Plant Nutrient Uptake Timing and Enhanced Efficiency Fertilizers

Cabin Fever, Havre

January 8, 2010

by Clain Jones, Extension Soil Fertility Specialist
and Kathrin Olson-Rutz, Research Associate
clainj@montana.edu; 994-6076

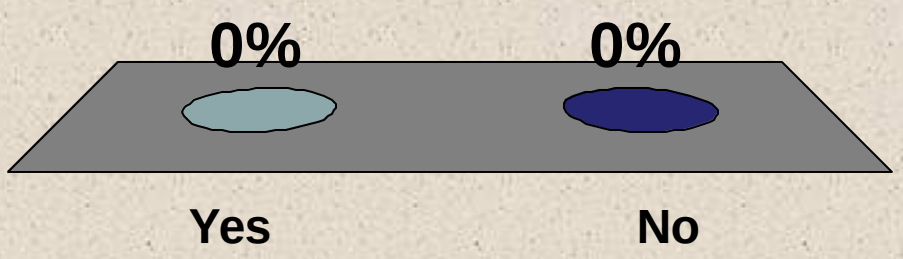
MONTANA STATE UNIVERSITY EXTENSION

AGRICULTURE

MAKING A DIFFERENCE IN MONTANA COMMUNITIES

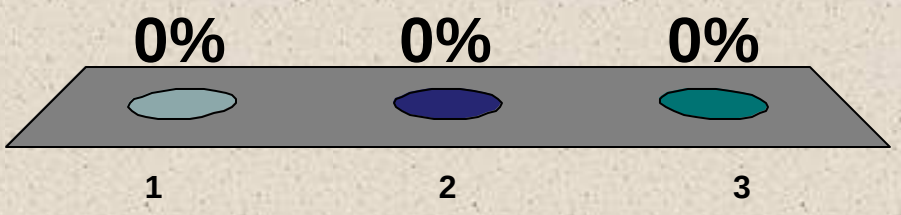
Have you used a clicker system in a presentation before today?

1. Yes
2. No



How often do you or your clients apply a N source (e.g. urea, manure, etc.) to a typical crop?

1. I don’t apply or recommend N
2. Once per year
3. More than once (e.g. at seeding and then topdress)

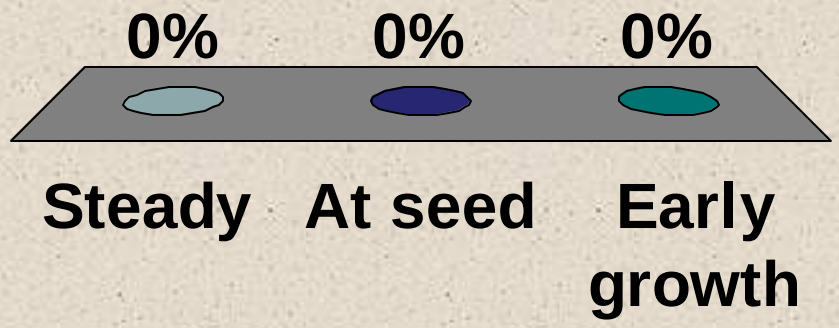


Objectives

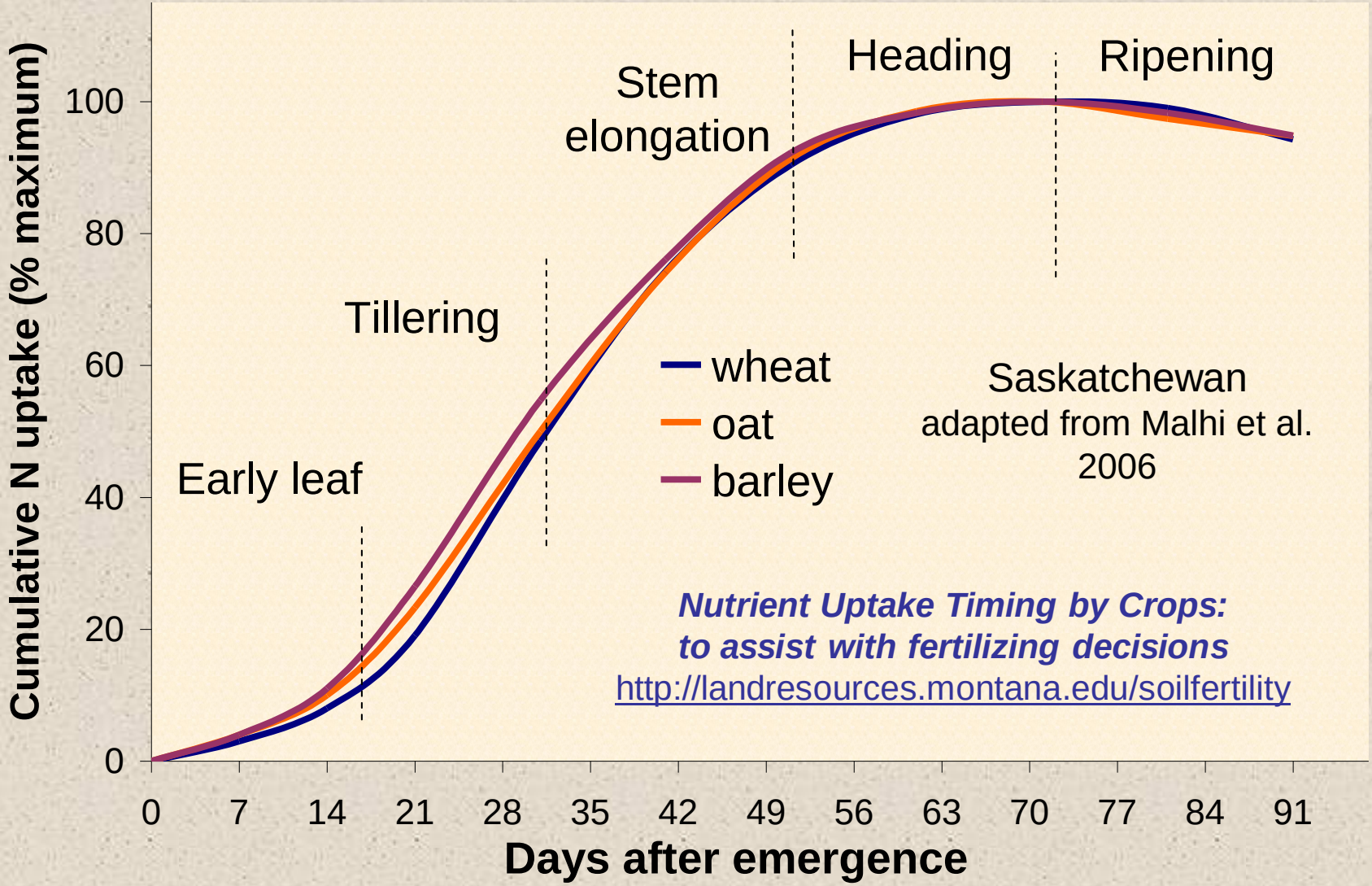
- Illustrate crop nutrient uptake patterns
- Present fertilizer management options to better match uptake
- Explain pros and cons of enhanced efficiency fertilizers

What do you think best describes plant nutrient uptake through the season?

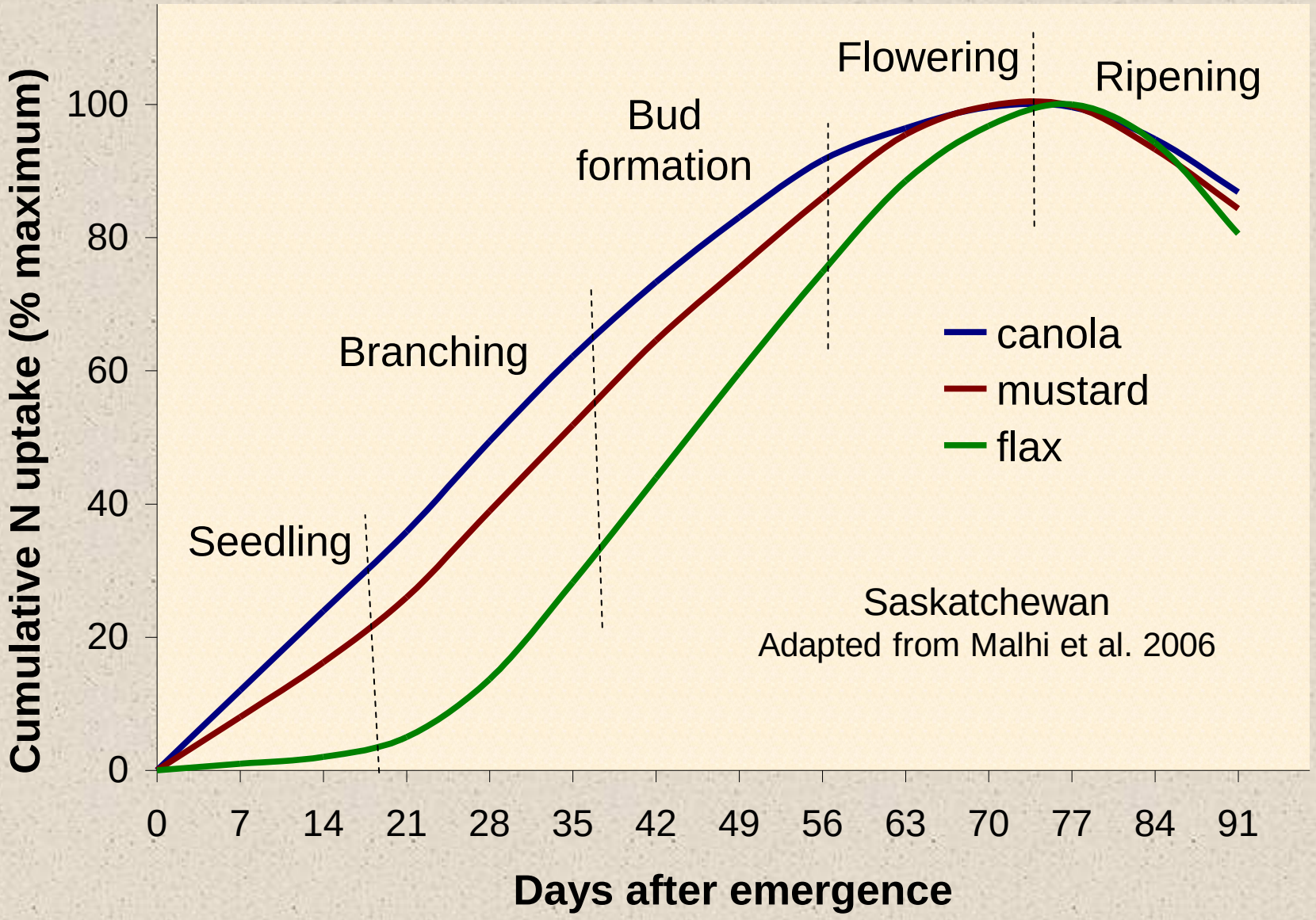
1. A steady rate throughout the season
2. Highest uptake during seed set/or ripening
3. Highest rates during early growth stages of tillering/branching



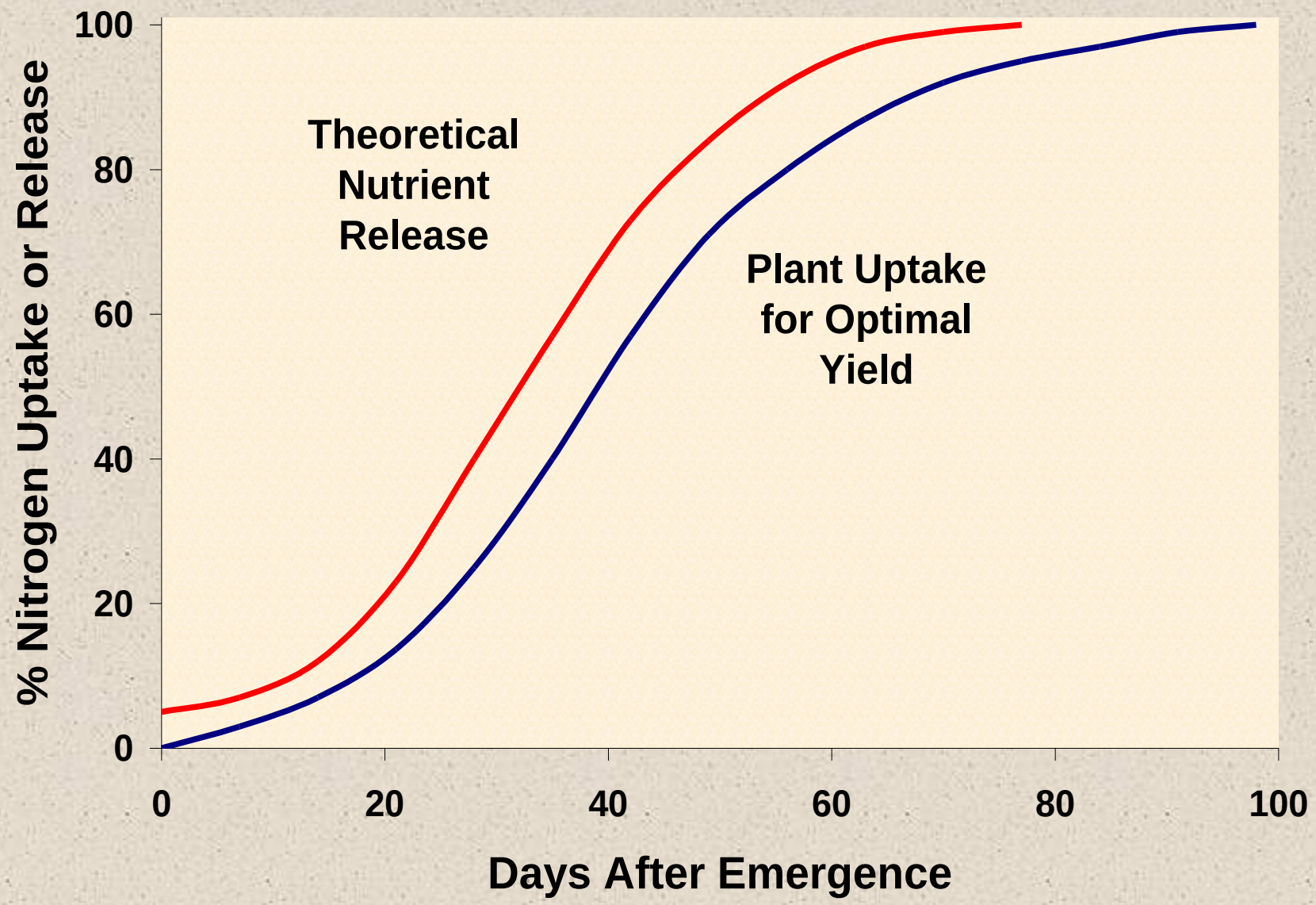
Cumulative N uptake by small grains



N uptake by oil seed crops

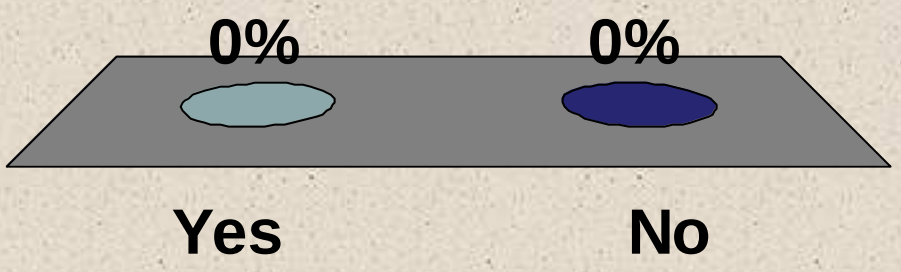


Nutrient availability from ideal fertilizer

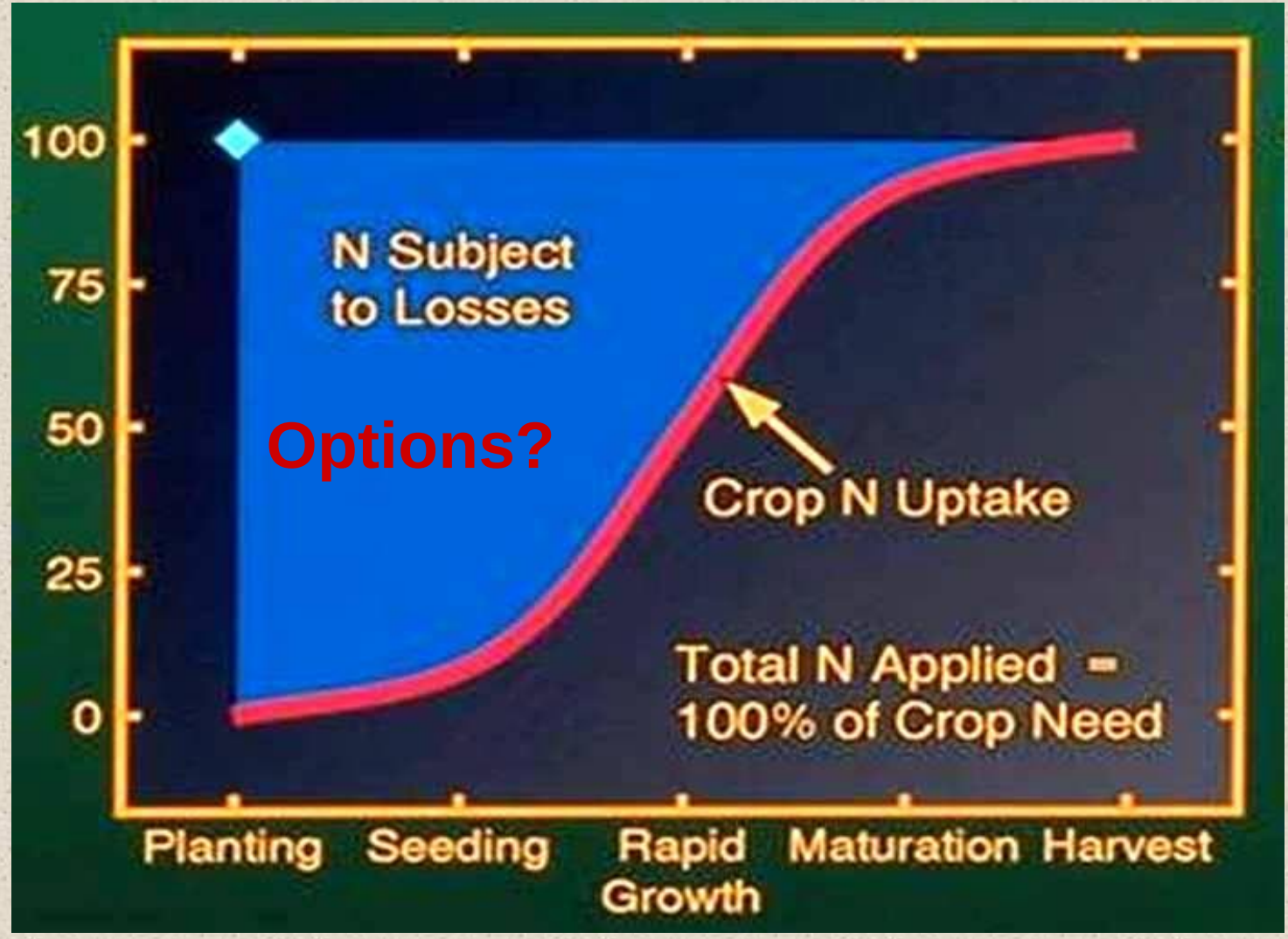


Do you think release of conventional urea or UAN matches plant nutrient uptake?

1. Yes
2. No



Single application of conventional fertilizer

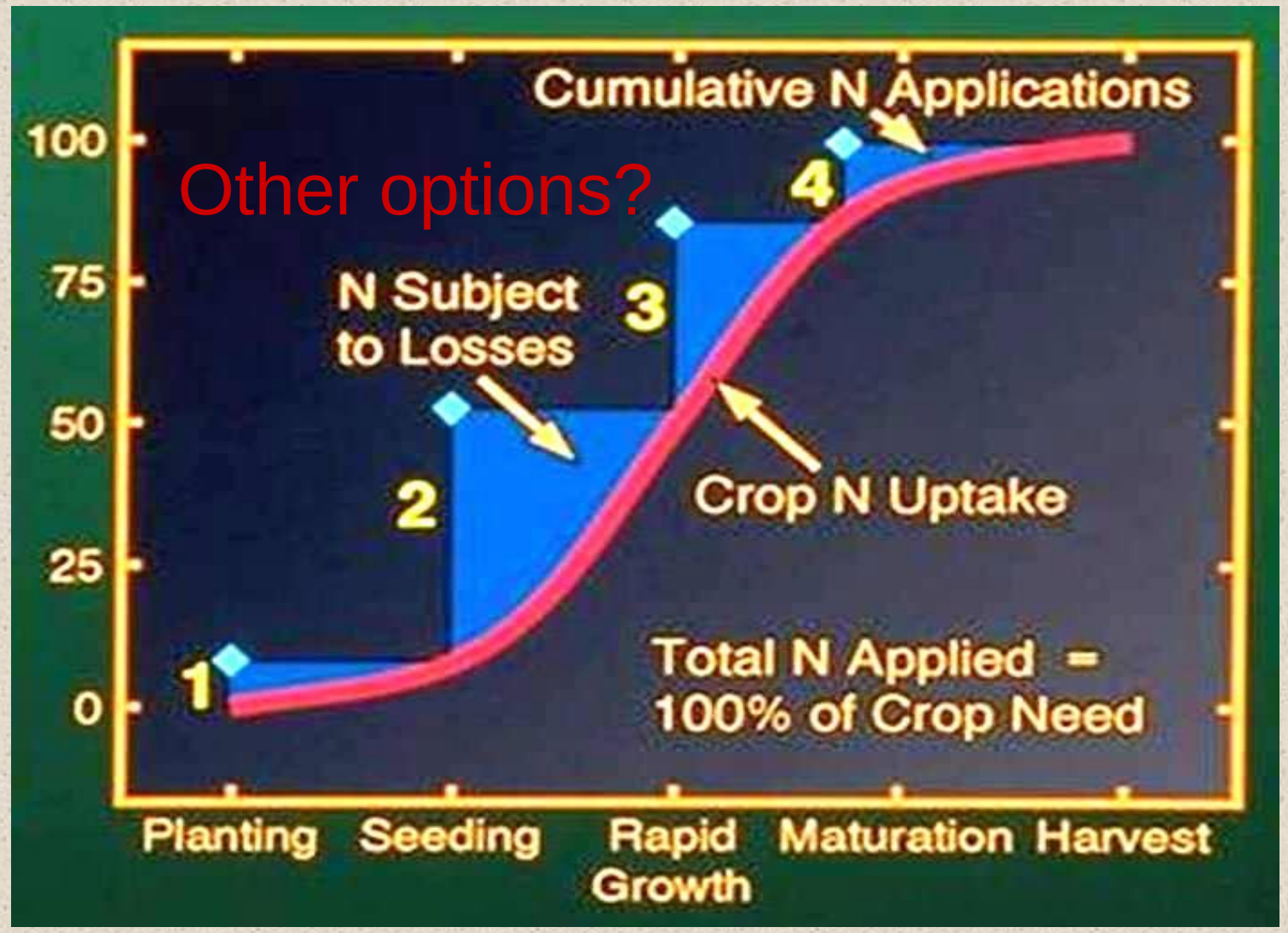


Modified from HortTechnology. 9(4): 603.

How can you better match N release to reduce potential losses and increase yield?

- Use split application (pre-plant and topdress)
- Use an “enhanced efficiency fertilizer”

Reduction of potential N loss through split applications



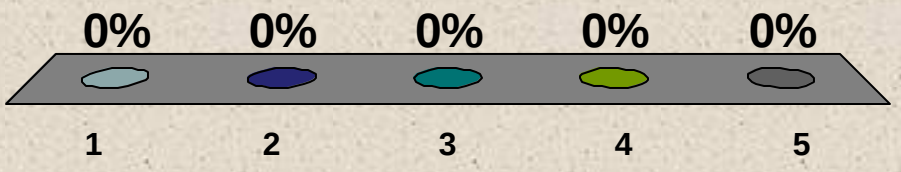
Modified from HortTechnology. 9(4): 603.

Enhanced Efficiency Fertilizers EEFs

- Specialized fertilizers designed to:
  - Increase fertilizer availability
  - Decrease fertilizer losses
- 3 major methods of action
  - Stabilized - alter soil microbial or enzymatic reactions
  - Slow release - have additives which require chemical or biological decomposition to release nutrients
  - Controlled release - a semipermiable coating, usually a polymer, regulates release

What is your experience with EEFs?

1. Never heard of them
2. Heard of them but never used or recommended
3. Have used once
4. Have used more than once
5. Have recommended their use



Stabilized Urease Inhibitors

N_2 and N_2O

Plant Uptake

Volatilization

Plant Uptake

Denitrification

NH_3

NO_3^-

Nitrification

NO_2^-

Leaching

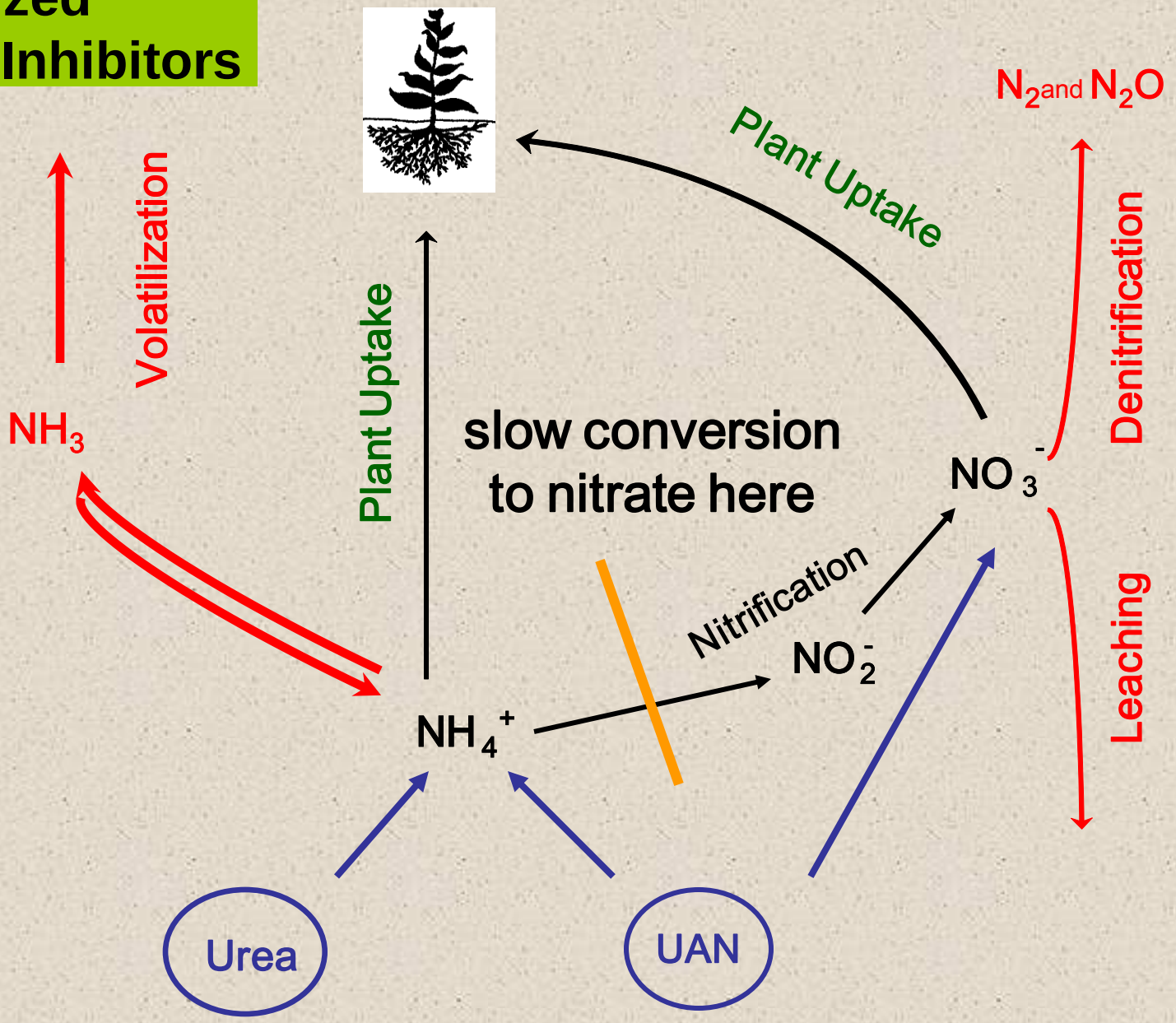
slow urea hydrolysis here, most common is NBPT

NH_4^+

Urea

UAN

Stabilized Nitrification Inhibitors



Slow and Controlled Release

N_2 and N_2O

Plant Uptake

Volatilization

Plant Uptake

Denitrification

NH_3

NO_3^-

Nitrification

NO_2^-

Leaching

NH_4^+

Urea

UAN

Slow/control release here

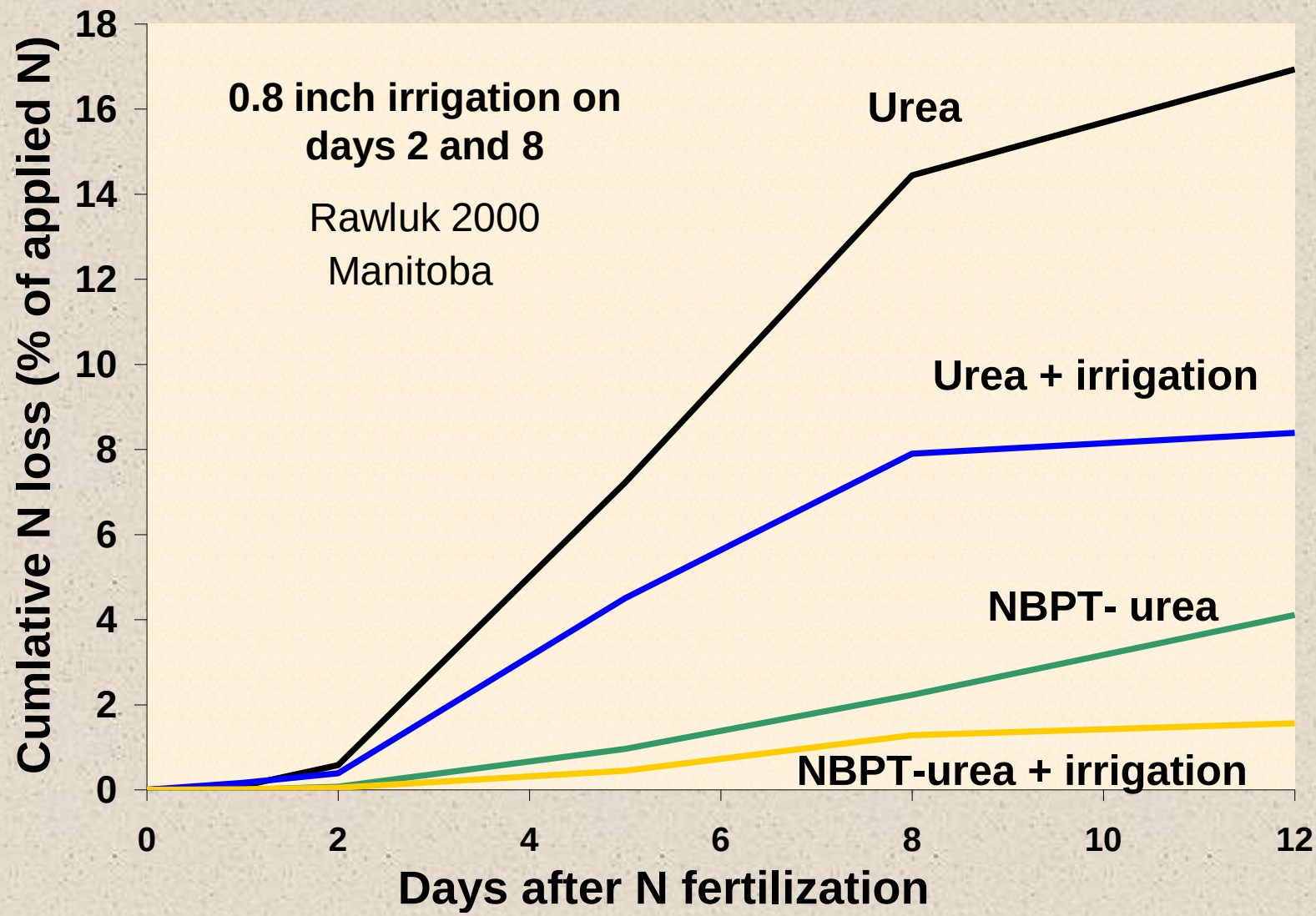
Questions?

Under what growing conditions would you expect EEFs to work better?

- High potential volatilization loss
  - **coarse soils**
  - **moist surface**
  - **warm temps**
  - **long time between application and incorporation**

- High potential leaching
  - **coarse soils**
  - **high moisture content/irrigation/rainfall**

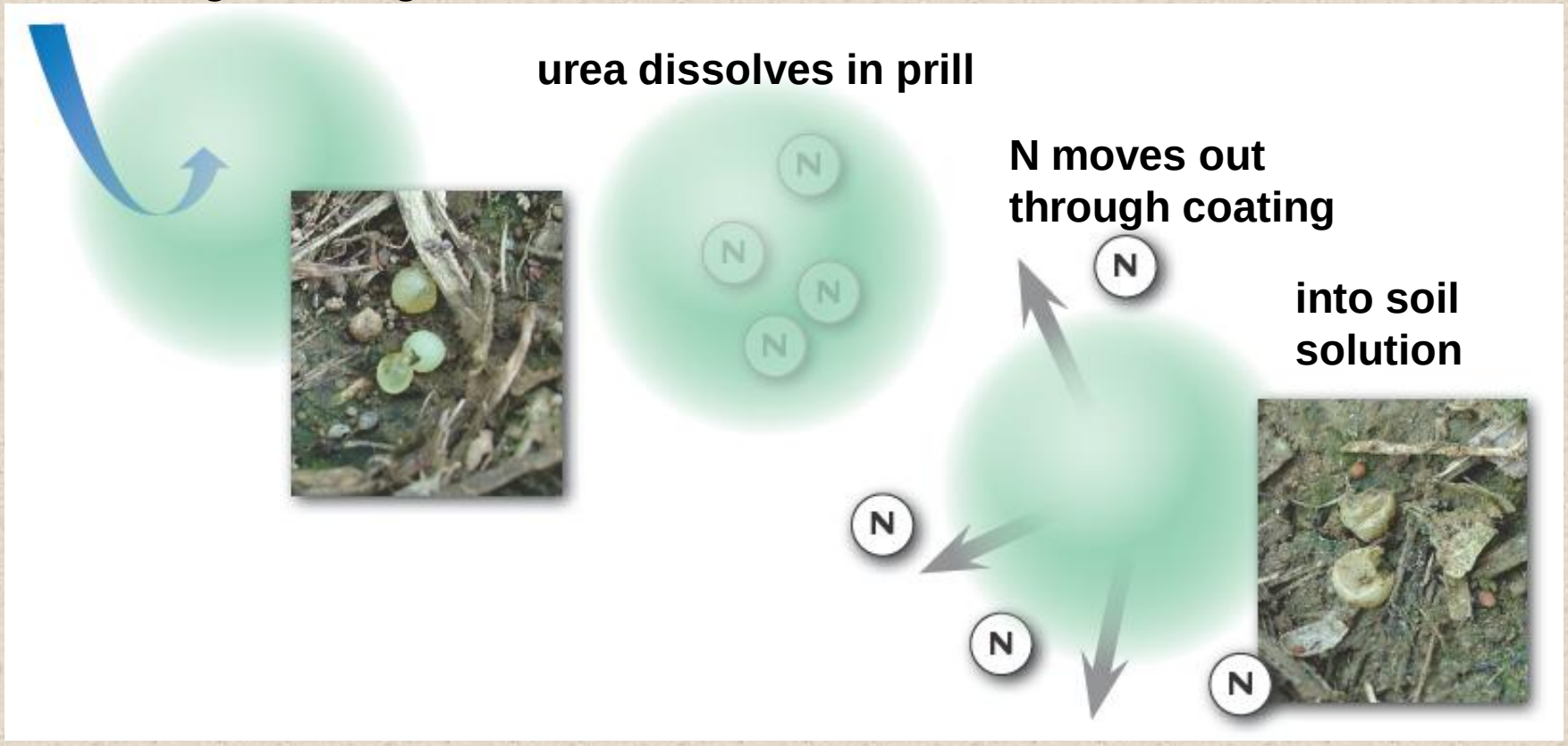
Effect of irrigation and NBPT on volatilization



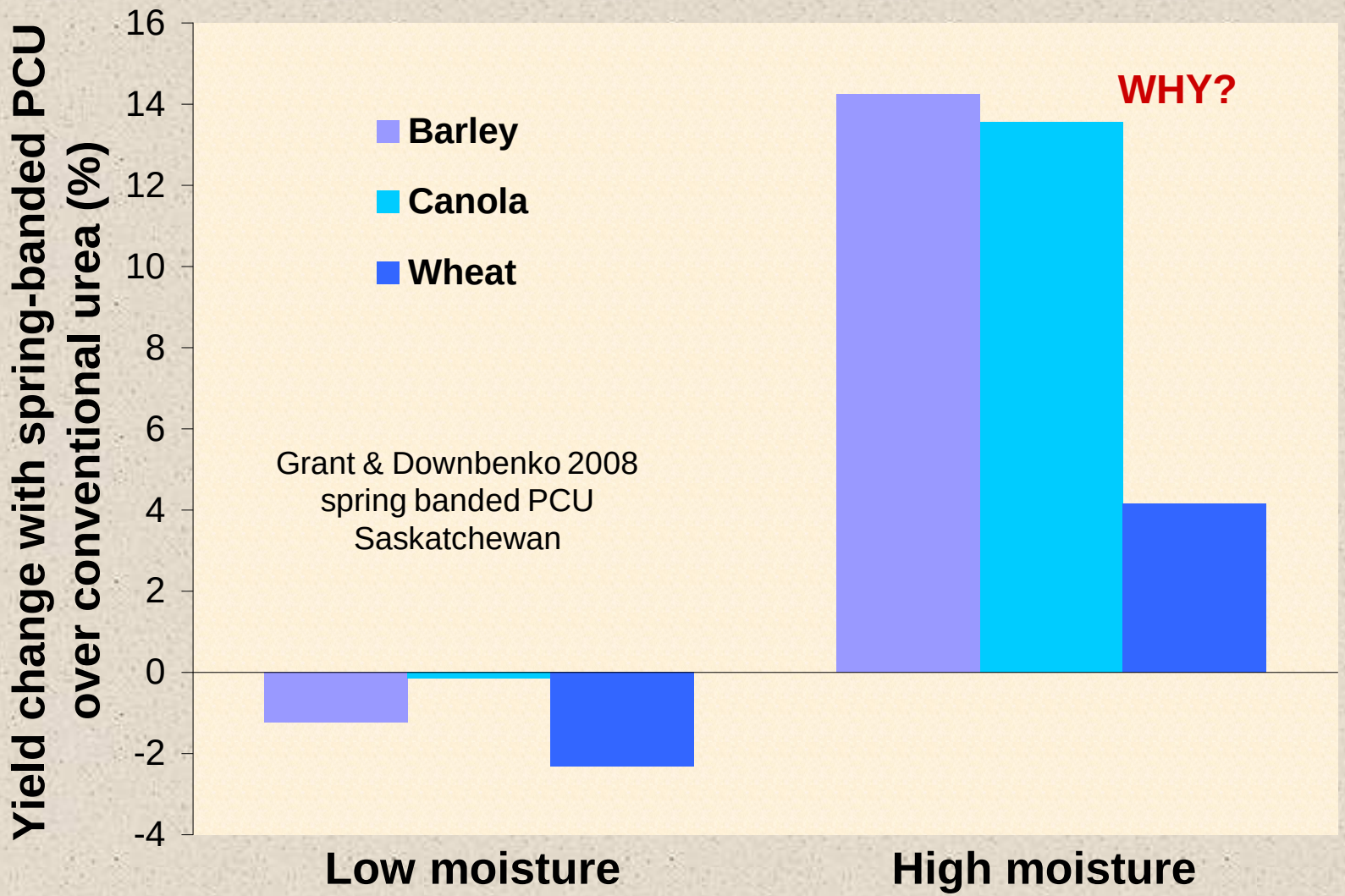
NBPT uses

- Can minimize urea volatilization for up to 14 days
- ‘Buys’ time for rainfall, irrigation or mechanical incorporation to protect urea
- Warm weather top-dressing
- Cool weather broadcast

N release by polymer-coated fertilizers



Effects of over-winter moisture conditions on effectiveness of PCU

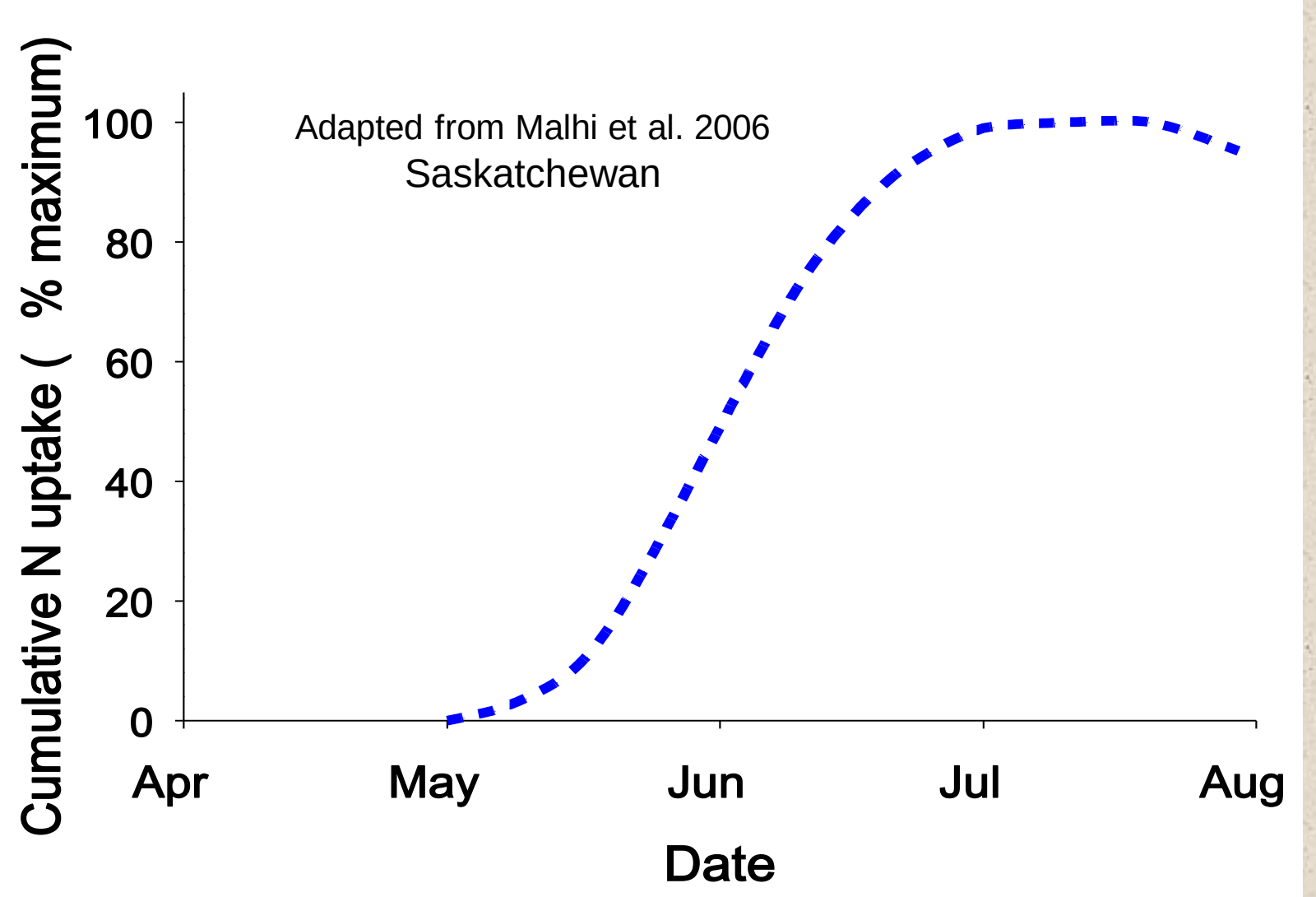


What type of crops would you expect slow release to work better?

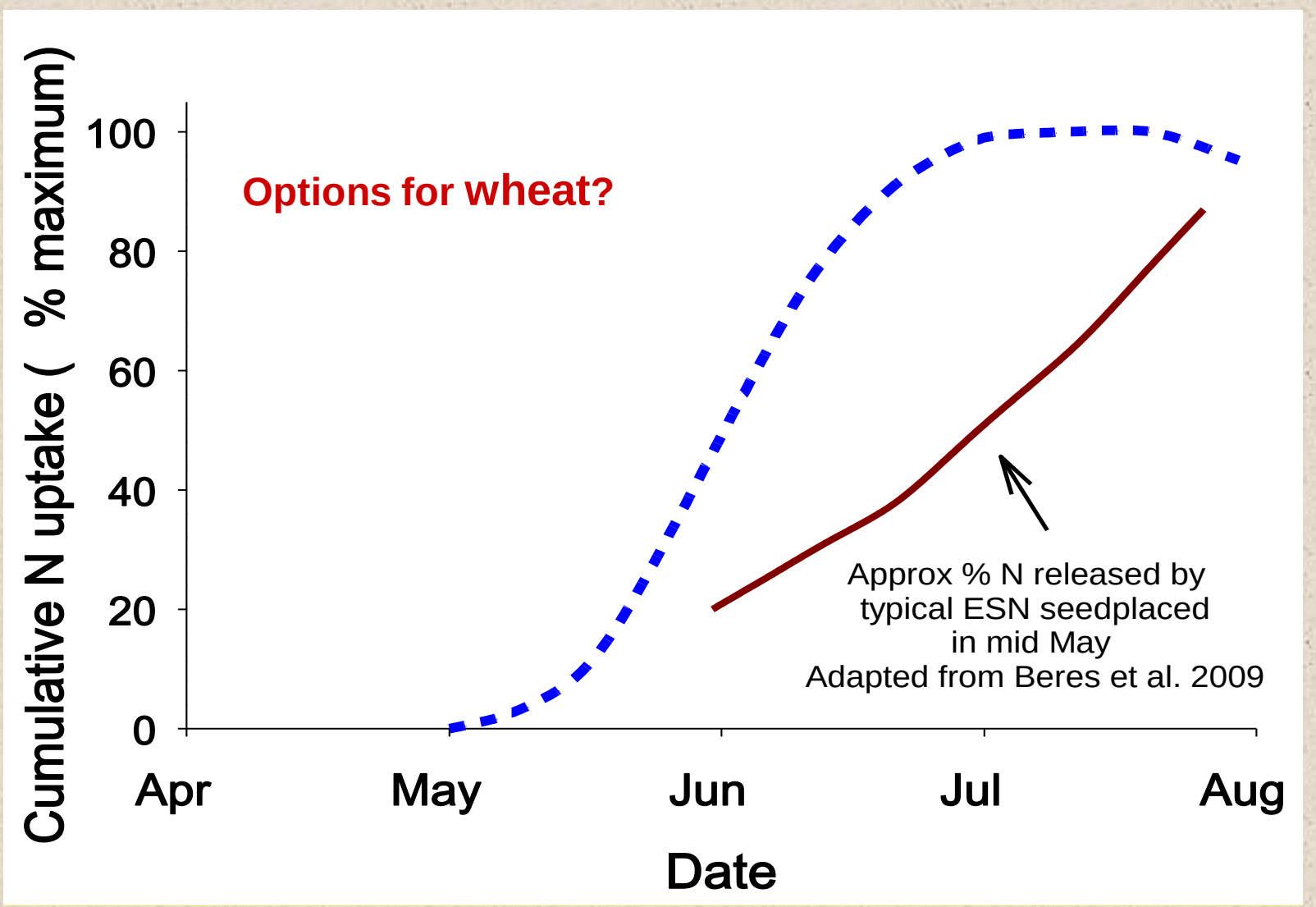
- Irrigated
- Warm season

What about dryland cool season crops?

Timing of N uptake by spring wheat in Prairie Provinces



Timing of N uptake by spring wheat in Prairie Provinces and ESN® N release



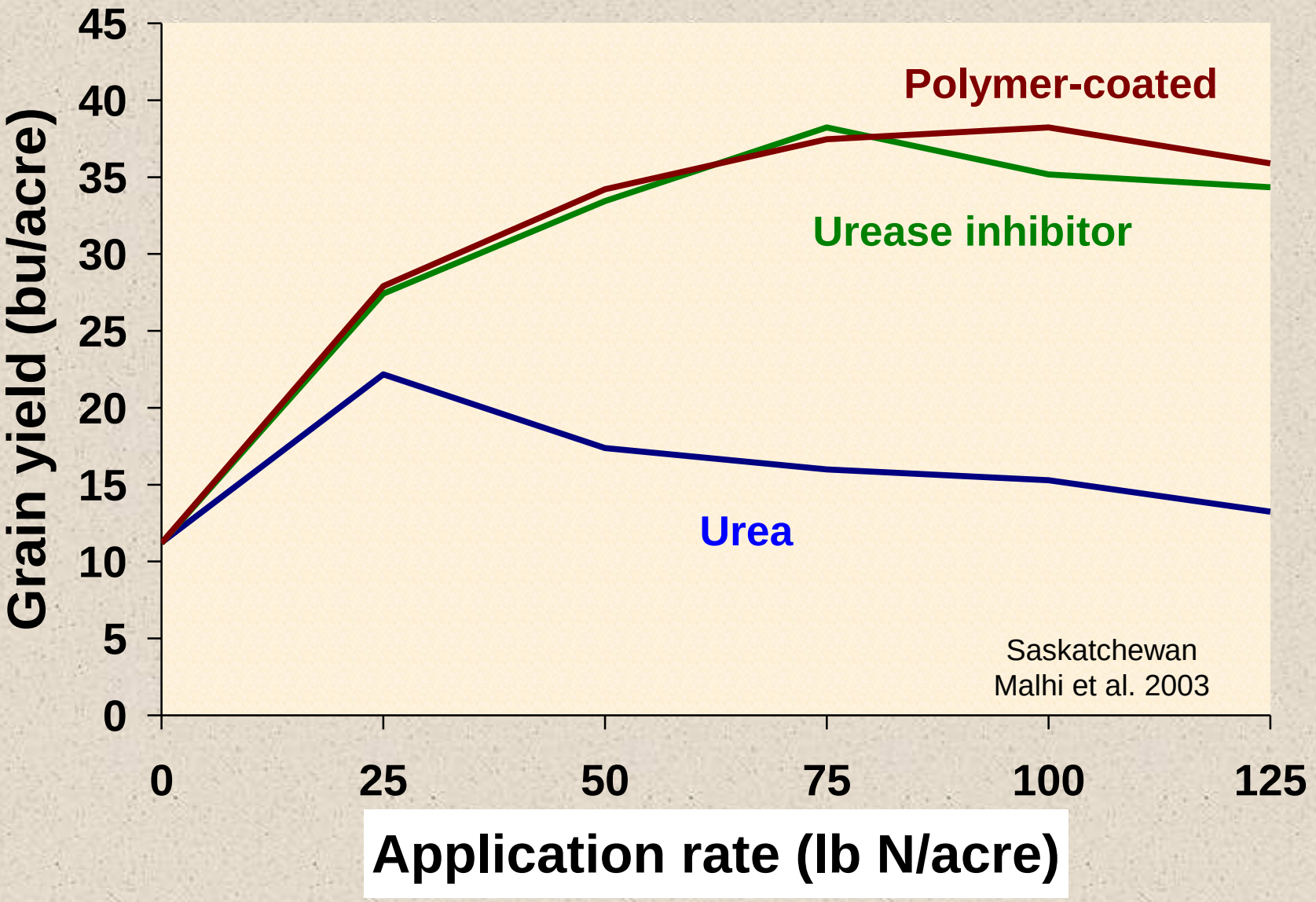
How does PCU work for small grains?

- Fall/winter pre-plant works well. PCU is in soil long enough to dissolve in time for plant need.
- Late winter/spring broadcast PCU does not - may dry out, release is too slow.
- Incorporation is important, especially late winter/spring.
- Blending is recommended with late winter/spring surface applied PCU.

Seed placing EEFs

- Can apply ~ 2 – 4x as much slow release product as urea directly with small grain seeds
- Saves on field passes – fuel, labor, soil disturbance

Effect of N source applied with the seed on dryland spring wheat yield



How to manage PCUs

- Apply several weeks before peak crop demand
- Incorporate into the soil or seed place
- Blend with conventional fertilizer
- Adjust rates, blends and application timing for handling abrasion

Foliar application

- Some N can be absorbed through leaves
- However, most foliar applied N ends up being washed off and taken up by roots:

  Only 8-11% of foliar applied liquid urea was taken up by leaves, whereas 37-67% of soil-applied N was taken up by plant in same study (Rawluk et al., 2000).
- Risk of burn?

Timing

- Yield and quality are affected by timing
- Because urea may take days to weeks to become available, urea should be applied earlier than AN historically was for fast green-up (AN simply dissolves, UR requires a chemical reaction to become available).

Timing, continued

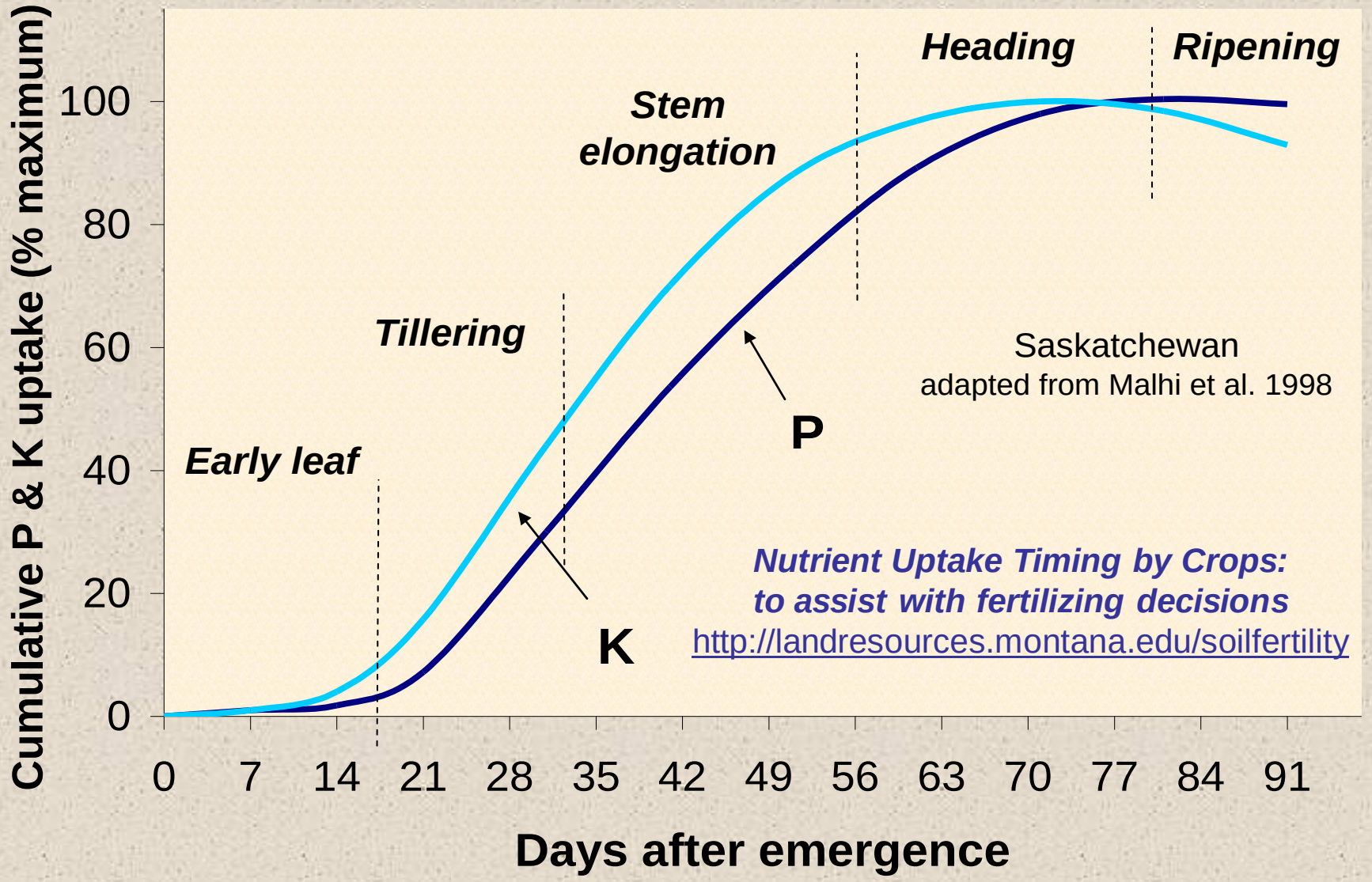
- Fall vs Spring

  Generally better to apply near peak uptake to avoid losses (volatilization, denitrification, leaching, immobilization). However, weather conditions (temp., precip.) in first few days after application combined with soil texture may be more important.

1. Ex: Shallow, coarse soil. Fall or Spring?
2. Ex: Cool Fall temps with large rainstorm predicted. Fall or Spring?

Questions on N?

Cumulative P and K uptake by small grains



P and K fertilization considerations

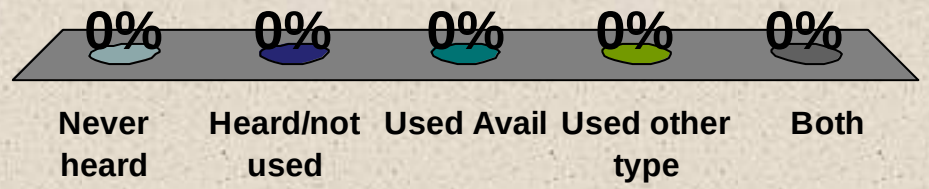
- P and K are not readily lost from the system, so they can be:
  - Placed with seed or banded early in season to ensure availability
  - Built up over time in the soil
- P and K bind strongly to soil surface so less effective topdressed than N

Phosphorus EEF

- Types
  - Polymer coated
  - Avail® which reduces the rate of P mineral formation
- Limited regional research
  - Soil P levels often above critical

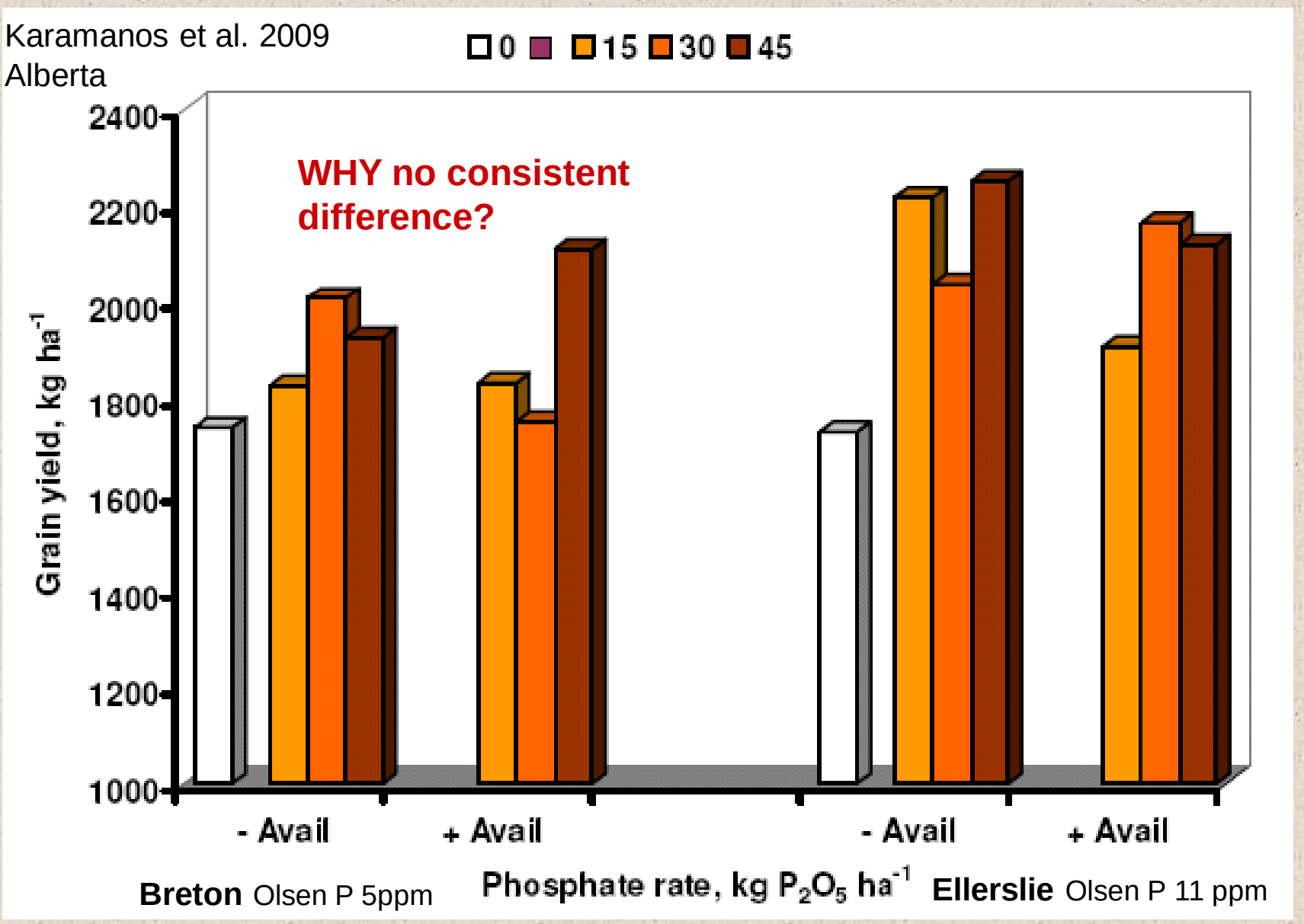
What is your experience with P EEF?

1. **Never heard of**
2. **Heard of but not used or recommended**
3. **Have used or recommended Avail®**
4. **Have used or recommended other type**
5. **Have used or recommended Avail ® and other type**



Wheat response to P and Avail®

Karamanos et al. 2009
Alberta



Potential limitations of Avail®

- Mechanism may have difficulty in highly calcareous soils
- Existing soil properties may outweigh product ability

Ex: 100 lb MAP with Avail® contains < 0.25 lb of organic acids – the active ingredient

Organic acids occur naturally in soil, and are elevated in the root zone

Questions on P or K?

Conclusions

- Crops' highest rates of N, P and K uptake are during tillering and branching.
- N, P and K must be available early in growing season for optimal production.
- If all the needed N is applied at seeding there is higher potential for N loss.
- Options are to split applications or use EEFs
- P and K have lower loss potential and should be seed placed, banded, or built up in the soil

Conclusions

- Improved EEFs and blending with conventional fertilizer may provide a good match between crop uptake and fertilizer availability.
- More EEF can be placed with the seed than conventional fertilizer, possibly saving a fertilizer pass and fuel costs.
- EEFs can reduce losses to the environment and are an NRCS CSP enhancement for this reason.

Additional info in:

Nutrient Uptake Timing by Crops (EB0191)

Enhanced Efficiency Fertilizers (EB0188)

http://landresources.montana.edu/soilfertility

Go to Fertilizer Information


Questions?
Watrous, SK, 1920's