SOIL NUTRIENTS AND SMALL GRAIN DISEASE

Custer County

September 2, 2015

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MSU Soil Fertility Extension

Goal

- Present relationship between soil nutrient management and disease potential
- Suggest N management for healthy plants to minimize disease and lodging
- Present management considerations for other nutrients to consider in disease prevention

Nutrients and disease interaction

- Healthy plants are less likely to have substantially reduced yields because of disease
- Insufficient nutrients can leave plants stressed and more susceptible to attack by insect and disease pests
- Over fertilizing (especially N) can create:
  - environment favorable to diseases (rusts, septoria, powdery mildew, and some viruses)
  - Lodging
  - Excess foliage with light kernels
- The key is nutrient balance with right rate, time, placement, source and rotations

Image from MT200913AG

How does one recognize excess N?

- With lodging resistant varieties, presence of lodging is no longer a very useful indicator of excess N
- Grain protein and flag leaf N are not good indicators of excess N in irrigated hard red winter wheat (Brown and Petrie, 2006)
- Soil test

How do I determine N fertilizer amount? Basic steps for all crops

1. Determine yield potential
2. Determine available soil nutrient level – soil test

3. Look up suggested nutrient guidelines for given crop and yield in *Fertilizer Guidelines for MT Crops* or crop specific bulletins (e.g. pulse, forage)
4. Calculate difference between what is available in soils and what is needed to get fertilizer recommendation

Online tool for MSU fertilizer recommendations @ www.sarc.montana.edu

Example N rate calculation

- Based on field history, example reasonable yield goal is 50 bu/acre
- Soil N test from top 2 feet
- Soil test in spring if possible. Why? Soils can:
  - Gain N over winter, especially in high organic matter soils with moderate precipitation
  - Lose N over winter, especially in soils with >60 lb N/acre
- Look up N guidelines in *Fertilizer Guidelines for MT Crops*

Date Sampled

Nutrient In The Soil		Interpretation			
		VLow	Low	Med	High
0-6"	15 lb/ac				
6-24"	24 lb/ac				
24-42"	63 lb/ac	********			
0-24"	39 lb/ac				

Soil N = 39 lb/ac

WHEAT-WINTER	
Yield Potential (bu/a)*	Available N (lbs/a) **
30	78
40	104
50	130
60	156
70	182
80	208
90	234

N rate adjustments

- Suggested rate –residual N: 130 – 39 = 91 lb N/acre needed
- Stubble: small grains stubble is high in carbon to N (C:N). Adjust fertilizer N up by 10 lb N/1000 lb stubble up to 40 lb N
- After fallow: assume ½ of stubble has decomposed over previous year, cut additional N for stubble in ½
- After cover crop/legume rotation:
  Adjust fert N rate down, they add N to soil

Crop	N credit (lb N/acre)
Alfalfa	~40
Annual legume 1x	~10
>3x	~20
Legume cover crop 1x	~20-30
>3x	~30-50

N rate adjustments (cont)

- SOM
  - <1% SOM, add 15-20 lb N/acre
  - >3% SOM, reduce 15-20 lb N/acre
- Tillage – No-till may require extra N for 6 to 15 years

Image in EB0182

Optimize fertilizer N rate

Danger of aggressive N fertilization?

- Increased disease and lodging risk
- Hot dry season, low protein discounts, lower net returns, and higher leaching/volatilization N losses.
- In wet year if all N is applied early can lead to excess tiller production and decreased yields.
- Risk of high forage nitrates

Strategy to avoid these possibilities?

- Use a conservative pre-plant N rate
- Apply a 2nd application if needed

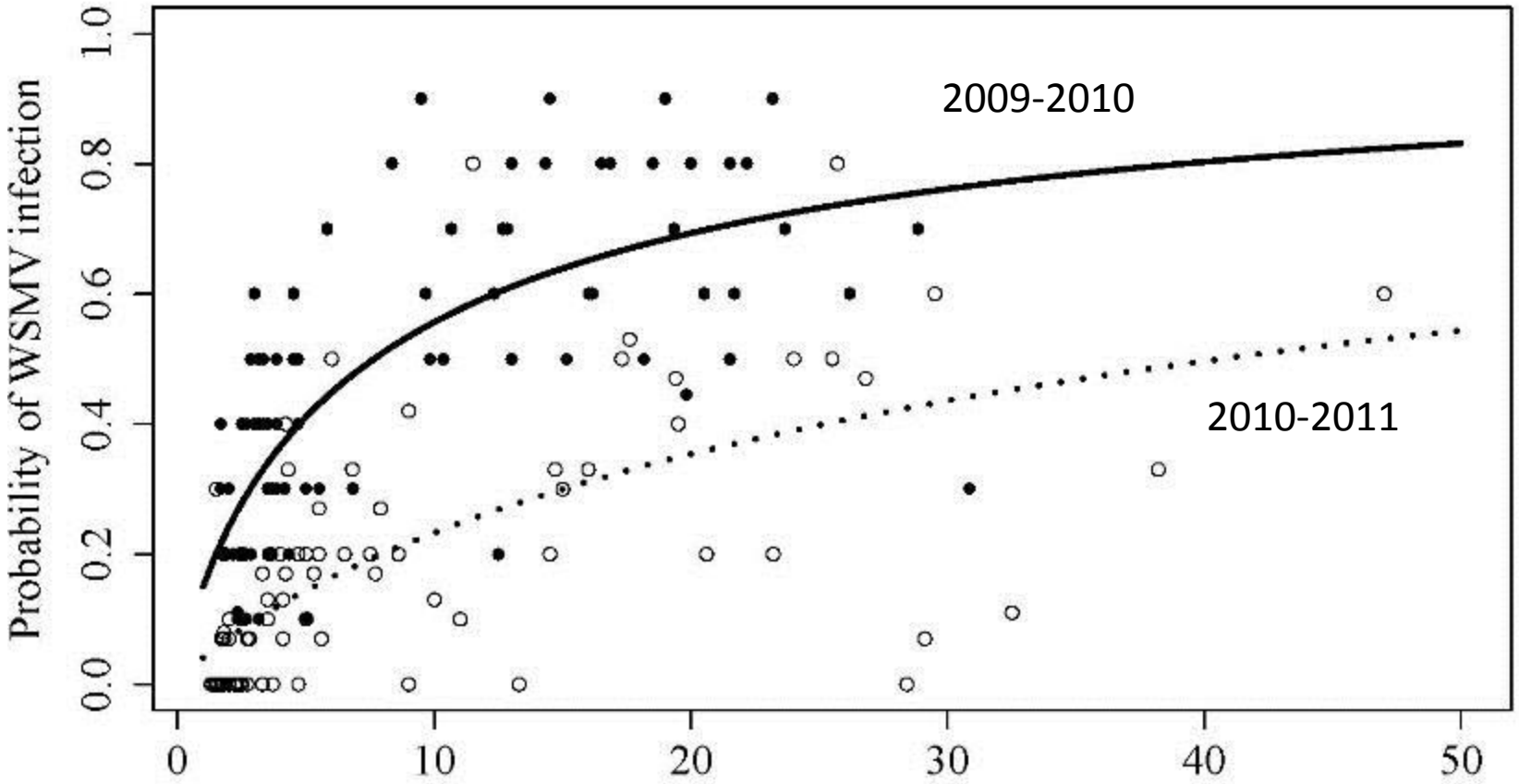
Split/In-season N Applications

- Fall broadcast supplies early growth needs
- In-season adjustment for estimated yield potential based on precip to date
  - Don't apply 2nd application if dry
  - Apply large 2nd application if wet
- Later applications:
  - Less chance of causing lodging
  - Potential to increase protein rather than yield

Timing

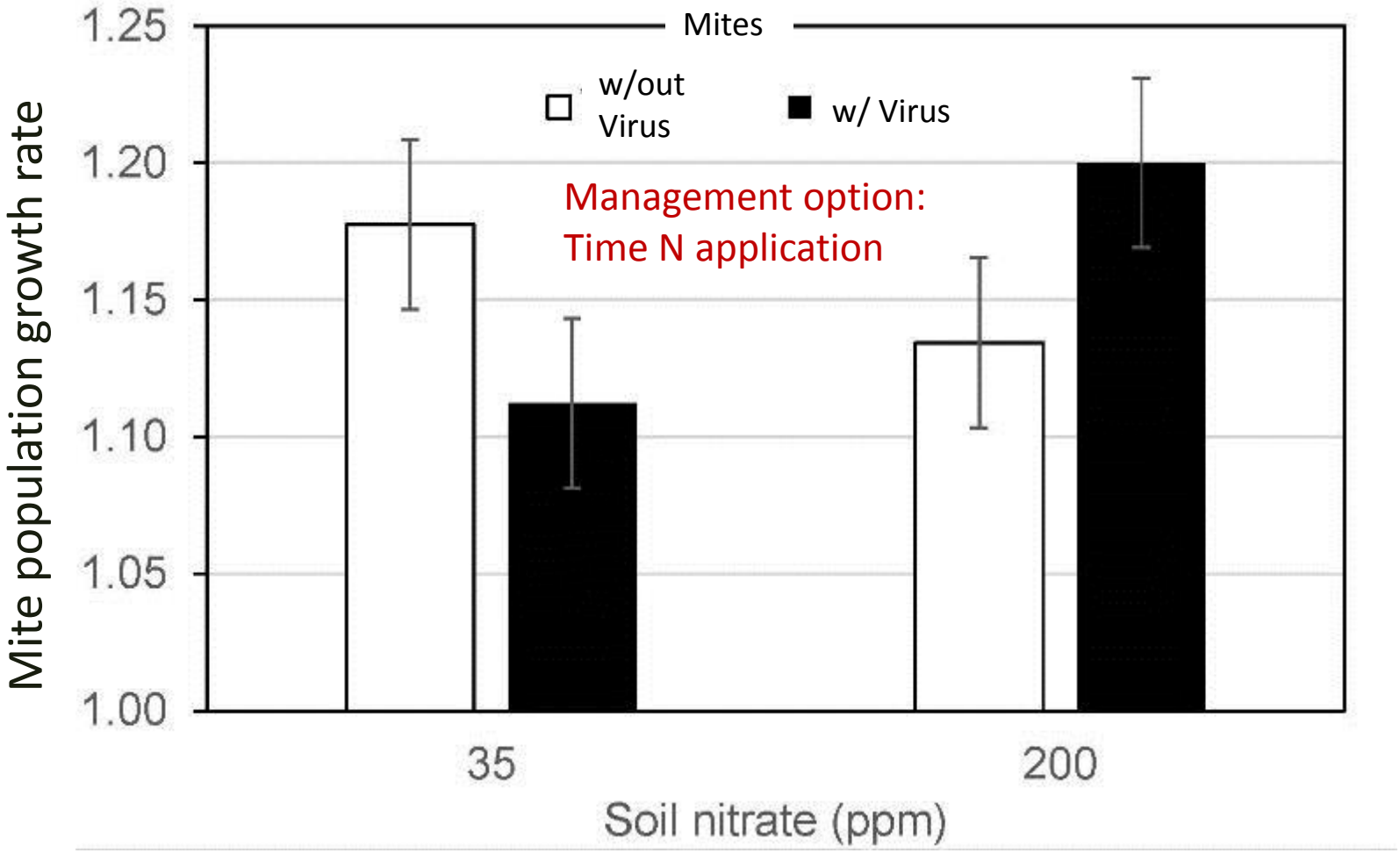
- To reduce disease and lodging
- To optimize uptake of fertilizer N
- To reduce economic and environmental risk

Example: Soil N increases wheat streak mosaic virus susceptibility



Miller et al., 2015
Gallatin Valley

Mite population growth rate with N rate



At high N, mites with virus increase more than mites w/out virus

Miller et al., 2015
Gallatin Valley

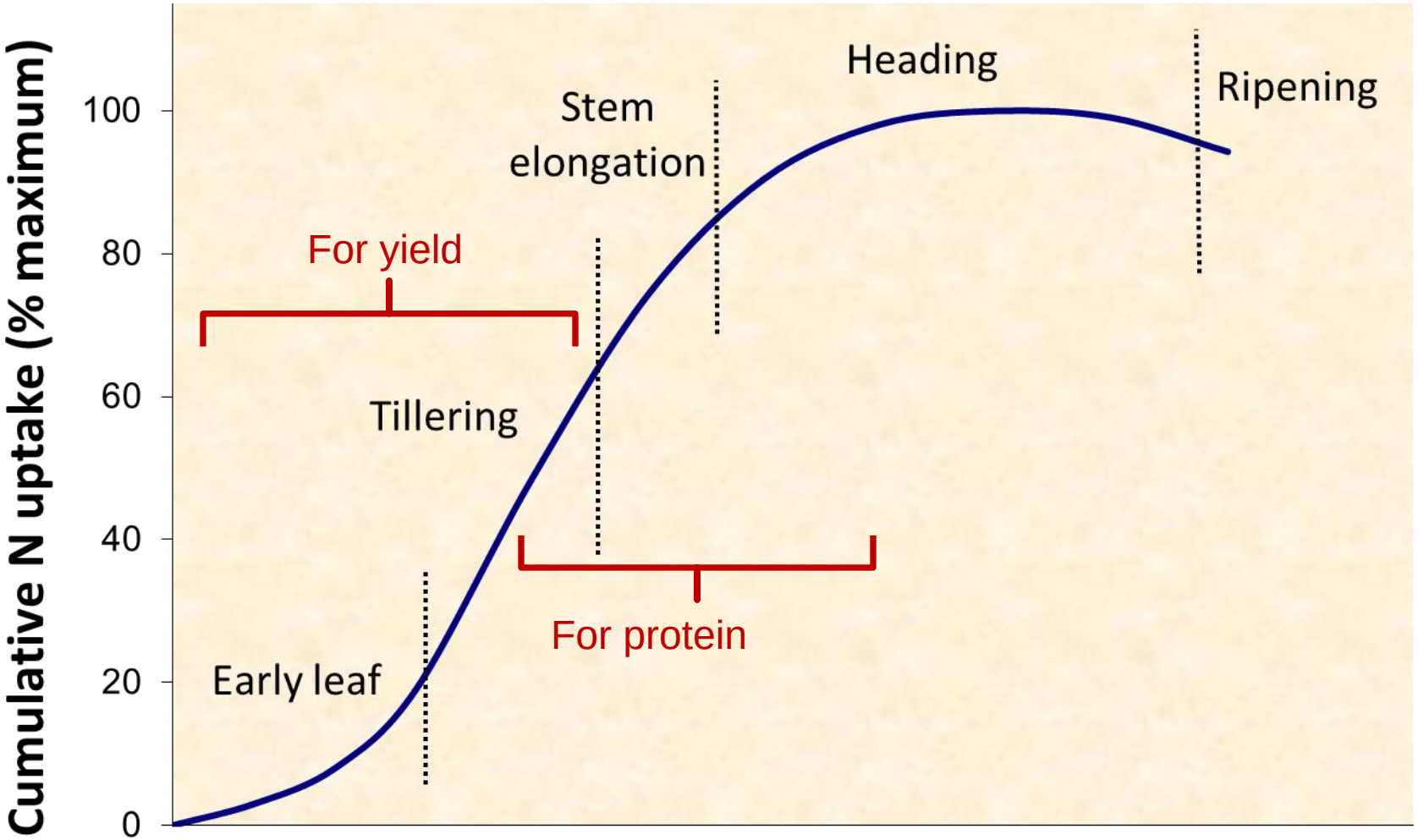
Timing depends on source

- Slowly available (Manure and slow-release N)
  - take time to become available
  - apply well before needed – e.g. in fall and incorporate

Image courtesy Agrium, rights reserved

- Readily available (urea, ammonium)
  - Apply when needed – e.g. spring
  - foliar/liquid options

Timing depends on source – N must be *available* to benefit yield and protein



More info in *Nutrient Uptake Timing* (EB0191)

Timing considerations

- In-season N needs to be ‘incorporated’ with water – a ½ inch in one event as rain or irrigation.
- If there is risk of scab do not irrigate within 5 days of flowering, so do not fertilize within that time
- In irrigated systems delay N until early stem elongation or later to reduce lodging

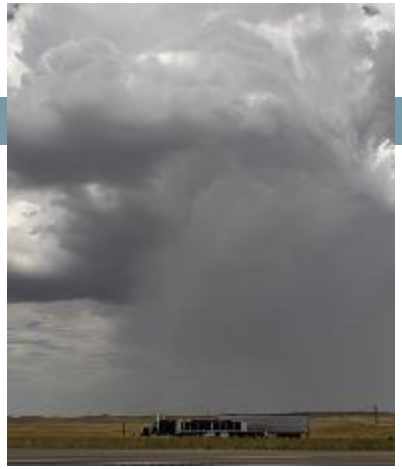
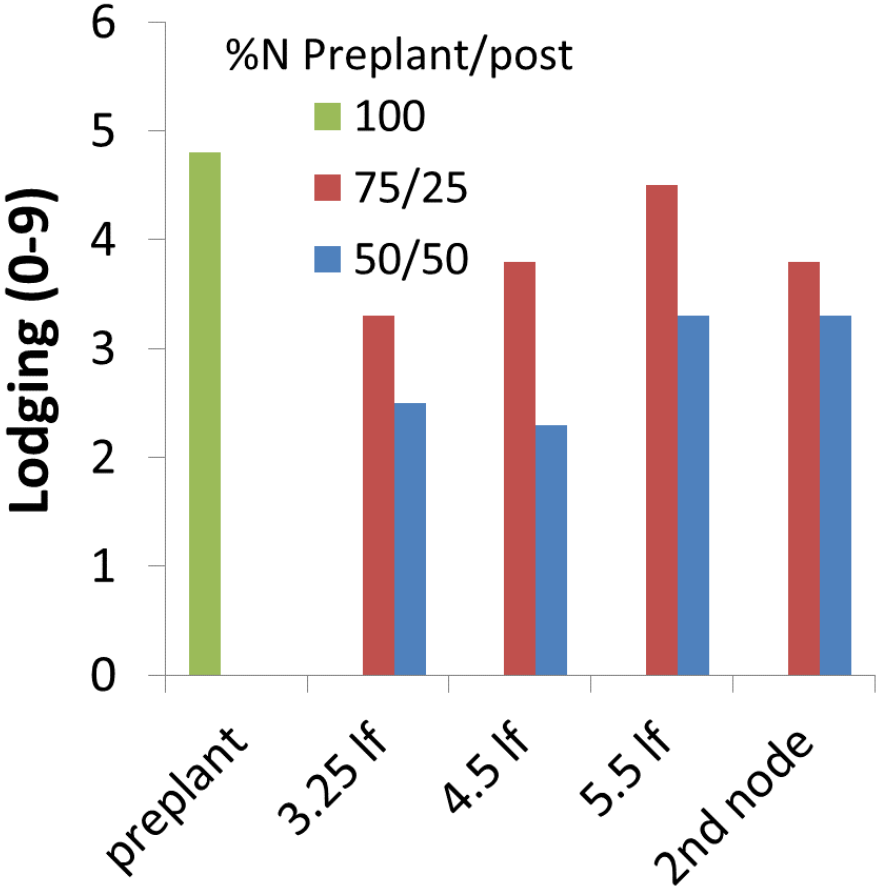


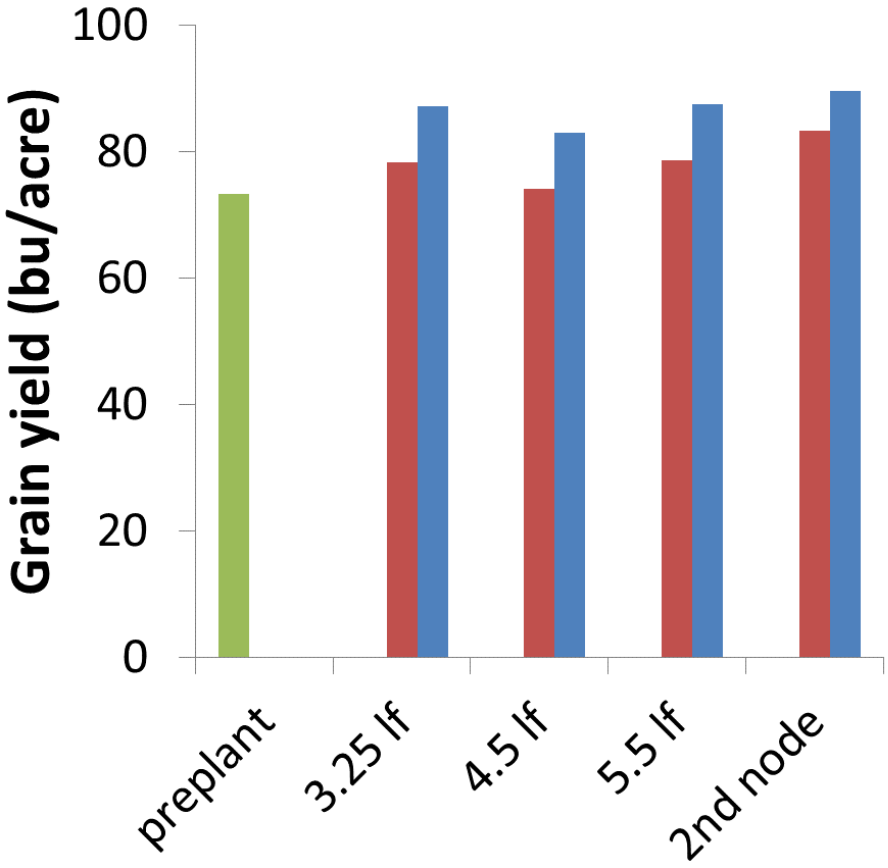
Image by BisonDoc

Image in MT200806AG

Timing and N rate on lodging with irrigation

Total N 180 lb/ac, ≈ 96 lb N as fertilizer
Pre-plant incorporated urea
Post emergent 28% UAN streamer bar





Plant Growth at Time of N Application

Hendrickson et al., 2003
Carrington, ND

Questions?

N source

- Urea and ammonium based N must be incorporated by tillage or water to reduce volatilization loss
  - $CO(NH_2)_2 + H_2O \rightarrow 2(NH_3) + CO_2$; $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$
- UAN has lower volatilization loss
- Addition of NBPT, active ingredient of Agrotain® reduces volatilization loss for a few weeks
- Foliar N fertilizer burn can reduce yield. Foliar should be moved to soil by water to be effective
- Polymer coated and controlled release fertilizers release N too slow if applied late winter or spring

Crop rotations to manage disease

- Break disease cycles
- Increase soil health
- Use excess nutrients
- Legumes provide N

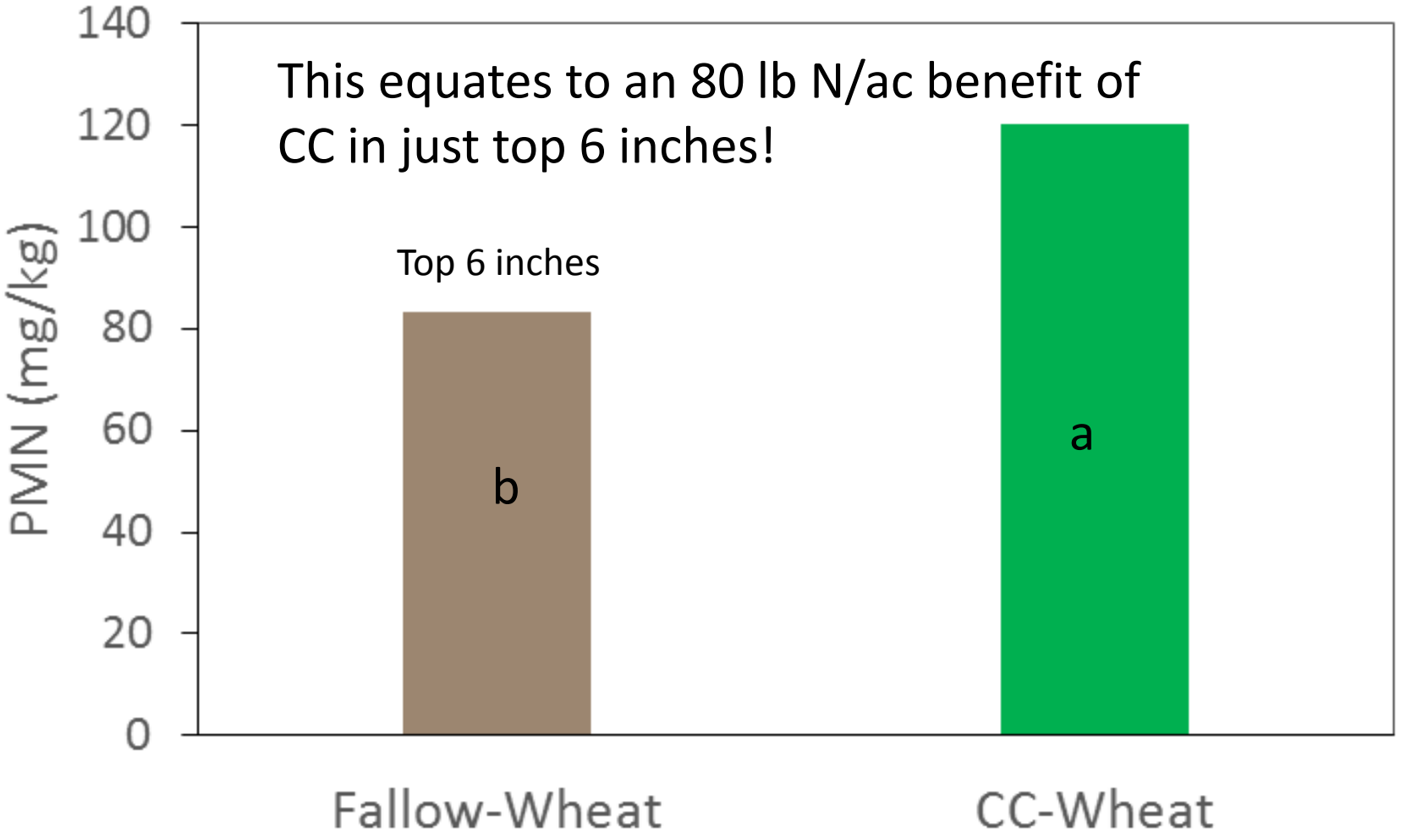
Image from MSU Extension

Legumes in rotation

- The increased soil microbial diversity and activity following legumes usually promotes biological pest control
- When is soil N and economic benefit realized?
  - Legumes provide N credit after 1 year but wheat yield goal is lower than after fallow
  - Protein benefit comes before yield benefit
  - Economic benefit comes after several rotations

    more stability *and* less dependence on N fertilizer

Potentially mineralizable N (PMN)
Cover crop (pea)-wheat vs fallow-wheat (April of 8th yr)



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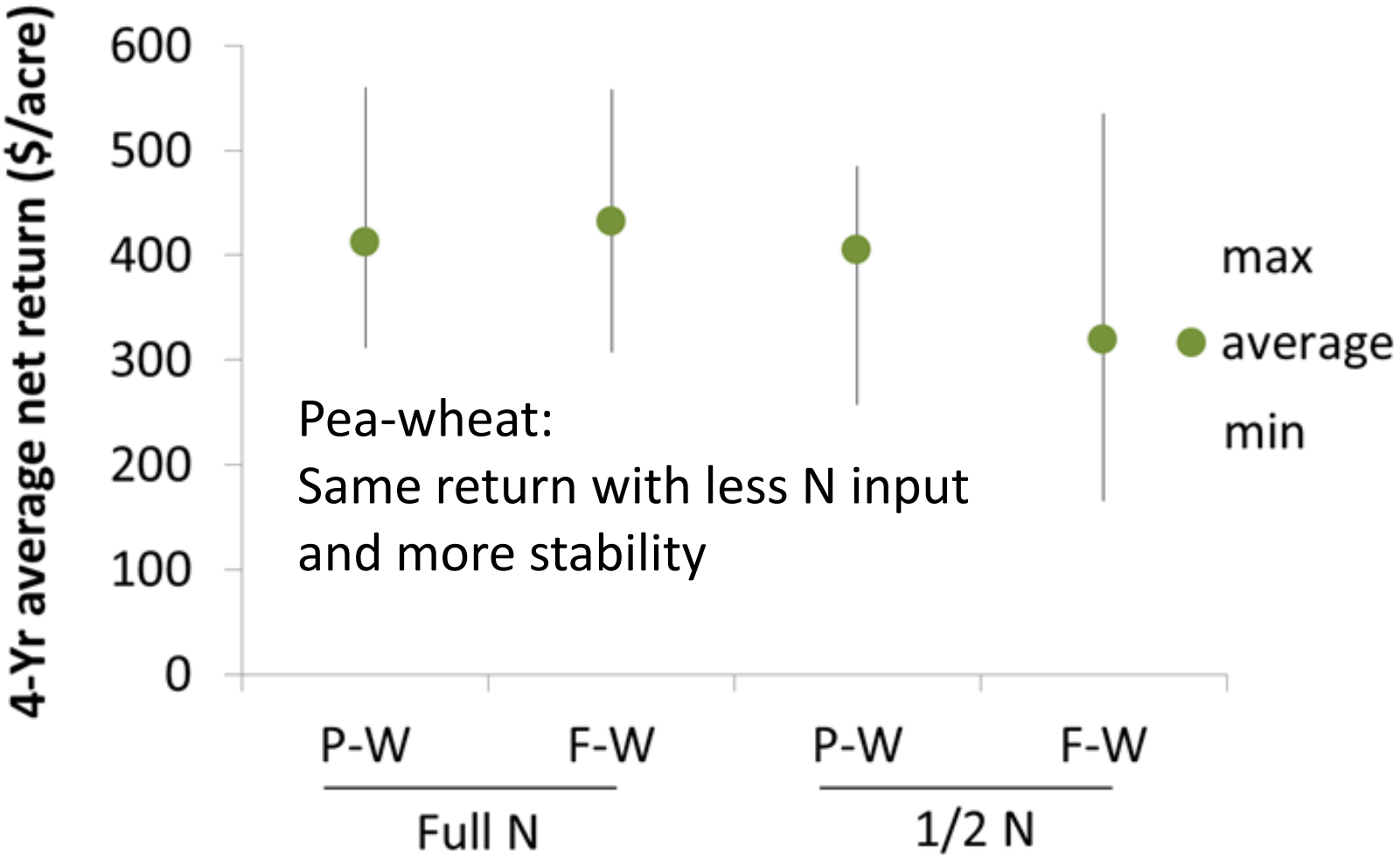
(Pea)

O'Dea et al. (2015)

Economics



Gallatin Valley
Miller et al., 2015

Other nutrients to consider

- Sufficient but not excess nutrients and healthy soils are the best approach
- Specifically consider
  - Phosphorus (P)
  - Potassium (K)
  - Chloride (Cl)
  - Copper (Cu)

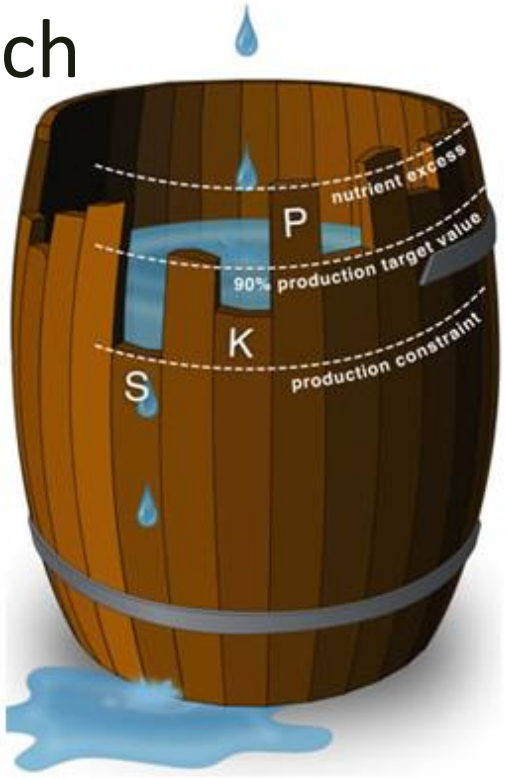
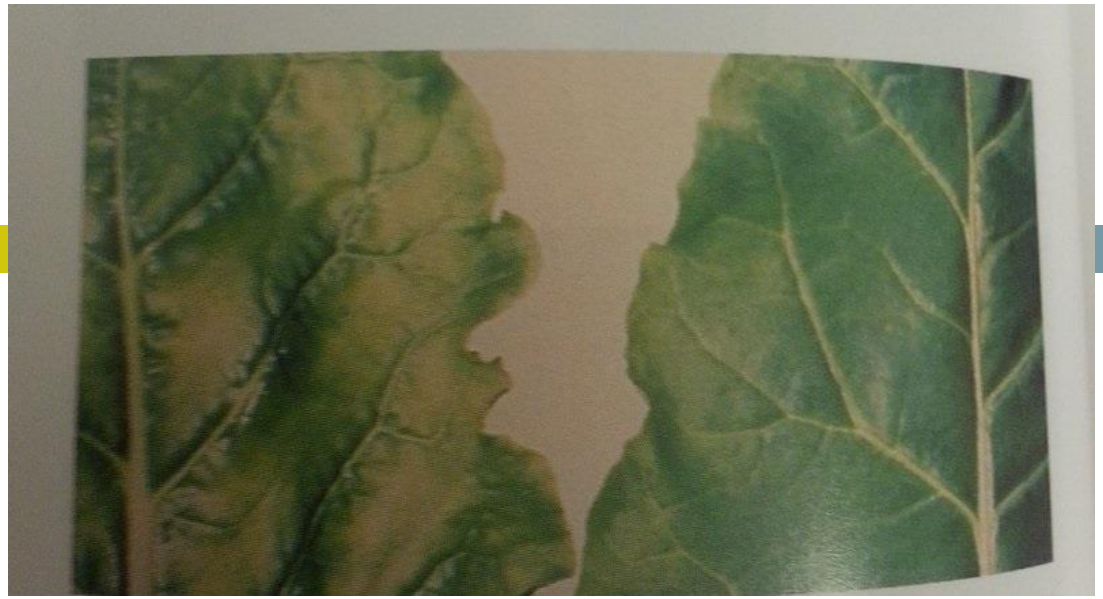


Illustration courtesy Government of Western Australia Dept. of Agriculture and Food


P helps winter wheat resist winterkill
Starter P gives spring wheat a strong start
Both sides received fall-banded 70-30-10-10
10 lb of starter P_2O_5 with seed
No starter P
Incorporate prior to seeding or place in rooting zone at seeding

Potassium (K), chloride (Cl) and disease

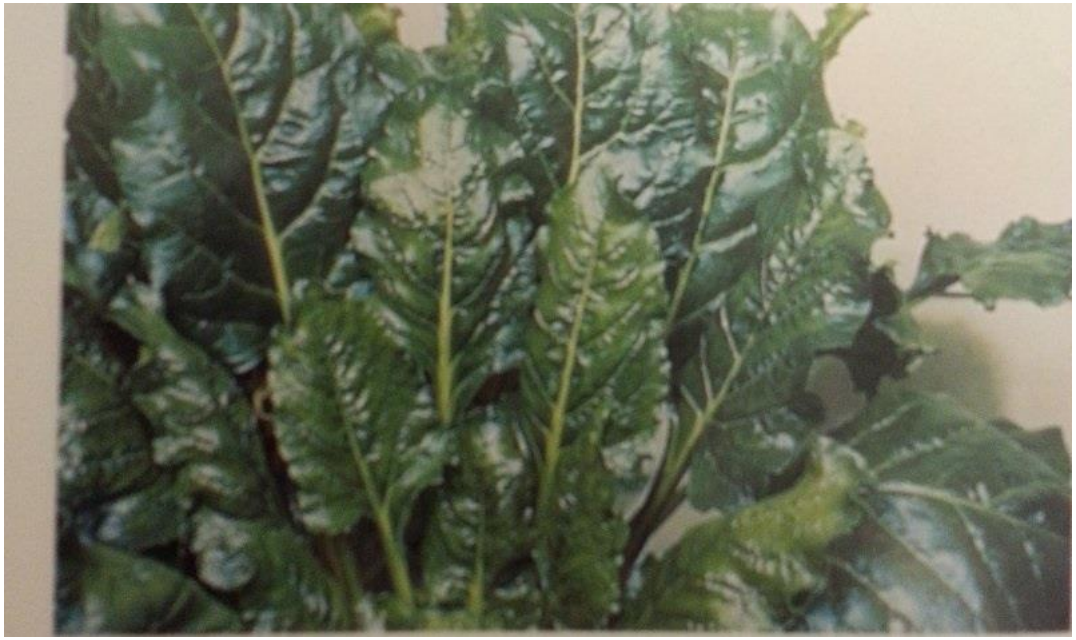
- K increases plant strength and ability to resist disease
- Leaf rust, leaf spot, powdery mildew, root rot reduced in part by Cl portion of KCl fertilizer (Sweeney et al., 2008; Karamanos and Flore, 2000).
- 20 lb KCl/acre prior to seeding may provide enough Cl
- If soil test K > 125 ppm in top 6" still get yield benefit from 25 lb K_2O seed-placed KCl (Karamanos and Flore, 2000). Recommended especially for varieties susceptible to disease.



Chloride Deficiency Symptoms

Interveinal chlorosis

Appears on new leaves
(not translocated)

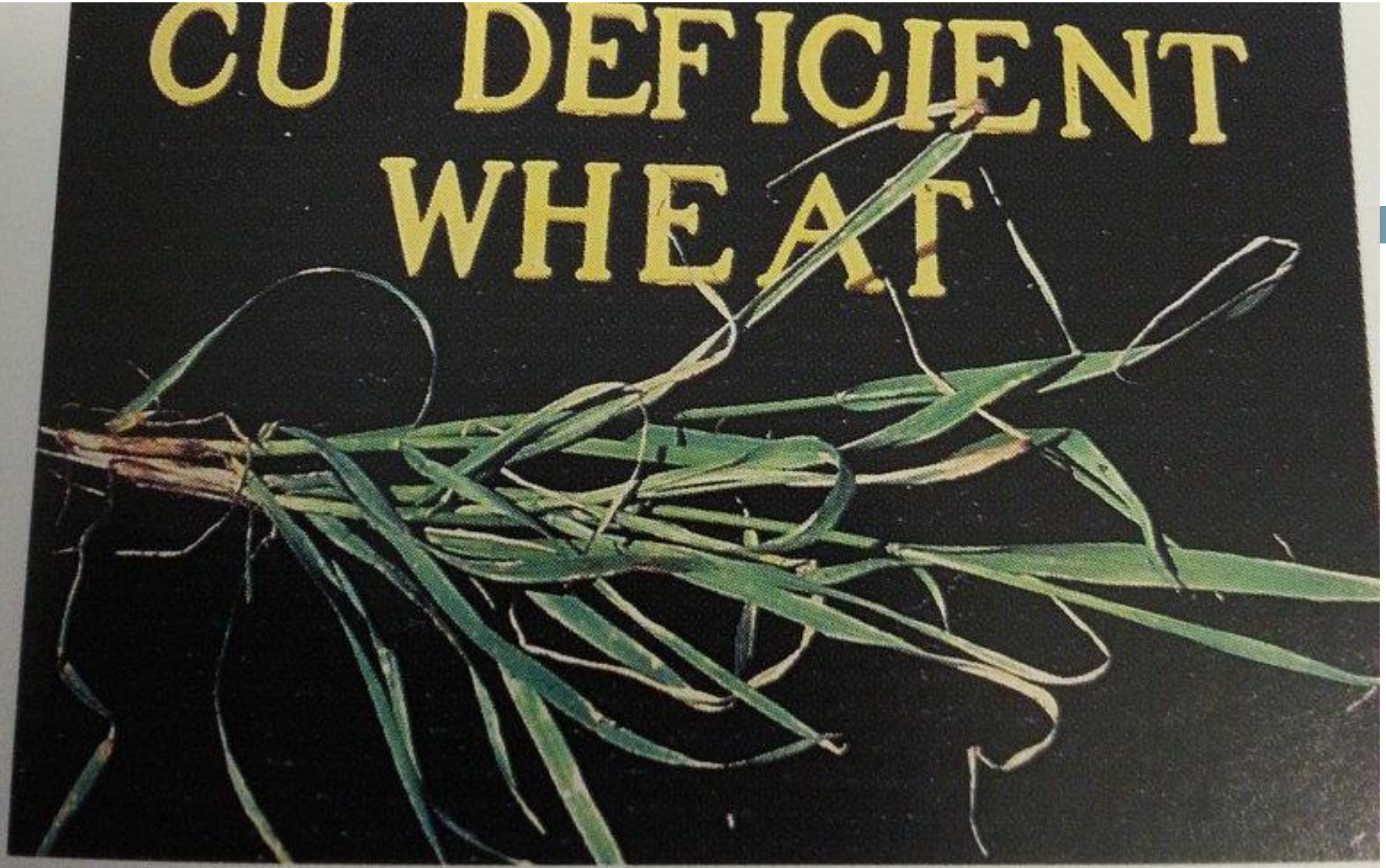


From: Nutrient Deficiencies & Toxicities In Crop Plants, Ed. W.F. Bennett, 1993

Copper effect on wheat disease

- Cu has little effect on leaf rust or tan spot in spring wheat (Franzen et al., 2008).
- Cu applied pre-plant reduced Fusarium head blight incidence and severity, increased yield, especially in sandy soils, organic matter < 2%, or soil Cu < 0.5 ppm (Franzen et al., 2008).
- If soil Cu < 0.4 ppm, Cu may increase spring wheat yield in Canadian Prairies (Karamanos et al., 2003), but not found in N. Dakota (Franzen et al., 2008).
- Broadcast and incorporate 3.5 lb/acre as Cu sulfate better yields and economics for 4 years than annual seedrow 3.5 lb/acre (sulfate or chelate; Karamanos et al., 2005)

Better than



73. Leaf tips of wheat discolored and distorted fro
Cu deficiency.

From: Nutrient Deficiencies & Toxicities In Crop Plants, Ed. W.F. Bennett, 1993

Summary

- Use soil testing and published suggested nutrient rates
- Split N application
- Timing depends on source, if intended for yield or protein, potential for incorporation, and disease/lodging risk
- Crop rotations break disease cycles and can be excellent source of N
- Adequate amounts of P, K, Cu and Cl early on help build strong plants and reduce disease

Questions?

For more information on soil nutrient management see Clain's website

http://landresources.montana.edu/soilfertility/