Nutrient Management with Limited Water

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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

Spring Wheat

Low = 9 in.
Mod. = 14 in.
High = 19 in.

Havre, MT
R. Engel
Fertilizer Fact #25

Available N (soil + fertilizer), lbs/a

Yield, bu/a

Low
Moderate
High

= MEY

1996

0 100 200 300

0 20 40 60 80
What other shape yield response curve might occur with low water? WHY?
Effect of N on Yield and Water Use Efficiency (WUE)
N Requirement based on Available Water

Spring Wheat

1996-1998

\[ y = 9.81x - 35.8 \]

\[ R^2 = 0.90 \]

Available water, inch

N requirement, lbs/a

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

- **Dry**
  - WUE (lb biomass/1000 lb water)
  - Applied P (lb P₂O₅/ac)
  - Levels: 0, 15, 50
  - Letters: a, bc, c

- **Wet**
  - WUE (lb biomass/1000 lb water)
  - Applied P (lb P₂O₅/ac)
  - Levels: 0, 15, 50
  - Letters: ab, bc, c

- **Medium STP**

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*Note: The diagram shows the effect of applied P on water use efficiency for both dry and wet conditions, with different levels of biomass production and water use efficiency.*
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.

Effect of K fertilizer on corn grain yield

![Bar graph showing the effect of K fertilizer on corn grain yield.](https://via.placeholder.com/150)

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$_2$O$_5$, 10-15 lb K$_2$O/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.
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?
The N Cycle

Nitrogen Fixation

$N_2(g) \rightarrow NH_3(g)$

Plant Uptake

$NH_4^+ \rightarrow NO_3^-$

Densitrification

$NO_2^- \rightarrow NH_3$ (g)

Plant Uptake

Organic Nitrogen

$NH_4^+ \rightarrow NO_3^-$

Nitrification

$NO_2^- \rightarrow NH_3$ (g)

Leaching

Nitriificaiton

$NH_4^+ \rightarrow NO_2^-$

Mineralization

Volatilization

End Result: More available N.

The N Cycle

Clay or O.M.
End Result: Less available P.
Potassium Cycling

End Result: Less available K.
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?