding rates.

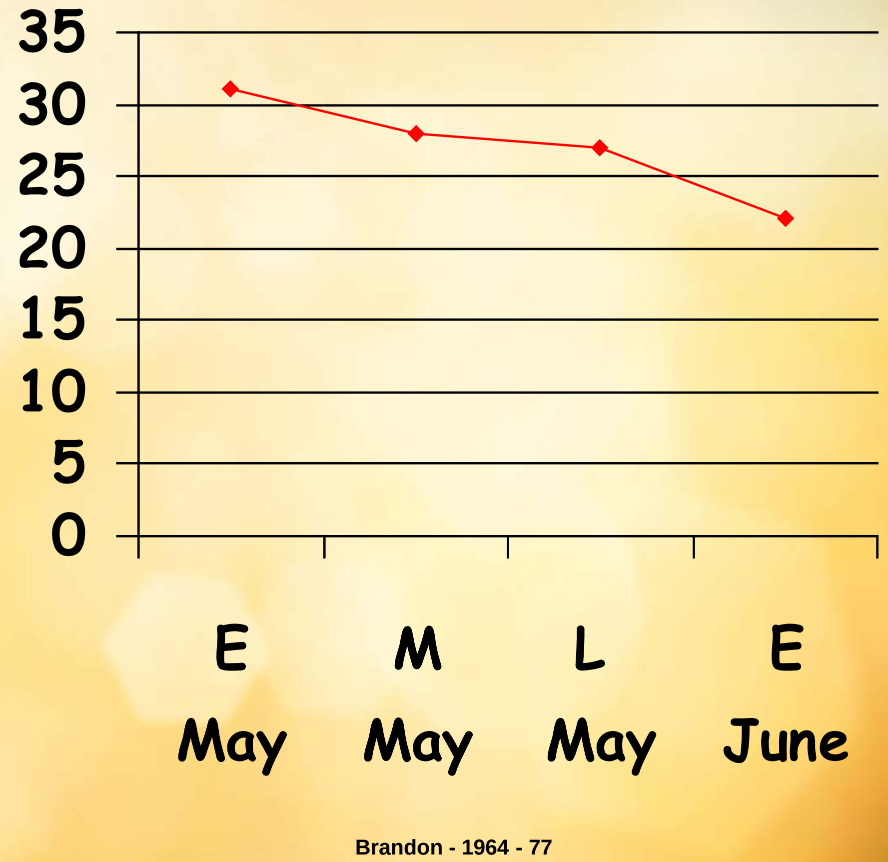
Summary Row Spacing; Seeding Rates

- Row Spacing
  - 15 cm ≥ 20 cm ≥ 25 cm ≥ 30 cm ≥ 35 cm
  - 6” ≥ 8” ≥ 10” ≥ 12” ≥ 14”
  - Other factors must be considered.
  - Plant survival rate ↓ as row spacing ↑
- Seeding Rate
  - Wheat is fairly forgiving with seeding rates
  - Optimum seeding rates will vary with moisture
  - More is usually better – to a point
  - May require PGRs at high seeding rates

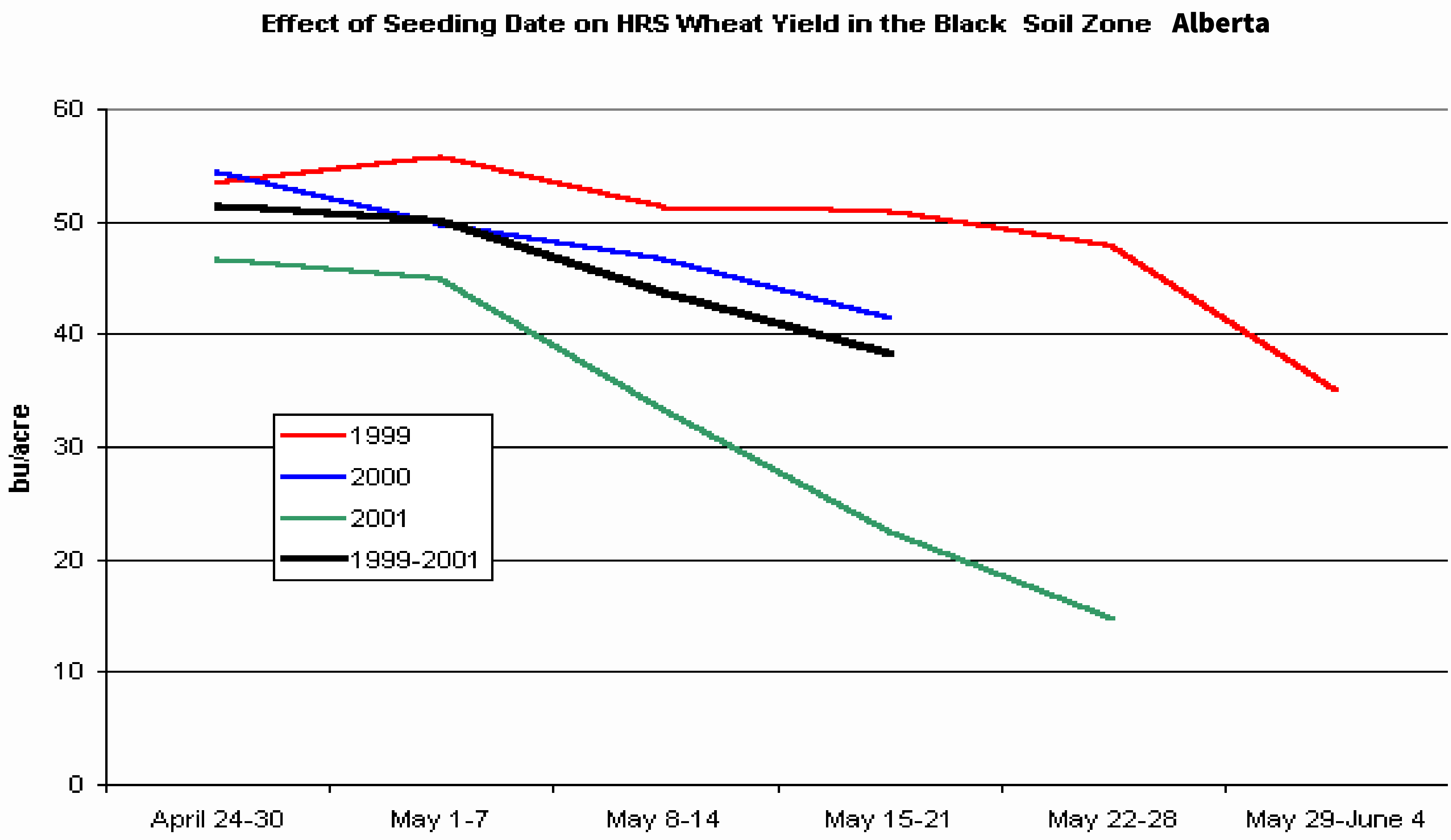
Crop Establishment – Seeding Dates

Wheat

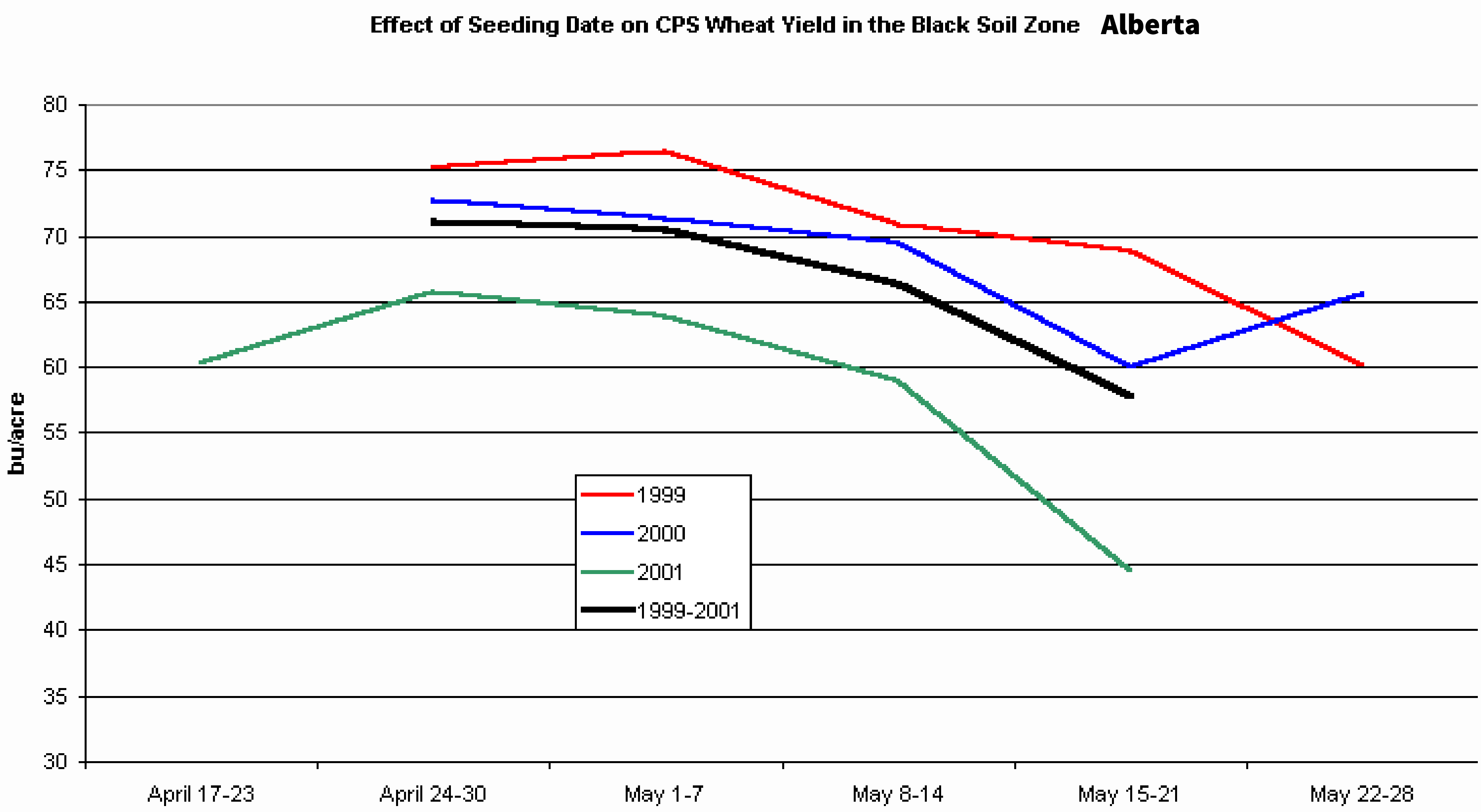
- 11% decrease from E May - L May
- Additional 17% decrease from L May - E June
- Brandon - 1964 - 77



Crop Establishment – Seeding Dates

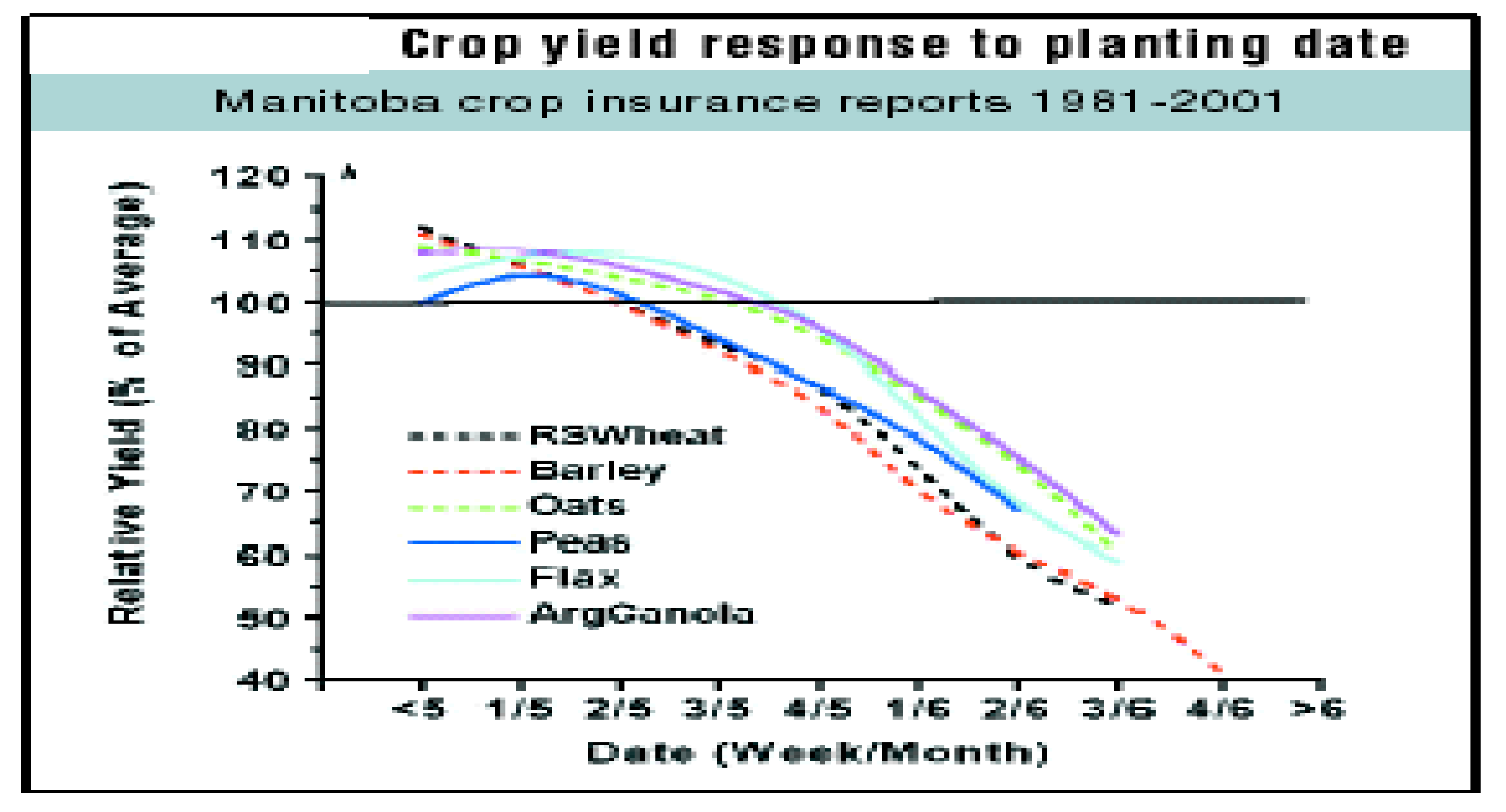


Crop Establishment – Seeding Dates



Crop Establishment – Seeding Dates

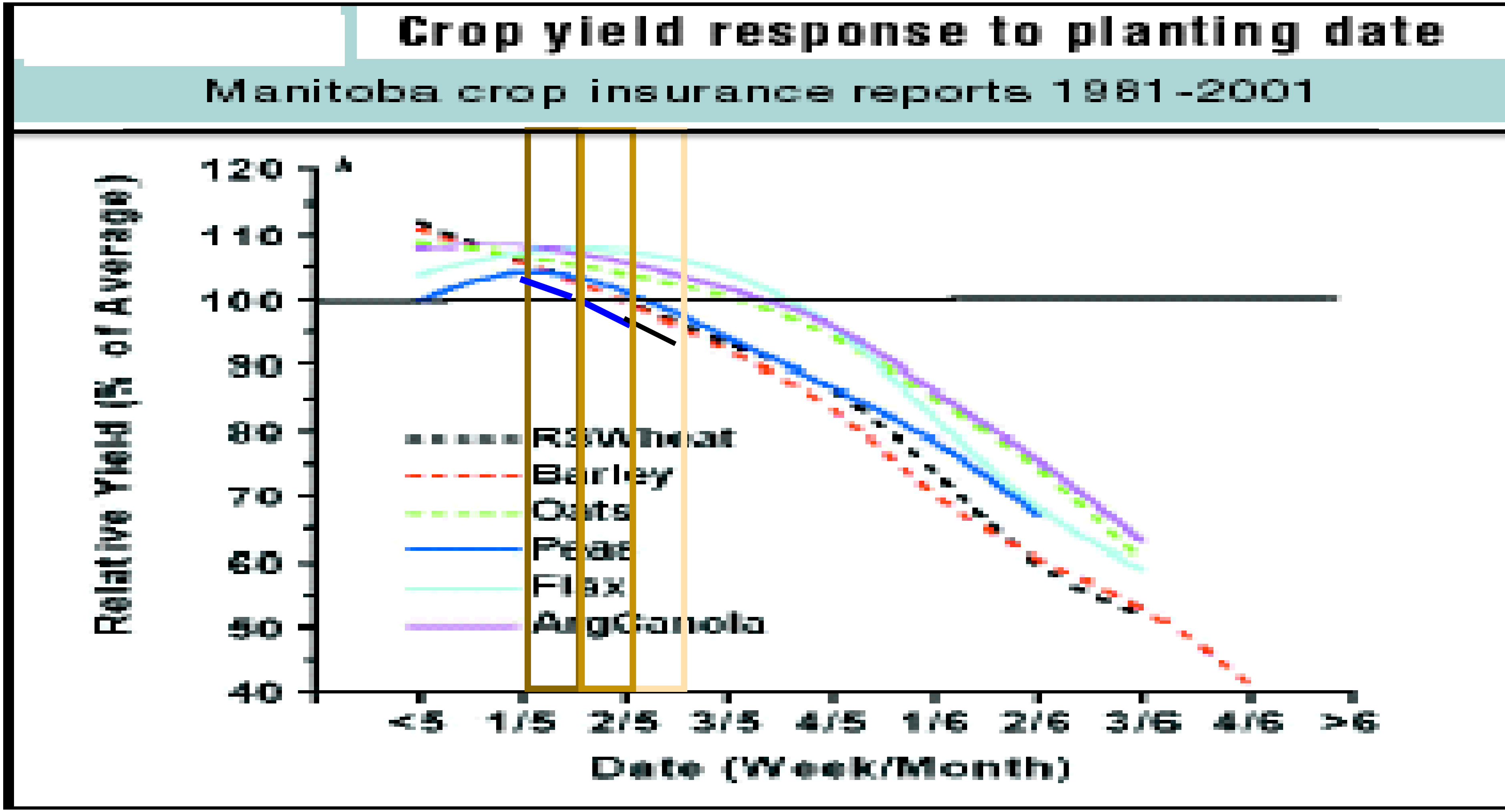
Manitoba Crop Insurance Data



Doug Wilcox MCIC

Crop Establishment – Seeding Dates

FarmersEdge



Doug Wilcox MCIC

[GROW.MORE.PRECISELY.]

Summary – Early Seeding

FarmersEdge

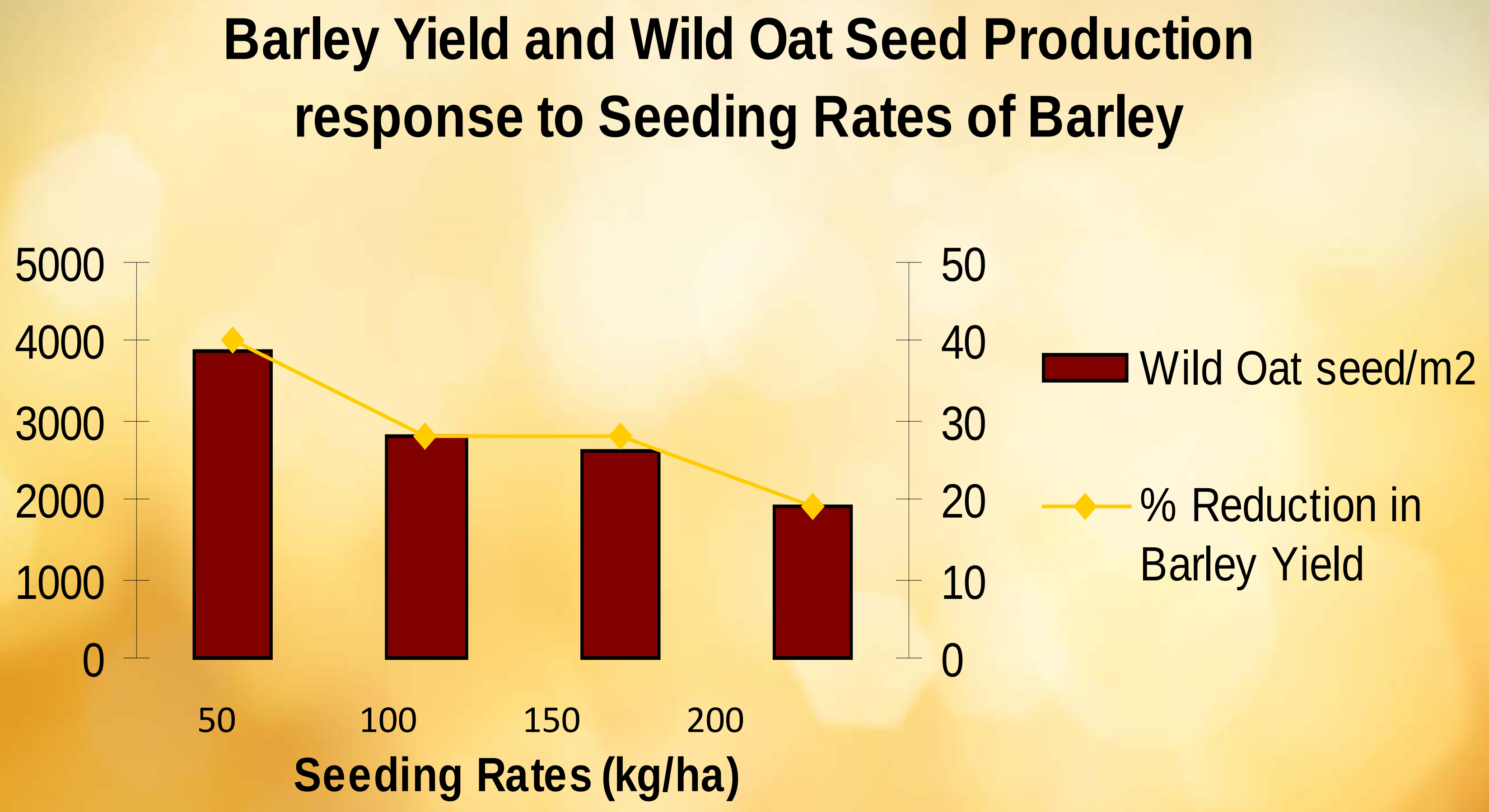
- For all crops - in most years there is a benefit to early seeding
- Benefits average 1.5 - 2% / day
- Benefits are fairly constant throughout spring

Weeds, Insects, Diseases

Weed, Disease, Insect Control

- Will provide protection of yield if – and only if – the target organism is present and causing a yield reduction.
- Control measures may include:
  - resistant cultivars, seeding rates, nutrition, chemicals
- Economic thresholds of a pest should be reached before control measures employed.

Crop Competition



Early Weed Removal

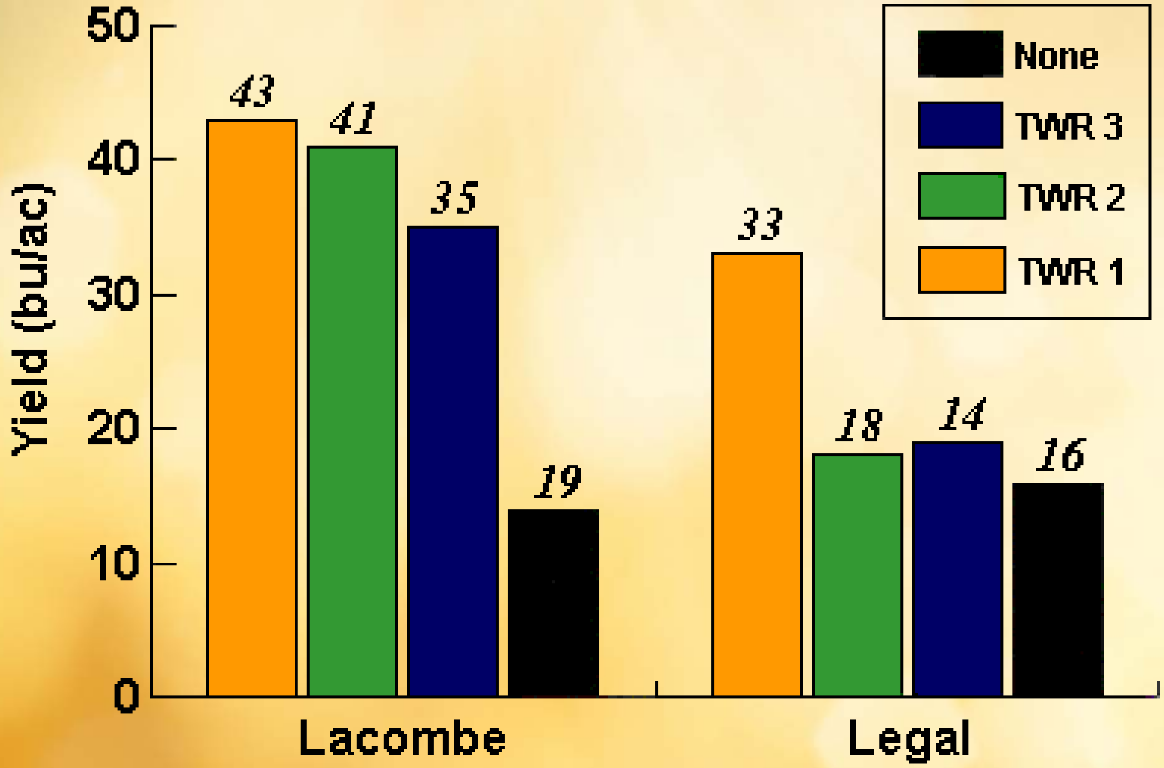


Figure 4. Removing weeds in 'Quest' Canola with Roundup applied at 1, 2, or 3 weeks after canola emergence –1997

Source: Harker, AAFC

Early Weed Removal

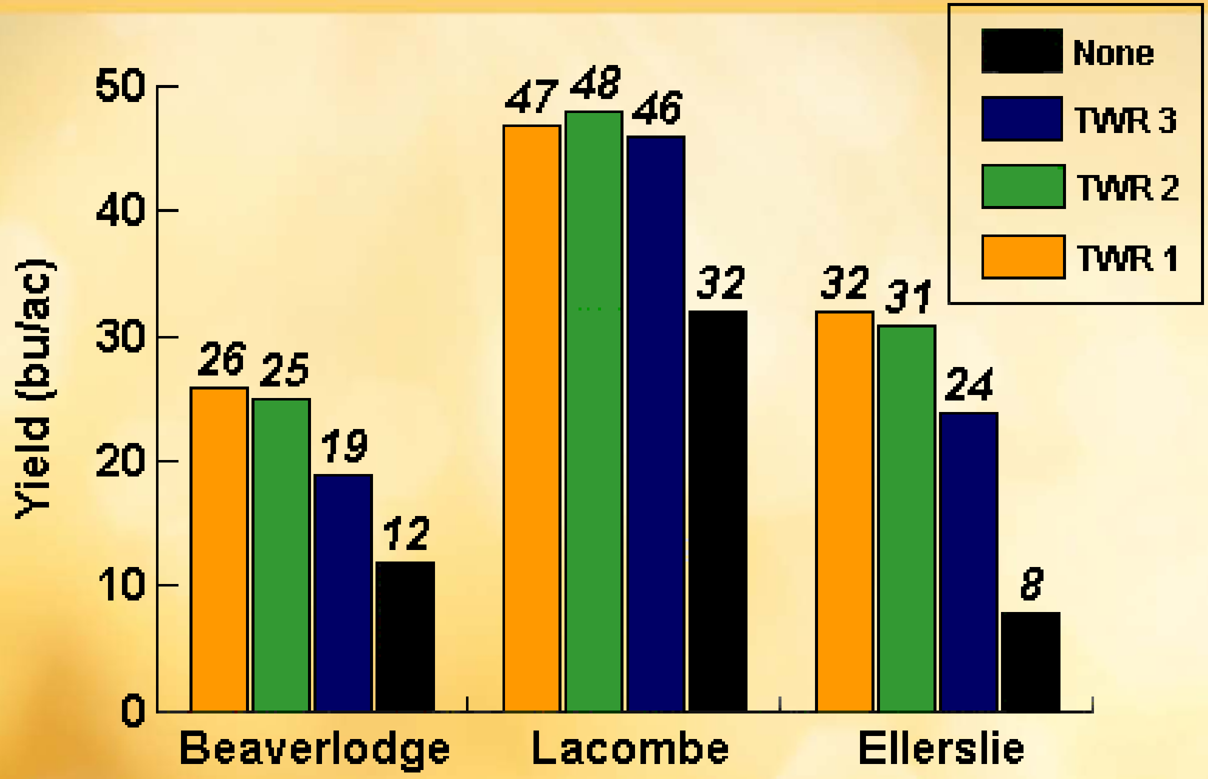


Figure 5. Removing weeds in 'Quest' canola with Roundup applied at 1, 2, or 3 weeks after canola emergence -- 1998

Source: Harker, AAFC

Spray Early for Maximum Yield

- Best yield response occurs 2 to 3 weeks after crop emergence (3 to 4 leaf stage of most crops)
- Best weed control at the 2 to 3 leaf stage of most weeds
- Delayed application may give the cleanest field, but never the highest yield
  - Modern herbicides have wide application windows
- *In competitive crops, late emerging weeds cause virtually no yield loss and produce little seed*

FarmersEdge

Spray Early for Maximum Yield

- Consider adding herbicides with residual activities to your glyphosate burnoff.
  - *Choose product depending on your weed issues*
    - *E.g. Pre-pass, Express Pro, Inferno DUO*

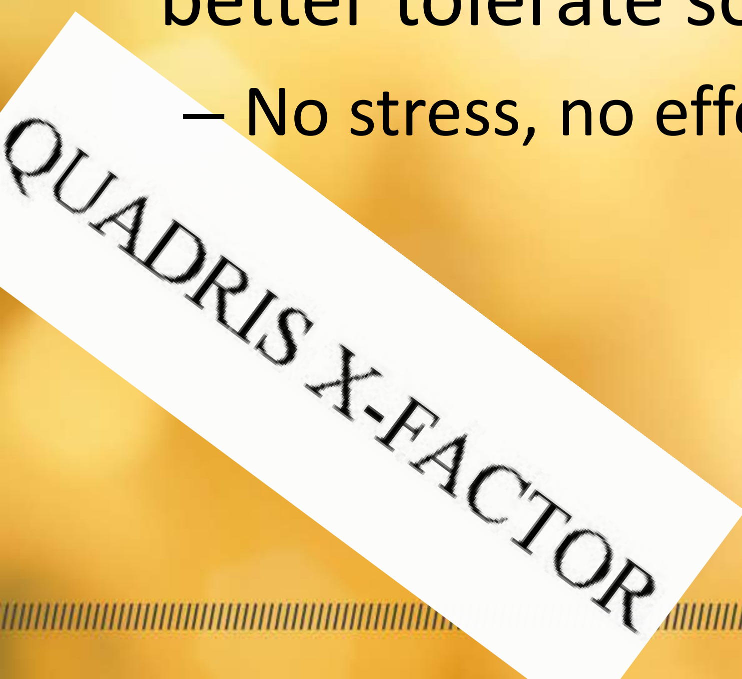
Fungicides

- Are effective when used correctly
- Applications of ½ rates of fungicides will do little, if anything to reduce disease or increase yields.
- Use the proper product – at the proper time – when disease pressures or forecasts warrant!

What about "Growth Promoting Fungicides"

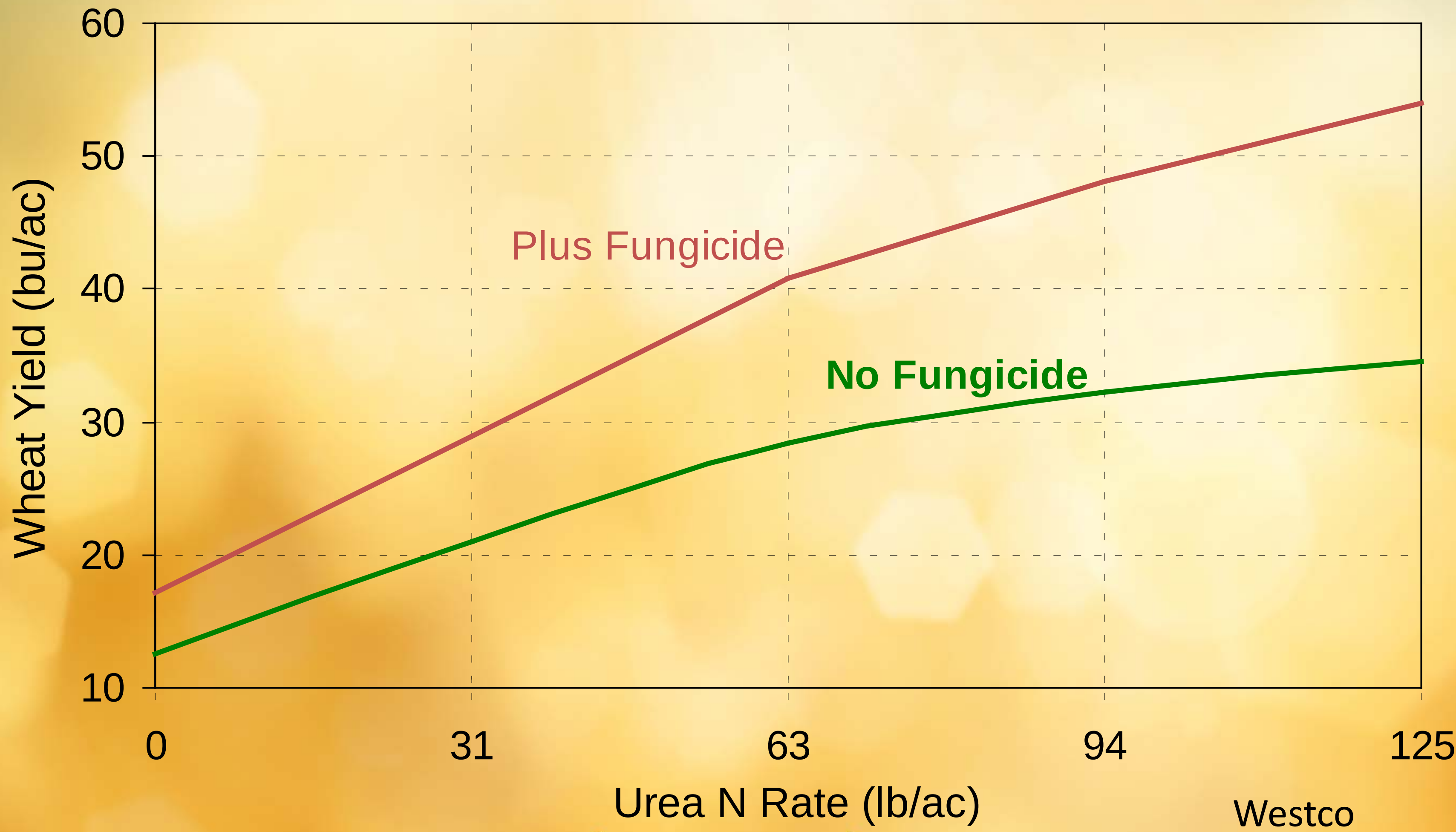
FarmersEdge

- These products work with hormones in the plant – usually ethylene.
- Strobilurin fungicides inhibit the biosynthesis of ethylene in the plant. This allows the plant to better tolerate some stresses.
  - No stress, no effect!



Improved FUE Due to Fungicide

2 Wheat Tests; Foxwarren, Man.



Source: Westco, 1993

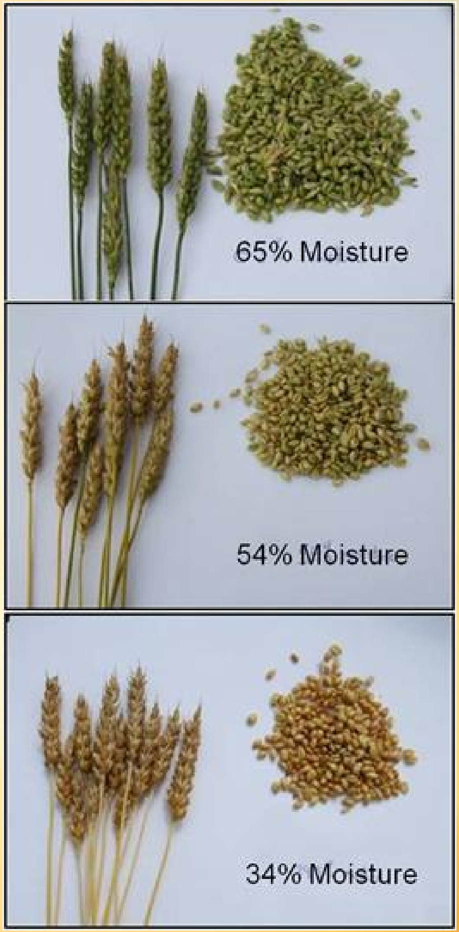
Harvest Management

FarmersEdge

Harvest Management

FarmersEdge

- Yield losses due to improper staging of harvest aid products can cost significant $$.
  - When glyphosate was applied at the soft dough stage (seed moisture content of approx. 50%), glyphosate did hasten crop dry-down, but also reduced kernel weight and test weight, thus significantly reducing overall yield. It also reduced protein slightly, varying by variety. Glyphosate residues were detected.
  - At hard dough (seed moisture content of approx. 35%), glyphosate did not reduce kernel weight, nor test weight. Loaf volume, crumb color, and crumb texture were unaffected as well. Protein also was not affected and no glyphosate residues were detected.
  - The dough mixing characteristics were affected by the use of pre-harvest glyphosate at both the soft dough and hard dough growth stage.



Harvest Management

- North Dakota State University (NDSU work reveals overloaded combine losses can reach 20 per cent of a crop's total yield.
- 10% losses are not uncommon.
- Losses should be in the 2-3% level.

Harvest Management

- 50 bushel / acre wheat.
  - 20% loss = 10 bushels = $62.50 (at $230 / tonne)
  - 10% loss =   5 bushels = $31.25
  - 2.5% loss = 1.25 bushels = $7.81
    - This is the acceptable level!

Summary - Harvest Management

- Apply harvest aid products at proper rates and stages.
- Ensure combines are properly set and maintained.

Grain Storage

Grain Storage

- Once you have your grain in the bin – ensure it stays in good condition!

Summary - Grain Storage

FarmersEdge

- You grew it – now store it properly and monitor frequently
- Protect your investment

Summary High Yielding Wheat

- Select the top yielding variety for your area that has all the other attributes you require.
- Soil test using a western Canadian Lab.
- Use recommended rates for desired yield goals.
- Plant as early as possible.
- Use as narrow a row spacing as is practical.
- Seed at the high end of recommended rates.

Summary High Yielding Wheat continued

FarmersEdge

- ✓ Seed as shallow as possible to seed into moisture.
- ✓ Use a seed treatment (especially if planting into cold, wet soils).
- ✓ Control weeds as early as possible to protect crop yield.
- ✓ Use fungicides at flag leaf or heading when needed.

Summary High Yielding Wheat continued

- ✓ If using pre-harvest glyphosate, ensure 80% of plants are at 30% moisture to avoid yield reduction.
- ✓ Have combines properly set.
- ✓ Don't overfeed combines.
- ✓ Ensure grain is in "storable condition" or dry.
- ✓ Use monitoring to ensure grain stays in condition