Soil Testing and Nutrient Management in and after Dry Years

Central Ag Research Center Research Roundup
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Questions for you

• What nutrient issues did you see this year?
• Were your nitrate-N levels this fall any different this year than last few?
• How was protein?
Goals for today

• Explain how drought directly impacts plant nutrients
• Offer suggestions to increase drought resiliency
• Describe soil testing
• Discuss drought effect on next year’s fertilizer needs
Drought affects plant nutrients

Plants
• Roots don’t reach nutrients or deep water
• Lacking evapotranspiration to “suck up” nutrients
• Poor N-fixation

Nutrients
• Low nutrient availability from soil
• Nutrients don’t move easily in dry soil to reach roots
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
Increase cropping intensity – recrop or cover crop

- Increases SOM
  - Takes time
  - Increases water holding capacity
- Rely more on legume N or manure N than fertilizer N if possible. *Both release more N when wet which is when you need more.*
Reduced fallow has apparently reduced regional spring and summer air temperature. June 15 to July 15 maximum temps (1976-2000) have dropped almost 3°F/decade in parts of Canadian Prairies likely due to large decrease in fallow acres (Gameda et al., 2007).
Encourage mycorrhhizal association for N and P uptake

Mycorrhiza reach places roots can’t.

Plants with better nutrient status can manage drought stress better.

There is not a lot of evidence that mycorrhhizae improve response to drought, where nutrients are not limiting.
Questions?

On to soil testing and N
Drought on the following year fertilizer needs

Lower yields = higher residual soil N, as long as not leached

Fall soil nitrate in a wet vs dry year in central and north-central MT

Adjust N for next season
Capture with a fall planted crop or a shoulder cover crop

Data from AgVise
Drought on the following year’s fertilizer needs

Lower yields = less nutrients removed by harvest

Change in material harvested (grazed or salvaged hay vs grain) changes nutrients removed

<table>
<thead>
<tr>
<th>Amount/acre</th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain</td>
<td>40 bu</td>
<td>50</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Straw</td>
<td>1.8 ton</td>
<td>26</td>
<td>7</td>
<td>45</td>
</tr>
<tr>
<td>Hay</td>
<td>2 ton</td>
<td>50</td>
<td>20</td>
<td>76</td>
</tr>
</tbody>
</table>

Change in decomposition of residue
• immature residue decomposes faster than mature residue
• decomposition is slower in dry soils

P and K recycling changes depending on fall precip
So with all these unknowns, what should you do?

Soil Test!

- Take to 2 ft depth for N, 6” for P and K
- Consider sampling N to 3 ft if didn’t reach yield goal on previous crop or two
- Ideally taken in spring for N to adjust for overwinter changes, avoid under- or over-fertilization
November to April nitrate changes, Montana data based on 180 samples (Jones et al. 2011)

Nitrate decreased overwinter
Nitrate increased overwinter

April - Previous November Nitrate Change (lb N/ac)
Conceptual spring to fall soil nitrate-N differences
Actual Montana Data

P. Miller, C. Chen and C. Jones
unpub. data

after wheat harvested grain
no straw removal

Moccasin 2009
Denton 2000
Amsterdam 2001
Havre 2000
Moccasin 2008
Moccasin 2006
Moccasin 2007

CARC 30-yr avg ± 1 std.

Gain
Overwinter N
Loss

Late summer/early fall to spring nitrate-N change (lb/ac)

Fall to spring (Sept to April) precipitation (inches)
What else will affect overwinter soil nitrate differences?

- Organic matter
- Temp
- Soil texture
- Previous crop
- Initial soil nitrate and moisture
- Coarse and shallow soils (< 2 ft) and soils with > 60 lb N/acre in the fall are most likely to have lost N overwinter
Soil testing tips

• After unusual weather years, not a good time to invest in intense grid sampling b/c might be misleading for future years.

• Taking ‘good’ core samples in dry soil can be challenging – try to wait for some soil moisture

• Yields may be more variable across a field in drought, thus nutrient uptake and removal is more variable – on the go yield monitors can be helpful
Recommendations for Nitrogen

- Ideally, sample in early spring to avoid over- or under fertilization. Late fall if not possible.
- Apply additional N if needed. Lower N rate if fall to early spring is dry (since limited leaching).
- Lower early N – allows flexibility for given year’s precip, prevents excess vegetative growth.
- N credits will be lower than ‘usual’ after drought because they are partially biomass dependent.
Questions?

On to P and K
Drought on soil P and K

- P and K soil levels may be higher than average
- Long wet fall conducive to more decomposition of residue, increasing K levels
- Dry fall would lead to less P and K recycling from residue to soil.
P increased water use efficiency, thus drought tolerance, when initial soil test P was “low”

“drought” = no water for 21 days starting at initial flowering

Jin et al., 2015, Australia, field pea grown in buried cylinders under field conditions
Balanced N and P result in highest water use efficiency especially when start pushing the system with high N. In 1990 N rates started doubling.

Kroebel et al., 2012. SK
In dry years, it’s tempting to back off on all fertilizer, including P and K, best choice?

(Olsen P = 16-20 ppm; added 30 lb P₂O₅/ac; Scott, SK)

Environmental stress and K

• Higher K for drought, cold, heat, high light, salinity tolerance (Wang et al., 2013)
• Stressed plants may actually need more K
• “Luxury consumption” may be insurance against environmental stress (Kafikafi, 1990)
• Foliar K between 2 weeks before anthesis to grain fill can improve yield in drought stress (Shabbir et al., 2016, Pakistan; Raza et al., 2013, Pakistan)
Effect of K on Corn Grain Yield

"Medium" Soil Test K

Corn Yield (bu/ac)

K fertilizer (lb K₂O/ac)

Wet years
Dry years

Recommendations for P and K

• In dry years, use the same amount of P and K fertilizer as in a “normal” year

• P, K and S important for legume nodulation – don’t ignore
Sulfur can increase WW yield in drought years

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

And protein in both wet and dry years

Ffact No. 41, Knees, MT
Summary

• Consider management to increase O.M. and water capture and retention for long term resiliency.
• Account for nutrient removal by harvest, plant part harvested, maturity of residue
• Fall conditions influence decomposition rate, N availability, P and K recycling
• Catch residual N with a fall planted cover or cash crop. Soil test and adjust N rate in spring.
• P and K likely different from average, adjust according to 6” soil test.
For more information

http://landresources.montana.edu/soilfertility