Fertility Recommendations for Irrigated Wheat, Corn, Malt Barley, and Dry Bean

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MONTANA STATE UNIVERSITY EXTENSION

Goals today

1. Present the effects of
   - fertilizer source
   - rate
   - placement and
   - timing

   on irrigated crop yield and quality
2. Discuss interactions between these four factors

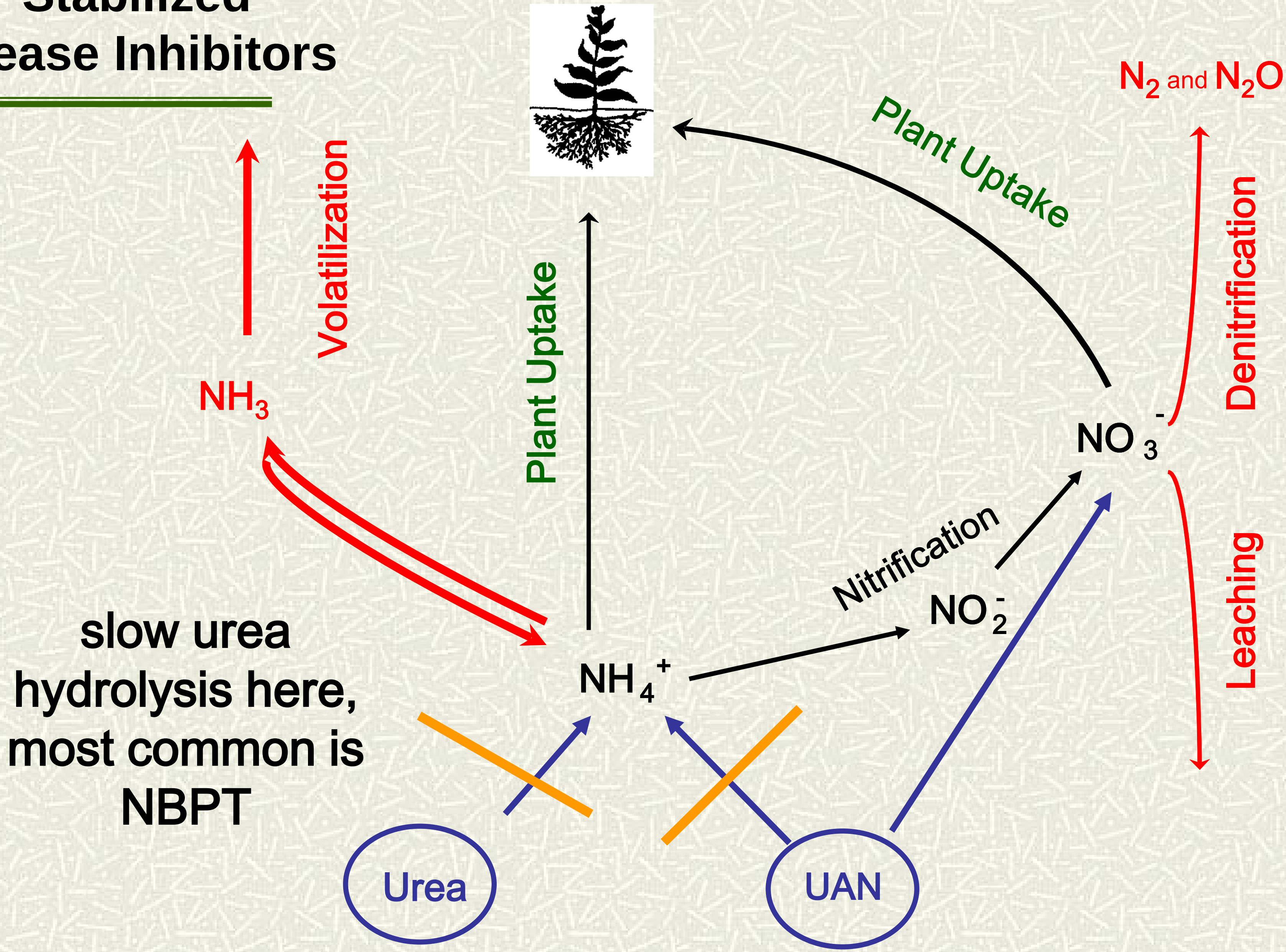
Source

- Conventional vs ‘enhanced efficiency fertilizer’
- MAP (11 52 0) vs DAP (18 46 0); Urea vs Ammonium Sulfate
- Solid vs liquid

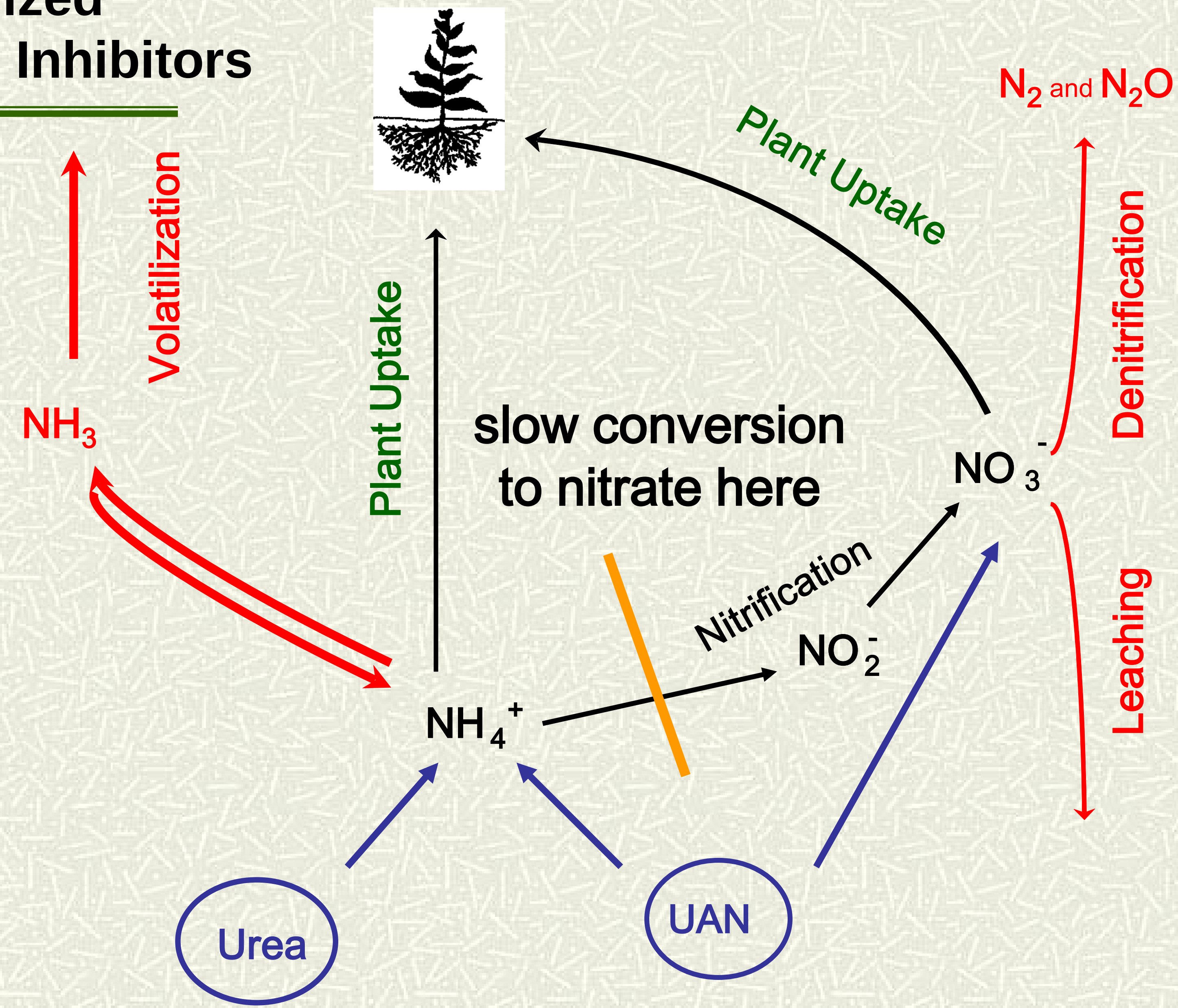
Enhanced Efficiency Fertilizers EEFs

- Any fertilizer 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 semi-permeable coating, usually a polymer, regulates release
- Most of these products are N fertilizers

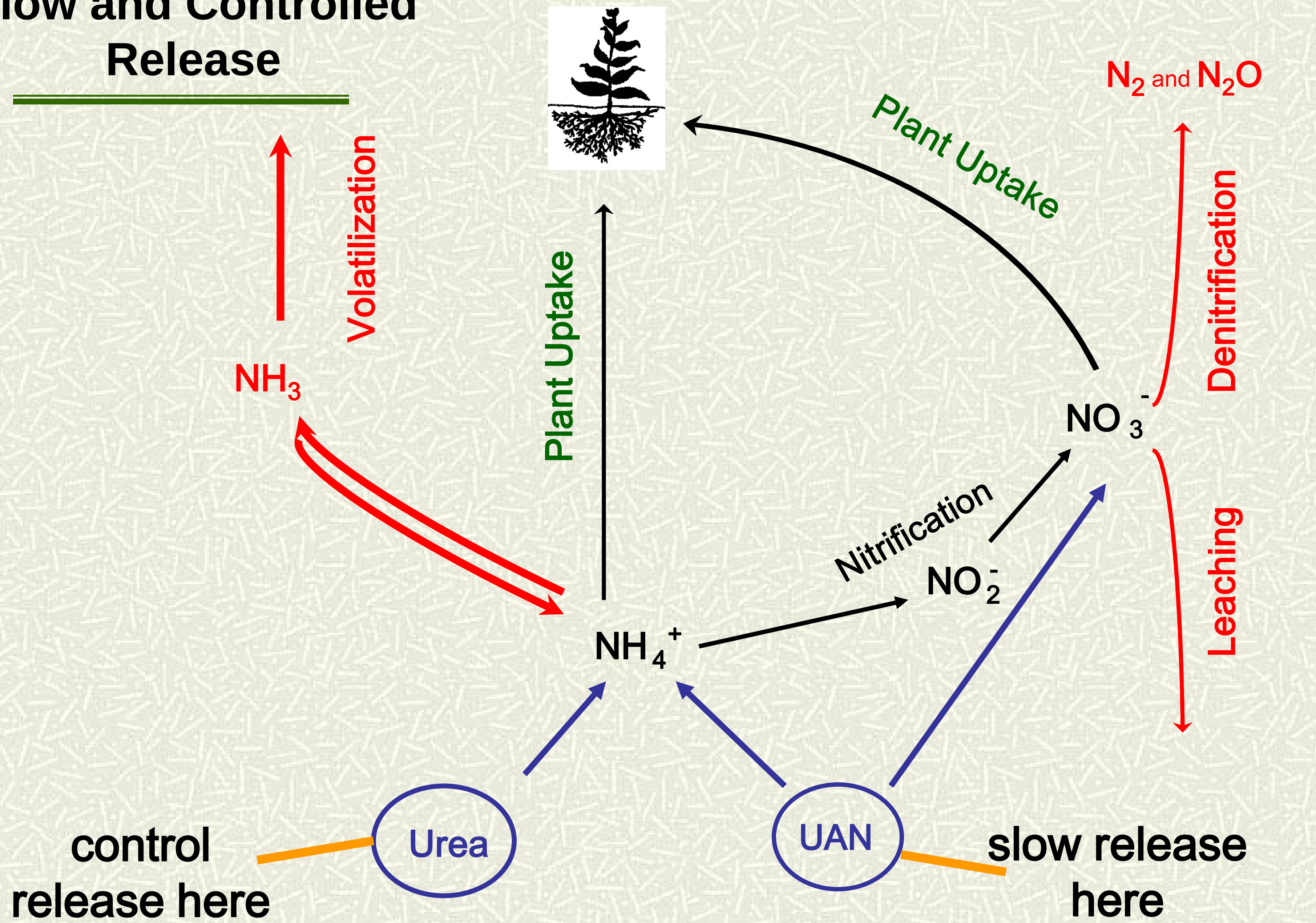
Stabilized Urease Inhibitors



Stabilized Nitrification Inhibitors



Slow and Controlled Release



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

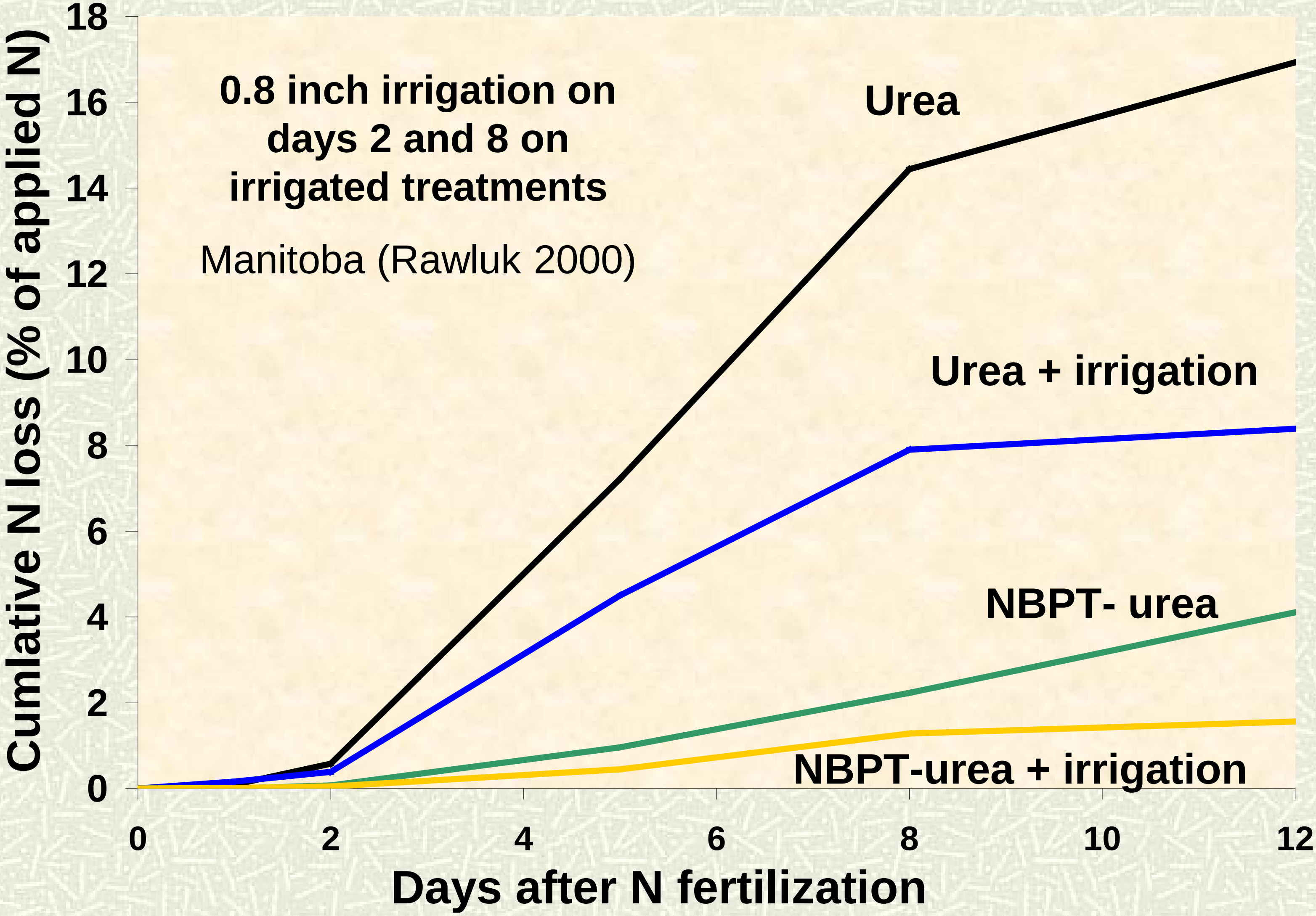
- High potential volatilization loss
  - **coarse soils**
  - **moist surface**
  - **warm temps**
  - **long time between application and incorporation (with tillage or irrigation)**

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

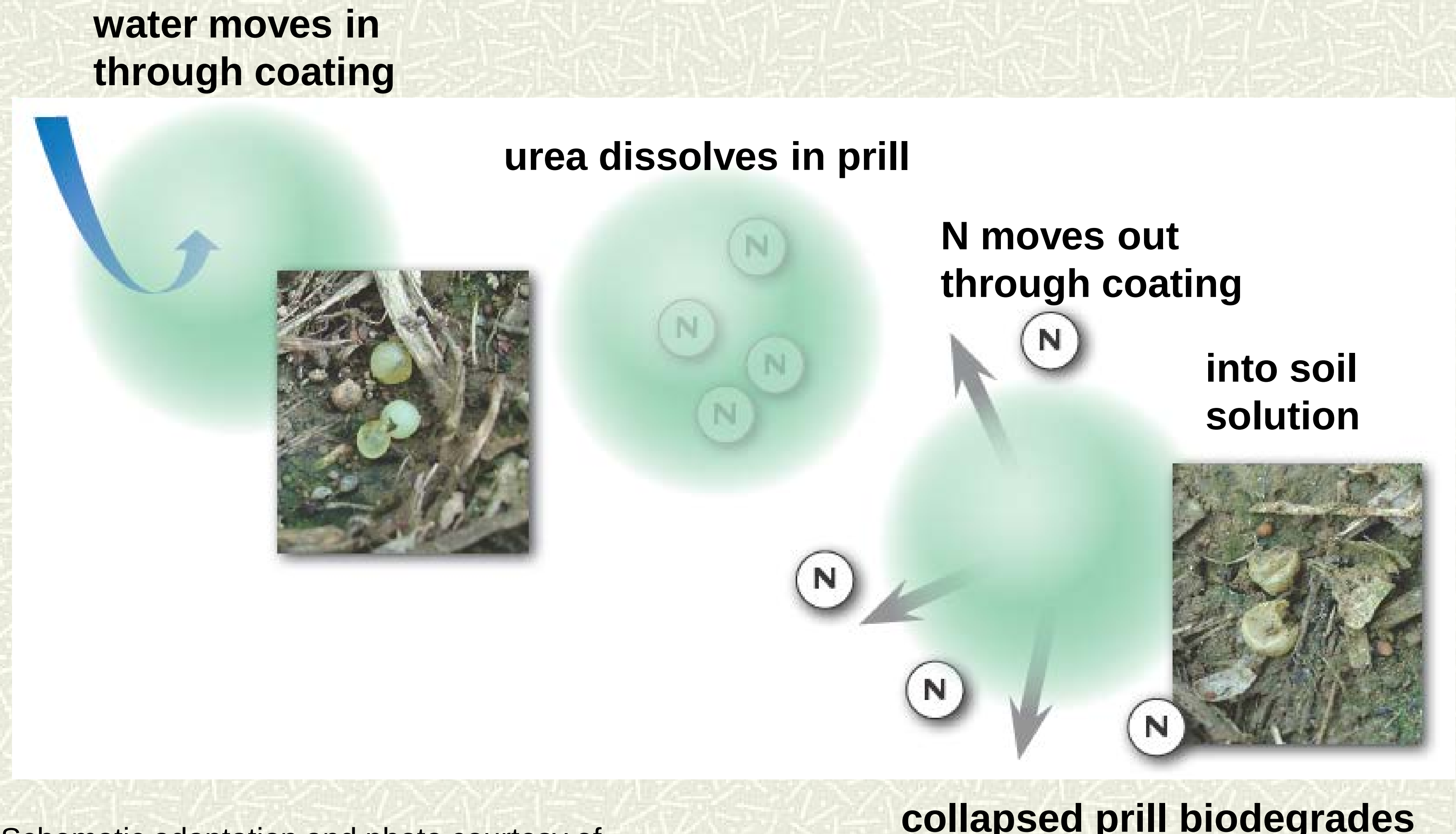
NBPT (Agrotain®) uses

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

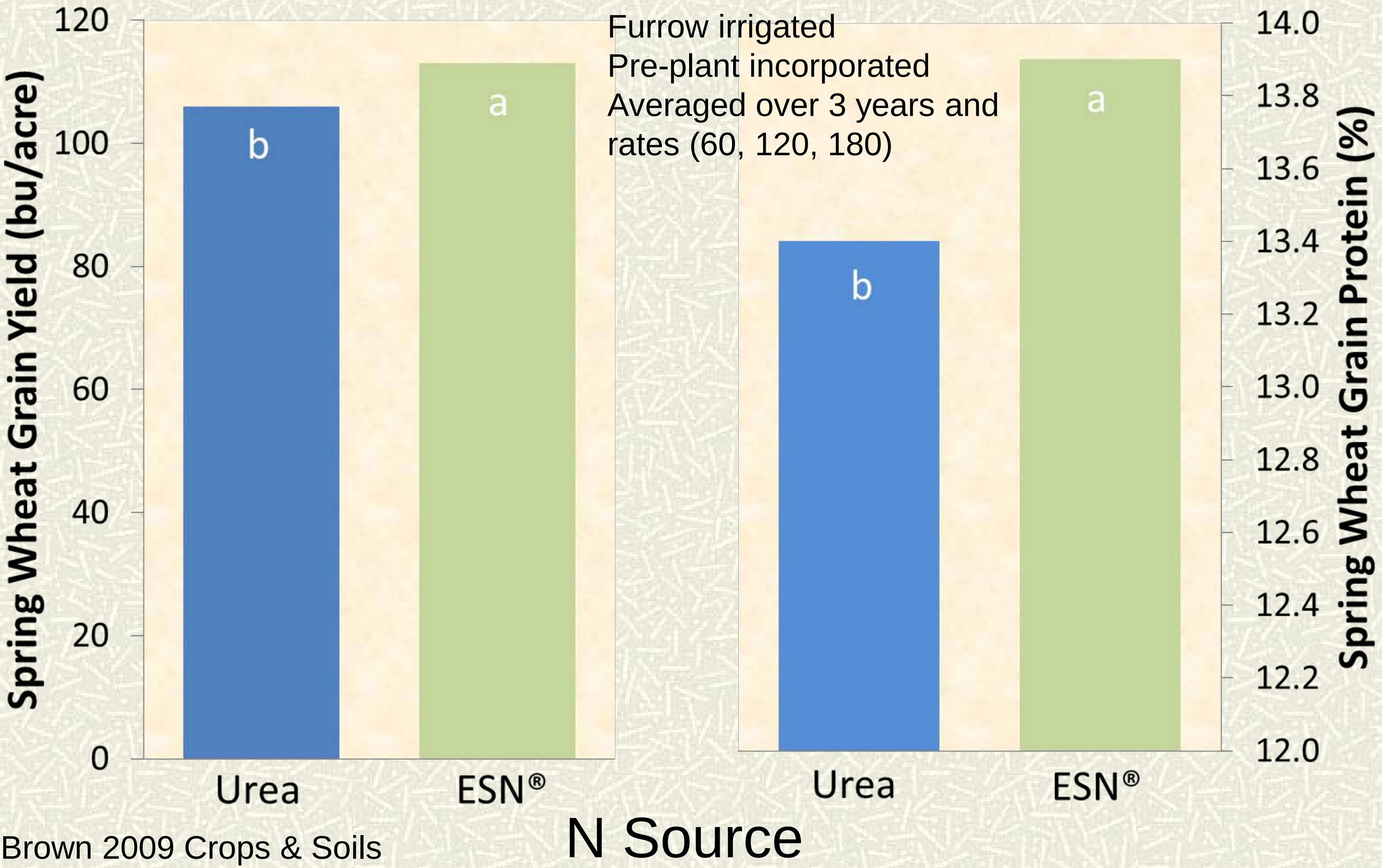
Effect of irrigation and NBPT on volatilization



N release by polymer-coated fertilizers

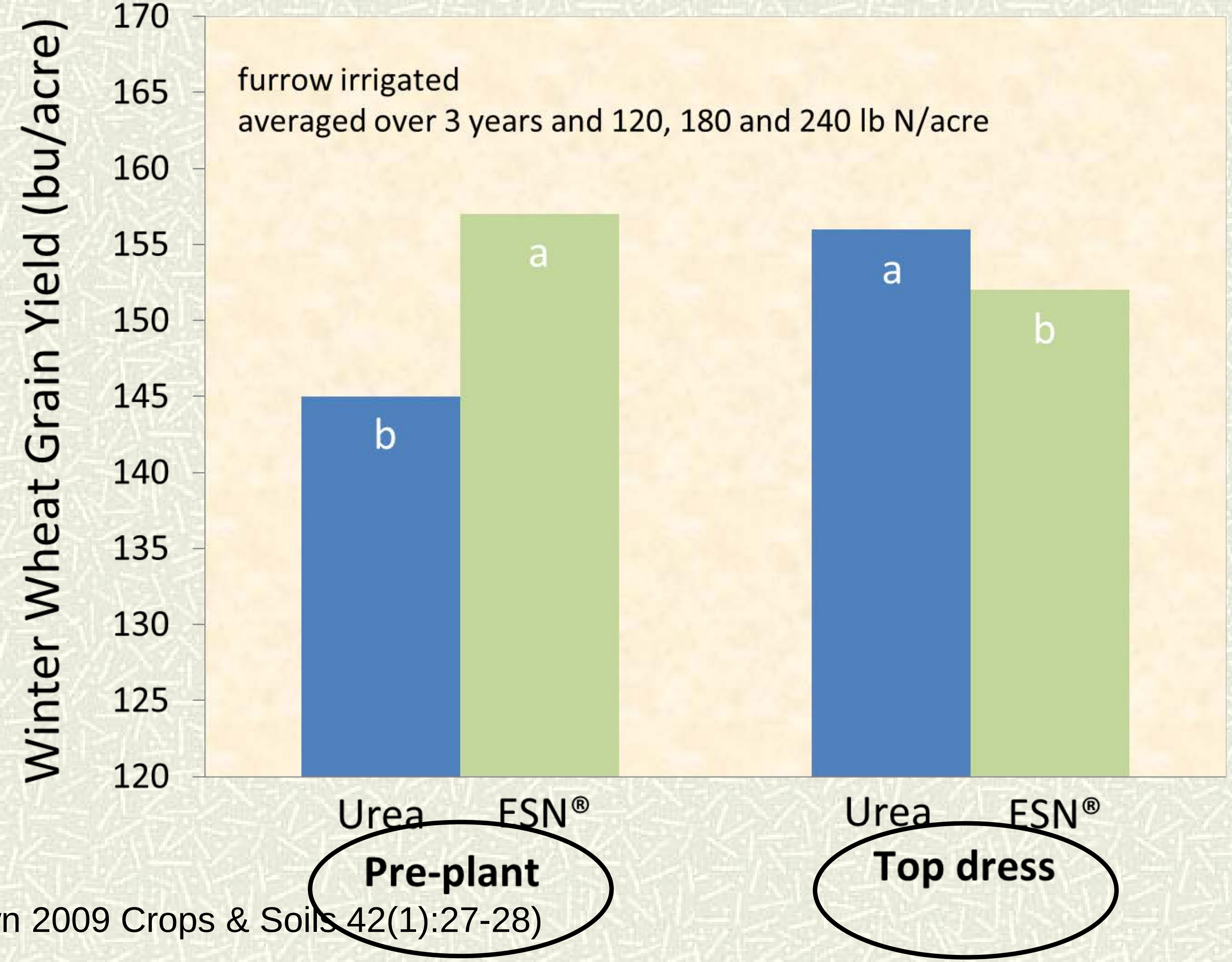


Effect of pre-plant ESN® and urea on furrow irrigated spring wheat grain yield and protein



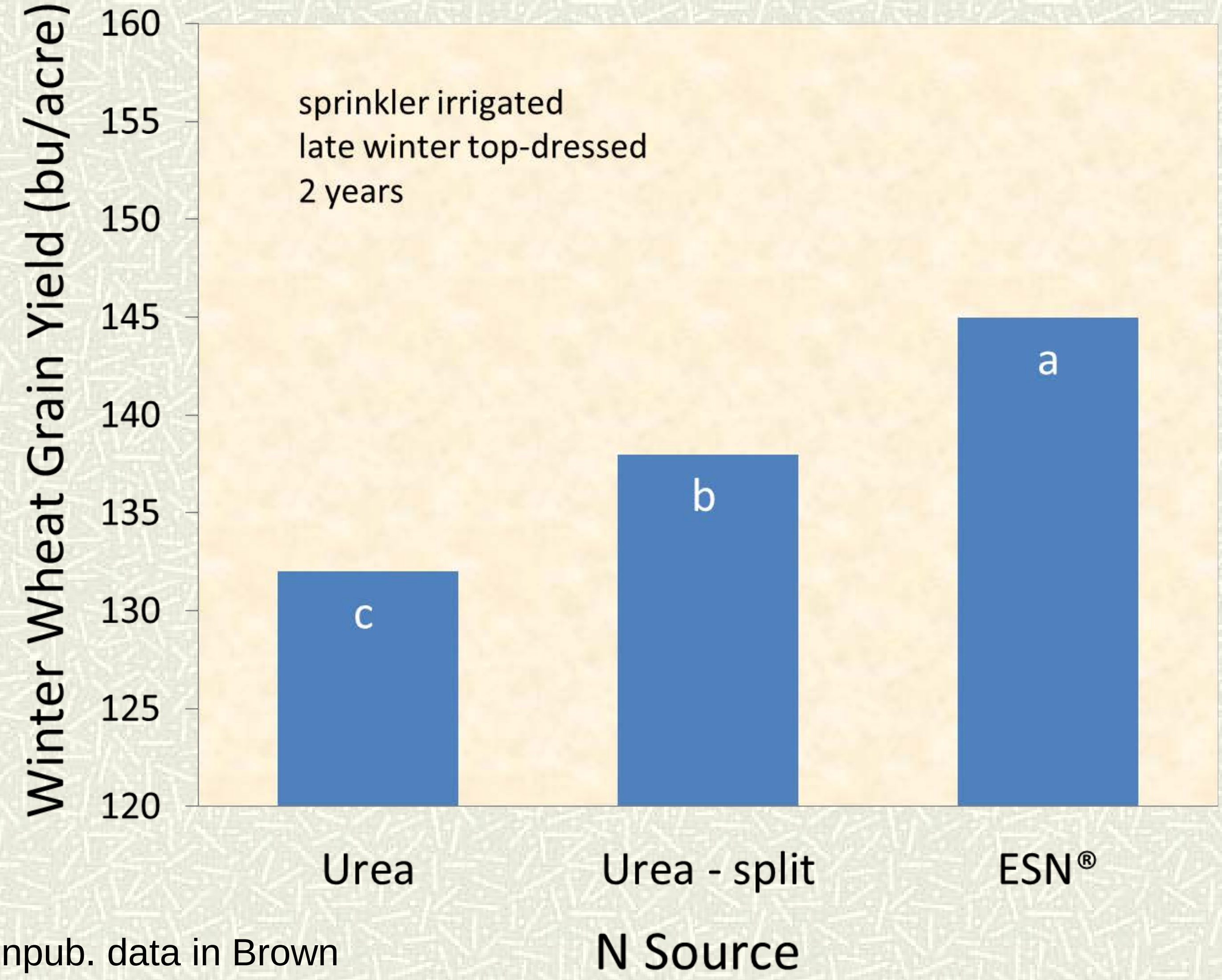
Brown 2009 Crops & Soils 42(1):27-28

Effect of pre-plant and top dress ESN® and urea on furrow irrigated winter wheat yield



Brown 2009 Crops & Soils 42(1):27-28)

Effect of top-dress ESN® and urea on sprinkler irrigated winter wheat grain yield



Horneck unpub. data in Brown 2009 Crops & Soils 42(1):27-28

Conventional N fertilizer sources

- urea vs ammonium sulfate vs UAN
  - Generally “a pound of N is a pound of N” so use price and convenience to select.

Some exceptions:

- In cool soils, urea can take up to 5 weeks to become available. Nitrate and ammonium are instantly available.
- Nitrate is more mobile (good for plants, bad for leaching) than ammonium. Ammonium converts to nitrate within a few days to 2 weeks.

Nitrogen Liquids (Foliar Application/Fertigation)

- Some N can be absorbed through leaves
- However, most foliar applied N ends up being washed off and taken up by roots (Rawluk et al., 2000).
- Risk of burn if > ~ 20 lb N/ac (crop dependent). Yield losses at higher rates (40-60 lb N/ac).
- Liquid urea causes about ½ the burn of UAN (Brown and Long, 1988)

Conventional P fertilizer sources

- MAP vs DAP vs liquid ammonium polyphosphates “a pound of P_2O_5 is a pound of P_2O_5”

  One exception: in highly calcareous soils (>20% $CaCO_3$), liquid P is more available

Questions on Fertilizer Source?

Fertilizer Rates – Nitrogen based on yield goal

Crop	N rate
Wheat	3.3 lb N/bu (sw); 2.6 lb N/bu (ww)
Corn	9 lb/ton (silage); 1.2 lb/bu (grain)
Malt Barley	1.2 lb N/bu
Dry Bean	5 lb N/100 lb

Other crops? See Fertilizer Guidelines for MT Crops (EB0161) at http://landresources.montana.edu/soilfertility
Click on Fertilizer Information or Extension Publications

Phosphorus Rates (in lb P_2O_5/ac) Based on Olsen P

Crop	Olsen P 4 ppm	Olsen P 8 ppm	Olsen P 12 ppm	Olsen P* 16 ppm
Wheat (spring)	45	35	30	20
Corn (silage)	65	50	35	25
Malt Barley	40	30	20	10
Dry Bean	25	20	15	5

*Note: To maintain P levels, could use P removal rates: Wheat (0.62 lb P_2O_5/bu); Corn silage (~4.5 lb P_2O_5/ton); Barley (0.36 lb P_2O_5/bu); Dry Bean (0.79 lb P_2O_5/bu)

Questions on Fertilizer Rates?

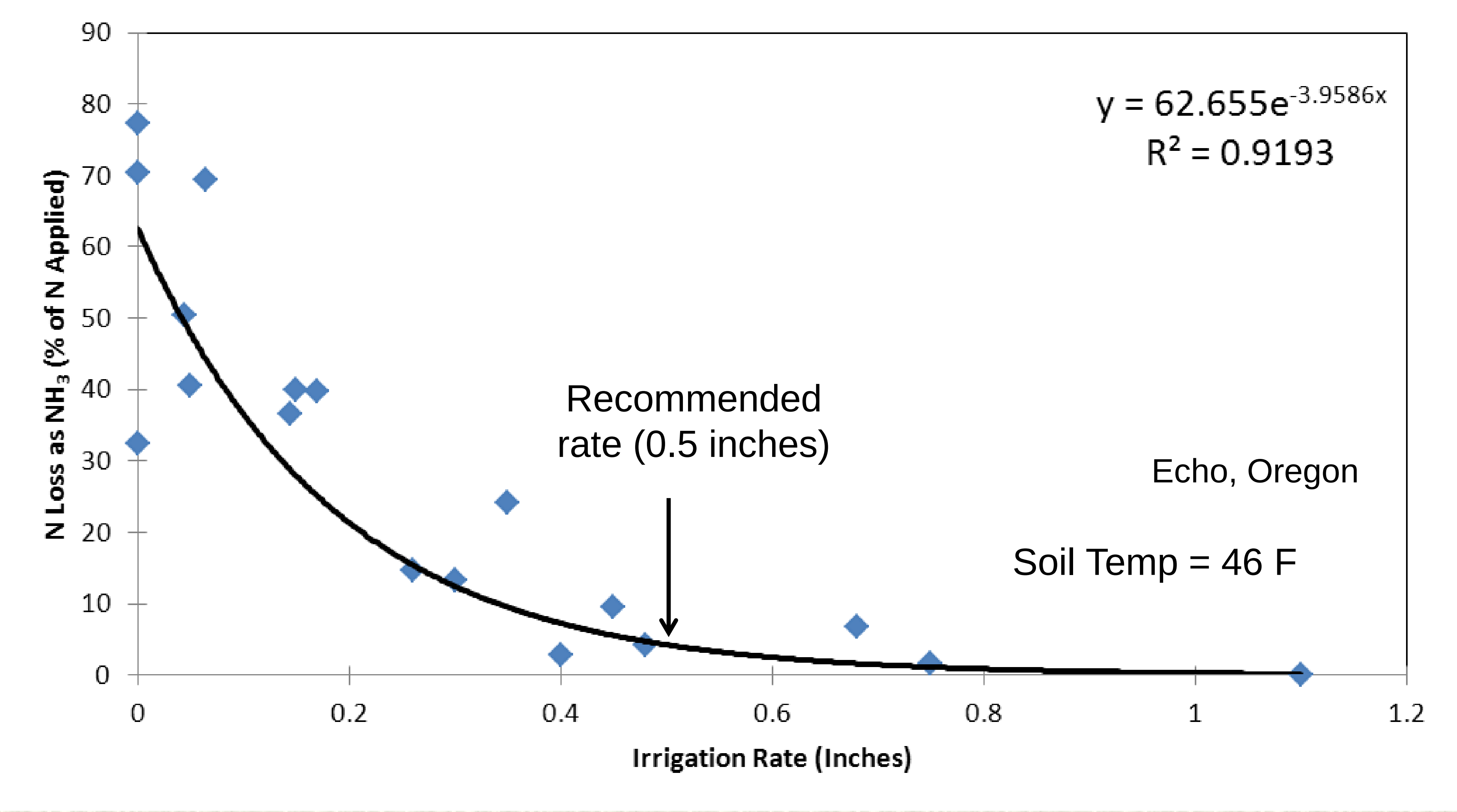
- Note: K and micronutrients also contained in MSU Fertilizer Guidelines

Fertilizer Placement

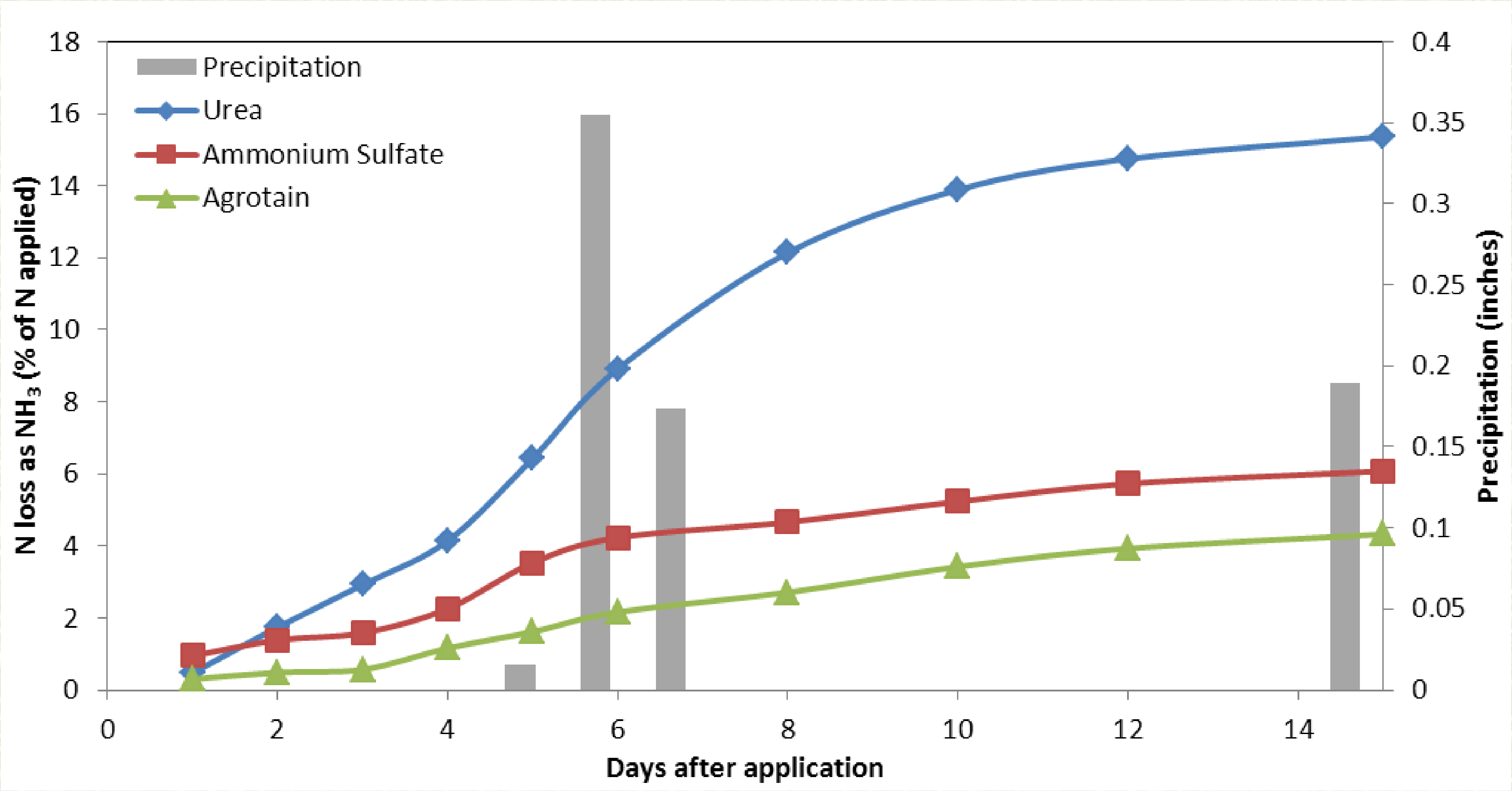
Surface broadcast urea

- Recent research in MT has found ~20% of broadcast urea volatilizes on no-till fields (go to: http://landresources.montana.edu/ureavolatilization for more information)
- To avoid this risk, incorporate with tillage or irrigation within 2 days of application
- How much irrigation??

Effect of irrigation rate on broadcast urea volatilization (Horneck, unpub. data)

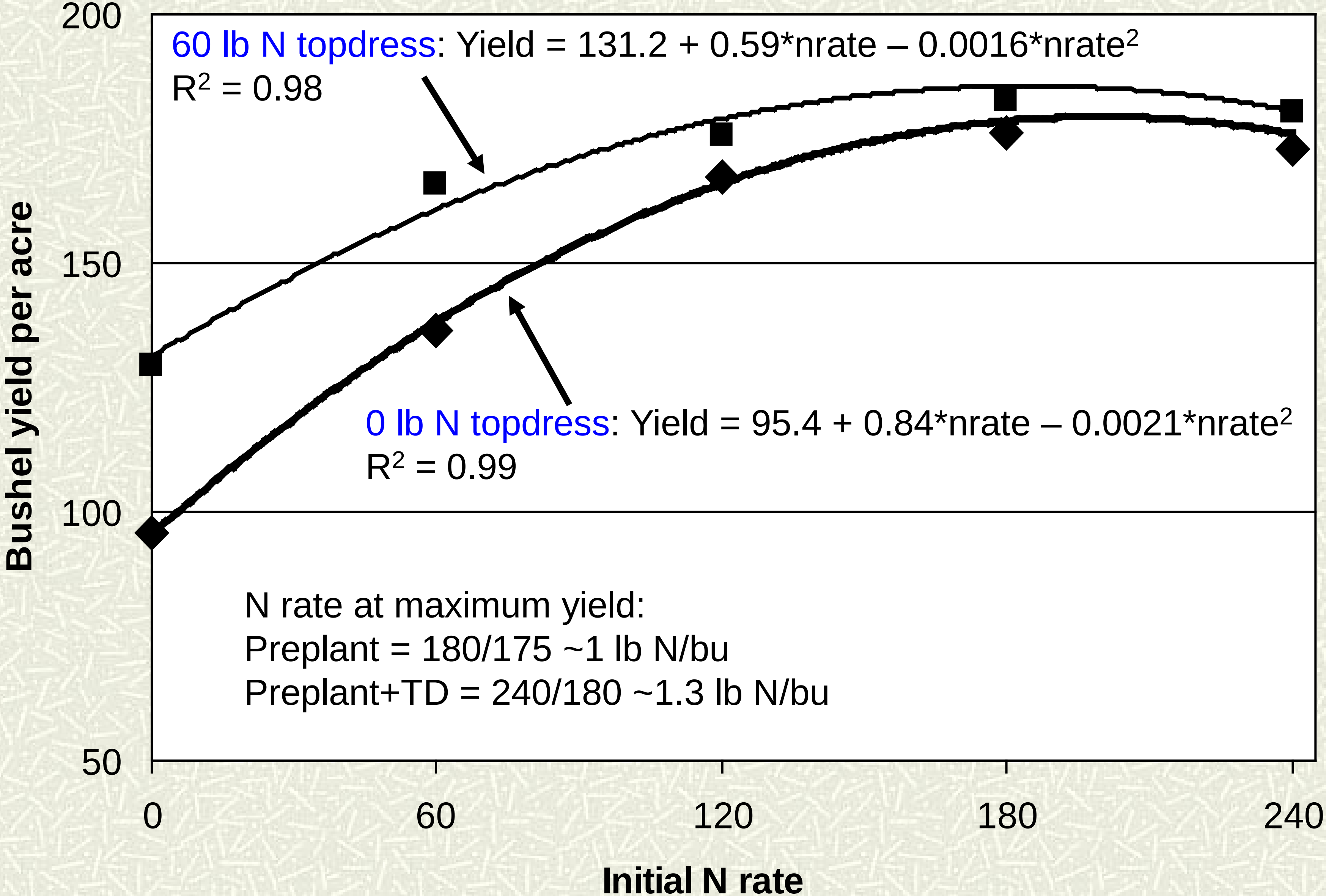


Does ½ inch of rain also stop volatilization? (Horneck unpub data)



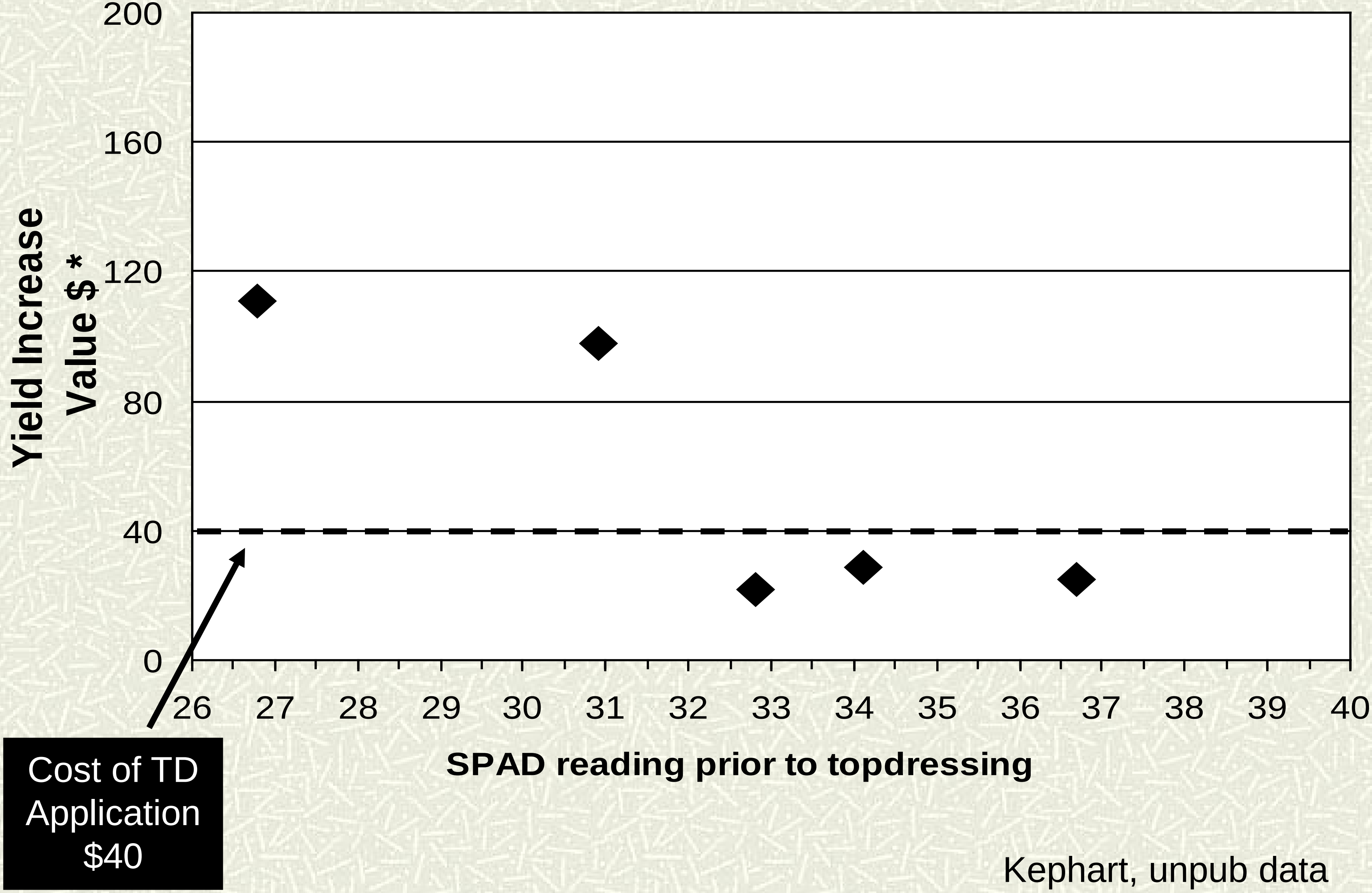
Not if spread out over 3 days

Effect of pre-plant N Rate and topdressing on Corn Yield - SARC



Kephart, unpub data

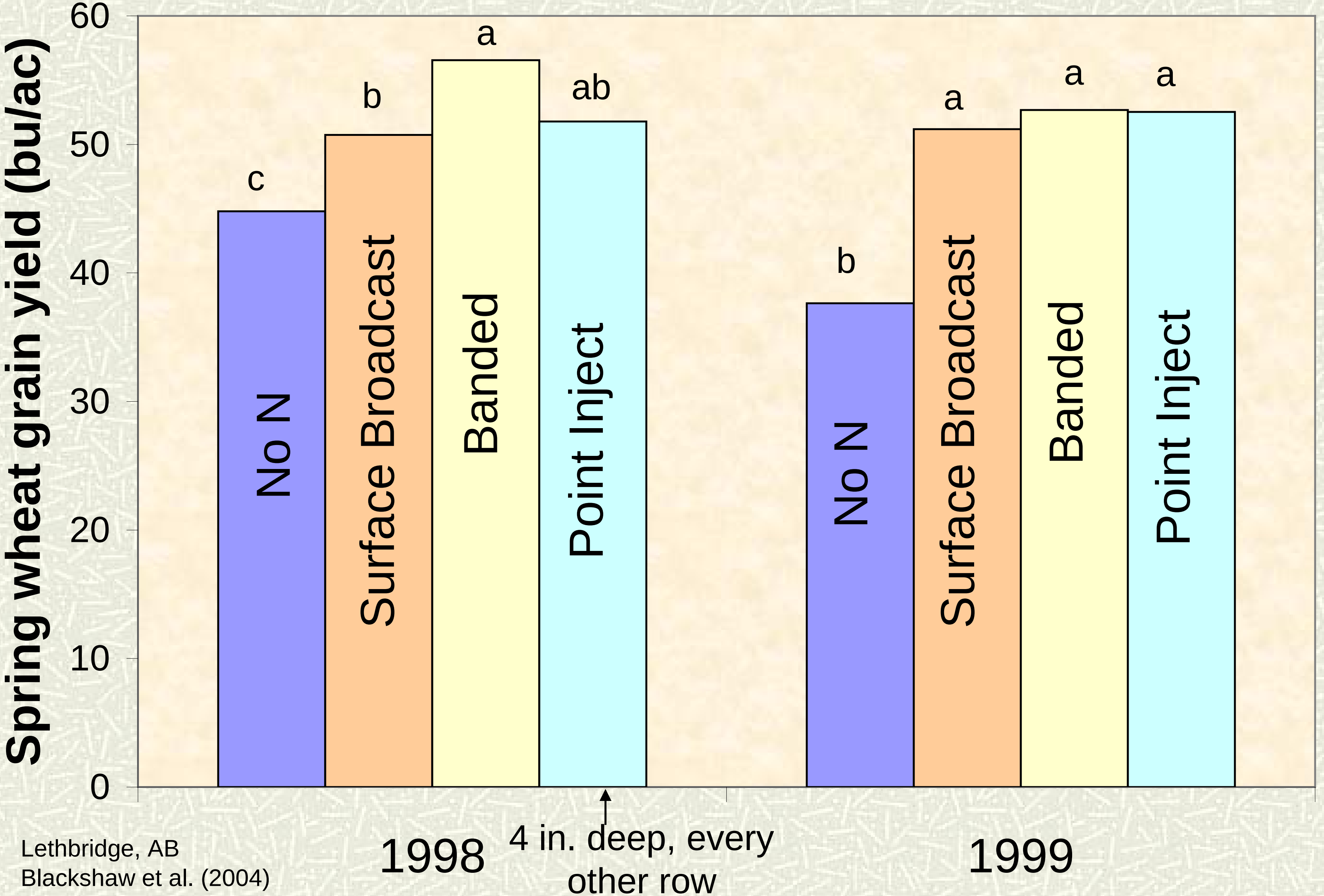
Increased corn value due to topdressing (60 lb N/acre) SARC



Kephart, unpub data

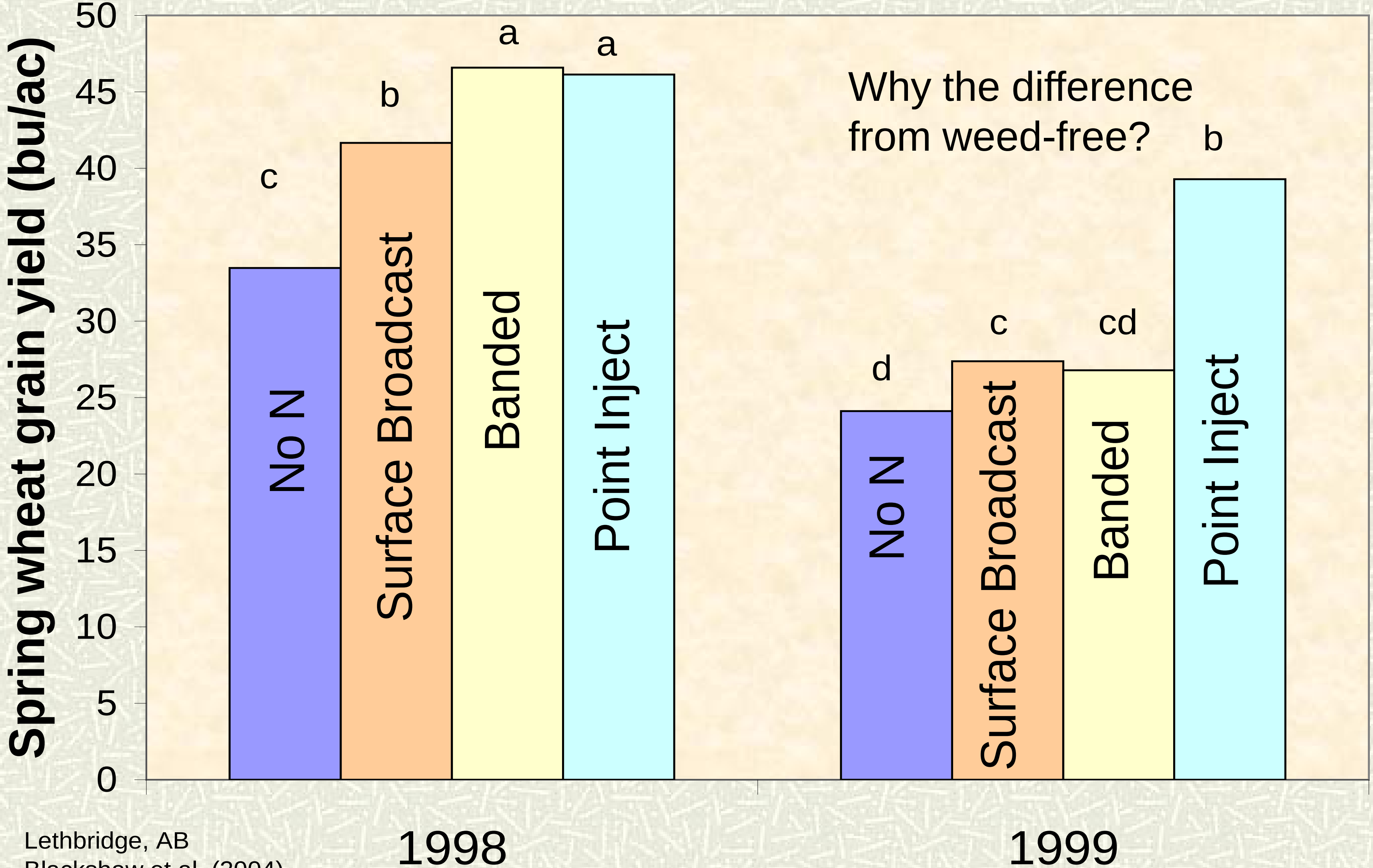
* Value of yield increase based on $3.30/bushel price for corn.

Effect of Placement on Spring Wheat Yield – Weed Free



Lethbridge, AB
Blackshaw et al. (2004)

Effect of N Placement on Spring Wheat Yield-With Wild Oats



Lethbridge, AB
Blackshaw et al. (2004)

Banding vs Unincorporated Broadcast Phosphorus

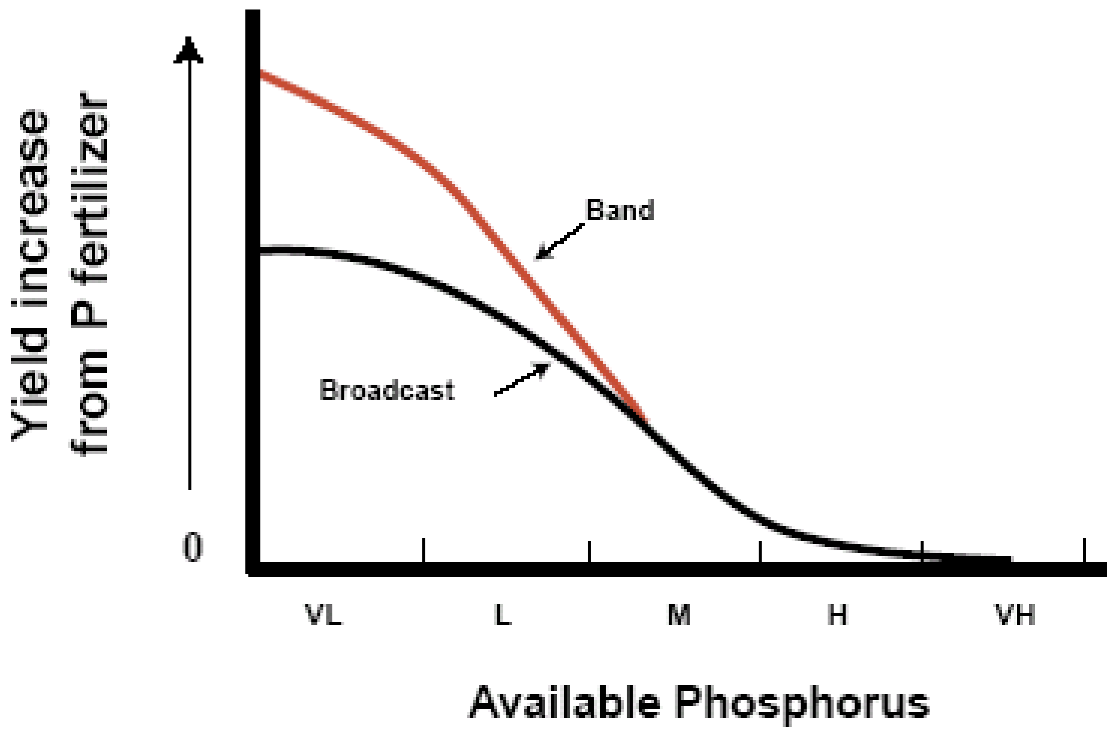


Figure 7. The advantages of P banding are greatest when STP levels are very low (VL) to low (L). From Randall and Hoeft (1988).

Banding P is much more effective than banding N, because P is much more immobile in the soil.

QUESTIONS on Placement?

Fertilizer Application Timing

- Phosphorus and potassium are best applied somewhat before or at seeding
- Nitrogen can be applied later, especially on wheat to maximize protein

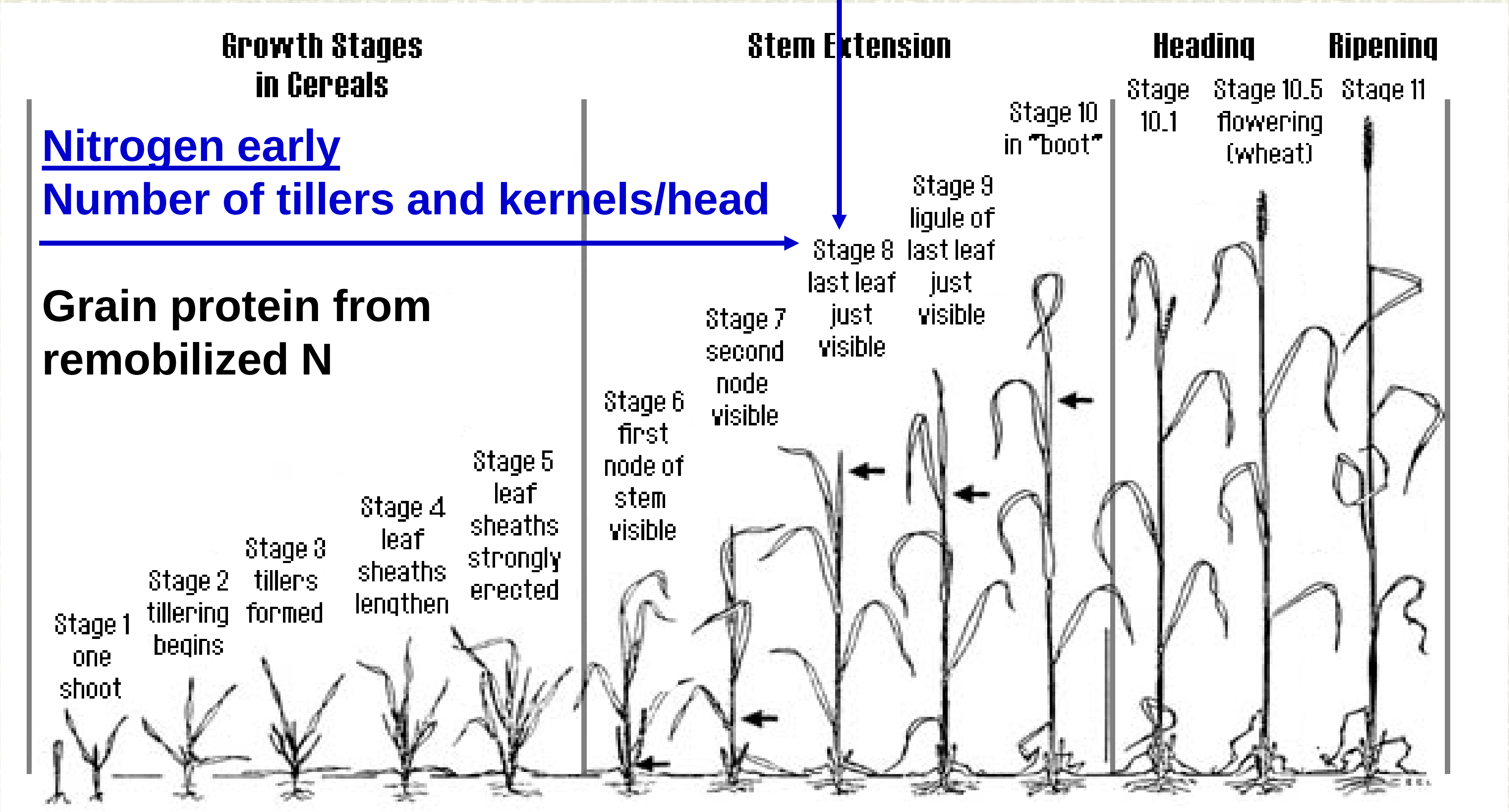
N application timing effects on yield and protein

Nitrogen late
Weight/kernel

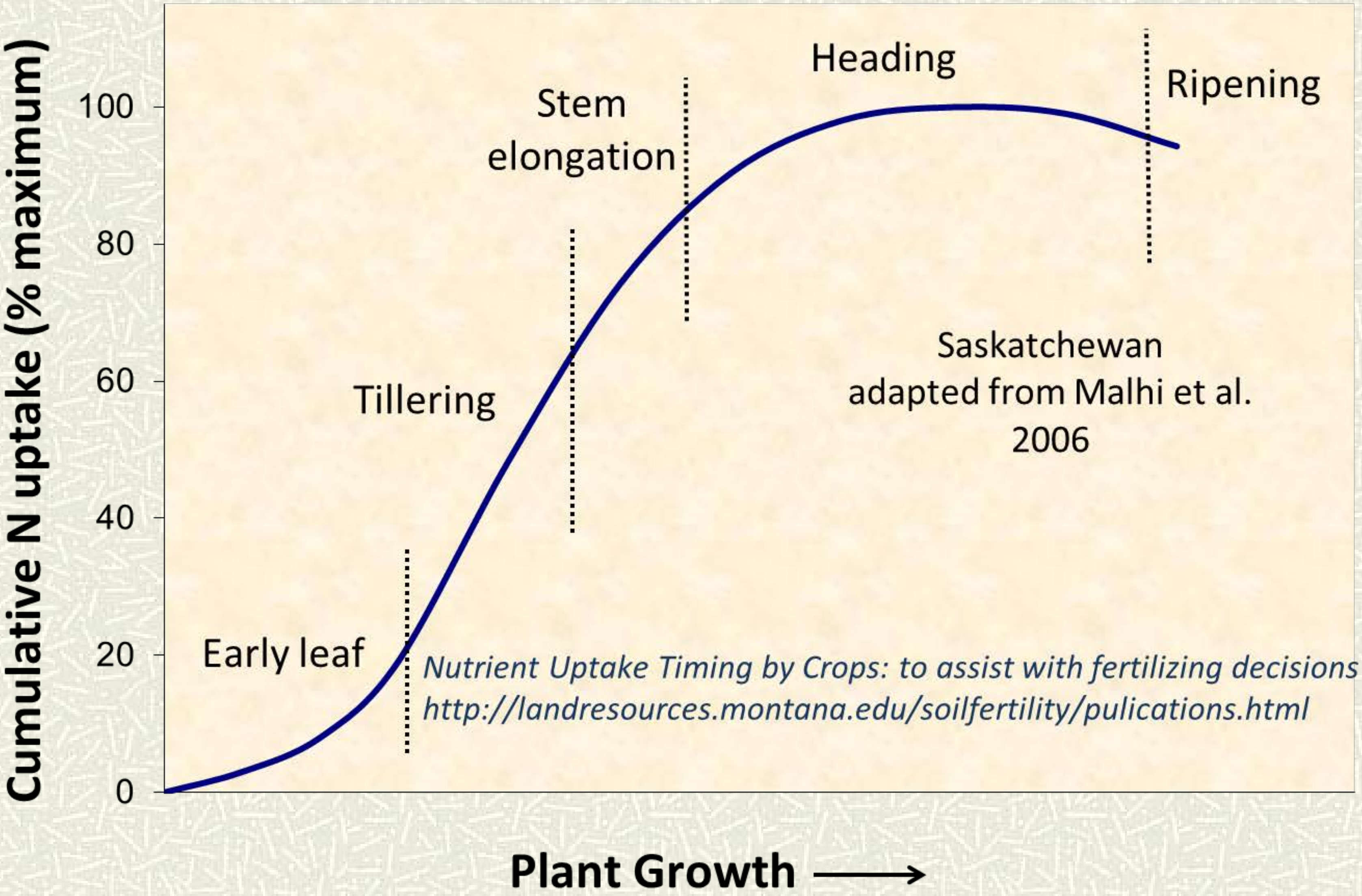
Higher grain protein

Nitrogen early
Number of tillers and kernels/head

Grain protein from remobilized N



Cumulative N uptake by wheat



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

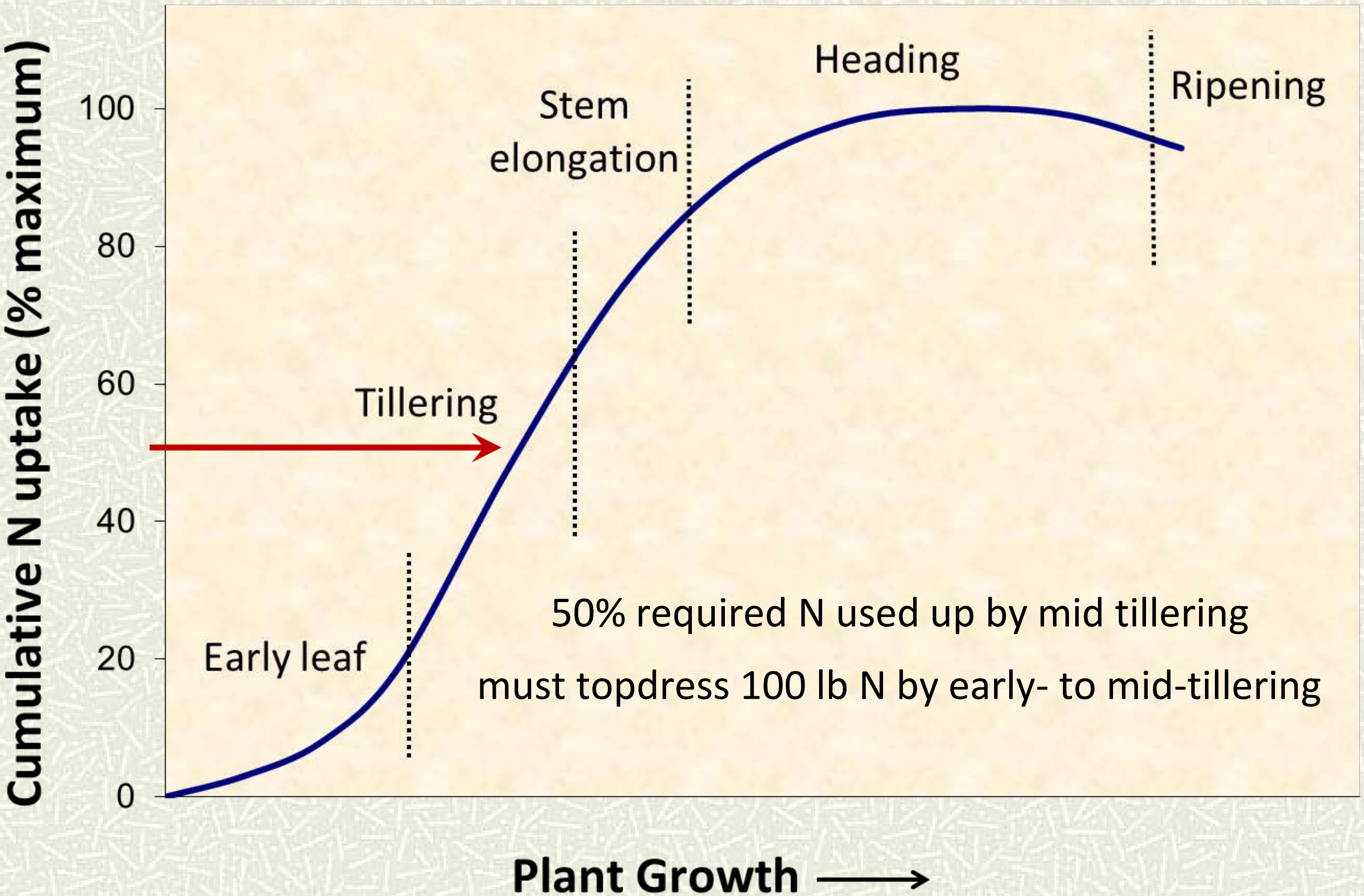
- Use split application (pre-plant and topdress or just topdress)
- Use a slow release fertilizer

Use Nutrient Uptake figure to time top-dress

Example on per acre basis:

- 200 lb N total need, 40 lb N in soil, 60 lb preplant N
- soil and preplant supply 100 lb N = 50% total N required
- (200 – 100) = 100 lb N top-dress

Top-dress amount and timing based on plant growth stage



Conclusions

- Controlled release urea has produced higher wheat yields when applied early enough
- Controlled release urea has produced lower wheat yields when applied too late if furrow-irrigated
- Surface broadcast urea should either be immediately incorporated to prevent volatilization or treated with NBPT. Use at least 0.5 inches of irrigation to incorporate.
- Placing N near the seed should maximize yield and decrease weed density
- Use split applications, based on N uptake curves, to maximize grain protein in wheat.
- Phosphorus should be banded near the seed or incorporated to optimize yields.

For additional information

- Soil Fertility Website:

  http://landresources.montana.edu/soilfertility

  Contains links to my presentations including this one, economic N rate calculator, fertilizer facts, press releases, Extension publications, this presentation, etc.

QUESTIONS?