

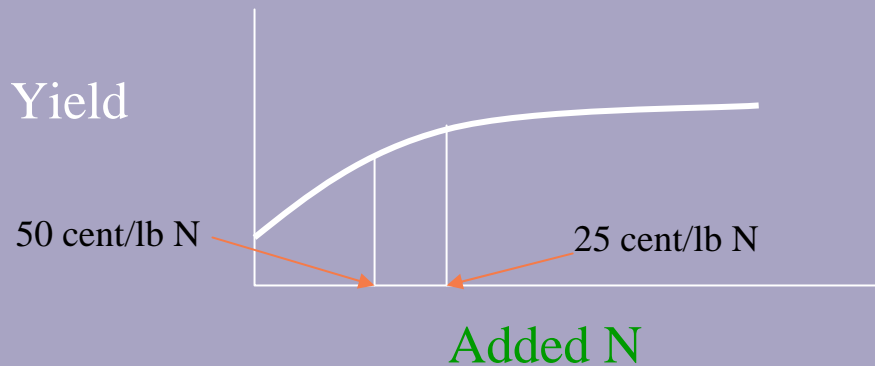
Some Canola Fertility Considerations for 2009

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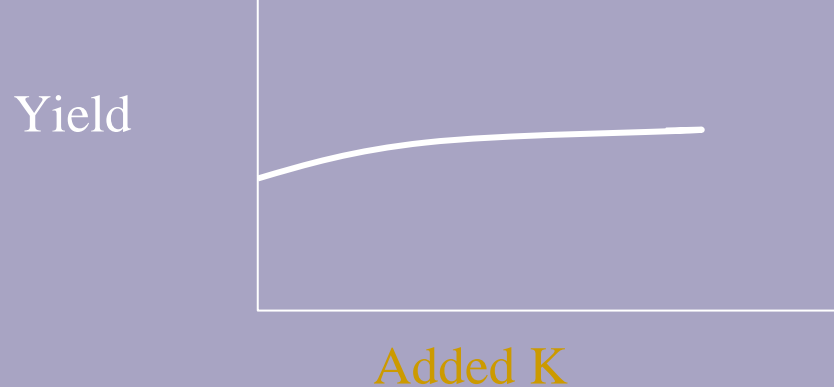
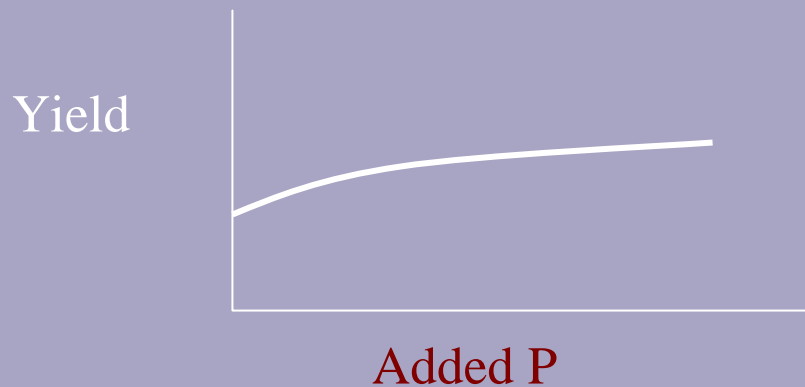


Evaluate your fertility program.

Where are you on each of these curves?



Soil Test to Find Out!



Success in making the most of fertilizer \$\$ is knowing where you're at, which nutrients are giving you most bang for the buck!

Soil Fertility Assessment (Soil Testing) Is Important!

Tells you where you are on the curves, how to provide optimum economic rate of each nutrient for crop.

DIFFERENT FIELDS HAVE DIFFERENT OPTIMUM RATES OF FERTILIZER



SET A REALISTIC TARGET YIELD AND FERTILIZE ACCORDINGLY

Stored Soil Moisture + Growing Season Rainfall = Yield Potential

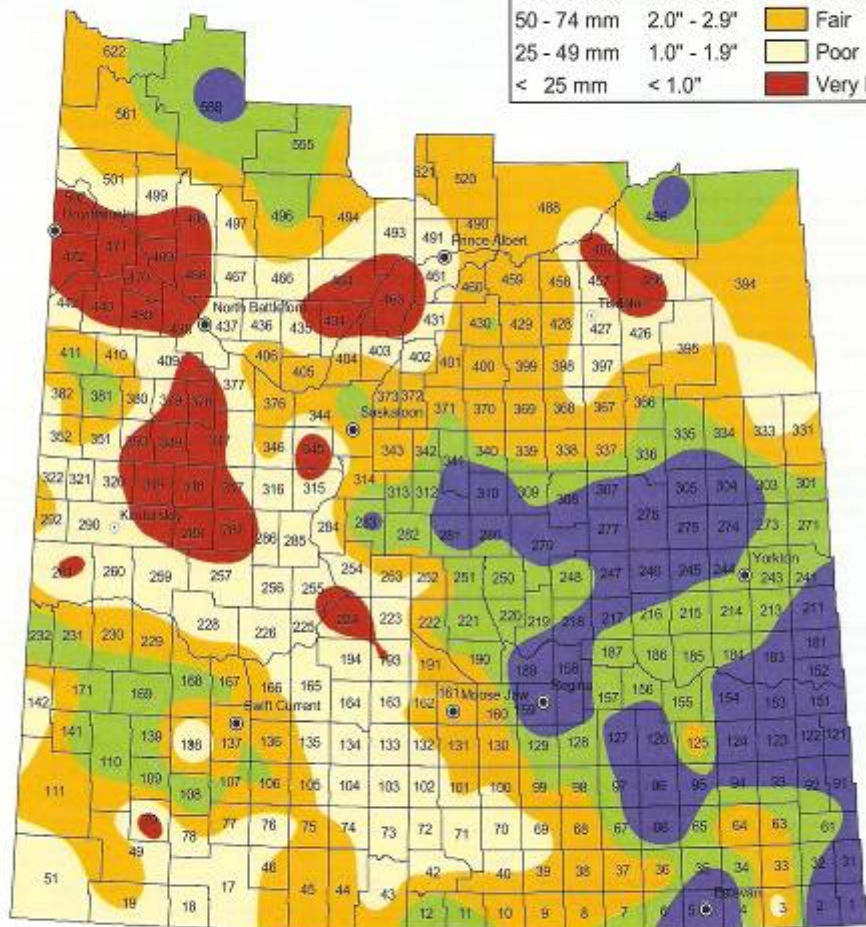
Want to balance rate of nutrient with yield potential
as governed by moisture!



Stubble Subsoil Moisture Map

Nov 1, 2008

Millimeters/Inches of Available Soil Water		
> 100 mm	> 4.0"	Very Good
75 - 99 mm	3.0" - 3.9"	Good
50 - 74 mm	2.0" - 2.9"	Fair
25 - 49 mm	1.0" - 1.9"	Poor
< 25 mm	< 1.0"	Very Poor



NOTE: Since techniques used to smooth the transition between zones can affect the values in localized areas, this map should be used for regional analysis only.

Saskatchewan Ministry of Agriculture
 0 25 50 100 150 200 Kilometers
 Moisture data - Saskatchewan Ministry of Agriculture
 Other data - © Information Services Corporation of Sask.
 Prepared by: Geomatics Services Date: Nov 20, 2008

Measuring stubble subsoil moisture to determine stored water

A soil moisture probe can be made by welding a 1.9 cm (3/4 in.) steel ball on one end of a 1.1 metre (3.5 ft.) long 1.27 cm (1/2 in.) rod and welding a handle on the other end

Table 1. Plant available water stored in moist soil for various soil textures

Soil Texture	Amount of soil water per foot (305 mm) of moist soil
Sand	0.75 in. (19 mm)
Loamy sand	1.00 in. (25 mm)
Sandy loam	1.25 in. (32 mm)
Loam	1.50 in. (38 mm)
Clay loam	1.75 in. (44 mm)
Clay	2.00 in. (51 mm)

How much soil water is enough?

Determining the minimum amount of soil water that is needed is not an easy task. Several factors need to be considered such as: the amount of risk the farmer is willing to take, the expected precipitation for the growing season, crop and variety selection, and the use of special strategies to improve moisture use efficiency like stubble height, balance of fertilizer nutrients, direct seeding, seeding date, timing of weed control, etc.

Yields of wheat, barley and canola can be estimated using the equations in Table 2. (Y is yield in bushels per acre; WU is inches of plant available stored soil water plus inches of growing season precipitation); the first coefficient adjusts for the water needed to grow the crop to the heading or podding stage and the final coefficient is water use efficiency in bushels per inch of water). These yields could be attained or exceeded by fertilizing according to soil test recommendations and following good crop management practices (like using new high yielding varieties).

Growing season precipitation

Table 4 gives a 30-year average of precipitation of sites across Saskatchewan as collected by Environment Canada. If you have late maturing crops, then part of the August precipitation can be added into the May through July to give Growing Season Precipitation.

Many farmers have been recording Growing Season Precipitation for a number of years. This data can be used to calculate the average Growing Season Precipitation (May, June, July, and part of August, for late maturing crops) for your farm, and used to calculate the yield potential for the coming year by using the yield equations in Table 2. These yield equations assume good agronomic practices were used; e.g. fertilizing to soil test recommendations, etc.

The actual yield may be higher or lower because of a number of factors that influence yield such as: weed competition, amount and balance of nutrients, disease and insect damage, distribution of rainfall, unfavourable weather, etc.

Table 2.* Yield equations for wheat, barley and canola by soil zone.

Soil zone	Wheat(CWRS)	Barley	Canola
Dry Brown	Y=(WU-2.5)x3.5	Y=(WU-2.5)x5.3	Y=(WU-2.5)x2.0
Brown	Y=(WU-2.25)x3.75	Y=(WU-2.25)x5.7	Y=(WU-2.25)x2.5
Dark Brown	Y=(WU-2.0)x4.0	Y=(WU-2.0)x6.0	Y=(WU-2.0)x3.0
Thin Black	Y=(WU-1.75)x4.25	Y=(WU-1.75)x6.4	Y=(WU-1.75)x3.3
Thick/Gray Black	Y=(WU-1.5)x4.5	Y=(WU-1.5)x6.7	Y=(WU-1.5)x3.6
Gray	Y=(WU-1.25)x4.75	Y=(WU-1.25)x7.2	Y=(WU-1.25)x4.0

Y = yield in bushels per acre. (The equations in this table are based on pre-1990 varieties)
 WU = water use; inches of plant available stored soil water plus inches of growing season precipitation.

* Table 2 is adapted from "Criteria for Targeting Yields in Saskatchewan" Soils and Crops Workshop, 1991. R.E. Karmanos and J.L. Henry, Department of Soil Science, University of Saskatchewan.

Table 3. Estimated yield calculation

	Example	My field
Depth of soil moisture (spring) (A)	3 ft.	
Soil texture	loam	
From Table 1 Plant available water stored/foot (B)	1.5 in.	
Inches of stored water (AxB)=(C)	4.5in.	
Expected growing season rain (D)	7 in.	
Water Use (WU) = (C+D)	11.5in.	
Yield equation for wheat in the Dark Brown Soil zone (Table 2)	Y=(WU-2)x4	
Estimated yield calculation bushels/acre	Y=(11.5-2)x4	
	Y=38	

Table 4. Mean Monthly Precipitation Amounts at Selected Stations, 1971-2000

Location	May	June	July	Aug.	Growing Season	Sept.-Apr.	Year	
Broadview	mm inches	49.9 1.9	68.0 2.7	88.8 3.5	58.3 2.3	236.0 9.3	178.6 7.0	412.6 16.2
Estevan	mm inches	59.8 2.4	78.3 3.1	85.0 3.4	48.5 1.9	246.4 9.7	188.9 7.4	433.3 17.1
Kradersley	mm inches	43.2 1.7	63.2 2.5	59 2.3	42.7 1.7	206.1 8.1	130.2 5.1	336.3 13.2
Lloydminster	mm inches	41.4 1.6	64.7 2.5	68.8 2.7	51.6 2.0	236.9 9.3	191 7.5	421.9 16.6
Maple Creek	mm inches	48.1 1.9	63.2 2.5	47.3 1.9	38.3 1.5	197.1 7.8	182.2 7.2	379.3 15
Meadow Lake	mm inches	45.5 1.8	63.5 2.5	78.4 3.1	67.7 2.7	209.1 8.2	165.9 6.6	415 16.4
Moose Jaw	mm inches	48.9 1.9	69.2 2.7	57.2 2.3	38.8 1.5	206.2 8.1	159.1 6.3	365.3 14.4
North Battleford	mm inches	38.6 1.5	61.3 2.4	71.2 2.8	53.9 2.1	229.8 9.1	148.4 5.9	378.4 14.9
Nipawin	mm inches	44.7 1.8	75.9 3.0	78.1 3.1	68.0 2.7	267.7 10.5	155.8 6.1	423.5 16.7
Outlook	mm inches	44.5 1.7	63.7 2.5	57.1 2.3	38.3 1.5	203.4 8.0	134.6 5.3	338.0 13.3
Prince Albert	mm inches	47.7 1.9	72.6 2.9	76.8 3.0	58.0 2.3	251.1 9.9	189.2 7.5	440.3 17.3
Regina	mm inches	52.8 2.1	75.1 3.0	64.4 2.5	43.2 1.7	235.5 9.3	167.6 6.6	403.1 15.9
Saskatoon	mm inches	48.4 1.9	61.1 2.4	60.1 2.4	38.8 1.5	206.4 8.1	146.6 5.8	353.0 13.9
Swift Current	mm inches	44.5 1.7	65.6 2.6	52.4 2.1	39.9 1.6	207.4 8.2	141.7 5.6	349.1 13.7
Wynyard	mm inches	49.0 1.9	75.9 3.0	66.7 2.6	52.5 2.1	248.9 9.8	175.6 6.9	424.5 16.7
Yorkton	mm inches	48.2 1.9	79.4 3.1	74.2 2.9	62.1 2.4	263.9 10.4	187.0 7.4	450.9 17.8

Source: Environment Canada
 For more locations see: Canadian Climate Normals at www.ec.gc.ca using the search feature or use your own precipitation records.

Know Depth of Moist Soil in Profile !

Sand: 1 foot moist soil = 0.75 inch available water

Loam: 1 foot moist soil = 1.5 inch available water

Clay: 1 foot moist soil = 2.0 inch available water



Example: Dark Brown Soil Zone: Canola

Yield = (Inches soil stored + Growing season water – 2.0) x 3.0

Very Poor: (0.5” + 4.0” – 2.0) x 3.0 = 8 bu/ac

Very Good: (4.0” + 12” – 2.0) x 3.0 = 42 bu/ac

WHAT ALL DO YOU NEED Micronutrients?

- Could be a limitation for certain crops on certain soils, especially when aiming for the top end of the yield curve.

But

- Deficiency unlikely to be widespread across entire field.
- Most often observed in patches: eroded knolls may have low Cu and Zn, sandy or gravelly areas could be low in Cu, Zn, maybe B.
- Maybe boron for canola, but limited response of canola to B in recent trials at Melfort (Gray Luvisols) with low B testing soils.

Sources of Variation in Nutrient Availability and Productivity Across Fields:

1) Topography 2) Past Management (or Mismanagement) 3) Parent Material





- Soil test, tissue test suspected areas. Get a sample from **problem area** and another from a **good area** for **comparative** purposes.

Fertilizer Rates

CANOLA IS A NUTRIENT HUNGRY CROP!

Nutrient Uptake	Canola	Wheat
lb/ac	(35 bu/acre)	(40 bu/acre)
N	112	85
P ₂ O ₅	52	32
K ₂ O	81	73
S	20	9

Source: CFI Nutrient Uptake and Removal Guide

~ 70% of N and P taken up is removed in seed, 50% of S and 25% of K

- High yielding hybrid varieties require more nutrient to achieve yield potential (Ulrich et al. 2002; Brandt, 2004).



Workhorse versus Racehorse

- Some work (Karamanos and Flore, 2002) indicates hybrids have higher efficiency of N use:

Hybrid 2 lbs N/bu *versus* Traditional 3.3 lbs N/bu

Higher yields with same rate of fertilizer under optimum P and S fertility.

Thavarajah (2002) reported in field trials at four sites across Saskatchewan that rates ~ 60 - 80 lbs N/acre produced optimum yield of canola,



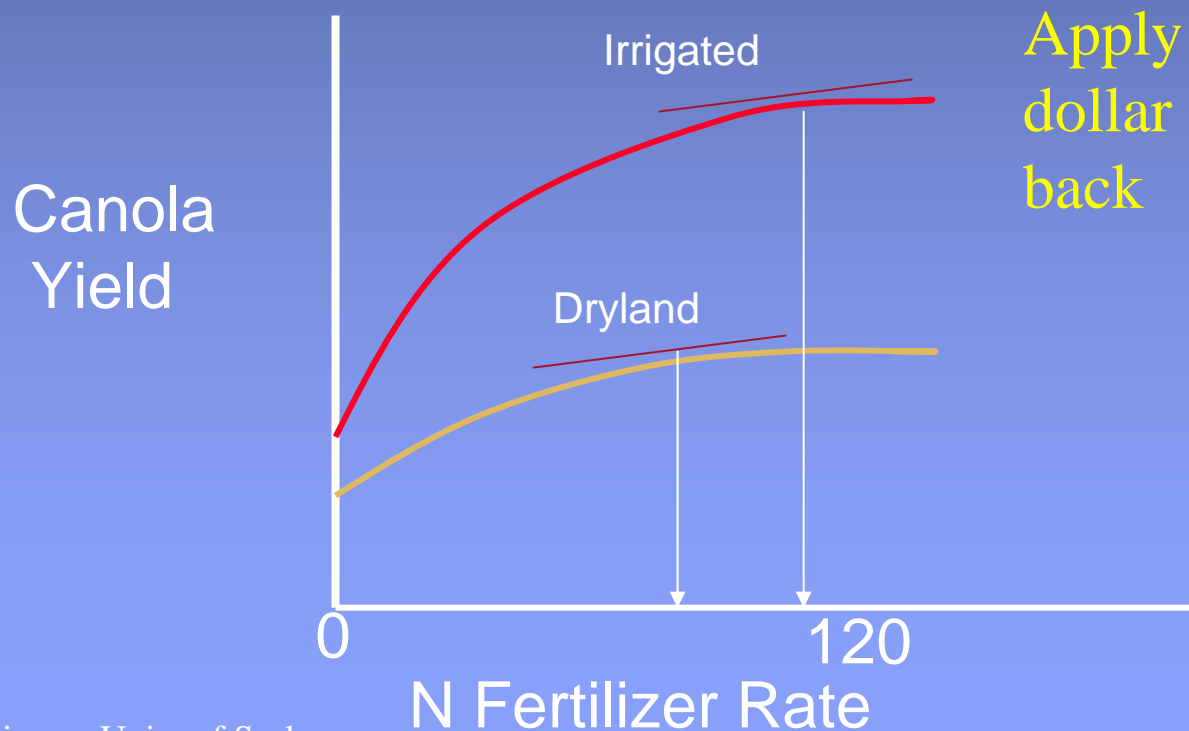
with lower requirements in soils with greater N mineralization potential and/or residual nitrate.

Need to soil test to assess N fertility, predict response:
Varies according to environment!!!

Yield (bushels per acre) of canola (Invigor) grown on wheat stubble with different rates of urea fertilizer in 2000 (Thavarajah et al. 2002).

	<i>N rate (lbs/acre)</i>		
	0	30	60
Scott yield (Dk Brown, dry)	12	20	20
Melfort yield (Black, wet)	30	38	45

Use predicted response curve to apply at rate that will maximize net return



Apply to point where last dollar spent gives you a dollar back

Fertilizer Placement, Additives

*Don't Compromise Stand Establishment By Cramming
Too Much Fertilizer in the Seed-Row!*

Pay Attention to Guidelines. Reduce Seed-Row
Fertilizer Rates When Dry and Risk of Multiple
Stresses: drought, seed quality, disease etc.

Risk of crop injury from too much fertilizer placed too close to seed is **increased** under dry conditions

- Salt effect of fertilizer on holding back moisture is increased by dry soil conditions.
- Less moisture, greater number of air-filled pores means more free ammonia gas, can also move further.

Wet



Dry



Fertilizer In The Seed-Row

✓ Pretty good placement but there is a **limit!**

$$\text{Seed Bed Utilization} = \frac{\text{opener spread}}{\text{row spacing}}$$

Example:

$$\begin{array}{l} \text{Disc } 1'' \\ \text{-----} \\ \text{Spacing } 9'' \end{array} = 11\% \text{ SBU} = \text{Max } 10 \text{ lbs N / acre} \\ \text{for canola}$$

$$\begin{array}{l} \text{Sweep } 3'' \\ \text{-----} \\ \text{Spacing } 9'' \end{array} = 33\% \text{ SBU} = \text{Max } 30 \text{ lbs N / acre} \\ \text{for canola}$$



With single shoot systems, pay attention to these limits!

Inhibitors, coatings added to urea fertilizer can reduce seedling injury risk and reduce N losses.

Urease inhibitors, Nitrification Inhibitors
Coatings to slow release

***Largest benefits in reducing losses occur under high loss potential conditions:
surface application, fall application, excess moisture***

Putting Fertilizer in a Band Increases Availability & Crop Utilization

- Concentrated bands of N reduce losses by slowing conversion of ammonium to the nitrate form that is susceptible to loss by leaching and denitrification.
- Phosphorus and potassium is more plant available in a band than when broadcast and incorporated. Less fixation, slower conversion to less soluble forms.

“Starter” Phosphorus and Potassium Placed in Seed Row or Close By Can Be Especially Beneficial for Early Nutrition of Canola

- because P and K can only move a few millimeters

- **Cool spring soil temperatures restrict early root growth and access to P and K**
 - **Starter P, K produces “pop-up” of crop, ensures early nutrition under these conditions.**
- **Crop rotations that reduce disease pressure, promote healthy roots will improve ability of crop to access soil P.**

Nitrogen is a mobile nutrient in the soil:
moves long distances (meters) along with water

Therefore, placement close to seedling roots not
critical:

N will move with water to roots



Surface dribble banding of liquid UAN (28-0-0)
can work well **if rains after application.**

Separation of N fertilizer from seed can also be easily accomplished with fluids by directing or “squirting” fertilizer away from seed row.



P+K Fertilizer in the Seed-Row

% of seeds planted that emerged over two weeks as affected by different rates of MAP (12-51-0), without and with 20 kg K₂O/ha as KCl (0-0-60) (Qian and Schoenau, 2009)

Wheat

Canola

Yellow Pea

12-51-0 kgP ₂ O ₅ /ha	P	P+K	P	P+K	P	P+K
0	93a	91a	95a	89a	97a	75a
10	95a	91a	98a	86a	76ab	68ab
20	91a	89ab	95a	82a	75ab	54bc
30	89ab	86ab	91a	80a	72b	39cd
40	91a	86ab	73b	75a	56b	25de
60	80b	82b	48c	59b	28c	18e
80	64c	68c	43c	45bc	19c	11e
100	52d	59d	36c	43c		11e

Nutrient Balancing

- Sulfur is critical for canola!



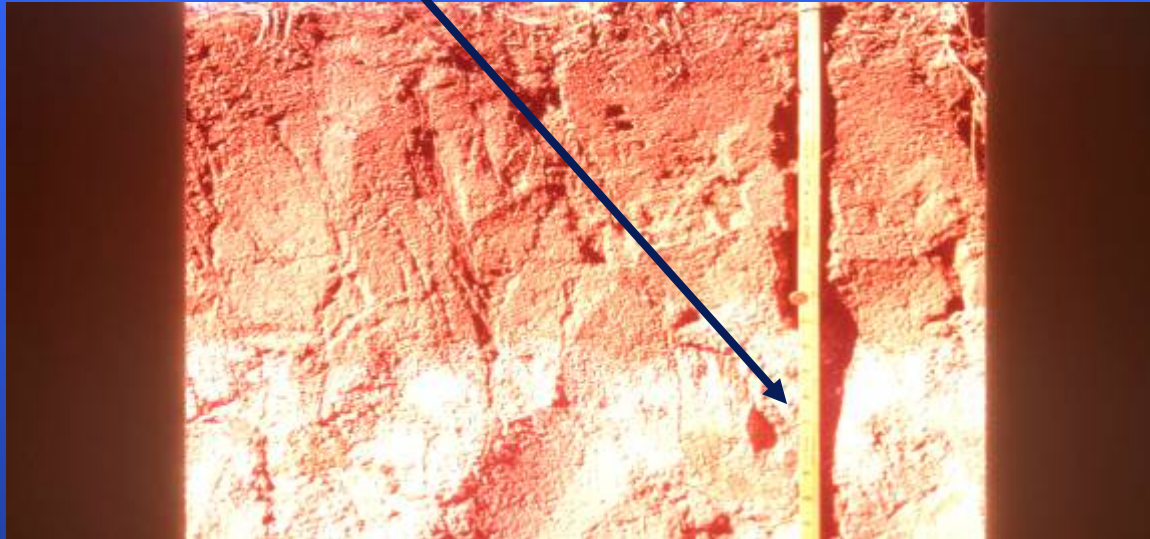
- Available N to Available S ratio following fertilization should be ~ 5:1 to 7:1
- 15 - 30 lbs S / acre of sulfate fertilizer generally sufficient.

- Soil sulfur levels across farm fields are extremely variable
 - difficult to get a representative sample.
 - as insurance against deficiency, S fertilizer recommendation is often made for canola, *regardless of what soil test says.*

Saline areas contain very high levels of sulfur: salts are sulfate salts



- Many soils in Brown and Dark Brown soil zone, have lots of sulfate (gypsiferous layer) in the sub-soil (12 - 24 inch depth).



- Canola could be sulfur deficient in early stages of growth, but when roots get to layer, the deficiency disappears.

Pay Attention to S Fertilizer Form:

- Use sulfate form when you need S available right away.
- Elemental forms can take a long time to oxidize to plant available sulfate. Variable oxidation rates: long term supply.

High use of N fertilizer, high yields and high crop S removal can quickly result in S deficiency conditions in soils susceptible to deficiency.

Post-emergent application of sulfate fertilizer can be effective in recovery of canola from S deficiency up to bolting (Malhi et al 2005).

Watch for S deficiency in canola grown on soils receiving swine manure, especially in second year following application (Schoenau et al., 2003).

- Some swine manures have low available S relative to N: storage in anaerobic lagoons.
- Not an issue with cattle manure.
- Can alleviate by applying supplemental S fertilizer.

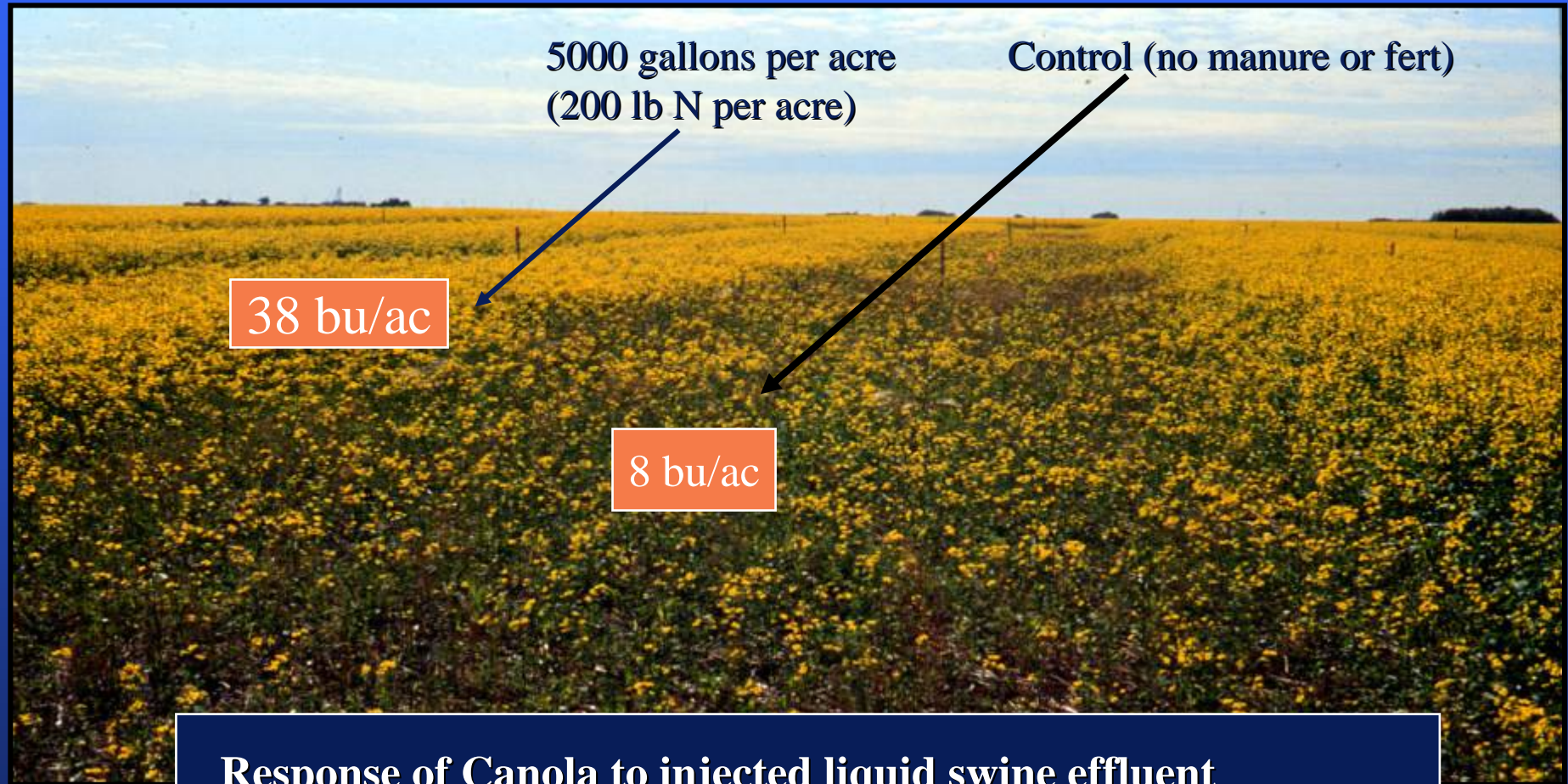
Organic Sources of Nutrient

Includes manures,composts, processing by-products



Not waste! A valuable source of nutrient and organic matter for soils and crops!

See good canola yield responses to manure



Benefits from Manure Use

Crop Yield & Protein Increase

\$ Economic Return ↑



Net Revenue over Three Years:

Based on Crop Response to Liquid Hog Manure at Dixon Field Trials, Black soil zone, East Central Sask.

Manure:

Crop Revenue minus Application Costs

Urea + MAP:

Crop Revenue minus Application Costs and Fertilizer Costs

2003 -2005 at Dixon, SK

2003 Barley, 2004 Canola, 2005 Wheat

2003 Barley valued at \$2.00 per bushel

	bushels/acre	cost/acre	net revenue/acre
Control	29.0	\$0	\$ 58.00
1X annual 3300gpa HM	68.6	\$33.00	\$ 104.20
1X annual urea + P fert (50 N + 15 P ₂ O ₅)	47.6	\$25.00	\$ 70.20



2004 Canola valued at \$6.00 per bushel

	bushels/acre	cost/acre	net revenue/acre
Control	4.8	\$ 0	\$ 28.80
1x annual 3300gpa HM	43.7	\$33.00	\$ 229.20
1x annual urea + P fert (50 N + 15 P ₂ O ₅)	35.2	\$25.00	\$ 186.20



2005 Wheat valued at \$3.50 per bushel

	bushels/acre	cost/acre	net revenue/acre
Control	16.2	\$0	\$ 56.70
1x annual 3300gpa HM	49.7	\$33.00	\$ 140.95
1x annual urea + P fert (50 N + 15 P ₂ O ₅)	54.9	\$25.00	\$ 167.15



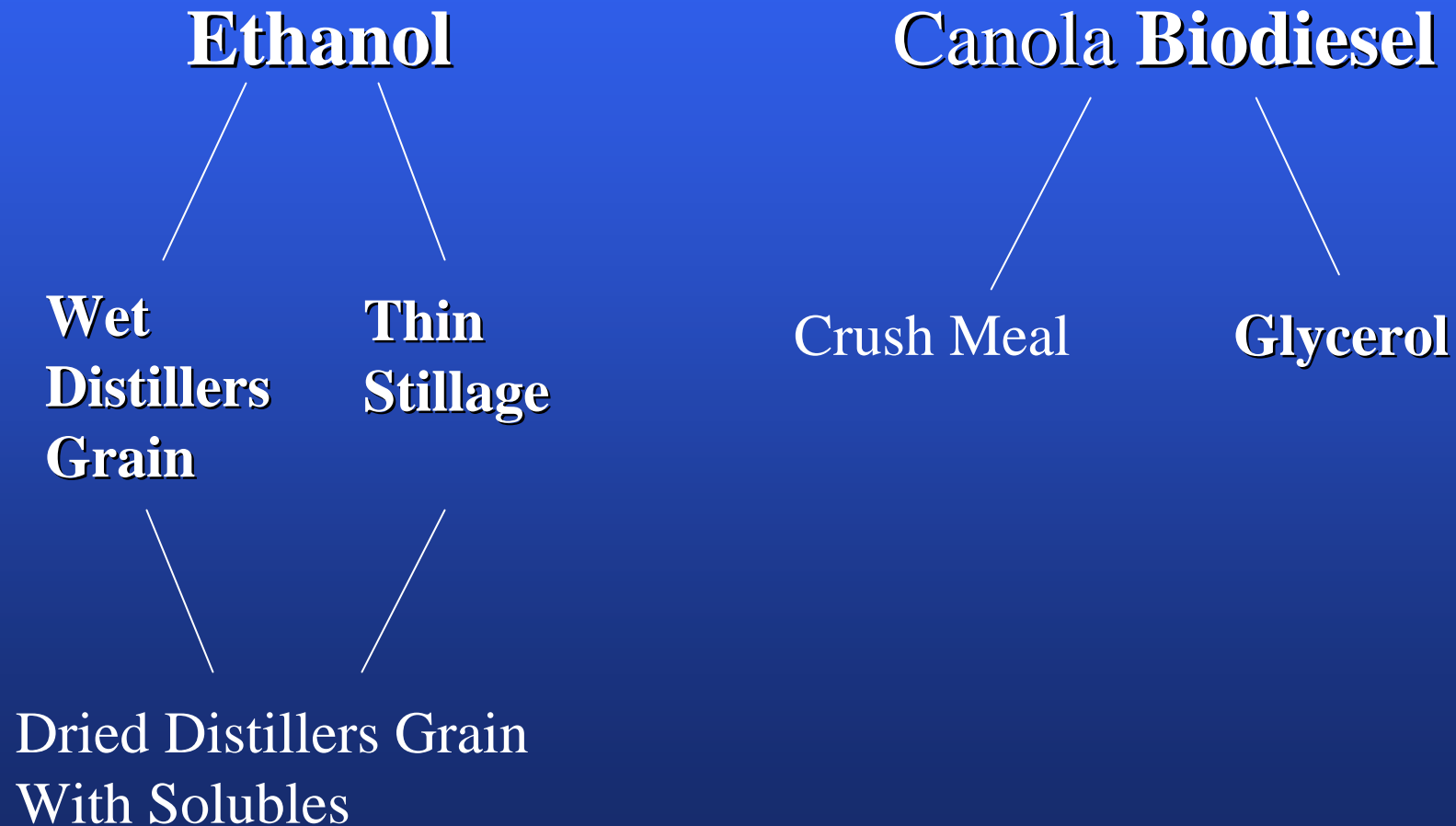
Over the three years 03-05

	Net revenue/acre
Control	\$ 143.50
1X annual 3300gpa	\$ 474.35
1X annual urea + P fert (50 N + 15 P ₂ O ₅)	\$ 423.55

Along with manures and composts,
biofuel and processing co-products can have value
as fertilizers

- *Co-products of biofuel production: distillers grain, thin stillage from ethanol production, glycerol from biodiesel*
- *Canola meal processing by-products, alfalfa pellets.*

Biofuel Production Co-Products



Why Important?

- **Biofuel** (ethanol, biodiesel) expansion
- **Feedstocks** compete for, utilize and contain nutrients
- Plant **nutrients** are a scarce and valuable resource
- Biofuels are hydrocarbons, need to effectively recycle nutrients that are left behind in co-products

Value as Fertilizer?

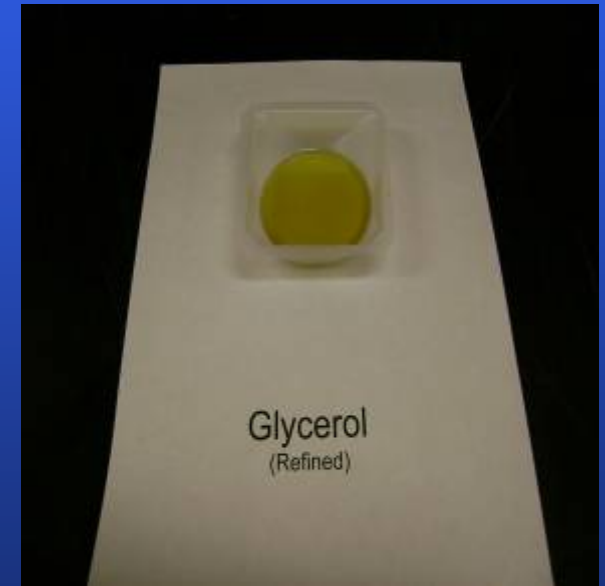
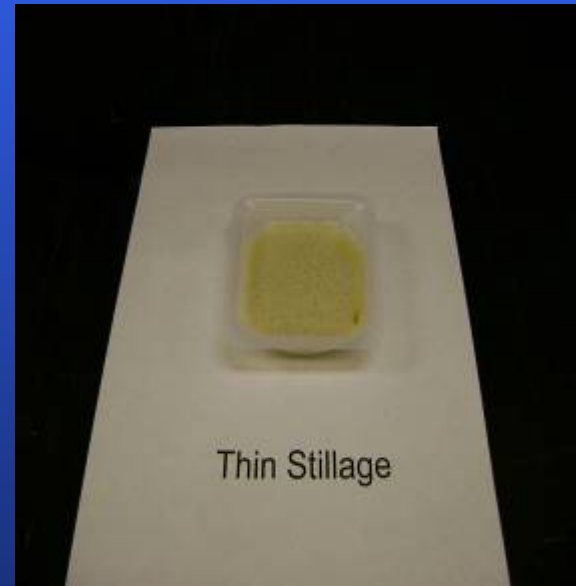
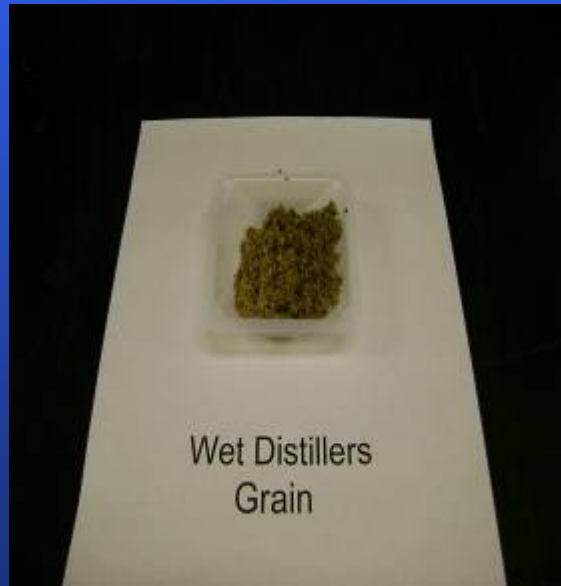
Controlled Environment Study

EFFECT OF:

Distillers Grain,

Thin Stillage,

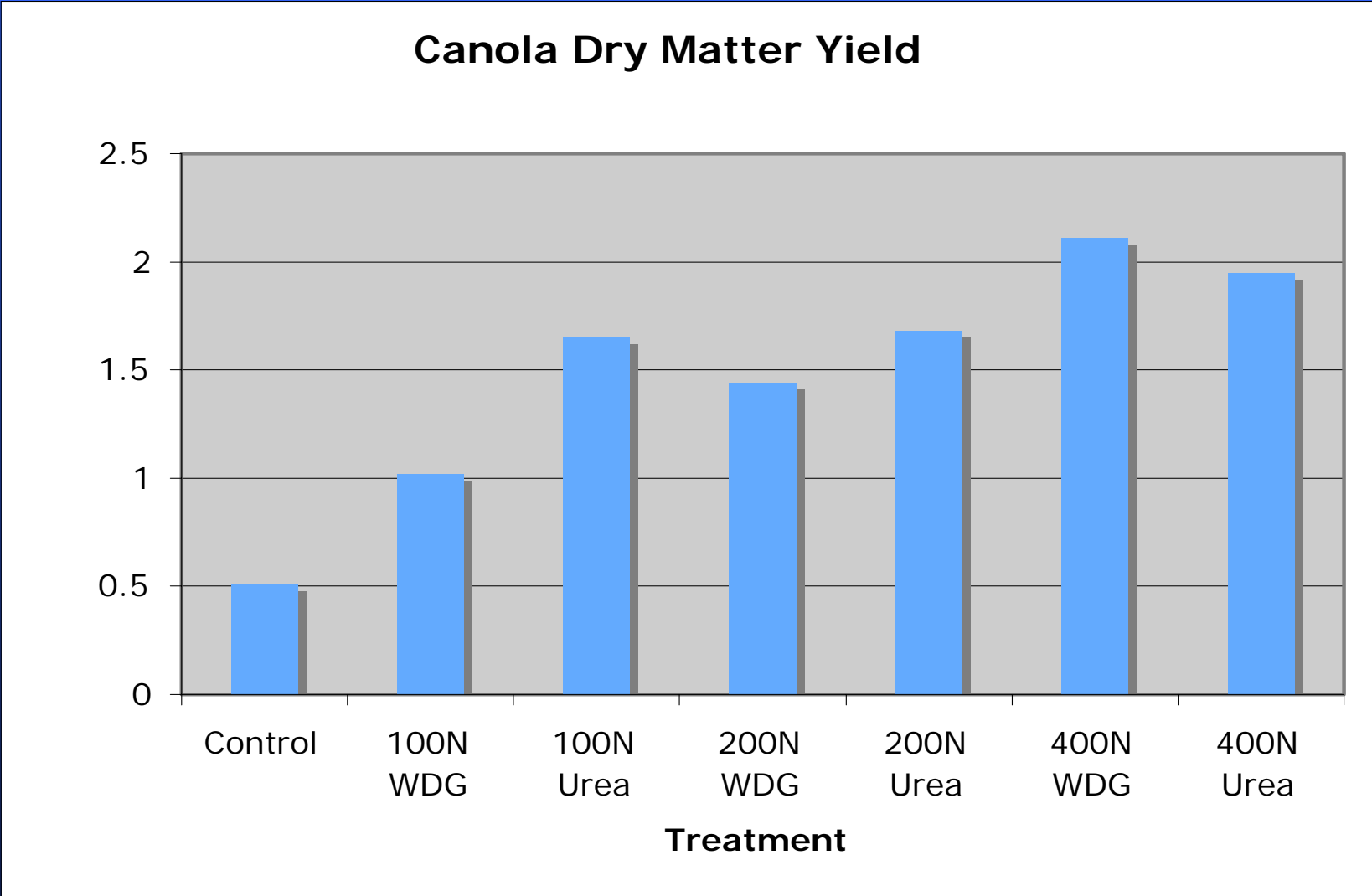
Glycerol

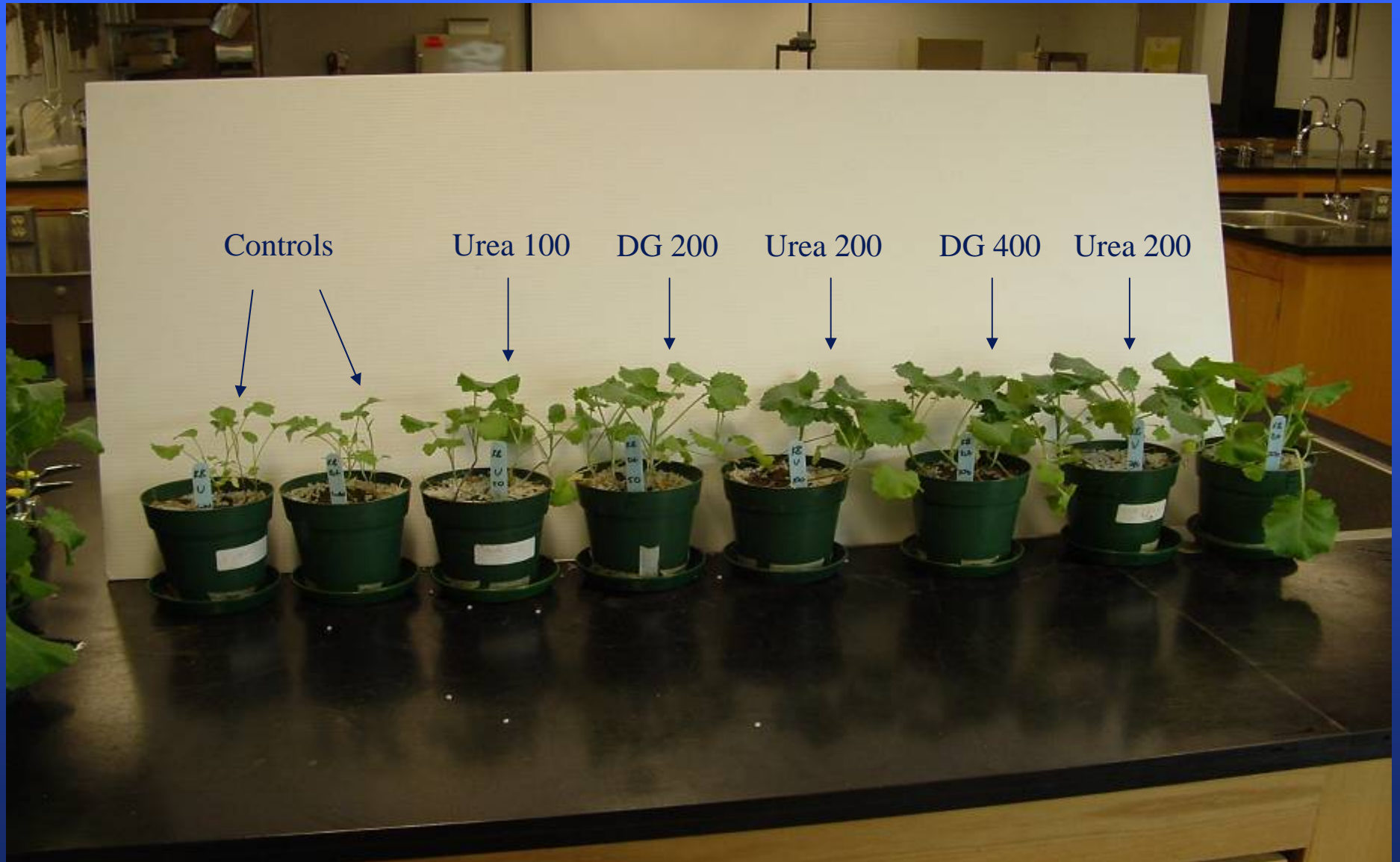


On Canola Growth, Soil Properties In Comparison to Urea



Canola Growth: Wet Distillers Grain vs. Urea





Controls

Urea 100

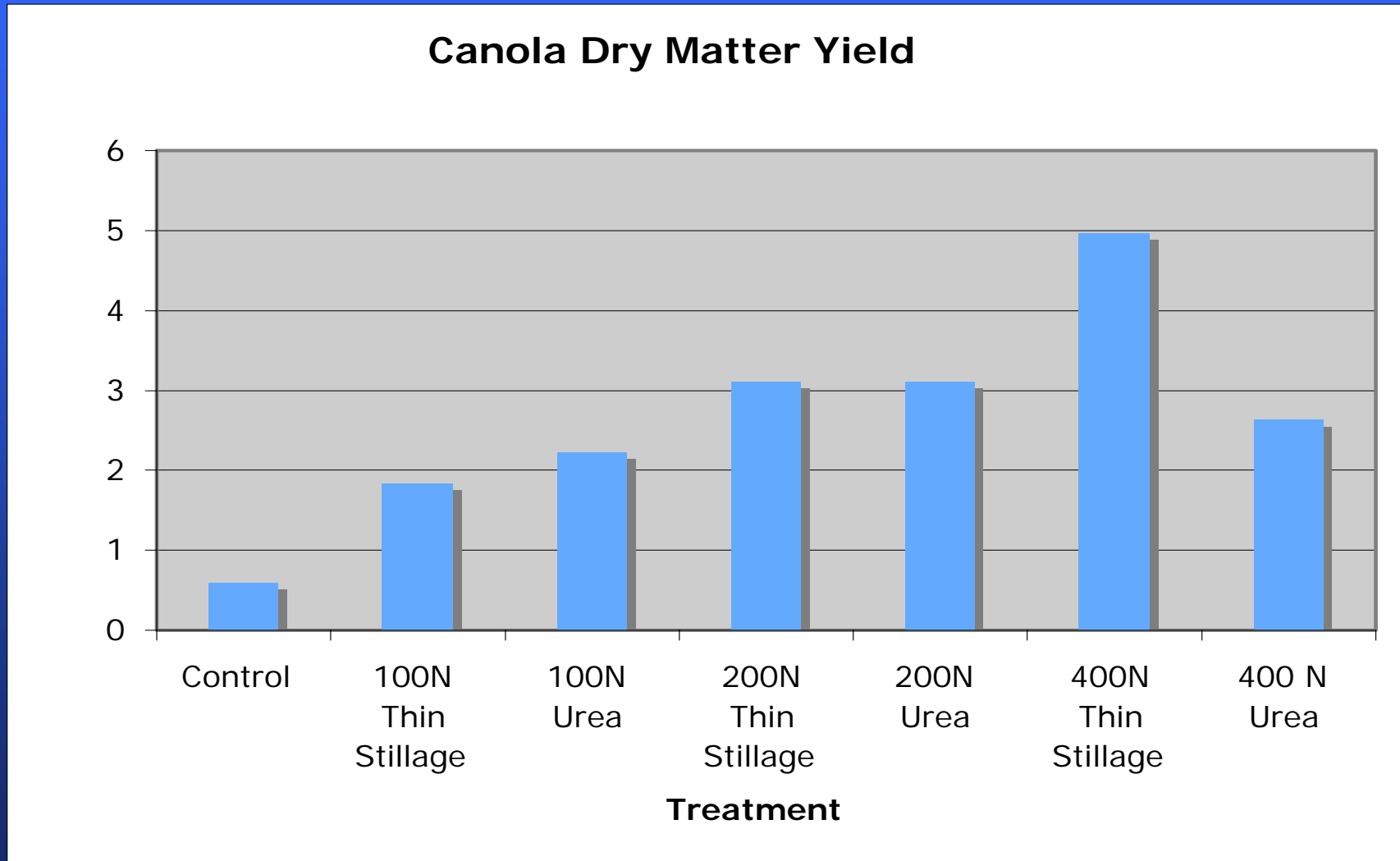
DG 200

Urea 200

DG 400

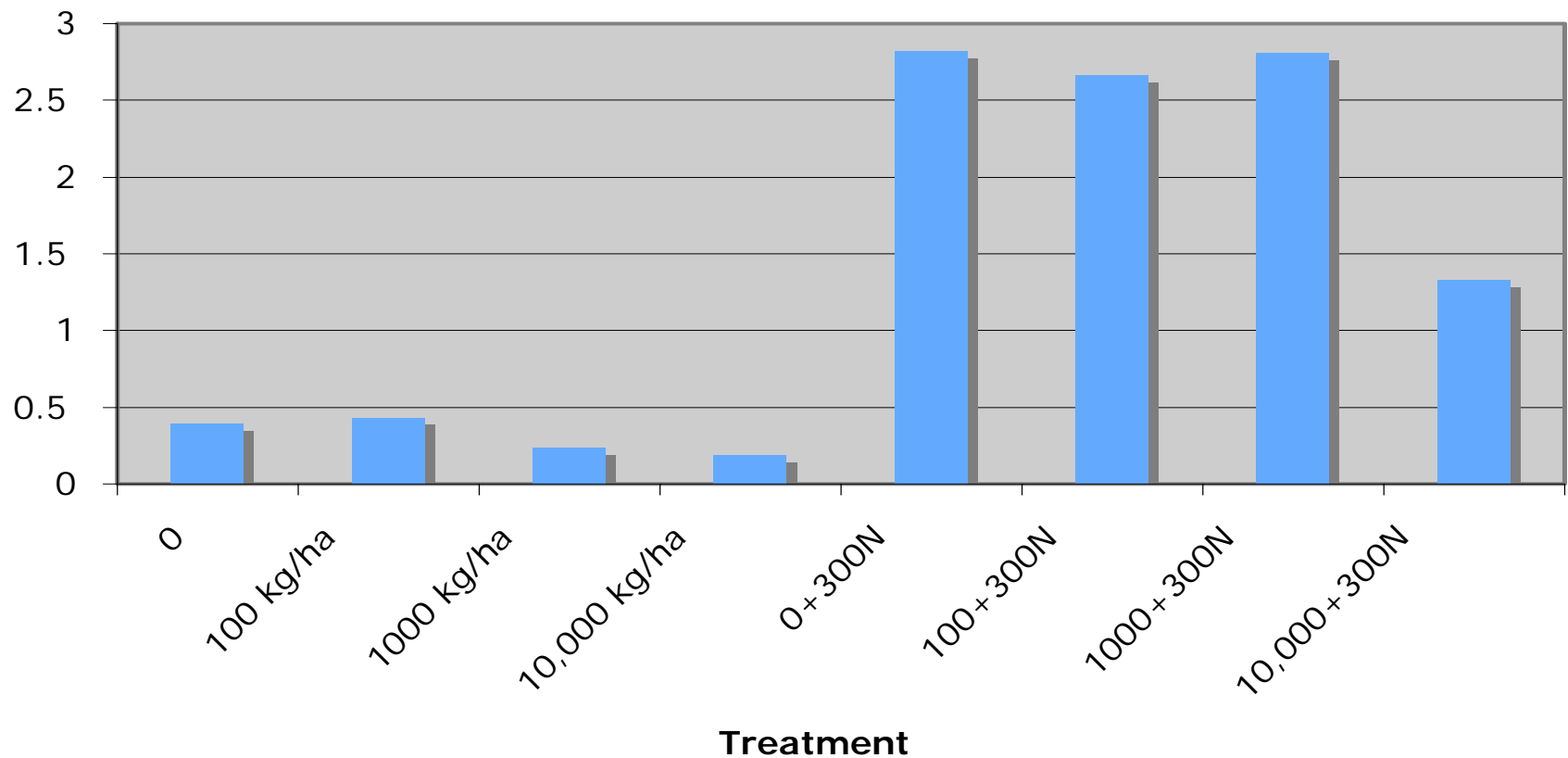
Urea 200

Canola Growth: Thin Stillage vs Urea



Canola Growth: Glycerol at different rates, without and with N fertilizer

Canola Dry Matter Yield





- Microorganisms need available nutrient from soil and fertilizer to decompose carbon source: reduces supply available to plant.

*Adding fertilizer N feeds both microbes
and plant*

Soil Organic Carbon

Glycerol Rate kg/ha	% Soil Organic C
0	1.78 _c
100	1.91 _{bc}
1000	1.86 _{bc}
10,000	2.18 _a

After 5 weeks, appreciable portion of C added as glycerol remains in soil.

Challenges with organic sources

Multi-element but low analysis: %N in single digits, usually 5% N or less, P 2% or less.

Makes transport and application challenging and expensive

Can't afford to move too far from site of production to where needed.

Economic hauling distances may be only a few km




How Does It All Add Up?

Efficiency is Key! Rate, Placement, Form
Conserving, Recycling Nutrients Important

Remember the law of mass conservation:

YOU CAN'T GET SOMETHING FOR NOTHING



Thanks! Questions?