Nutrient Concentrations and Balance in Corn Tissue Under Field Conditions

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(emeriti)

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Rationale

- Modern high yielding corn hybrids need more nutrients

  corn yields have increased 100 % in 20 years

- Different nutrient needs across growth stages

  can nutrient supply keep up with crop needs

- Location / area specific

  soil organic matter *and* ***mineral differences***

- Hybrid differences ?
- Are nutrient adequacy guidelines appropriate ?

Review

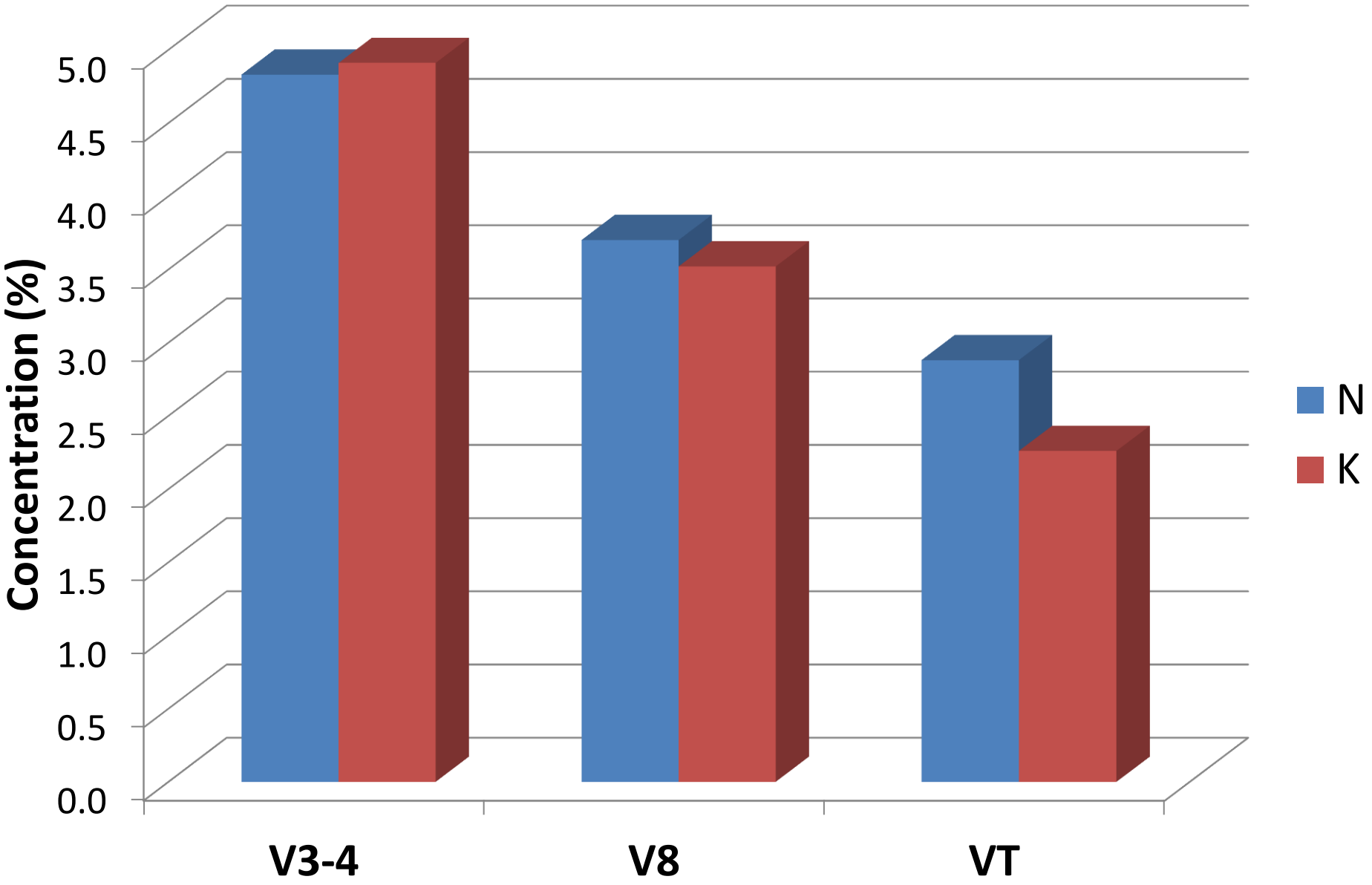
Year 1 (2012)

- Demonstrated that ear-leaf concentrations were the most likely to indicate deficiency
- Some indication of hybrid and location differences
- Most ear-leaf nutrient concentrations appeared to be dependent on leaf N status

Year 2 (2013)

- - New Observations - -

Effect of Growth Stage *Shelton - 2012*



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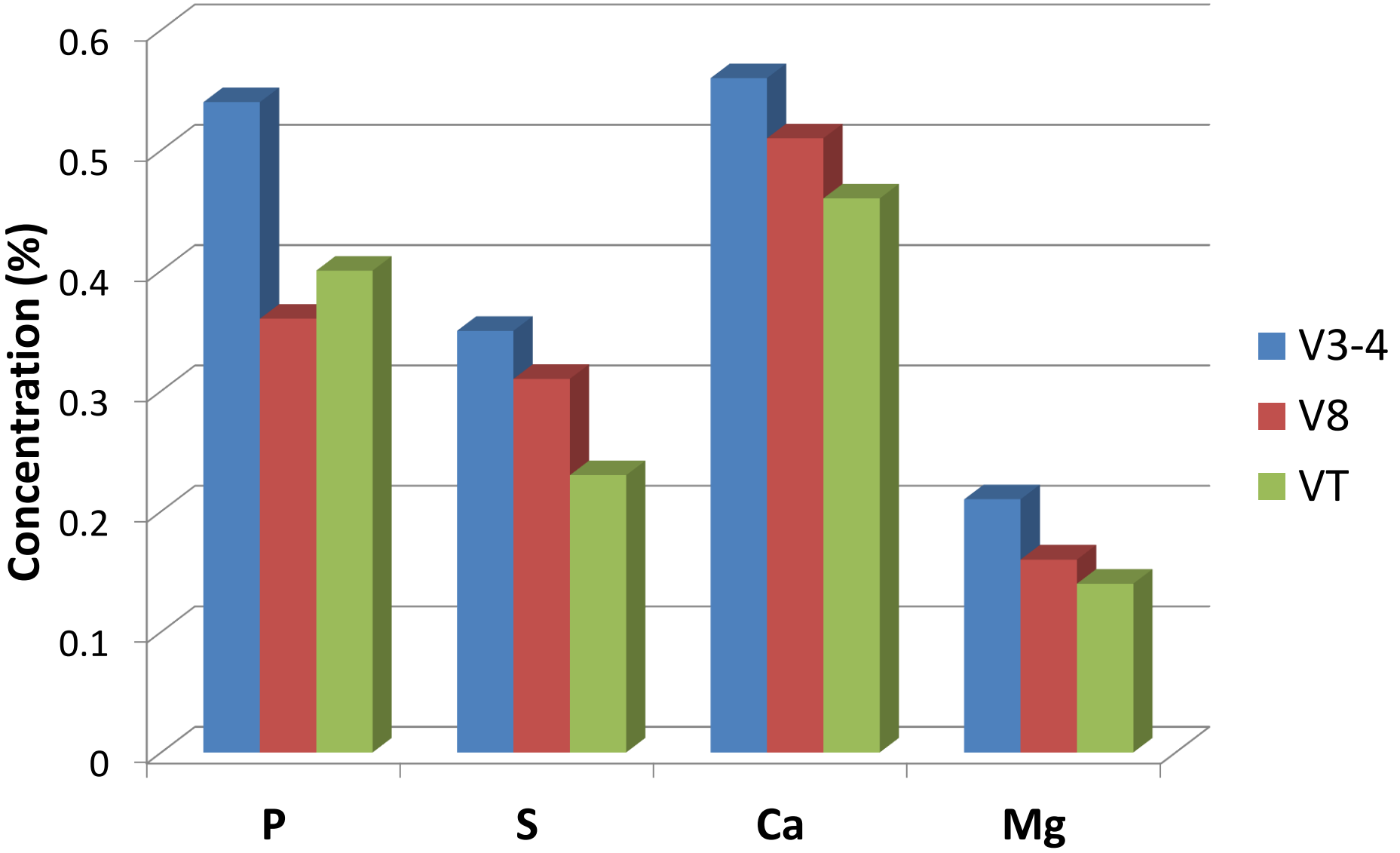

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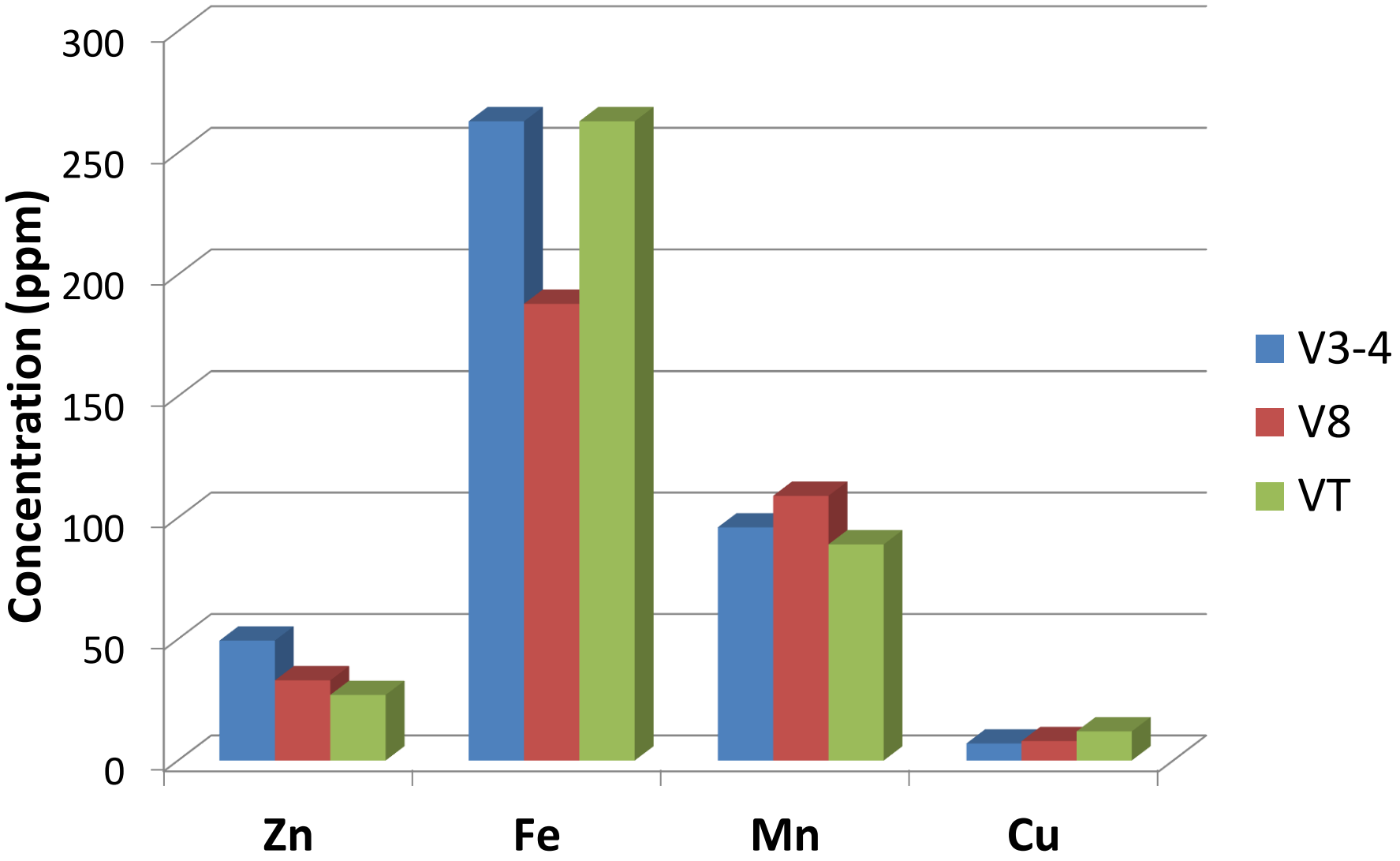


Sample :

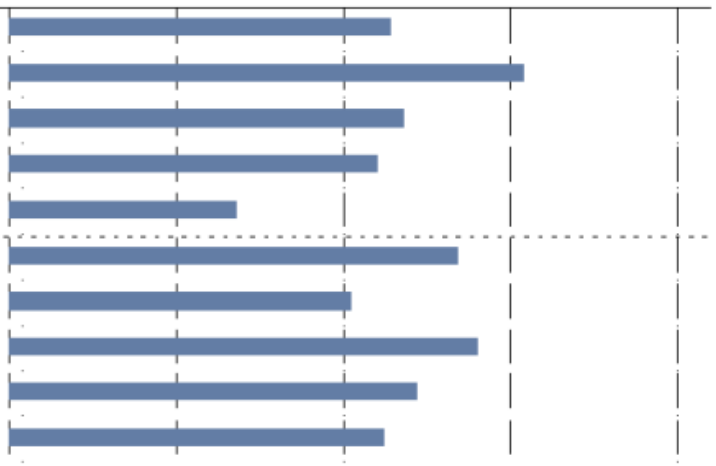
Tissue Testing Results

Results For : RS
Location : CORN
Sample ID : 305

Plant Type : Corn
Stage : Tassel

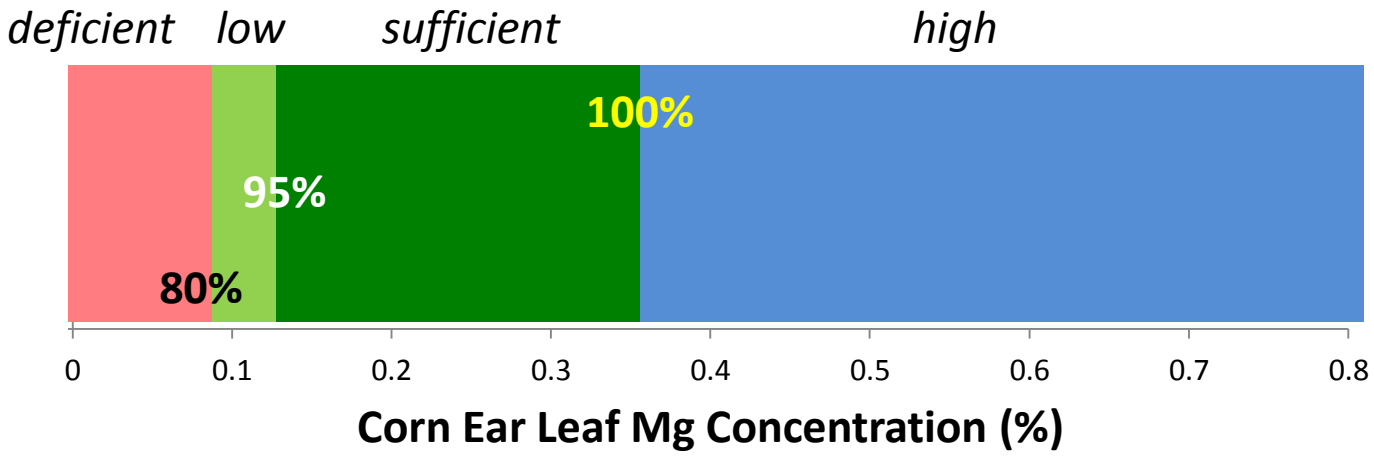
	Result Dry Basis
Nitrogen ,% N	2.90
Phosphorus, % P	0.37
Potassium, % K	2.22
Calcium, % Ca	0.357
Magnesium, % Mg	0.116
Sulfur, % S	0.22
Zinc, ppm Zn	20
Iron, ppm Fe	247
Manganese, ppm Mn	77
Copper, ppm Cu	8.9

Mg

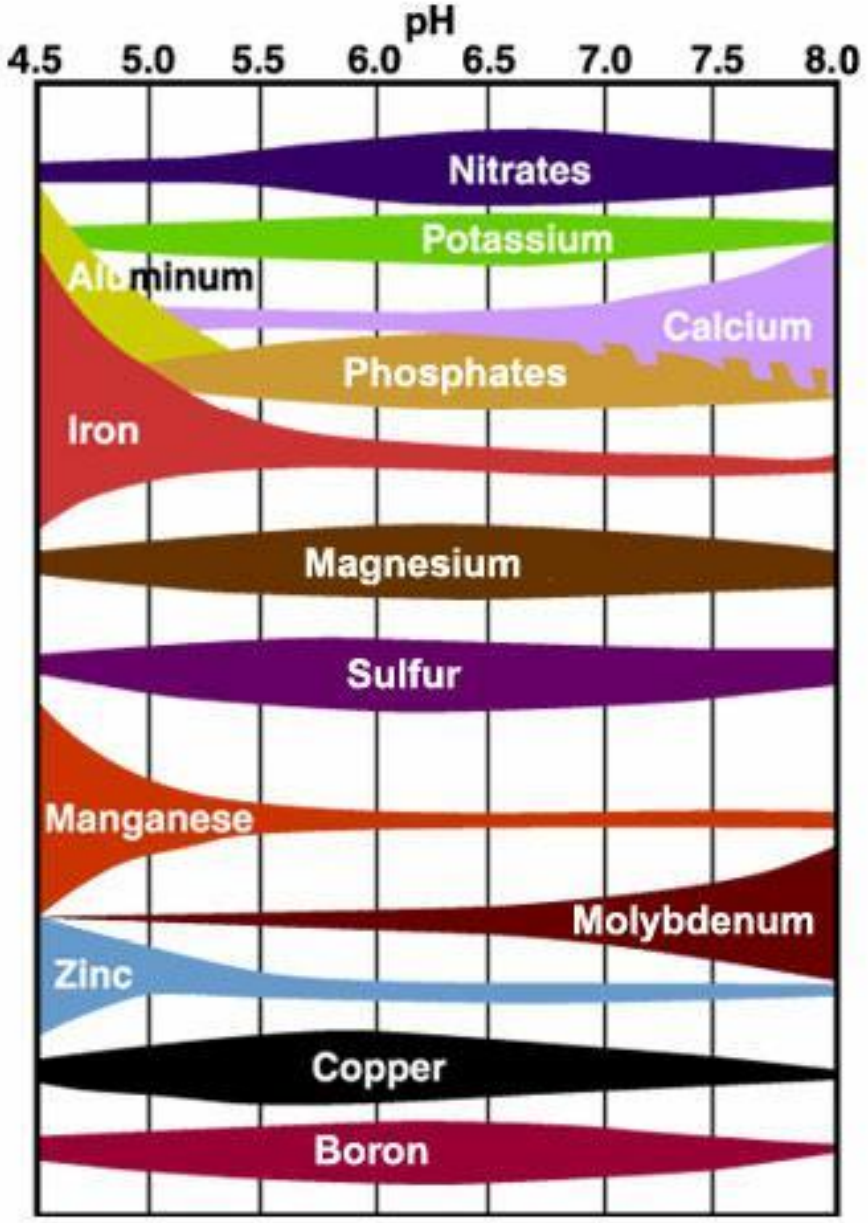


Sufficiency Level Delineation

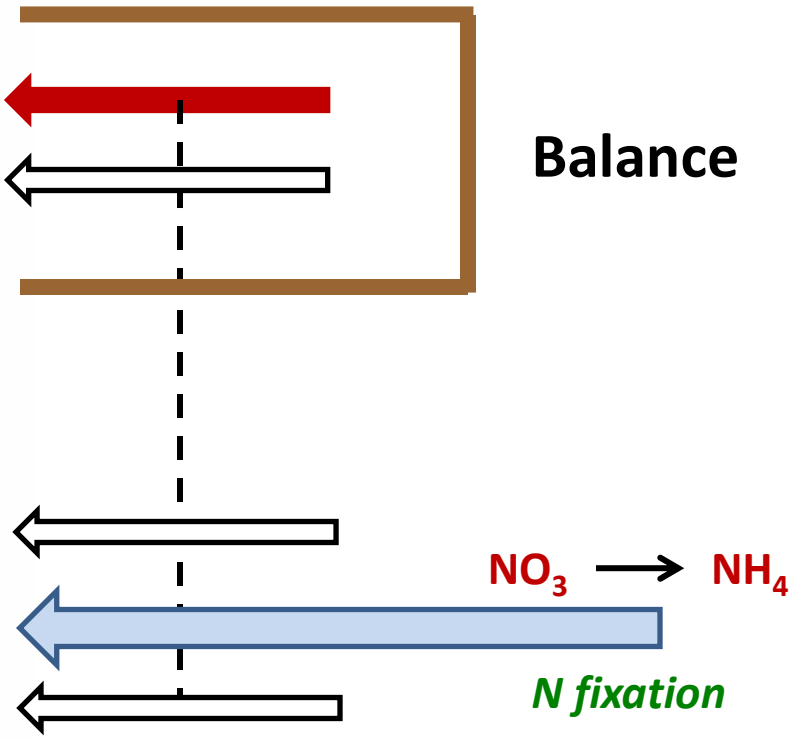
Range	Yield	Symptoms
Deficient	<80 %	deficiency present
Low	80 – 95 %	hidden hunger
Sufficient	95 – 100 %	normal yield
High	100 % ***down to 70 %***	excessive / toxic



Effect of pH on Nutrient Availability



Interactions and Antagonisms



Nutrient Mobility in Plants

Very Mobile

N P K Mg

Deficiency Symptoms - "**Older** leaves first"

Moderately Mobile

S Cu Fe Mo Mn Zn

Deficiency Symptoms - "**New** growth first"

Immobile

Ca B

Deficiency Symptoms - "**Stunted** development"

Relative Nutrient Uptake

(average five corn hybrids)

Pounds / Acre

Primary

N -	156.9
P -	36.2
K -	222.4

Secondary

Mg -	19.1
Ca -	22.5
S -	12.8

Micro

Fe -	2.2
Mn -	0.4
Zn -	0.3
Cu -	0.1
B -	<0.1

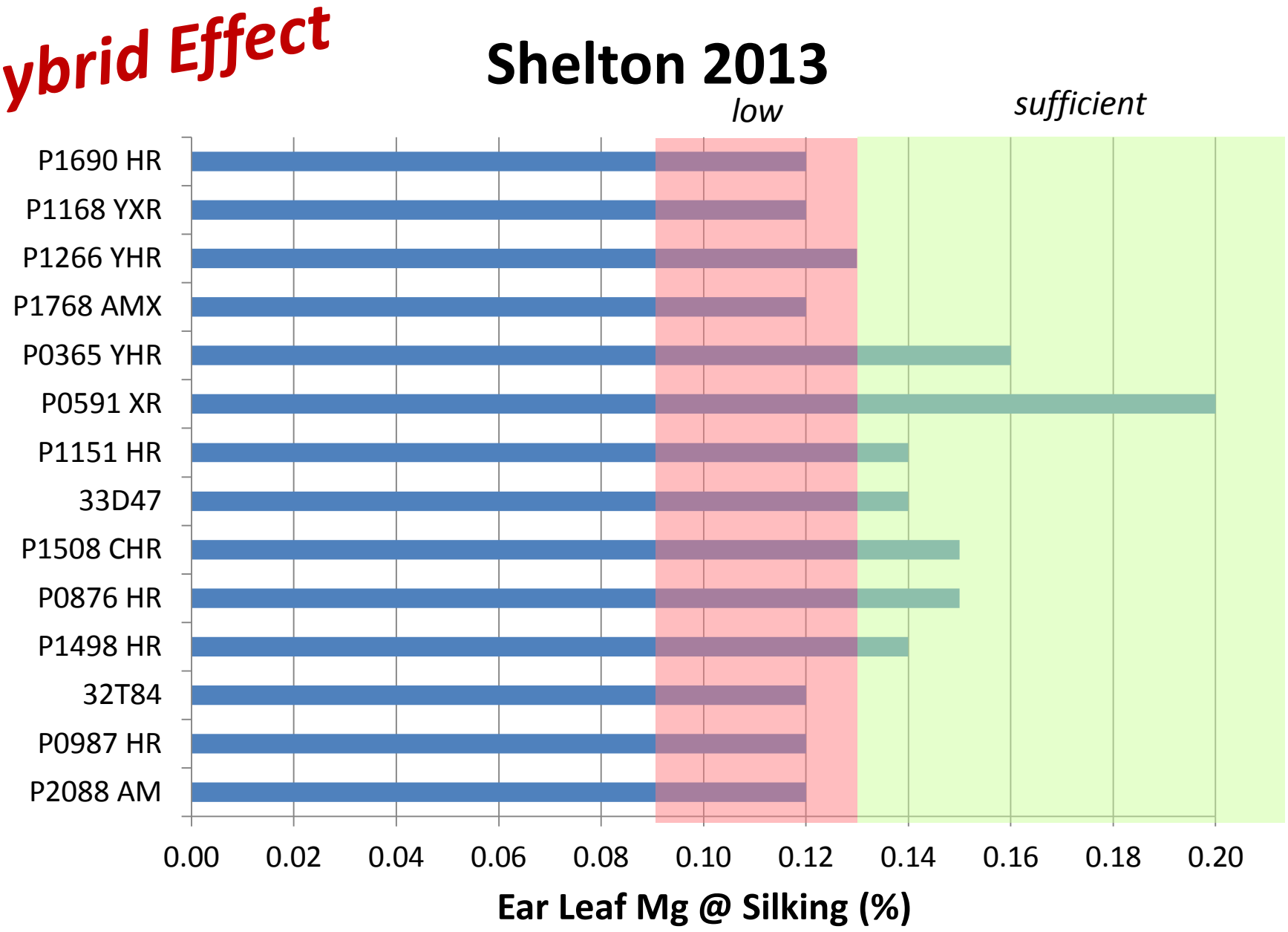
Other

Cl -	25.7

Yield - 179.3 bu/acre

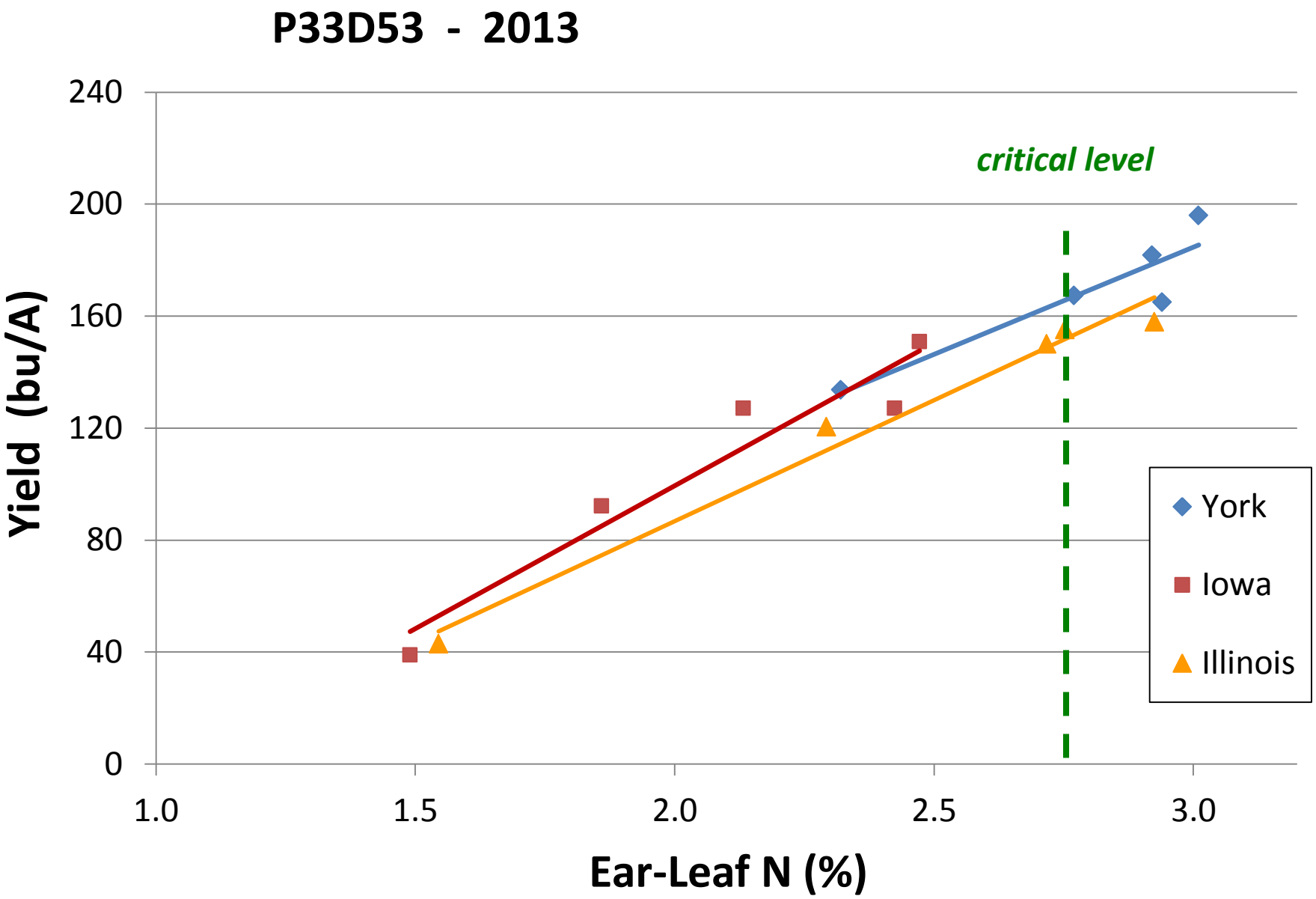
All Locations - 2013 VT

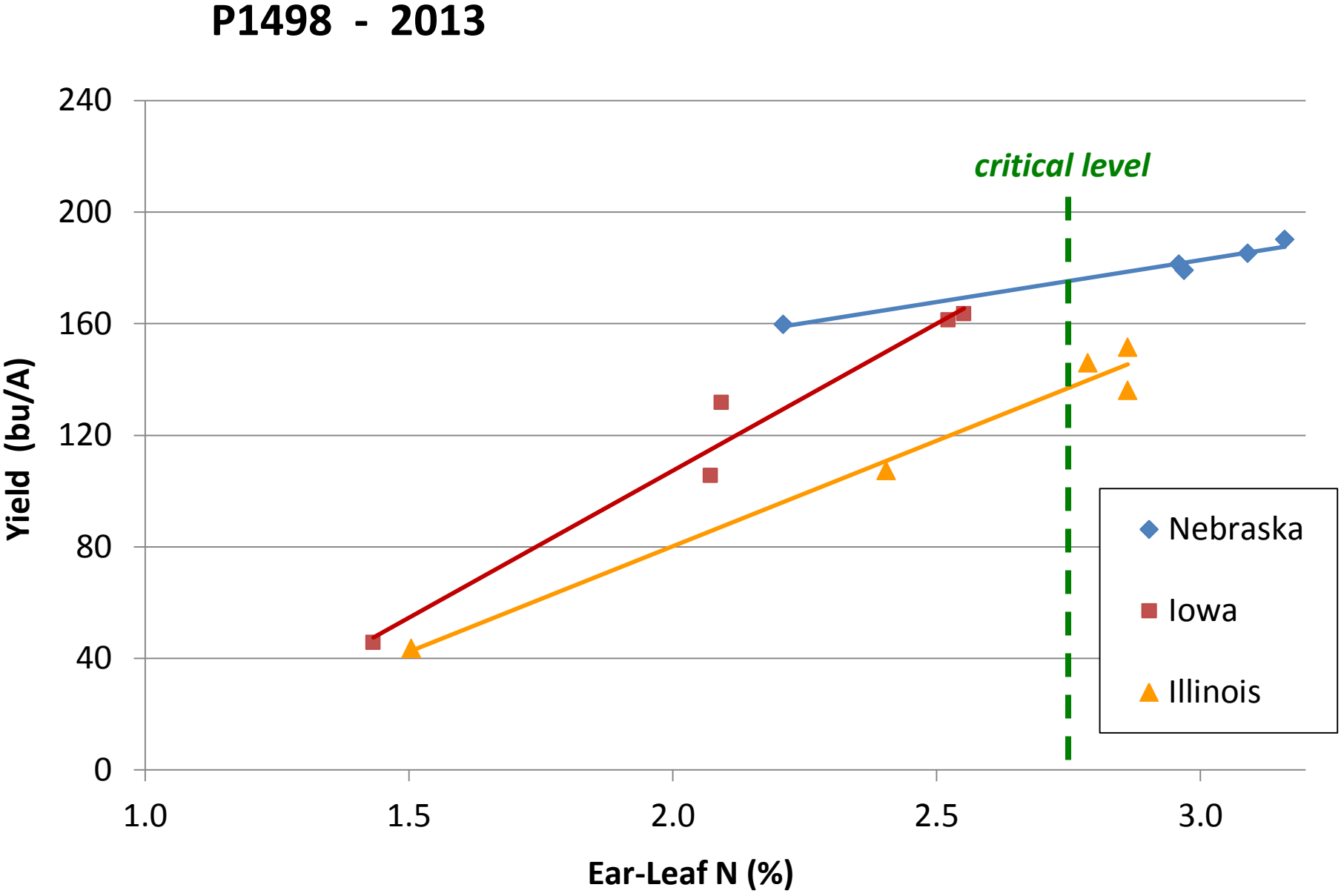
Hybrid Effect

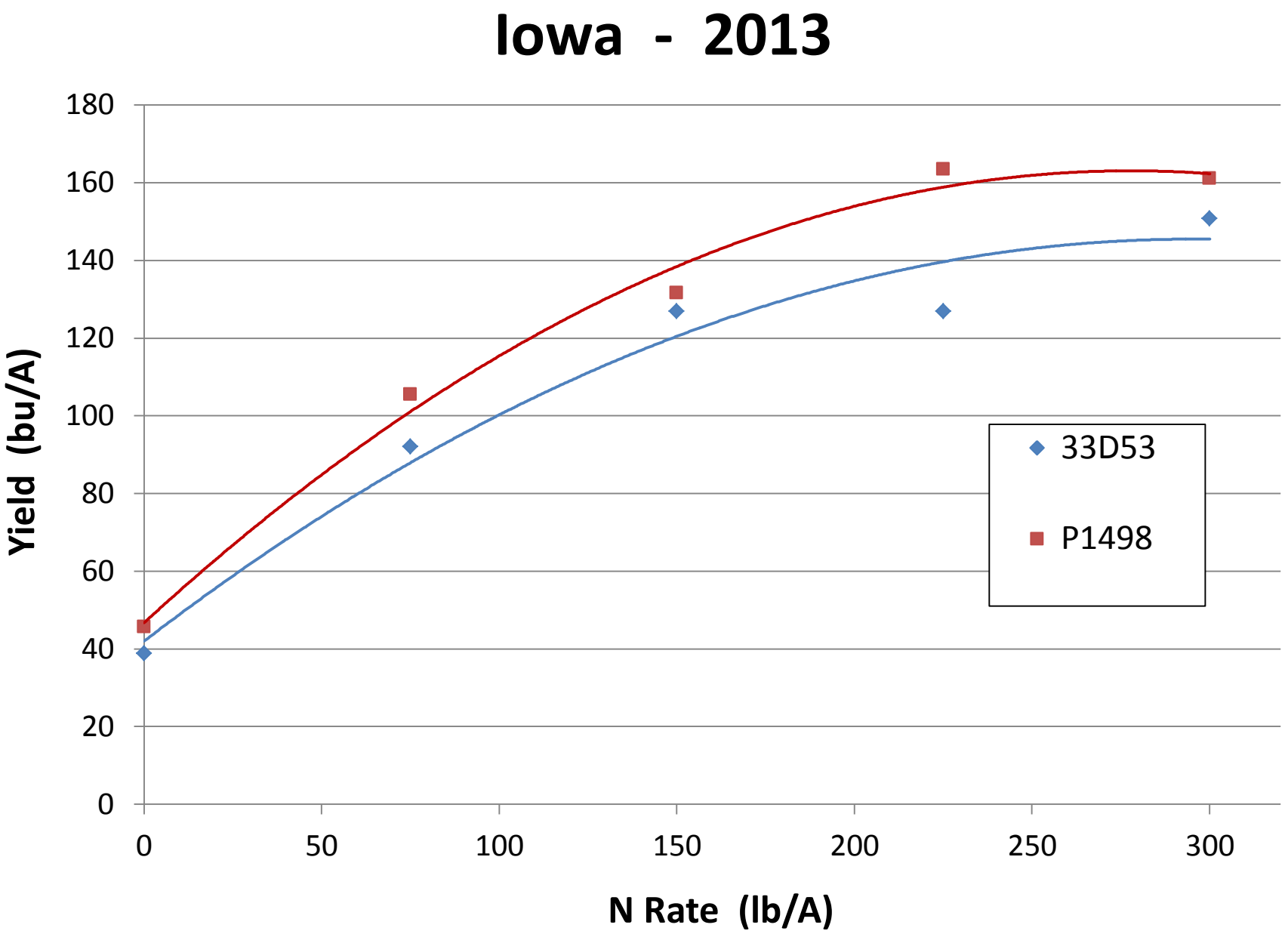


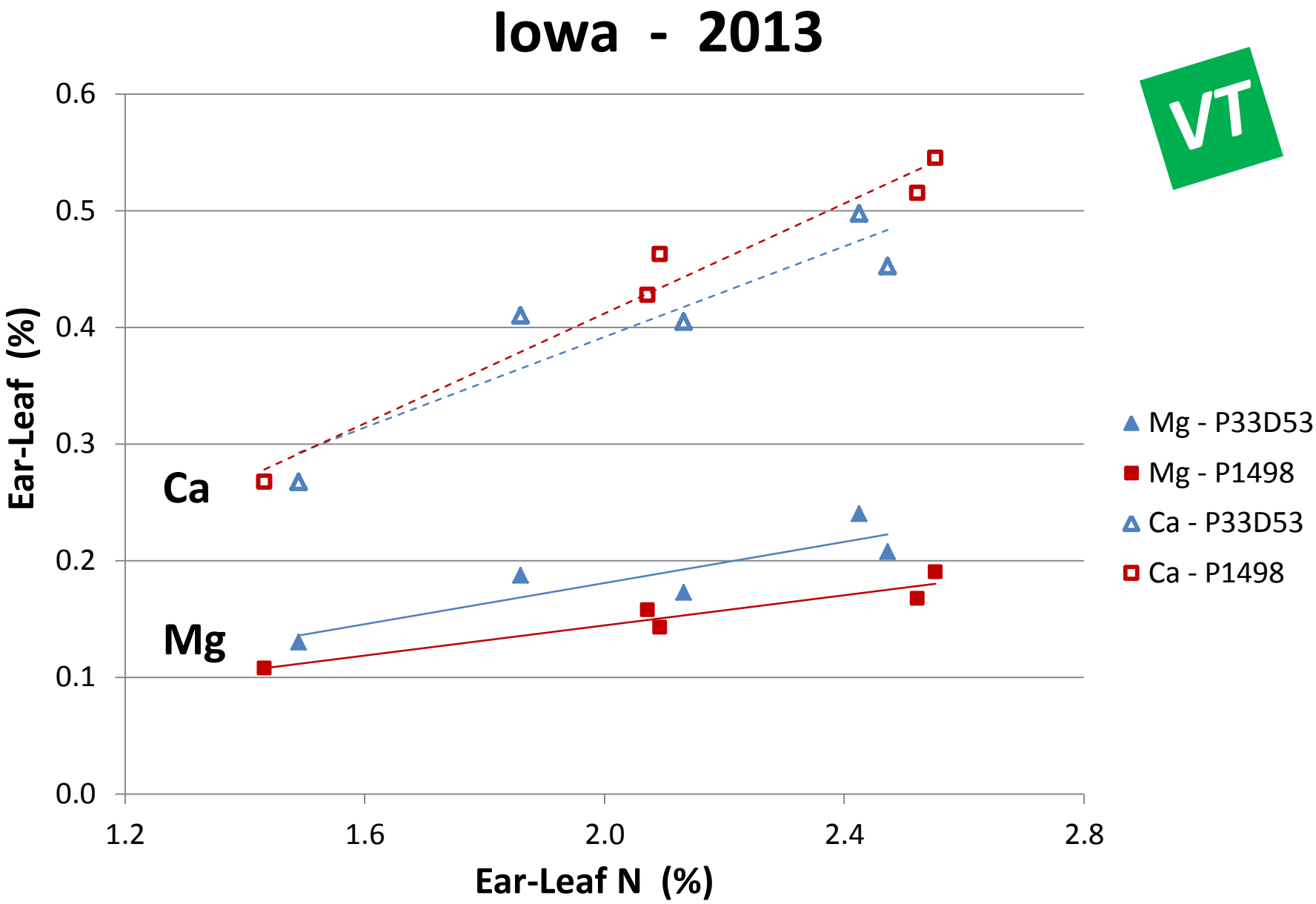
Effects of *Location* and *Hybrid*

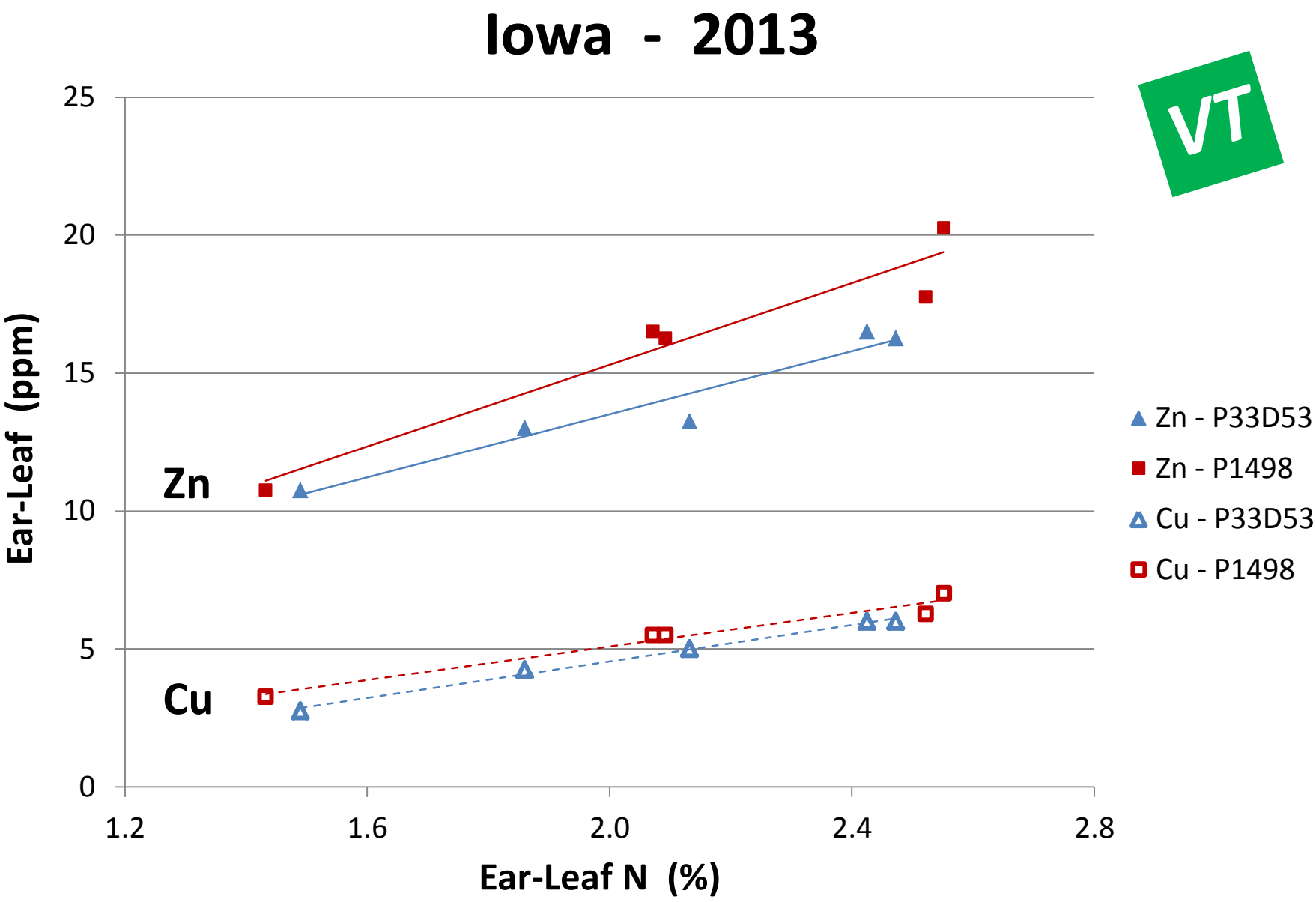
Location	Hybrid	Mg (%)
Illinois		
	P33D53	0.29
	P1498	0.17
Iowa		
	P33D53	0.21
	P1498	0.17
York		
	P33D53	0.17
	P1498	0.16
Shelton		
	P33D53	
	P1498	0.14

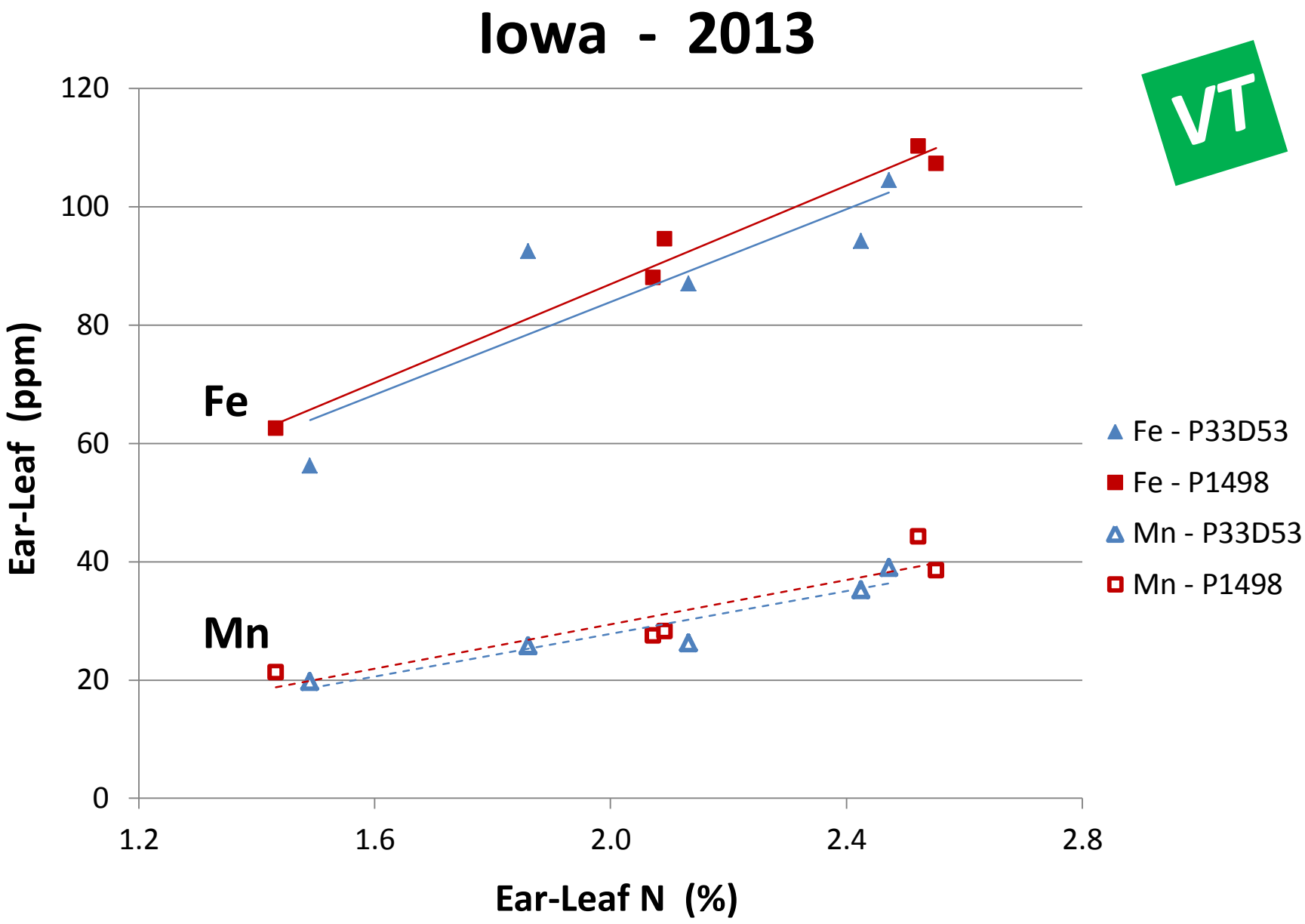

P33D53 - 2013
critical level
Yield (bu/A)
240
200
160
120
80
40
0
1.0
1.5
2.0
2.5
3.0
Ear-Leaf N (%)
York
Iowa
Illinois

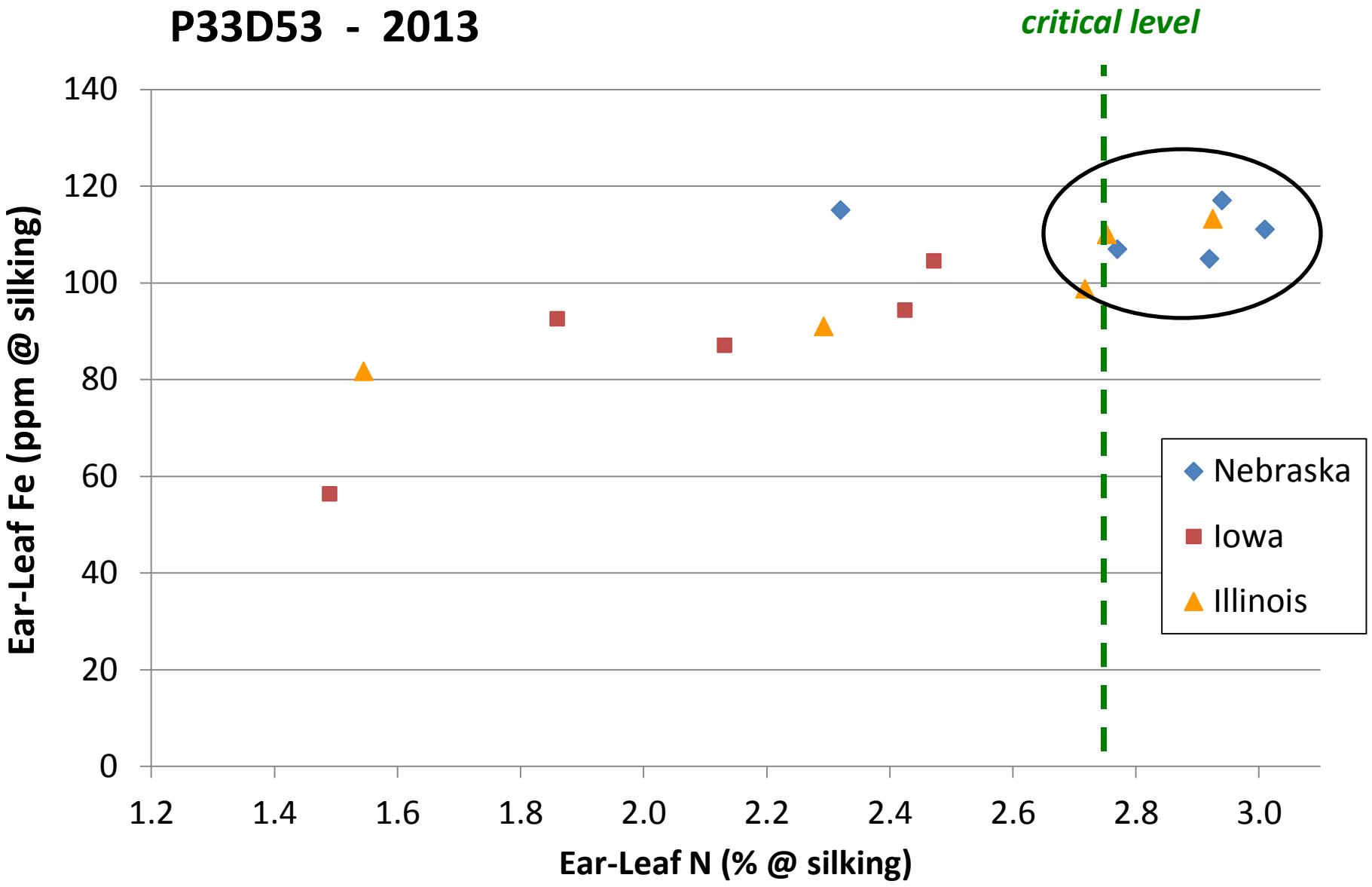

P1498 - 2013
240
200
160
120
80
40
0
Yield (bu/A)
critical level
1.0
1.5
2.0
2.5
3.0
Ear-Leaf N (%)
Nebraska
Iowa
Illinois


Iowa - 2013
Yield (bu/A)
180
160
140
120
100
80
60
40
20
0
0
50
100
150
200
250
300
N Rate (lb/A)
33D53
P1498


Iowa - 2013
VT
Ear-Leaf (%)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Ca
Mg
1.2
1.6
2.0
2.4
2.8
Ear-Leaf N (%)
Mg - P33D53
Mg - P1498
Ca - P33D53
Ca - P1498


Iowa - 2013
VT
25
20
15
10
5
0
1.2
1.6
2.0
2.4
2.8
Ear-Leaf (ppm)
Ear-Leaf N (%)
Zn
Cu
Zn - P33D53
Zn - P1498
Cu - P33D53
Cu - P1498


Iowa - 2013
VT
120
100
80
60
40
20
0
Ear-Leaf (ppm)
Fe
Mn
1.2
1.6
2.0
2.4
2.8
Ear-Leaf N (%)
Fe - P33D53
Fe - P1498
Mn - P33D53
Mn - P1498


P33D53 - 2013
critical level
Ear-Leaf Fe (ppm @ silking)
140
120
100
80
60
40
20
0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
Ear-Leaf N (% @ silking)
Nebraska
Iowa
Illinois

Possible

Interpretation

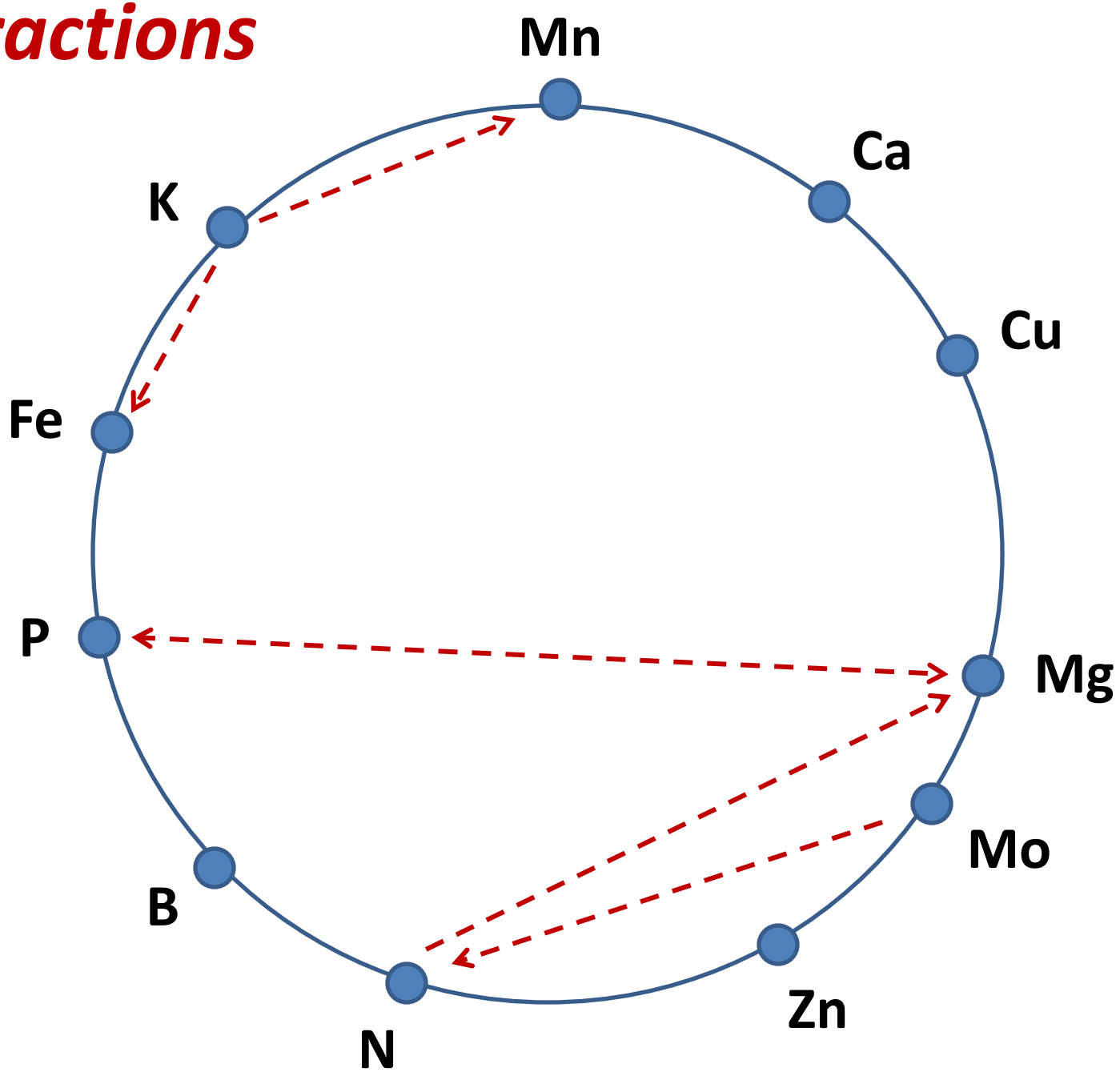
- Did N uptake enhance uptake of other nutrients

NO_3^- -------- K Ca Mg Zn Mn Cu Fe Co NH_4 +

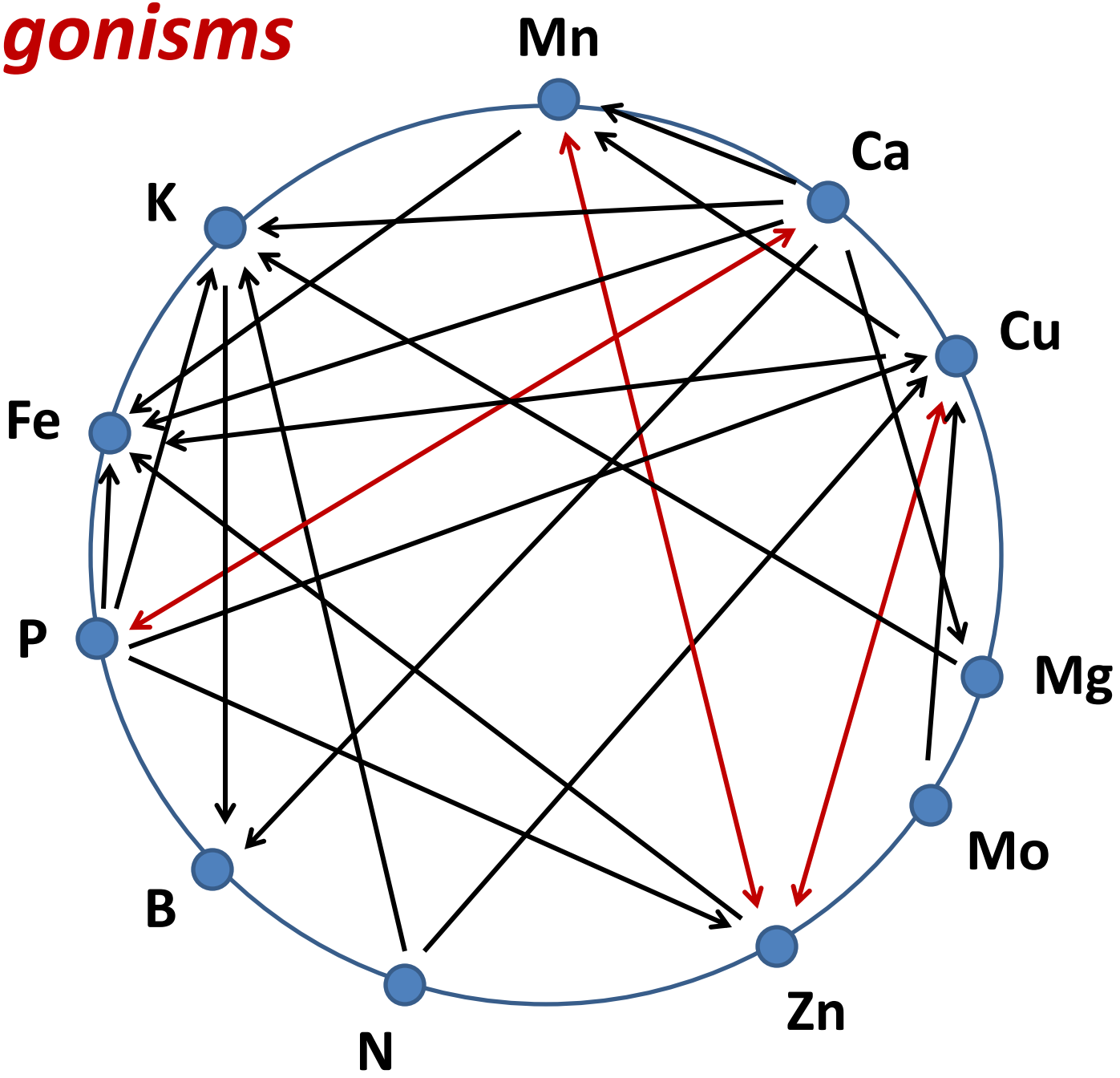
NH_4^+ -------- P S Cl B Mo NO_3 -

- Perhaps organic acids and root exudates are involved

Interactions



Antagonisms



What is *DRIS* ?

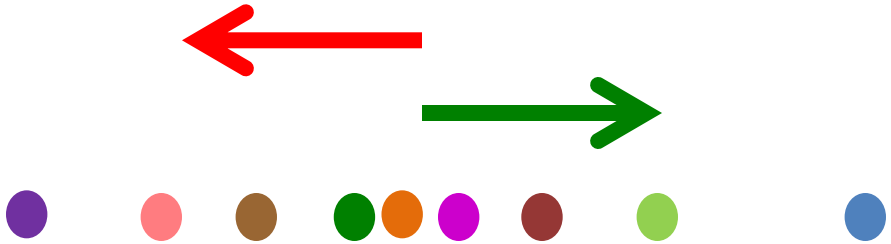
Diagnosis and Recommendation Integrated System

- Tool to identify relative ***abundance*** and ***shortage*** of nutrients in plant tissue

How ***DRIS*** Works

- Calculates nutrient concentrations relative to a "***reference***" value - i.e. ***"Norm"***

$$\frac{\textit{Sample Conc.}}{\textit{Reference Conc.}} = < 1.0 \cdots 1.0 \cdots > 1.0$$



What is the appropriate ***Reference Concentration*** ?

DRIS Relationships

N	**P**	**K**	**Ca**	**Mg**	**S**
N / P	P / K	K / Ca	Ca / Mg	Mg / S	
N / K	P / Ca	K / Mg	Ca / S		
N / Ca	P / Mg	K / S			
N / Mg	P / S				
N / S					

More relationships that include ***micro-nutrients***

Example of ***DRIS Norm Values***

Corn — ***Ear-leaf***

N (%)	3.29
P (%)	0.338
K (%)	2.40
Ca (%)	0.602
Mg (%)	0.258
S (%)	0.269

N / P	9.96
N / K	1.50
N / S	12.86
Ca / Mg	2.59

P : Zn
Fe : Mn
Fe : Cu
Others

Source: Walworth and Sumner, 1987

Published "***norms***" are crop specific and vary by climatic areas

How *DRIS* Works

- Calculates nutrient concentrations relative to a "***reference***" value - i.e. ***"Norm"***

Difference from Ideal

$$\frac{\text{Tissue N}}{\text{N } norm} = \frac{2.95}{3.29} = 0.897 \rightarrow \textbf{-0.103}$$

$$\frac{\text{N : K}}{\text{N : K } norm} = \frac{1.16}{1.50} = 0.773 \rightarrow \textbf{-0.227}$$

$$\frac{\text{N : S}}{\text{N : S } norm} = \frac{13.48}{12.86} = 1.048 \rightarrow \textbf{0.048}$$

Sum

DRIS Excel Spread Sheet

NutriVe
Agricultura en Evolución

Informe InSeason®

Santiago MN	#N/A	#N/A	7/2/2012
CR2	Sampling date	Analysis date	Date

#N/A	Jim Schepers	#N/A			5	Silty Loam	1250	#N/A
Farmer		Field		Sub-field	Samples	Soil Type	Bulk density Kg/m3	Deep m

12	13	15	14				10	11						
P3698	14	#N/A	#N/A	#VALUE!	#N/A	#N/A	2.60%	4.00%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Hybrid	Expected Yield	Stage	Uso Kg/Ton grn	NO3 prom ppm	N disp Kg N/Ha	Imb Fact	%M.O	Min Rate	N min Kg N/Ha	SPAD	SI	N Needed Kg N actual/Ha	NH3	UREA Kg/Ha de la Fuente Seleccionada	NV30

Tissue testign data and DRIS Analysis

Sample																
Santiago MN	Soil Nitrogen			Elemento	N	P	K	Ca	S	Mg	Fe	Zn	Mn	Cu	B	IB DRIS
1	N-NO3	ppm	#N/A	Lab data	2.93	0.30	2.12	0.59	0.30	0.24	156	35	99	14	9.9	
		Kg/Ha	#N/A	Ref EF	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	SPAD	lect	#N/A	CDRIS	29.3	3	21.2	5.9	3	2.4	156	35	99	14	9.9	-0.368
		ref	48	I DRIS	-3.197	-5.767	-0.436	-2.068	-2.308	-1.244	2.076	2.730	6.469	3.360	0.019	
#VALUE!	Nitrogeno			Elemento	N	P	K	Ca	S	Mg	Fe	Zn	Mn	Cu	B	IB DRIS
2	N-NO3	ppm	#VALUE!	DATOS	2.87	0.28	1.90	0.68	0.26	0.25	135	38	93	17	12.0	
		Kg/Ha	#N/A	Ref EF	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	SPAD	lect		CDRIS	28.7	2.8	19	6.8	2.6	2.5	135	38	93	17	12	0.558
		ref	48	I DRIS	-3.377	-6.800	-0.736	-0.487	-2.938	-1.264	0.425	4.852	5.409	4.306	1.168	
#VALUE!	Nitrogeno			Elemento	N	P	K	Ca	S	Mg	Fe	Zn	Mn	Cu	B	IB DRIS
3	N-NO3	ppm	#VALUE!	DATOS	2.65	0.24	2.19	0.59	0.26	0.25	129	35	61	17	9.5	
		Kg/Ha	#N/A	Ref EF	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	SPAD	lect		CDRIS	26.5	2.4	21.9	5.9	2.6	2.5	129	35	61	17	9.5	-2.120
		ref	48	I DRIS	-2.789	-7.907	0.131	-1.292	-2.778	-0.904	1.039	5.399	1.521	5.217	0.244	
#VALUE!	Nitrogeno			Elemento	N	P	K	Ca	S	Mg	Fe	Zn	Mn	Cu	B	IB DRIS
4	N-NO3	ppm		Datos	2.95	0.28	2.48	0.62	0.29	0.27	133	36	62	18	9.9	
		Kg/Ha	#N/A	Ref EF	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	25	#N/A	#N/A	#N/A	
	SPAD	lect		CDRIS	29.5	2.8	24.8	6.2	2.9	2.7	133	36	62	18	9.9	-2.727
		ref	48	I DRIS	-2.616	-5.796	0.279	-1.657	-2.608	-0.925	-0.057	4.635	0.883	5.145	-0.012	
#VALUE!	Nitrogeno			Elemento	N	P	K	Ca	S	Mg	Fe	Zn	Mn	Cu	B	IB DRIS
5	N-NO3	ppm		DATOS	2.9	0.3	2.2	0.6	0.3	0.3	138.3	36.0	78.8	16.5	10.3	
		Kg/Ha	#N/A	Ref EF	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	SPAD	lect		CDRIS	28.5	2.75	21.725	6.2	2.775	2.525	138.25	36	78.75	16.5	10.325	-1.169
		ref	48	I DRIS	-3.047	-6.506	-0.155	-1.431	-2.677	-1.100	0.846	4.415	3.598	4.519	0.370	

Sample **DRIS** Spread Sheet

Element	N	P	K	Ca	S	Mg	Fe	Zn	Mn	Cu	B	IB DRIS
DATA	2.9	0.3	2.2	0.6	0.3	0.3	138.3	36.0	78.8	16.5	10.3	
Ref EF	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
CDRIS	28.5	2.75	21.725	6.2	2.775	2.525	138.25	36	78.75	16.5	10.325	**-1.169**
I DRIS	-3.047	-6.506	-0.155	-1.431	-2.677	-1.100	0.846	4.415	3.598	4.519	0.370	

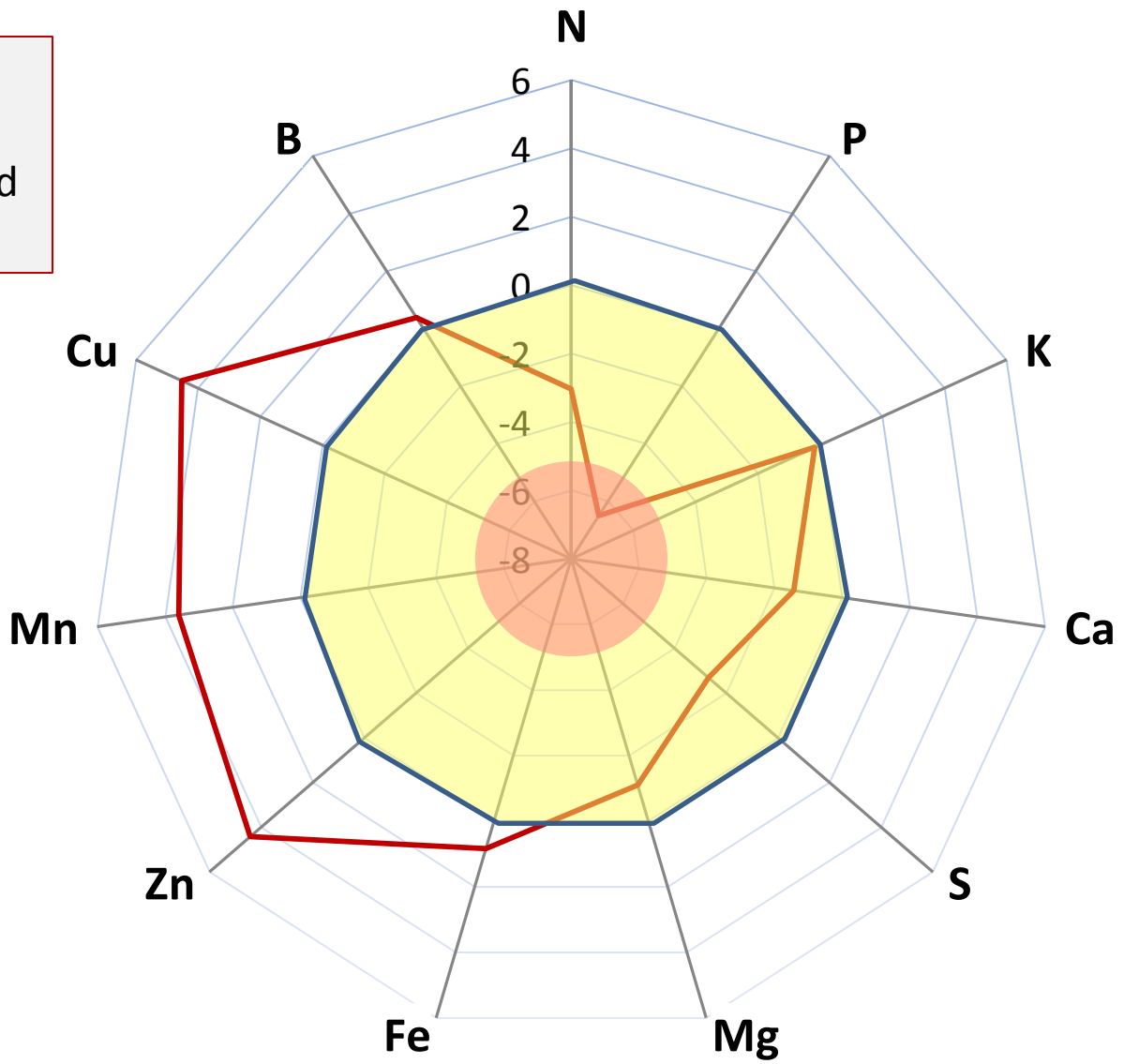
Most Limiting

Most Abundant

-5 Adequate **+5**

Radial Graph of **DRIS** Analysis

Cu, Mn, and Zn tissue concentrations were well above the “norms” established for corn in Nebraska.



Role of Nutrients in Photosynthesis

N - Major component of chlorophyll

P - Energy transfer

K - Helps cells maintain internal pressure

Mg - Only mineral constituent of chlorophyll molecule

S - Needed for chlorophyll formation

Ca - Aids in cell division and elongation

Fe - Necessary for the formation of chlorophyll

Zn - Necessary for the formation of chlorophyll

Mn - Essential for chlorophyll production and photosynthesis

Cu - Required for chlorophyll production

B - Role in cell division, translocation of Ca, hormone formation

Mo - Co-factor in nitrate-reductase enzyme

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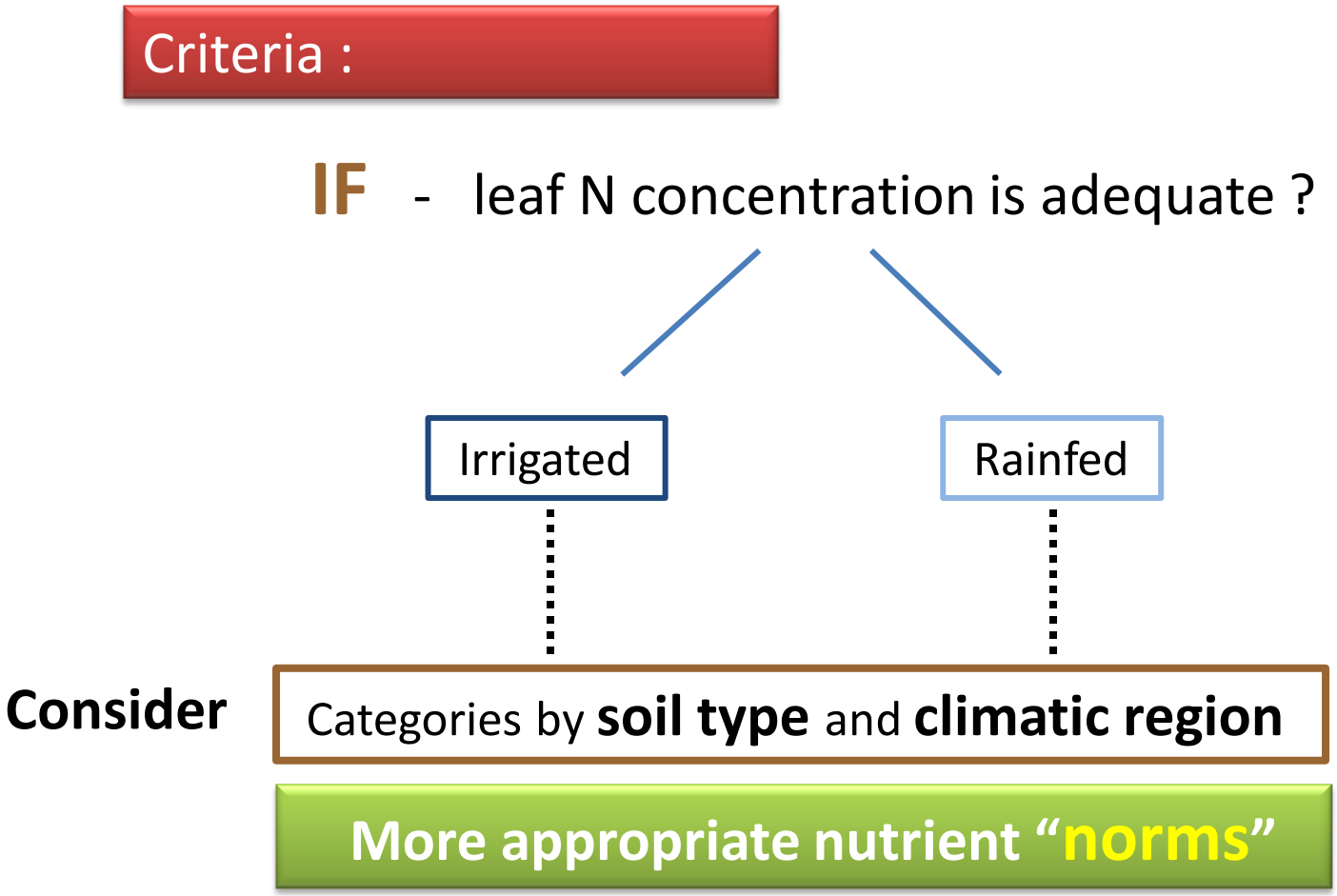
Chlorophyll molecules capture solar energy

Future Plans

Interrogate ear-leaf tissue testing results from several key labs



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- Randall Warden -