Nutrient Management with Limited Water

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MONTANA STATE UNIVERSITY EXTENSION

Questions

Who works with clients who irrigate?

Who works with dryland clients?

Who has seen drought stress or crop failure in past two years?

What changes in Nutrient Management do you make in dry years?

Please ask questions of me during presentation.

Nutrient Cycling with Limited Water

What's different?

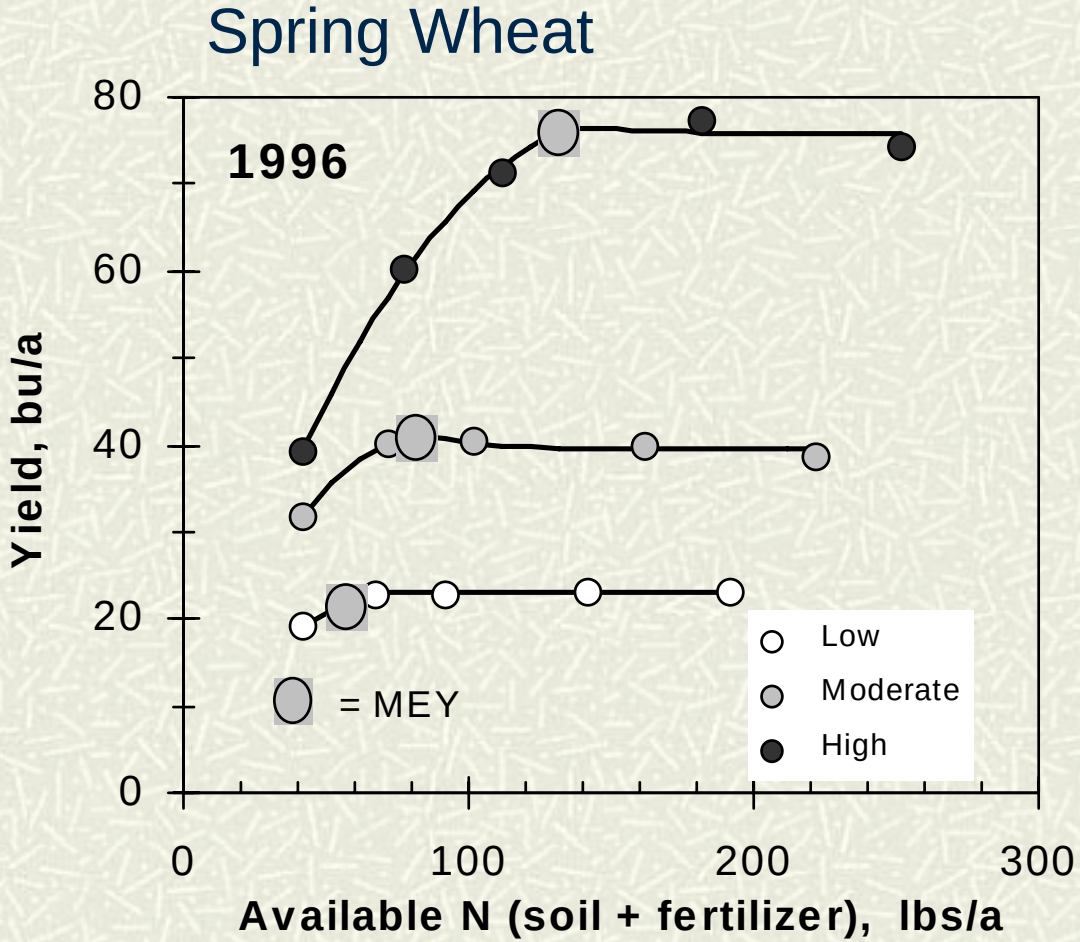
- Yield potential is less
- Crop uptake decreased
- Nutrient needs are less?

Nitrogen-Yield Responses

Low = 9 in.

Mod. = 14 in.

High = 19 in.

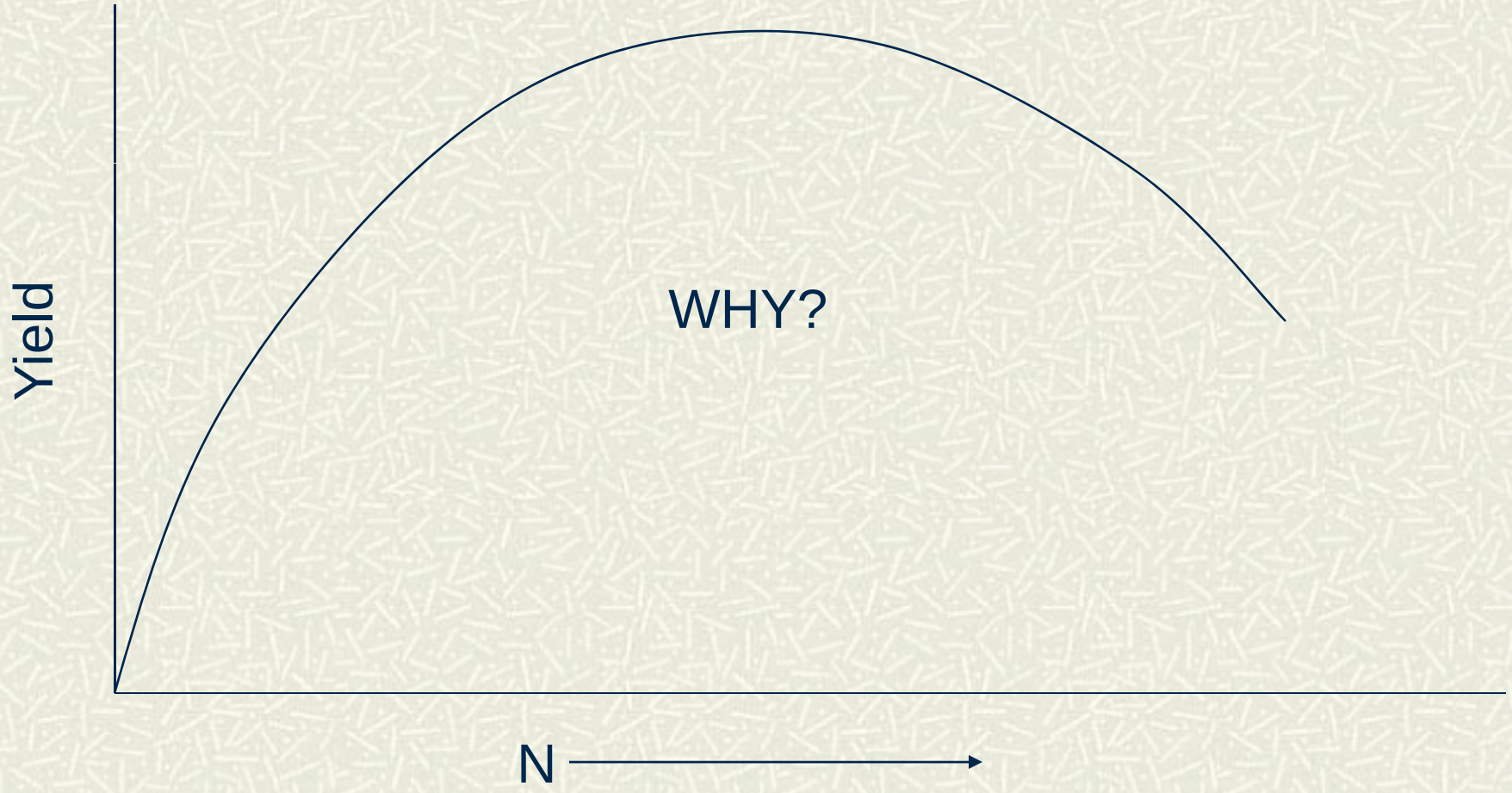


Havre, MT

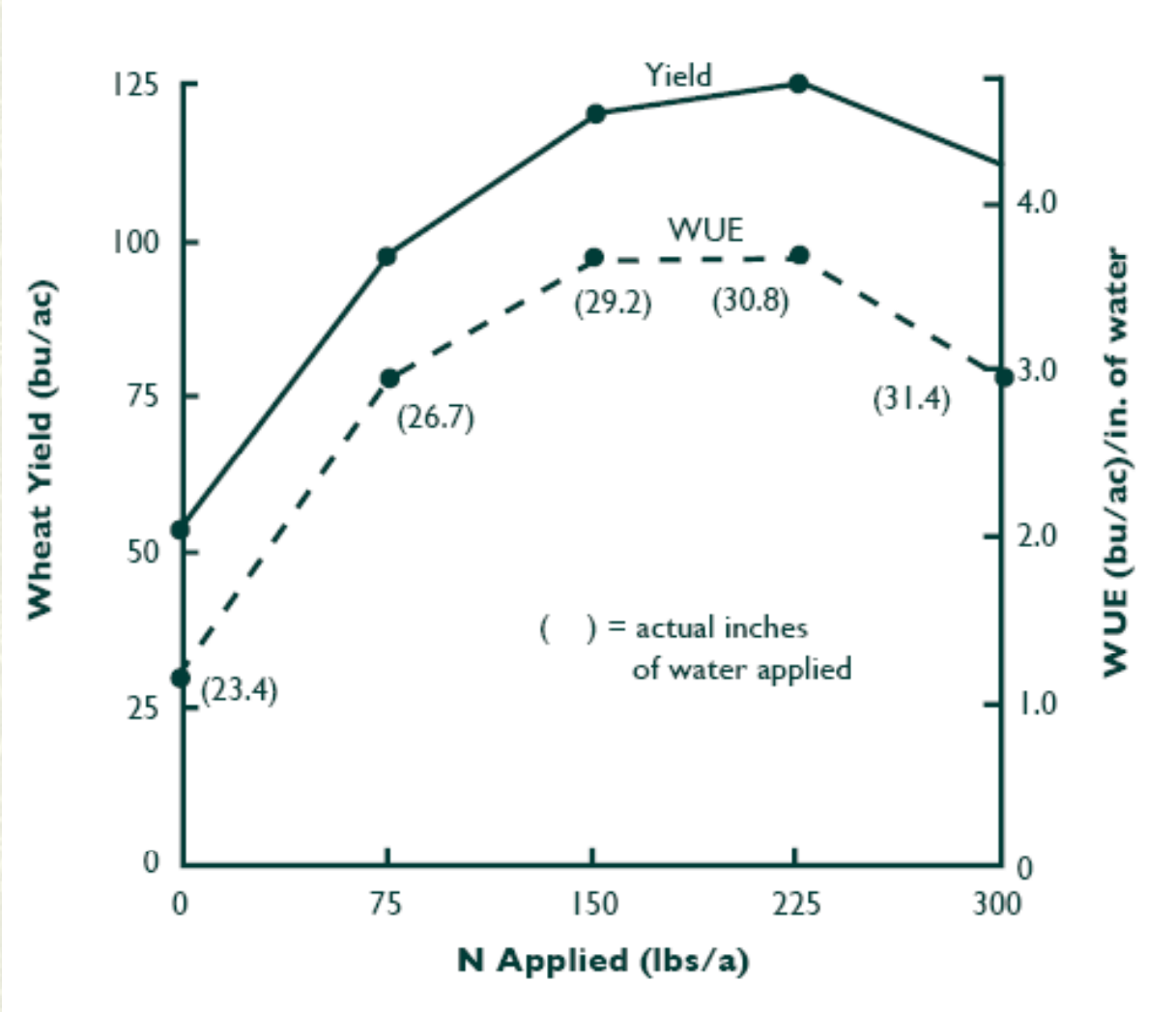
R. Engel

Fertilizer Fact #25

What other shape yield response curve might occur with low water?

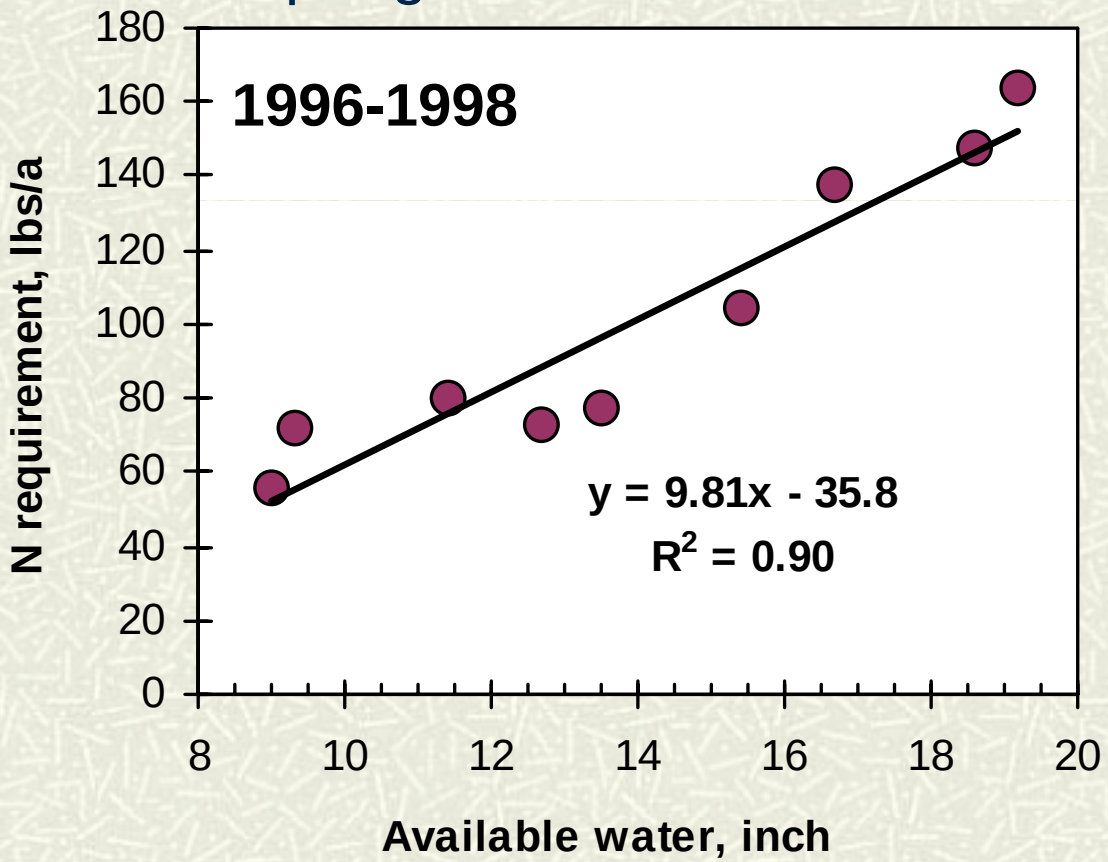


Effect of N on Yield and Water Use Efficiency (WUE)



N Requirement based on Available Water

Spring Wheat

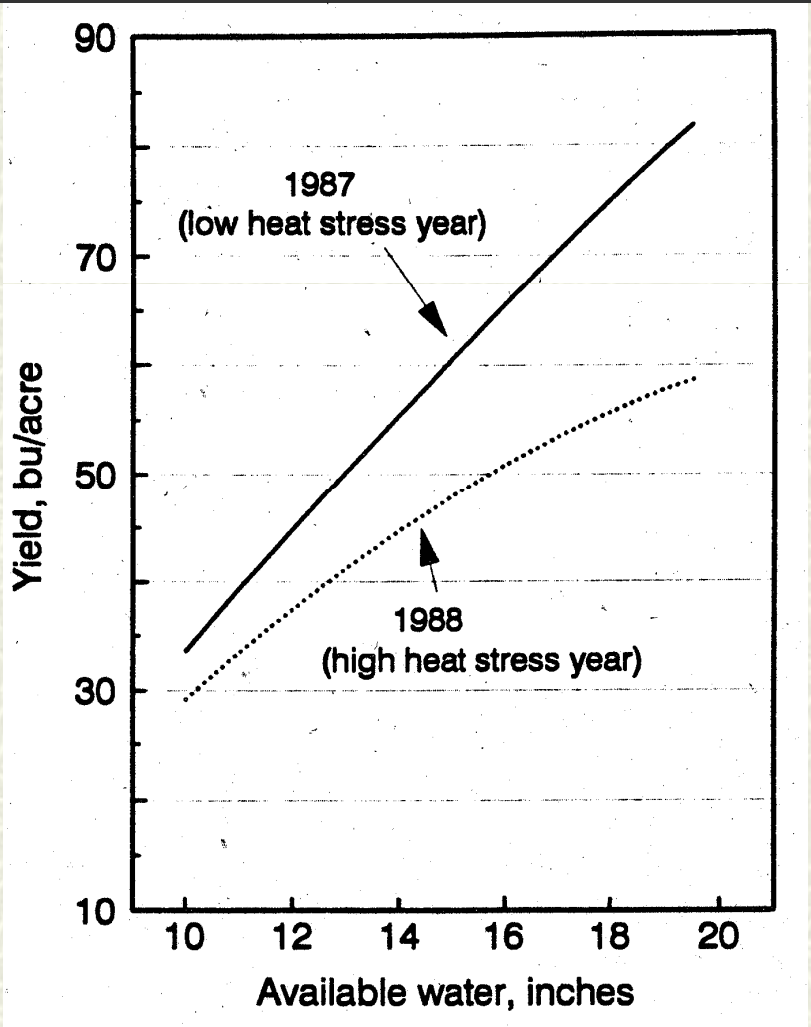


Havre, MT

R. Engel

Fertilizer Fact #25

How does heat stress affect yield, and hence, N needs?



Winter Wheat,
South central MT

Engel, 1993. MSU Fertilizer Fact #4

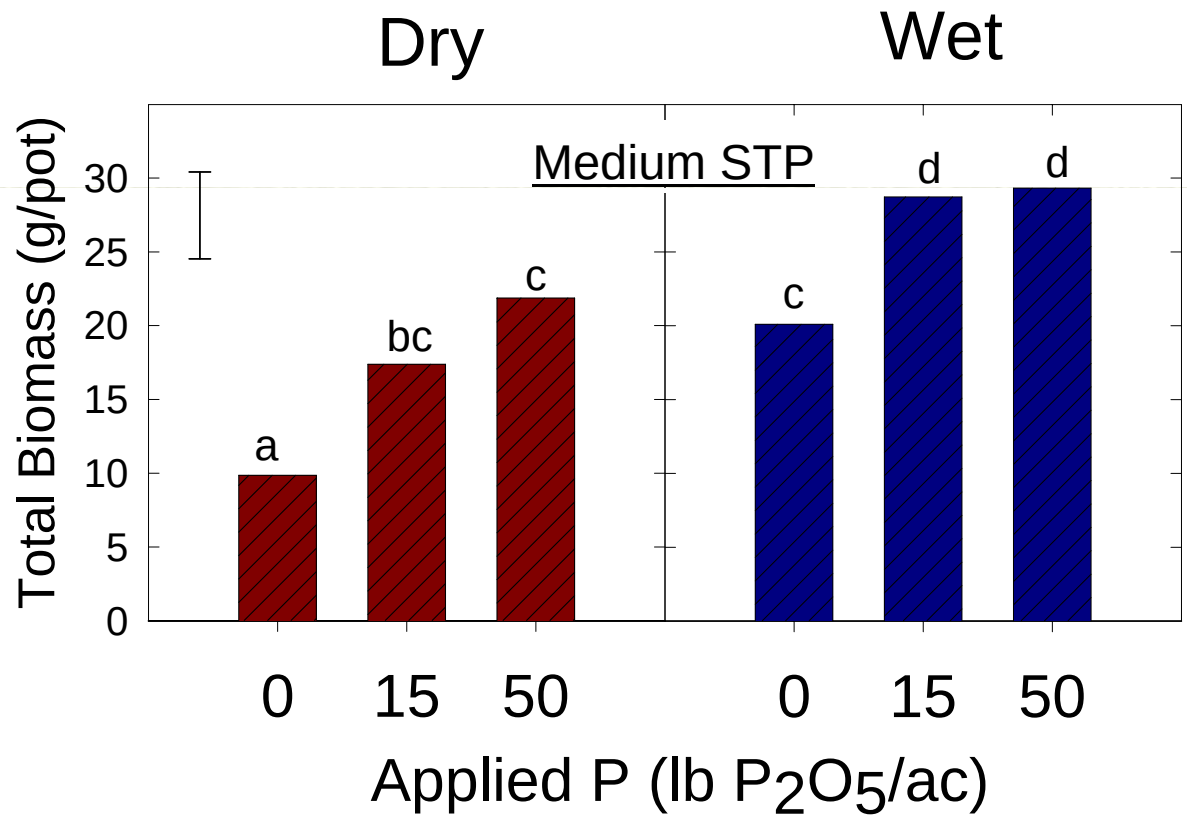
http://landresources.montana.edu/fertilizerfacts

Take home message

As expected, less N is needed when water is limited

How about phosphorus (P)?

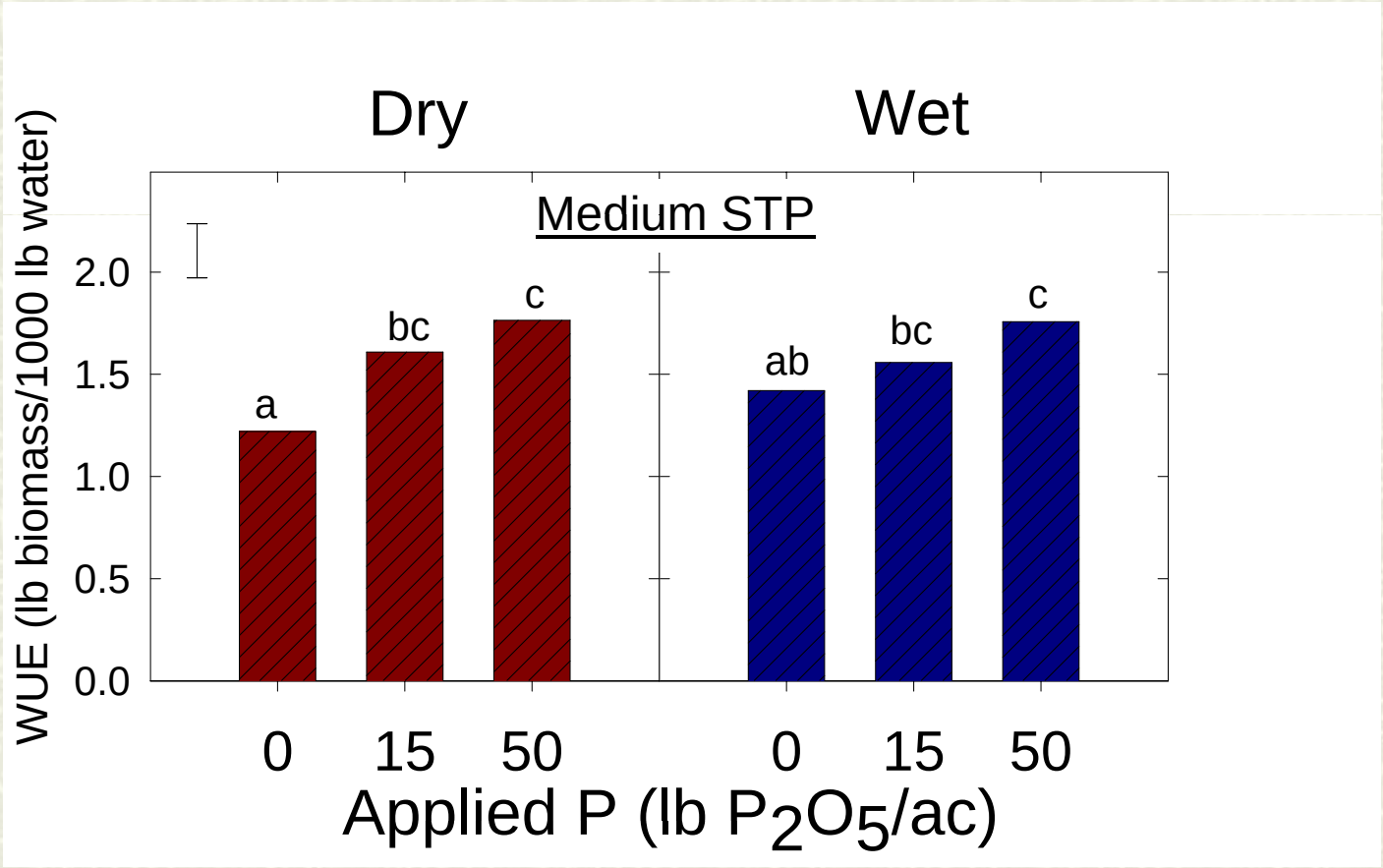
Effect of P Fertilizer on Total Biomass of Malt Barley



Jones et al., 2003

Fertilizer Fact #31

Effect of P on Water Use Efficiency (WUE) of Malt Barley



SO….

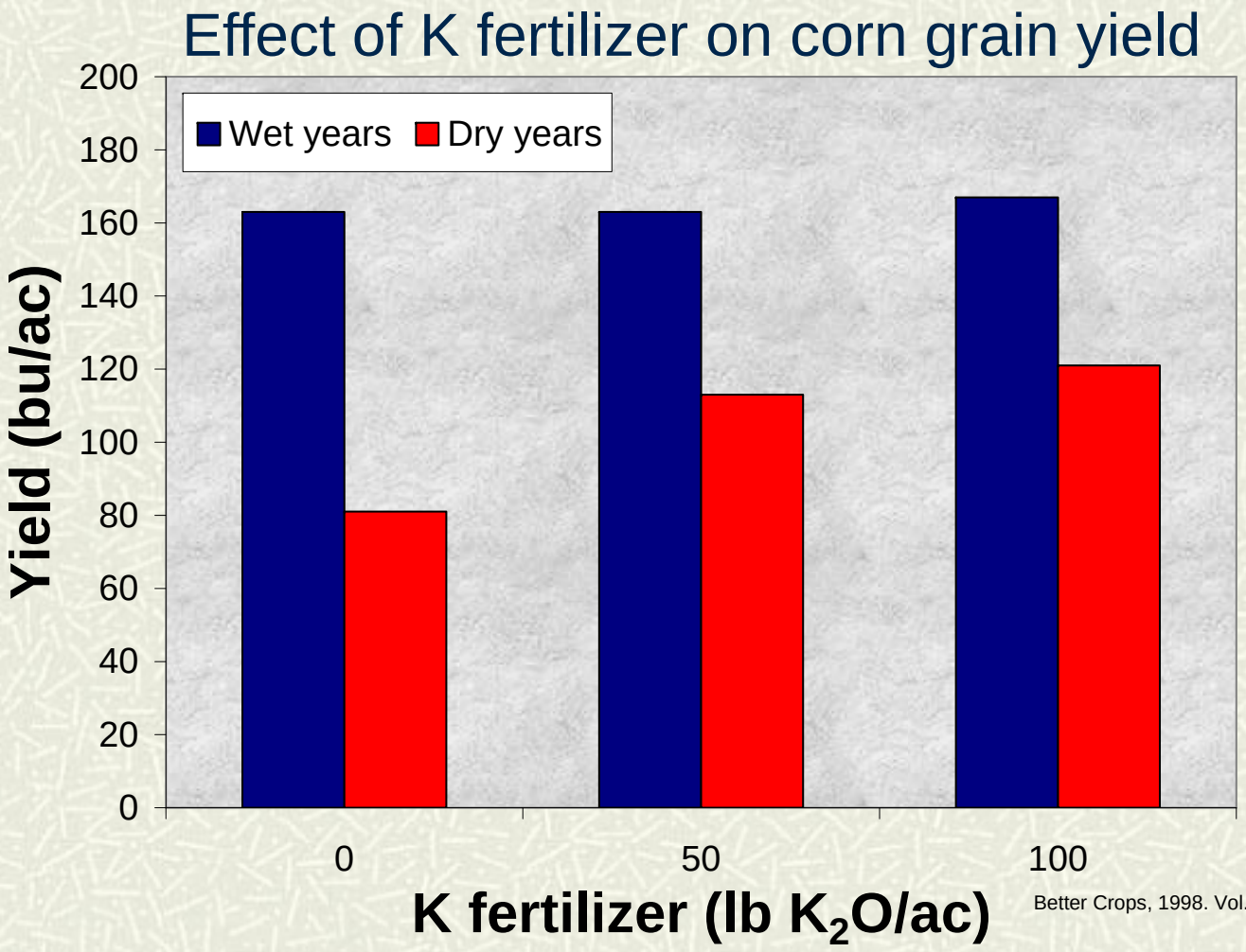
Phosphorus needs may be somewhat HIGHER in drier soil.

WHY?

1. Increases root growth, and hence, water use efficiency.
2. Less P dissolves/desorbs in dry year.
3. Controls opening of stomate.

QUESTIONS SO FAR?

Potassium (K) increases turgor pressure, reduces wilting, and decreases water loss.



Better Crops, 1998. Vol. 82(3).

How do you convince a client to fertilize with MORE P or K in dry years? Or should you try?

Alternate strategy: Encourage them to add more P and K in wet years to bring soil test P and K level up to ‘critical level’ so can better handle drought.

Fertilizer Management in Drought

- Starter Fertilizer - important to increase water and fertilizer use efficiency
  Example: 10 lb N, 15 lb P_2O_5, 10-15 lb K_2O/ac for any grain

- Placement – Seed germination problems may occur if apply near or with seed (NH_4^+, pH, and salt effect). Since generally have water at seeding, less of an issue for irrigators.
  Ex: Fertilizer on sugarbeet should be placed below and to the side of the seed, approx. 3 inches from seed.

- Timing – May need to topdress if get moisture late

- Amounts – Adjusted based on soil testing to avoid “burn”

What happens to residual nitrate in consecutive dry years?

Soil Testing

Important in dry period b/c nutrients can:

1) Be high due to less uptake
2) Be low due to less mineralization AND under-fertilization
3) Be unavailable if roots don't extend into a rock hard dry zone.

Fertilizer Recommendations with Limited Water Supplies

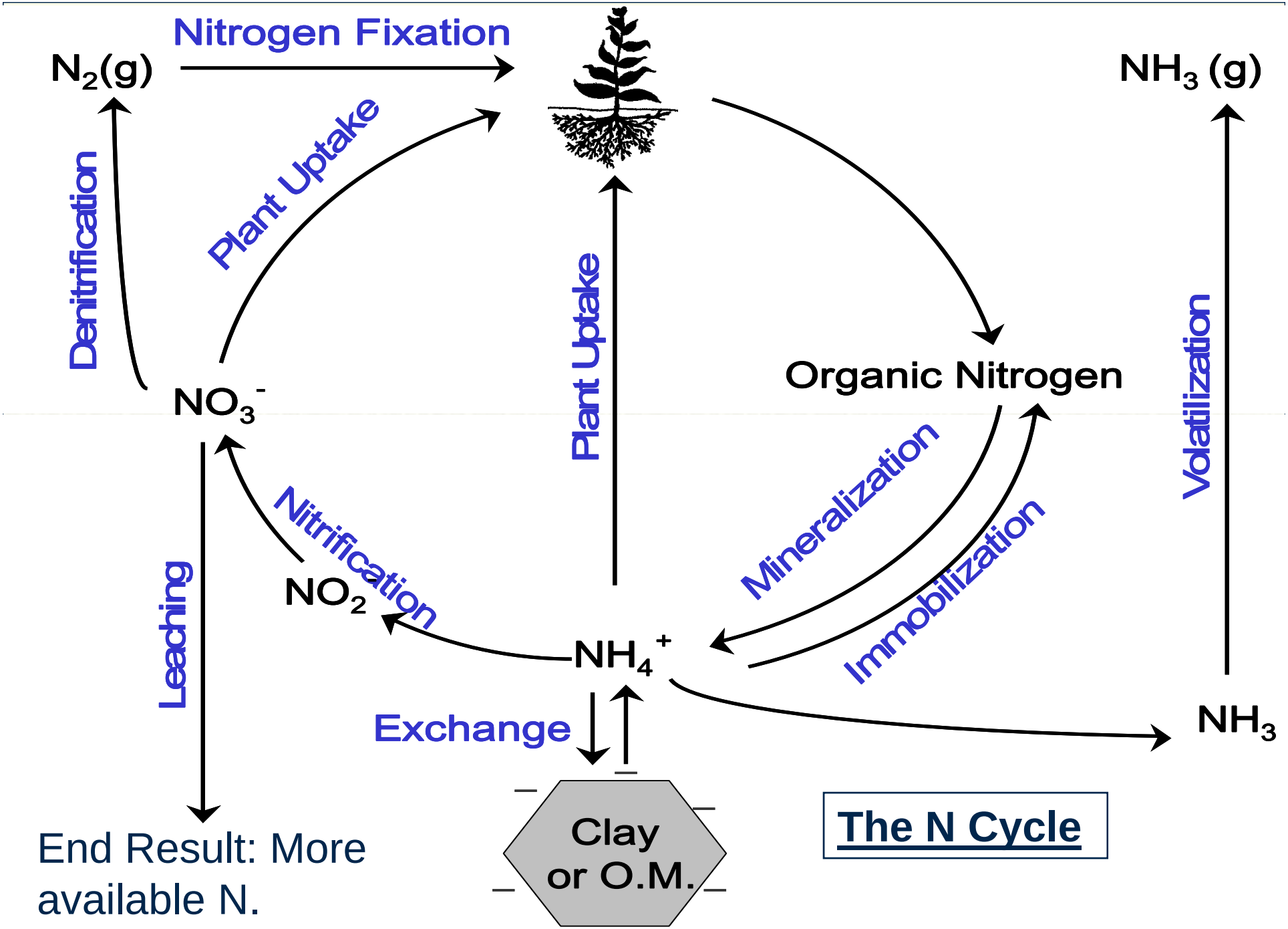
Wyoming Fertilizer Recommendations (B-1045) suggest decreasing N, P, and K amounts linearly as yield potentials decrease.
Basis: Less nutrients removed as yield is decreased.

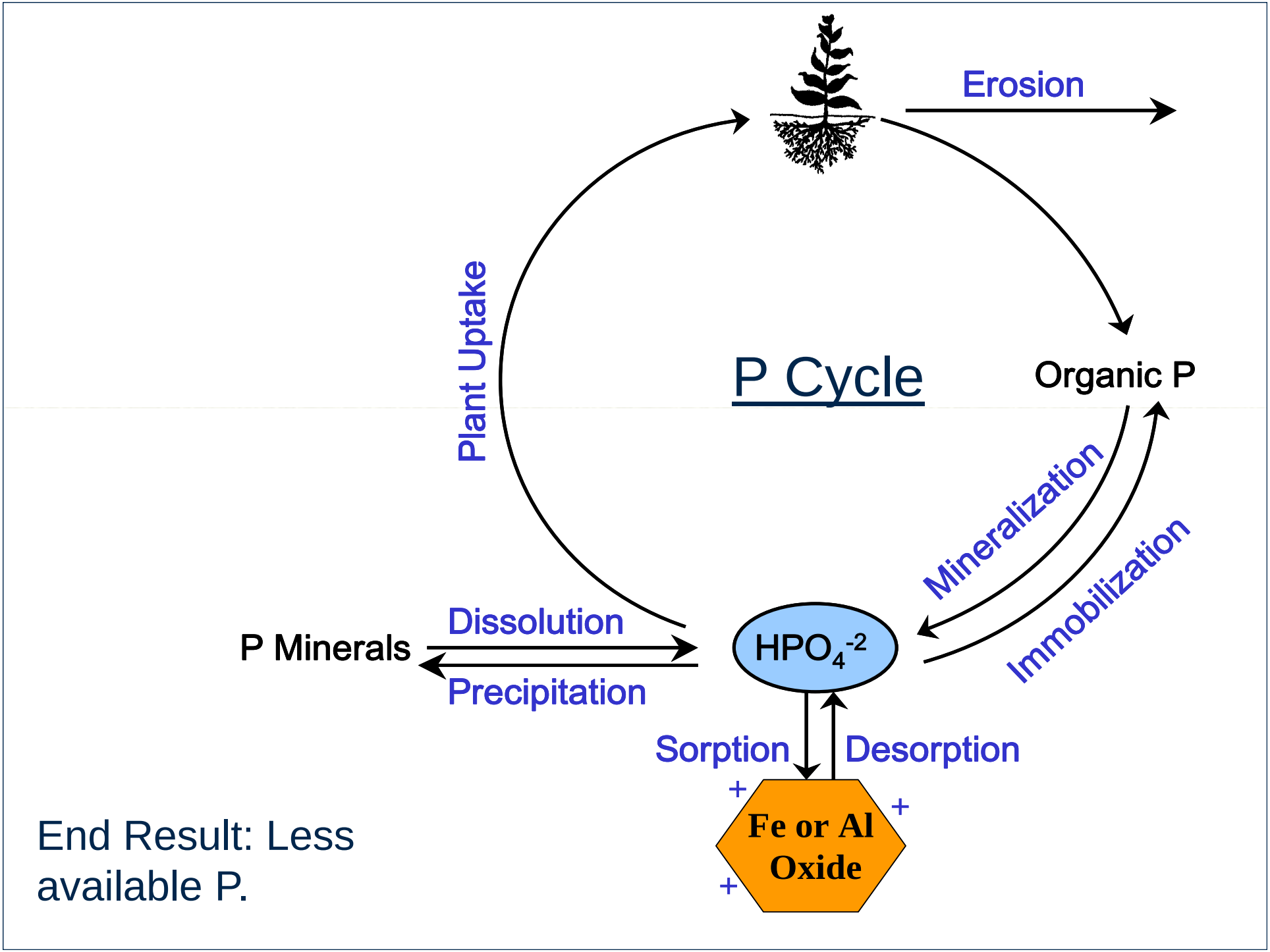
(Montana Fertilizer Guidelines (EB-161) recommend decreasing N at lower yield potentials but keeping P and K the same.
Basis: Both for simplicity and b/c goal is to raise soil test level to an optimum level)

Differences may be partly due to relative amount of irrigation in both states.

QUESTIONS SO FAR?

How does drought affect cycling of N, P, and K?

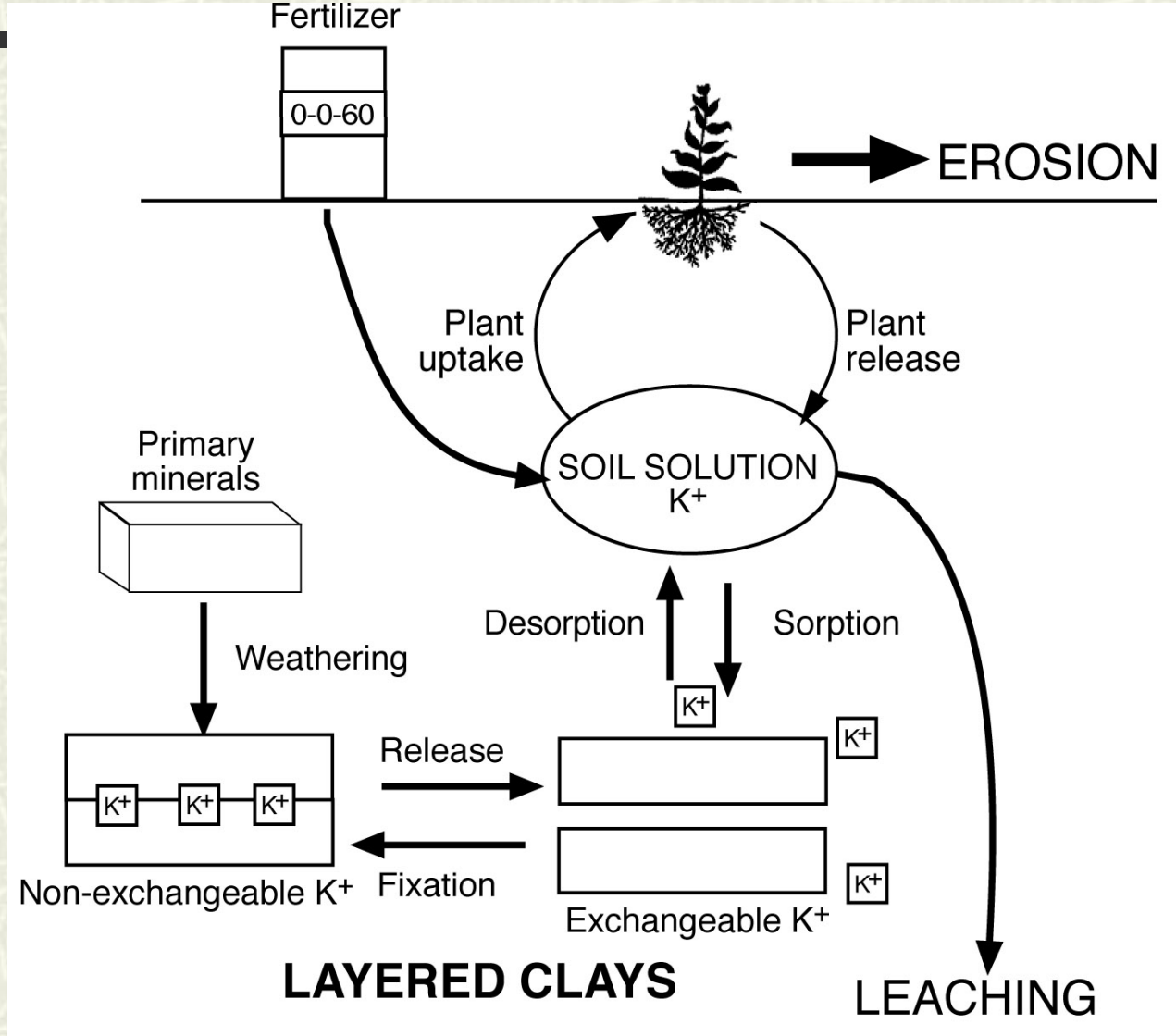

Nitrogen Fixation
$N_2(g)$
NH_3 (g)
Denitrification
Plant Uptake
Plant Uptake
Volatilization
Organic Nitrogen
NO_3^-
Mineralization
Nitrification
Immobilization
NO_2^-
Leaching
NH_4^+
Exchange
NH_3
Clay
or O.M.
End Result: More available N.
The N Cycle



End Result: Less available P.

Potassium Cycling

End Result:
Less available K.



Summary

- Nutrient cycling is altered in drier soils
- N needs generally decrease in dry year, though N can increase water use efficiency
- P and K needs may remain about the same, or increase, and both increase drought tolerance
- More seed germination problems from seed-placed fertilizer (N and K) when soil is drier
- Soil testing is important in extended dry periods to optimize yields

For additional information

http://landresources.montana.edu/soilfertility

Questions?