Canola Nutrient Management: Strategies for using costly fertilizer following drought

PNWCA Canola Workshop
Great Falls
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Question for you:

Why are there relatively few acres of canola in MT, compared to each of the western Provinces?

Objectives

We will discuss the following:

1. General soil preferences
2. Nutrient considerations for canola in rotation
3. 2021 DROUGHT! How affects 2022 fertilizer considerations
4. Soil fertility management using the right rate, source, timing and placement of N, P, K, and S

Optimum soil conditions for canola

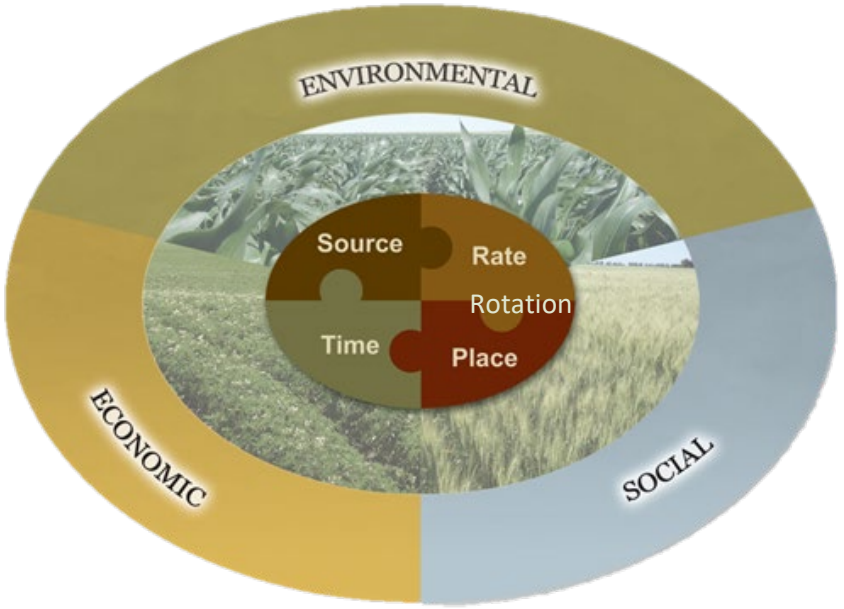
1. Soils with adequate infiltration and aeration
2. Low to moderate salt content (up to 6 mmhos/cm before yields decline) = similar to small grains, far more tolerant than pulses
3. Minimal tillage, continuous and high diversity rotations to keep residue on surface preventing crusting, and interrupt disease cycles
4. pH 6-7.5. **Acidic soils are becoming more common in MT and canola is among the most sensitive to low pH.**

Canola in soil with pH ~ 4.7

Use the 5 R's to aim for the best results

5 R's of fertilizer management

1. Rotation
2. Rate
3. Source
4. Timing
5. Placement



Soil nutrient considerations for crop rotations that include canola

Nutrient	Consideration
Nitrogen (N)	Can be provided by a legume
Phosphorus (P)	Canola and alfalfa are good P scavengers, deplete P for next crop
Potassium (K)	Canola leaves behind high K residue
Sulfur (S)	Canola is a good scavenger, depletes S for next crop
Other	Canola can reduce P, copper (Cu) and zinc (Zn) uptake by subsequent mycorrhizal crops (e.g., flax, legumes, small grains to a lesser extent)

Canola relative yields after other crops

Based on research at Mandan, ND, average over 4 rotations

	Crop to be grown			
Residue	SW, Barley	Pea, Lentil	Canola	Sunflower, Safflower
SW, Barley	1.00	1.19	1.09	1.81
Pea, Lentil	1.02	1.00	1.16	2.04
Canola	0.99	1.00	1.00	1.67
Sunflower, Safflower	0.95	0.99	1.00	1.00
Average	0.96	1.05	1.04	1.67

Adapted from Tanaka et al., 2005 and 2007, by K. McVay

On to nutrient issues during and after drought

Drought affects plant uptake and nutrient availability

Plants

- Roots don't reach deep nutrients or deep water
- Lacking transpiration to "suck up" nutrients
- Poor N-fixation (so less N credit after legume)

Nutrients

- Low organic matter decomposition
- Low nutrient availability from soil
- Nutrients don't move easily in dry soil to reach roots

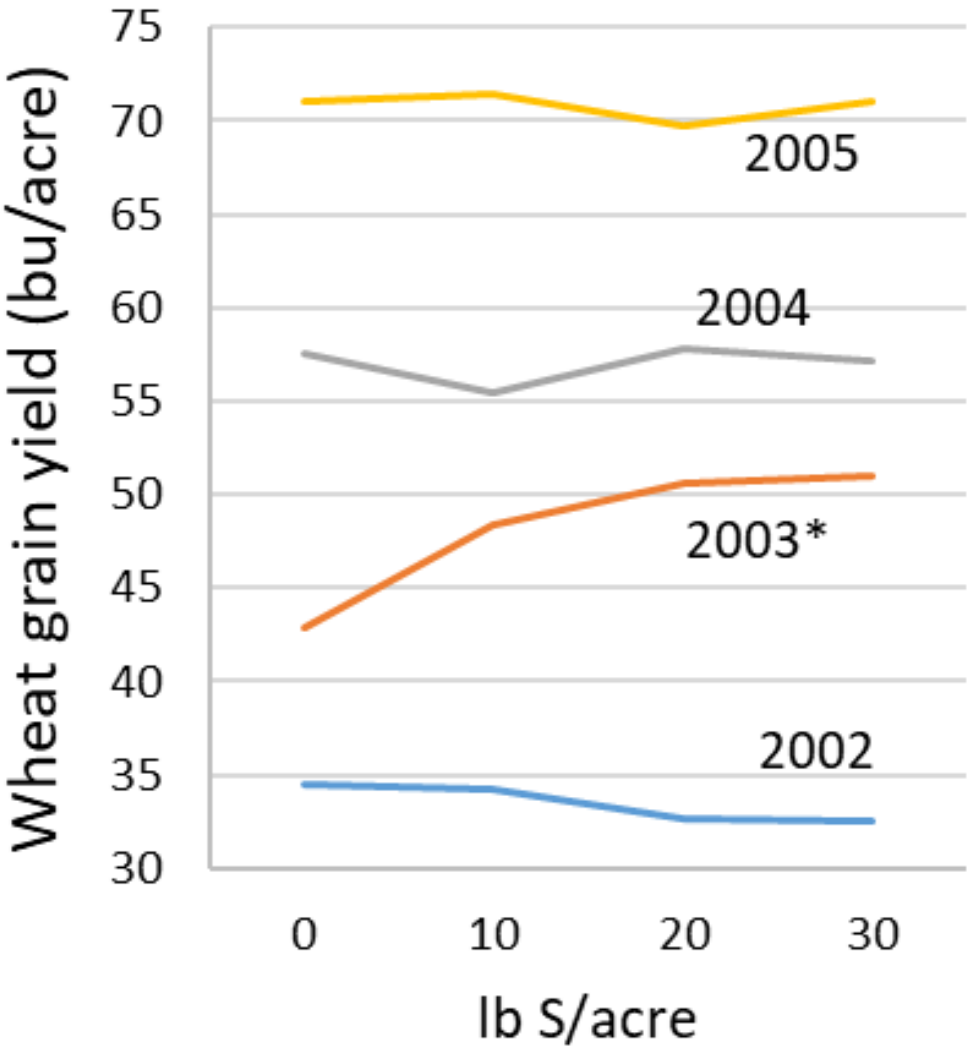
Drought on the following year's fertilizer needs

- Lower yields = less nutrients removed by harvest, higher residual soil N, if not leached
- Change in material harvested changes nutrients removed Ex. grazed or salvaged hay removes 3x K as grain
- Change in decomposition of residue
  - immature residue decomposes faster than mature residue
  - decomposition is slower in dry soils
  - What residue? Grasshoppers ate it!
- P and K recycling changes depending on fall precip

Recommendations for nitrogen post-drought and during drought

- Ideally, sample in early spring to avoid over- or under fertilization. Late fall if not possible.
- Lower N rate if fall to early spring is dry to average (since mineralization w/o much leaching or denit.).
- Lower amounts of early N – allows flexibility for given year's precip, prevents excess vegetative growth
- N credits will be lower than 'usual' after drought

Sulfur can increase yield in moderate drought, even in low S needing wheat

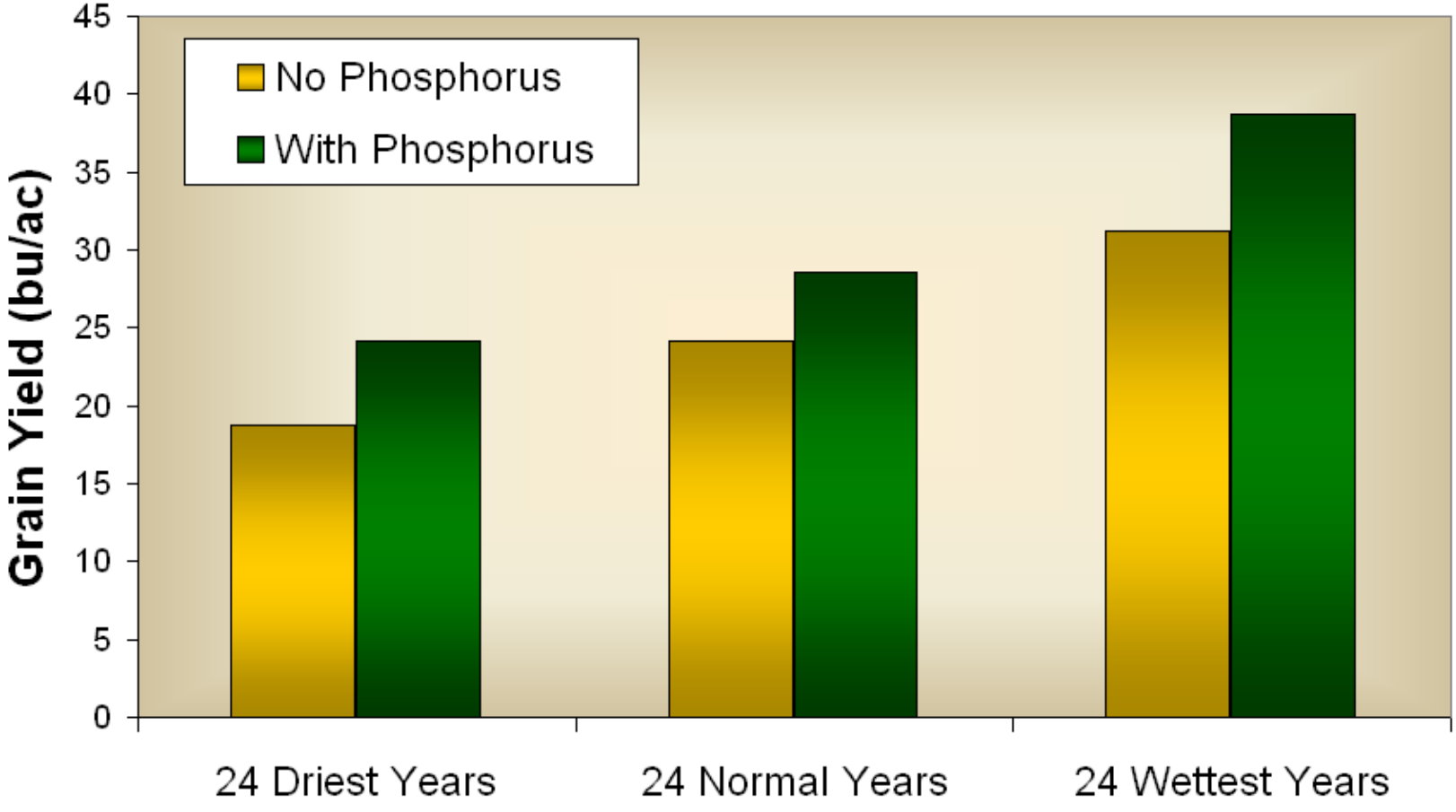


In severe drought (2002), water, not S, limited yield. In moderate drought (2003), perhaps less gypsum dissolved, and less SOM mineralized to provide S

More on S for canola later

Ffact No. 41, **Knees, MT**

In dry years, it's tempting to back off on fertilizer, including P. Is this the best choice?



(Olsen P = 16-20 ppm; added 30 lb P_2O_5/ac; Scott, SK)

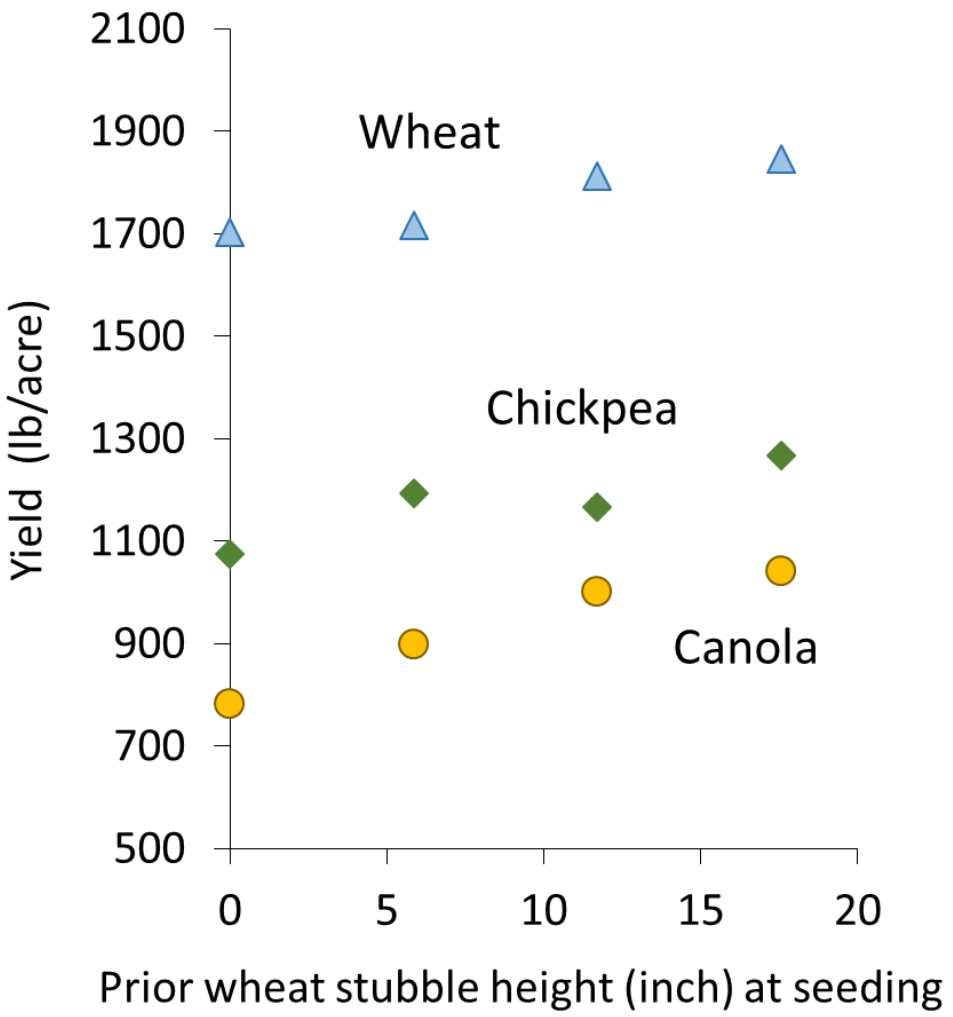
(Brandt, S. 2007. Phosphorus fertilization boosts yields in fallow wheat production. Better Crops with Plant Food. 91:15.)

Agronomic practices to improve soil water

Reduce tillage, increase residue and stubble to:

- Trap snow
- Reduce wind stress
- Reduce evaporation loss
- Reduce soil temperature
- Increase water infiltration and storage

➢ Recrop or plant covers



Cutforth et al., 2011, SK, All started with same soil moisture at seeding

Questions?

On to *tools to determine fertilizer rates and deficiencies*

Start with a realistic yield goal

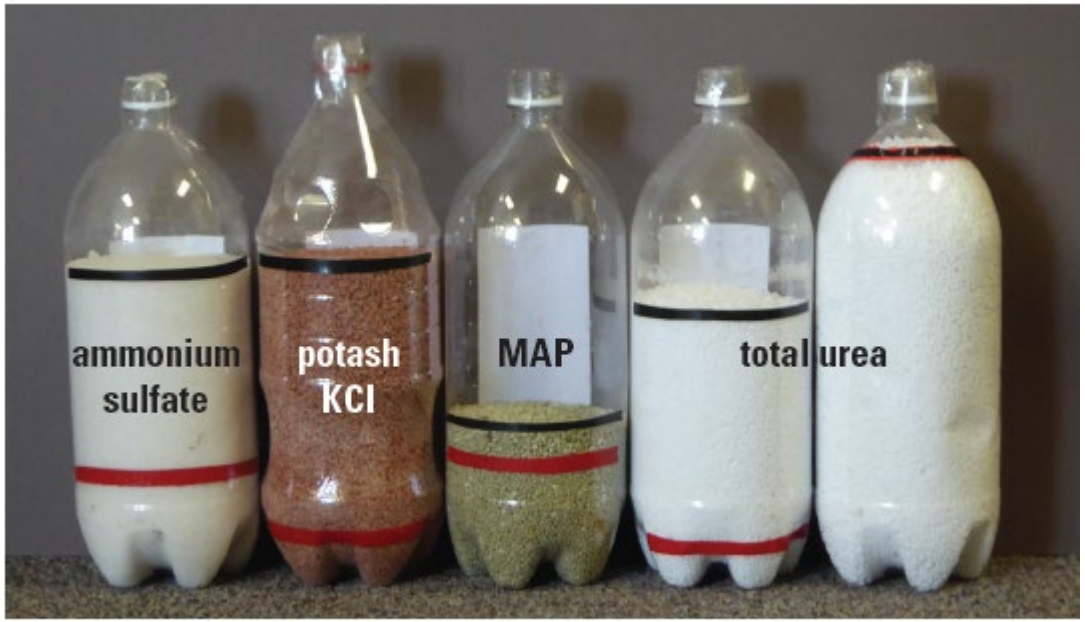
- Use MSU's variety trial results (https://agresearch.montana.edu/carc/2020StatewideSpringCanolaVarietyTrial_ADA2.pdf), or successful local producers' experience
- Past yields indicate future performance
- Having ability for in-season N application allows conservative yield estimate for pre-plant rate
- Then look up how much N is needed to produce a bushel of seed:

(soil nitrate + in-season organic matter decomposition + fertilizer)

How much fertilizer is removed by canola plant and a bushel of canola seed?

Total in mature plant to produce one bushel seed.

Removed by one bushel seed.



	lb/bushel			
	S	K_2O	P_2O_5	N
Total uptake	0.9-1.2	4.1- 4.2	0.9-1.2	2.7-2.9
In seed	0.2-0.4	0.5-0.6	0.7-1.2	1.5-1.9
MSU Fert Guideline lb N/bu				~ 3.25
Canola Council of Canada lb N/bu				2.9-3.5

Potassium and Sulfur needs are much higher for canola than wheat (per bushel)

Wheat 0-0-60 Canola 0-0-60 Wheat 21-0-0-24 Canola 21-0-0-24

Ideally soil test in spring; fall soil tests can lead to over or under-fertilized fields

High N crop residue and/or high O.M.

Mineralization

Over fertilized

Over winter

High Precip

High N on shallow or coarse soil, or after drought

N leaching (or N_2 gas losses?)

Under fertilized

Compare fall with spring a few times to see patterns of loss or gain for given pastures/rotation

Plant symptoms – once symptoms appear, yield may already be compromised

Boron

R. Karamanos

Nitrogen

GRDC Canola Guide

Sulfur

Gov. W. Aust., T. Potter

Phosphorus

IPNI, El Gharous

Potassium

IPNI, Roberts

Sulfur

R. Karamanos

Questions?

On to *calculating fertilizer rates and considerations when costs are HIGH*

N rate adjustments become more important when costs high

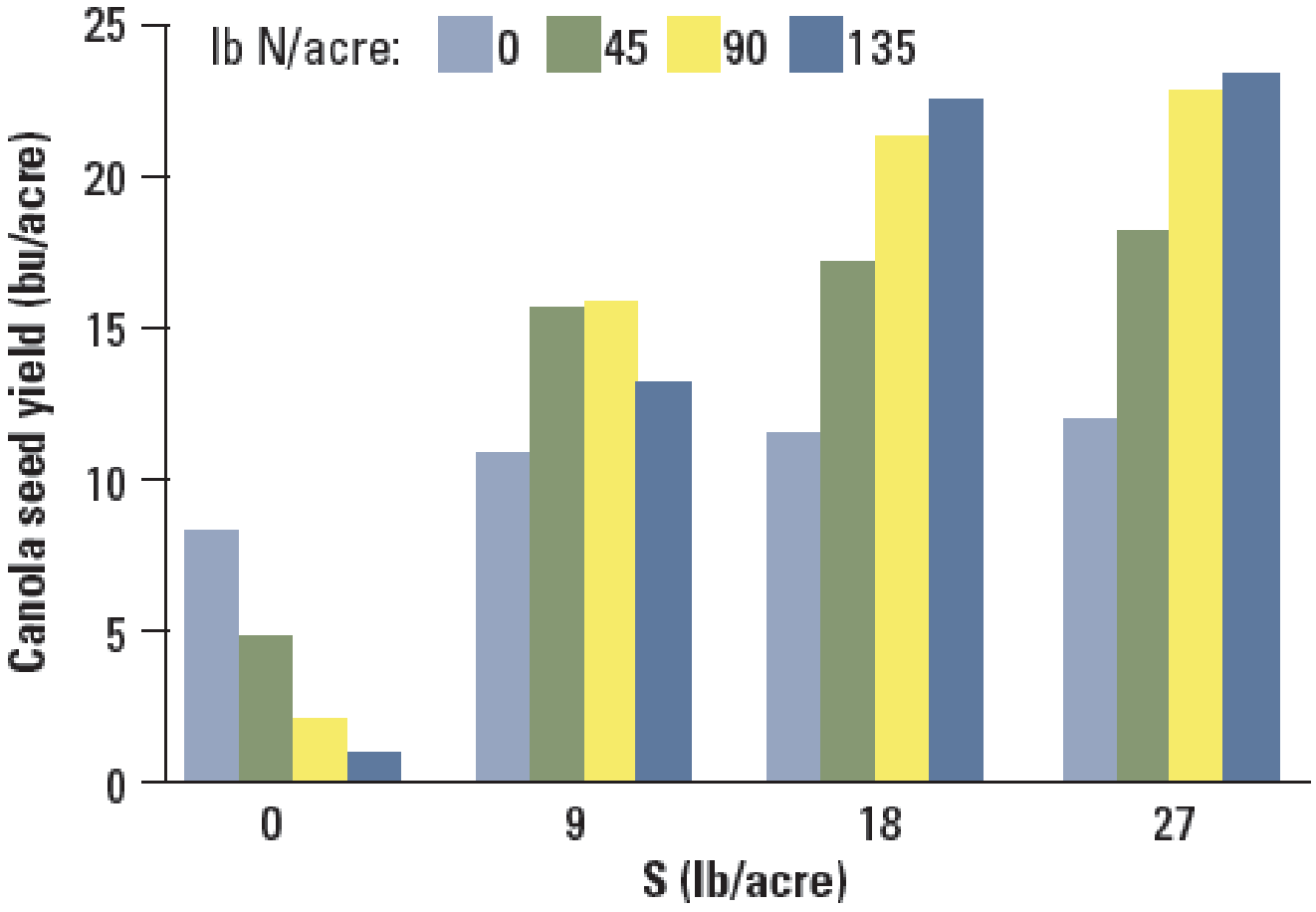
- SOM: 15 – 20 lb N/ac credit per % >2% (meaning adjust fertilizer down)
- After legume rotation:
  Adjust fert up or down?
  Legumes credit (add) N

Crop	N credit (lb N/acre)
Pulse grain 1-2 x	~10
Pulse grain ≥ 3 x	~20
Pulse cover 1-2 x	20-30
Pulse cover ≥ 3 x	30-50
Alfalfa	35-100 lb N/ac

Example N rate calculations depending on previous crop

	Spring wheat	Grain pulse grown 1x	Legume cover crop grown 1x
Canola yield goal (bu/ac)	18	20	23
Total soil N recommended (bu/ac x 3.25 lb/bu)	58	65	75
Spring soil N (lb/ac)	20	35	50
N credit (lb/ac)	0	10	25
Fertilizer N (lb/ac)	**38**	**20**	**0**

Canola can only respond to N if S is not limiting; meaning S INCREASES EFFICIENCY of N FERTILIZER



Tissue N:S of 7:1 only helpful if both are deficient, otherwise irrelevant

(Karamanos et al., 2007)

Open pollinated variety, N and S broadcast and incorporated just prior to seeding. Malhi et al., 2007 Western Canada

S for canola

S deficiency image by R. Karamanos

- Base S rate on field history, crop appearance, response to test strips, tissue & soil testing.
- S varies greatly across a field – but if <20 lb S/acre (to 2 ft. depth) then likely limiting
- 18-20 lb S broadcast at seeding
- 0.5 lb S/bu yield potential as 8-0-0-9, 21-0-0-24, or 12-0-0-26 (amm thiosulfate) as an in-season rescue through rosette (Janzen and Bettany, 1984)

P and K guidelines depend on soil test levels and do not vary with yield potential. CAN be 'banked'

Banded P and K fertilizer guidelines

Olsen P (ppm)	P_2O_5 (lb/acre)
0	45
4	40
8	35
12	30
16	25
>16	0.9 lb P_2O_5/bu or NONE when costs high

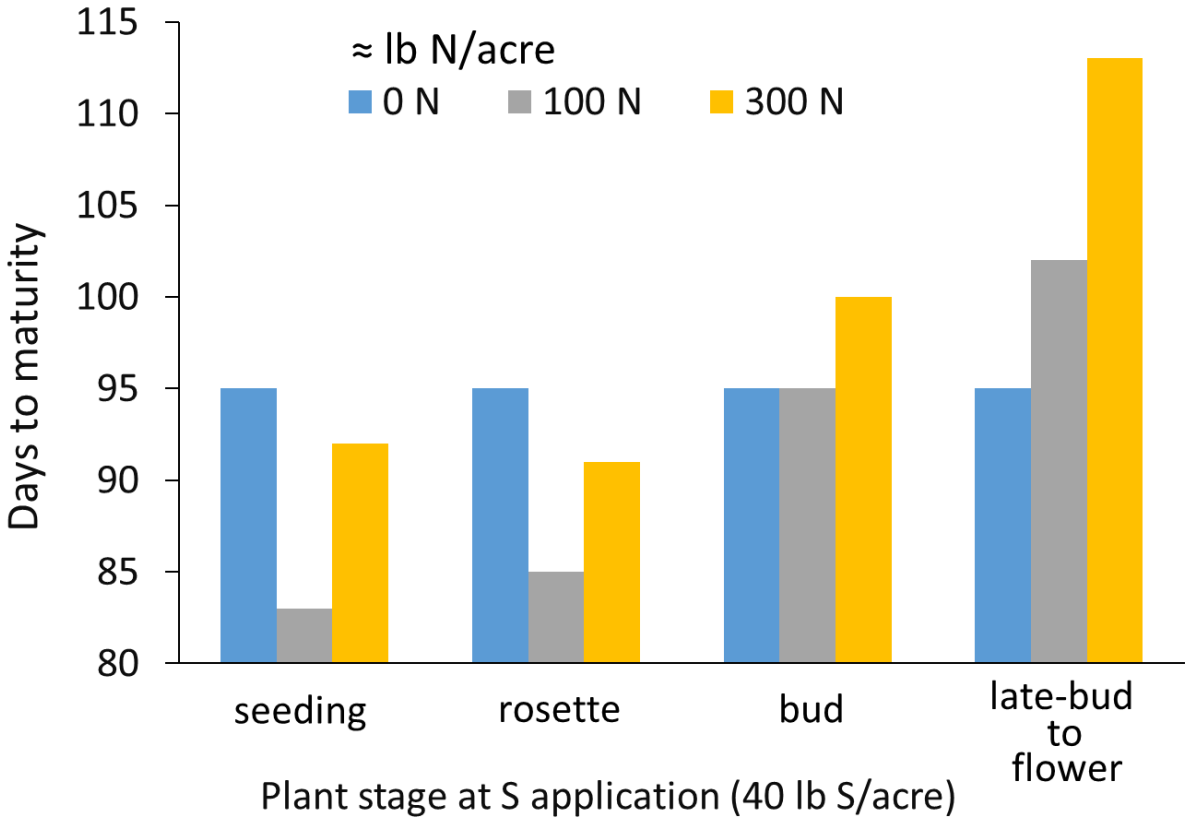
K (ppm)	K_2O (lb/acre)
0	45
50	40
100	35
150	30
200	25
250	20
> 250	0.5 lb K_2O/bu or NONE when costs high

More P needed if surface broadcast, especially at low soil levels

Application rates depend on source, placement and timing (coming later)

Can N, P, and S affect canola maturity?

- Starter P important for an early start
- Excess N slows maturity, especially in dry years or with delayed seeding



- Sufficient S needed before elongation stage for earlier maturity, insufficient S extends flowering period

(Janzen & Bettany, 1984, greenhouse study)

Questions?

On to *Source*

N source

Select readily available N, e.g., urea (46-0-0) vs. 28-0-0 or 32-0-0 based on:

- $/lb N
- ease of application
- leaf burn potential
- seed-placed safety
- potential leaching or volatilization loss to the air

	***POTENTIAL* loss compared to urea**	
Source*	Volat.	Leaching
AN, CAN, AS	less	≈
UAN	less	≈
+NBPT (Agrotain, ContaiN, Arborite Ag)	less	≈
+nitrification inhibitor (Nserve, Instinct)	≈	less
Combo (SuperU)	less	less
Polymer coated (ESN)	less	less
Slow release (Nitamin)	≈	less?
* Examples given do not imply endorsement		

See *Crop and Fertilizer Management Practices to Minimize Nitrate Leaching* (MT201103AG) *Management to Minimize Nitrogen Fertilizer Volatilization* (EB0209)

S source and timing to benefit seed yield

	2-plus years prior	Prior crop	Fall	Spring, before or at seeding
Sulfate – on soil surface or incorporated				
Elemental-S incorporated				
Rapid release elemental-S				

 ideal  not ideal but may benefit yield  not recommended

P source

- MAP vs liquids: base on $/lb P_2O_5, ease of application
- Animal manure: excellent source of P, K, micros. More P and K relative to N than plants need. Concentrations vary, beware of herbicide residue.

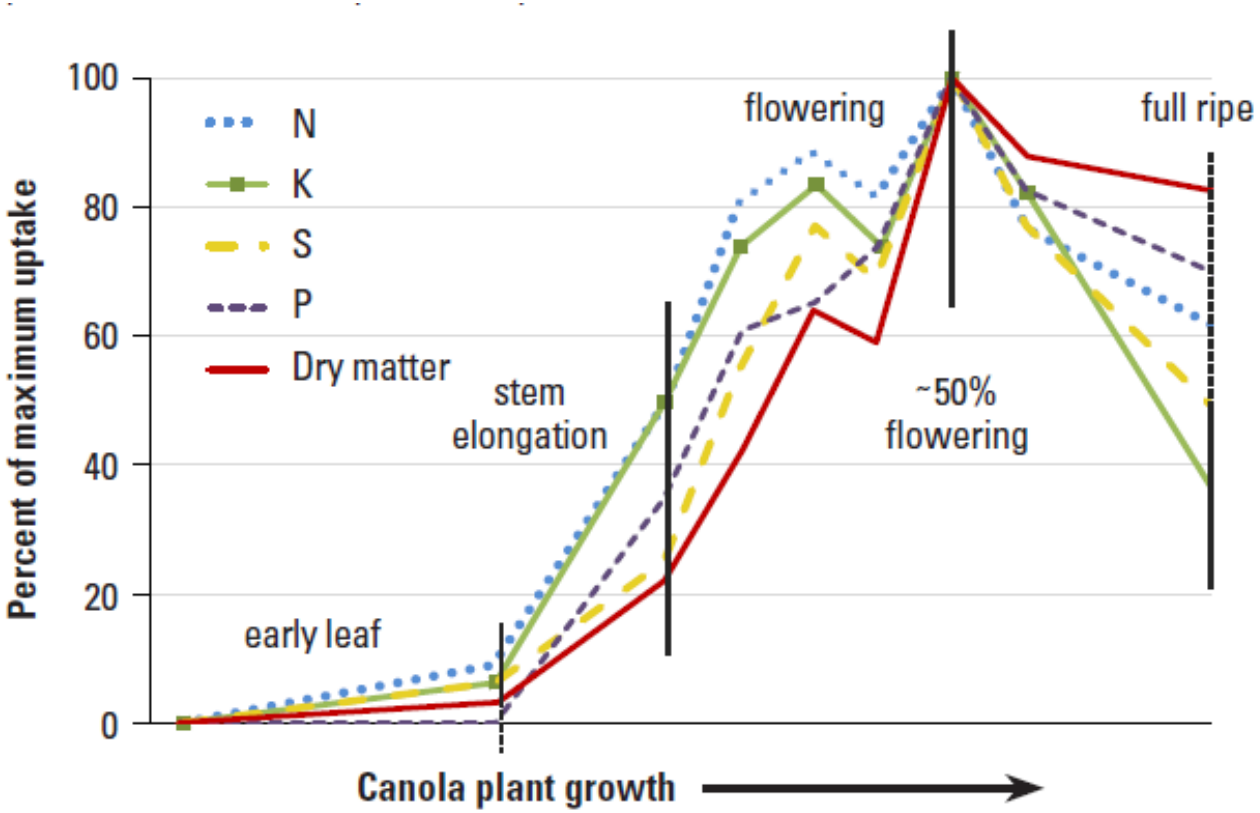
Questions?

On to *Timing and Placement*

Application timing – depends on source. Fertilizer needs to become 'plant available' but not be lost from system.

N: Ideally split application, 50 to 65% of N at seeding, remainder adjusted to current production potential by 5- to 6-leaf stage.

S: Rescue broadcast or foliar up to early flowering, followed by rain/irrigation. Foliar after 5th leaf emergence to minimize leaf burn.

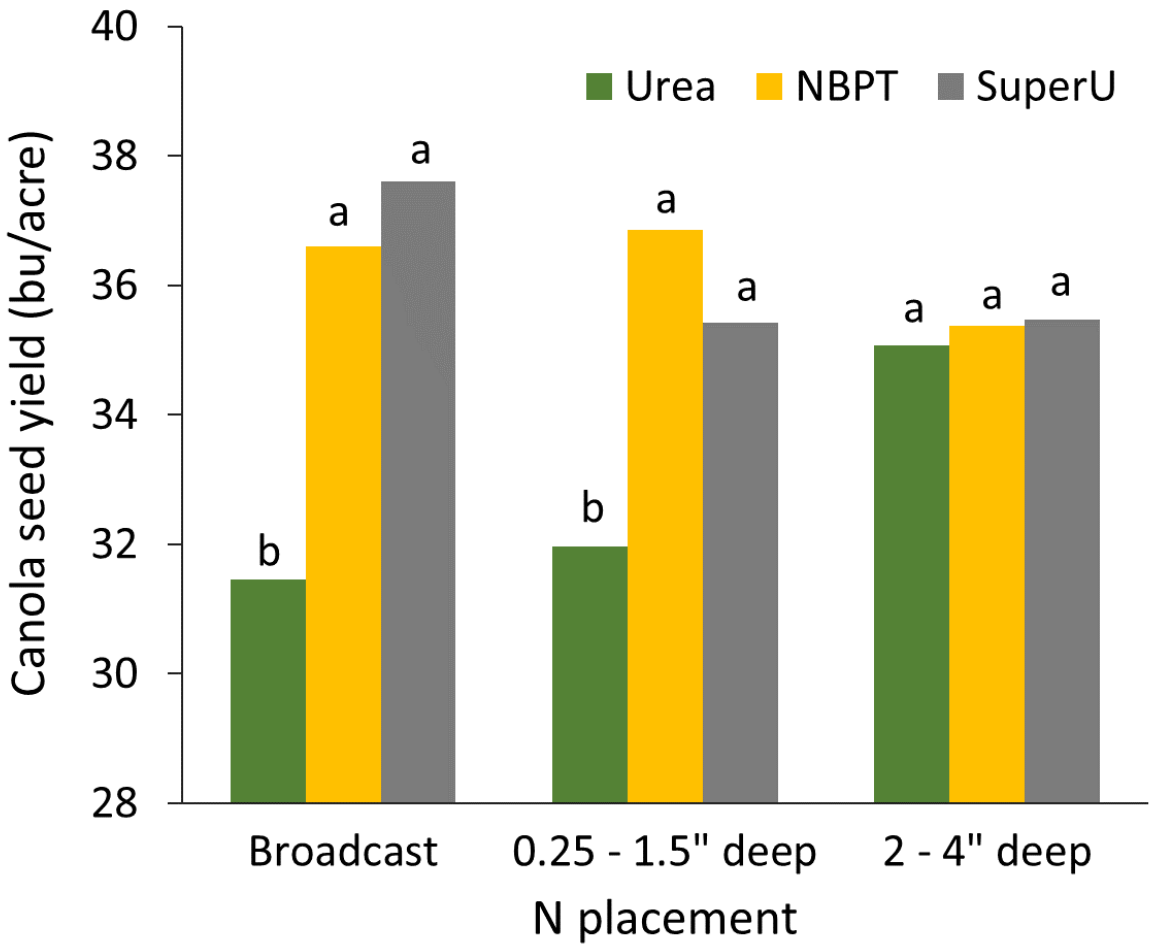


P and K: before or at seeding

Karamanos 2013

Placement: N

- side or pre-plant band >2” deep prior to packing
- early-spring broadcast with incorporation
- if seeder can’t place N deep, consider a product with NBPT
- 28-0-0, 32-0-0 better subsurface than surface band



Dick, Nebo, Holzapfel, Tenuta, unpub data
courtesy Karamanos
Western Canada

Placement: P and K

P: critical close to seedling roots in first 2-6 weeks

- Especially in cool or dry soil even if Olsen P > 16 ppm, 10-15 lb P_2O_5/acre seed placed or side band
- If more P required – sub-surface side band next to seed, broadcast incorporate before seeding, build with prior crop

K: best to broadcast and save P for seed row

Micronutrients

- A combination of deficiency symptoms, soil testing, and tissue testing may be best approach at identifying deficiencies. This is NOT an exact science.
- Micronutrient deficiencies are exception, not rule
- Cool wet conditions cause deficiency – likely disappear when weather warms
- Too much of some micros can hurt yield more than not enough
- The main challenge is even distribution of a very small quantity – consider foliar options, but likely can't apply enough to correct severe deficiencies

Summary

- Use soil tests, which are MORE important after drought and when fertilizer costs high
- Ensure nutrients are available before stem elongation
- Adjust N in-season to reflect the growing season
- Need adequate S to ensure N response
- Seed-placed P promotes a healthy start
- Select appropriate timing & placement for given source
- Consider pulse crop before canola

For more information and this presentation see MSU Soil Fertility Website
http://landresources.montana.edu/soilfertility/

Soil Nutrient Management for Canola (EB0224) – under 'Extension publications'

Canola: Nitrogen & Sulfur Management and *Canola: P, K, & Micronutrient Management* – both under 'Soil Scoop'

Canola Council of Canada *Canola Encyclopedia*
http://www.canolacouncil.org/canola-encyclopedia/

Safe seed-placed fertilizer rate calculator: SDSU and IPNI Online Fertilizer Damage Tool
http://seed-damage-calculator.herokuapp.com/

THANK YOU!

QUESTIONS?

Image by K. Olson-Rutz