Plant Tissue Testing in Wisconsin: What's New?

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Wisconsin Crop Management Conference
January 15, 2014

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UW Extension

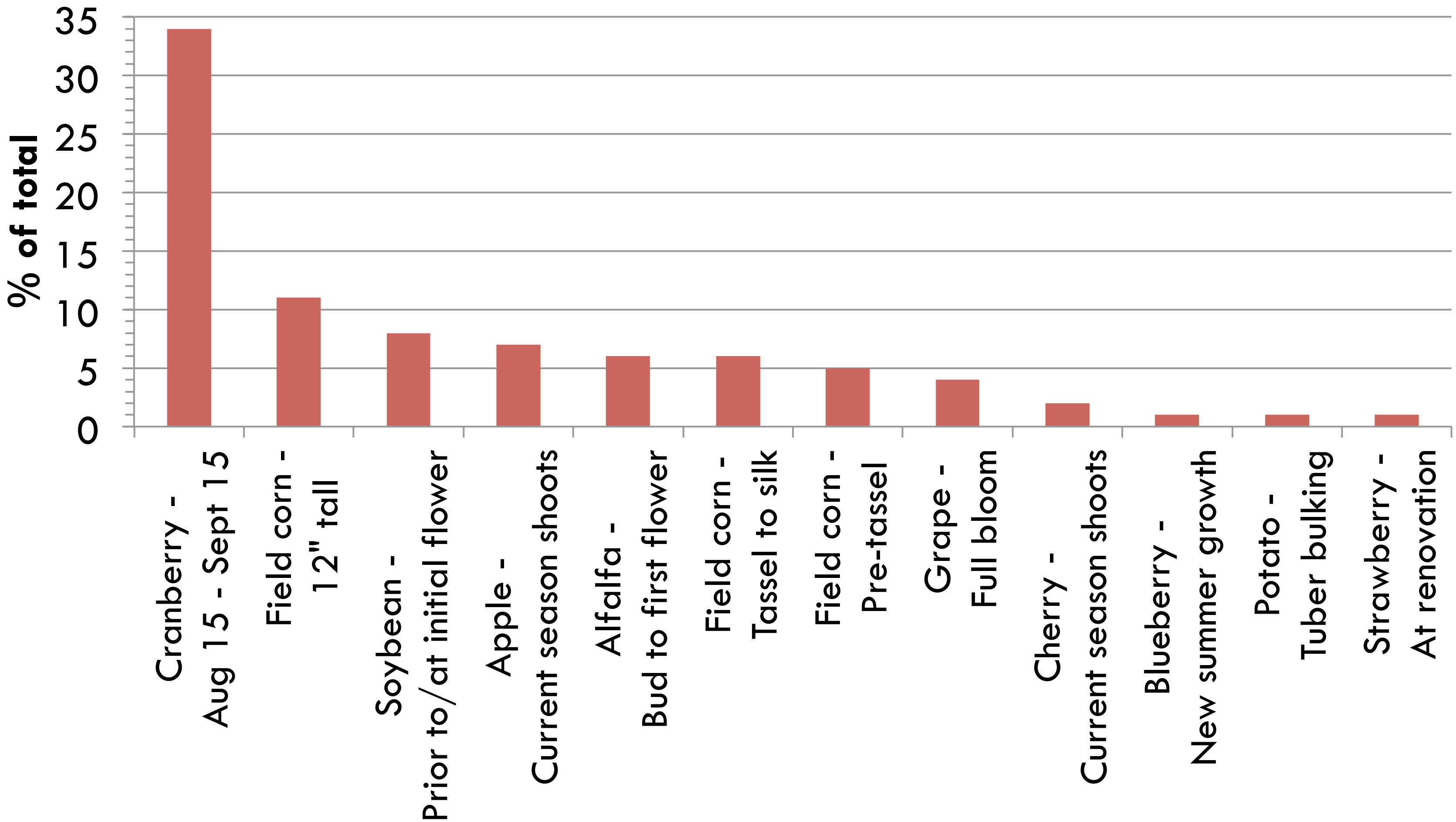
What do public labs provide to clients for the interpretation of tissue test results?

- Data only – client interprets
- Local/in-state values in database
- Literature values used for interpretation
- Combination of local and literature values

What is happening in other states in the upper midwest?

State	Data Only	Interpretation from literature + local data	Field research ongoing
Iowa	X		Yes
Kansas		X	Yes
Michigan		X	Yes
Minnesota		X	Yes
Missouri		X	No
North Dakota	X		Yes
South Dakota		X	Yes
Wisconsin		X	Yes

Distribution of plant analysis samples by crop and stage of maturity.



UW SPAL data, 2002-2013

Interpretation of Tissue Test Results in Wisconsin

- Sufficiency range approach (SR)
- Diagnosis and Recommendation Integrated System approach (DRIS)
- Plant analysis with standardized scores (PASS) system

Sufficiency Range

Advantages

- Simple
- Values are independent – level of one element does not influence the interpretation of another

Disadvantages

- Too few categories to aid in interpretation
- Does not rank low to high
- **Sensitive to maturity and part sampled**

DRIS

Advantages

- Scale is continuous and easy to interpret
- Nutrients are ranked from most deficient to most excessive

Disadvantages

- Computations are complicated
- Indices are not independent of each other

DRIS Interpretation

- < -20 – almost certain response
- -20 - -15 – possible response
- -15 - +15 – normal
- +15 - +25 – unlikely response
- > +25 – remote chance of response

PASS

Advantages

- Combines the features of both SR and DRIS

Disadvantages

- Interpretations available for only 3 crops

Samples Analyzed By:
UW Soil & Plant Analysis Lab
8452 Mineral Point Rd
Verona, WI 53593
(608) 262-4364

PLANT ANALYSIS REPORT

COOPERATIVE EXTENSION
University of Wisconsin-Extension
University of Wisconsin-Madison
Department of Soil Science, Madison, WI

Client:
Soil & Forage Analysis Lab
8396 Yellowstone Dr.
Marshfield, WI 54449

Send to:
Soil & Forage Analysis Lab
8396 Yellowstone Dr.
Marshfield WI, 54449

Account: 555901

Lab Information

Lab Number: 12345
Date received: 7/22/2002
Date processed: 1/2/2007
County: Dane

Sample Information

Sample ID: 1
Field: 1
Crop: Field corn
Growth Stage: Tassel to silk
Plant Part: Ear leaf
Appearance: Normal
Soil Submitted: Yes

SUFFICIENCY RANGES

Plant Results

Element	Low	Sufficient	High
N (%)	1.00		
P (%)	0.10		
K (%)		1.90	
Ca (%)	0.15		
Mg (%)	0.10		
S (%)	0.12		
Zn (ppm)		32.00	
B (ppm)		8.00	
Mn (ppm)		31.00	
Fe (ppm)			232.00
Cu (ppm)		4.00	

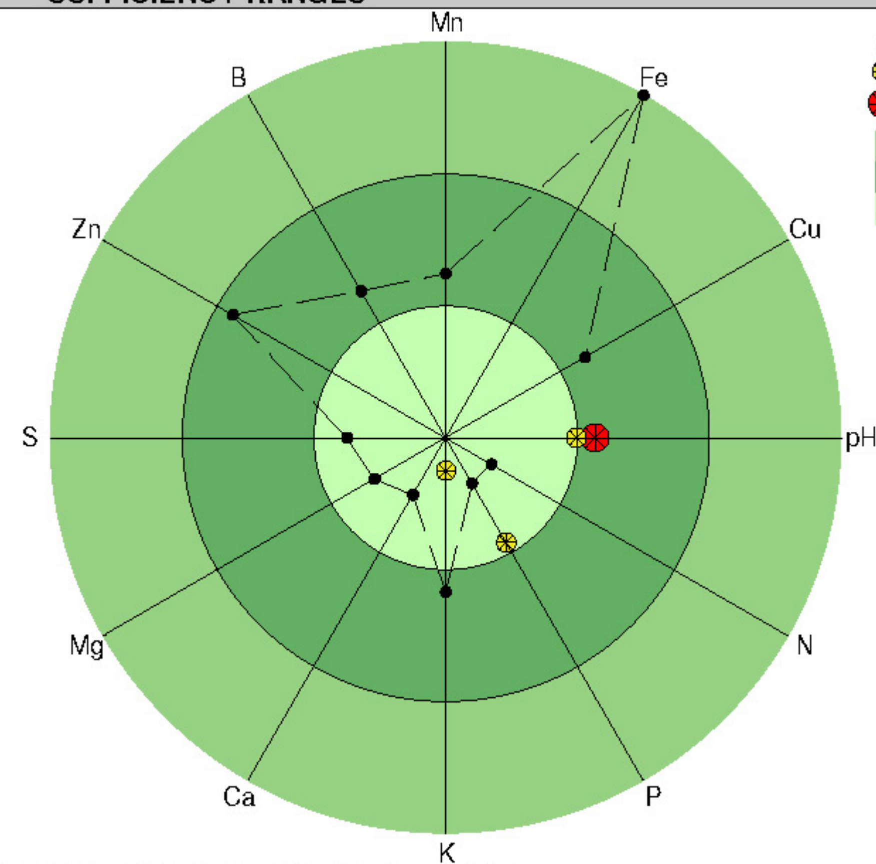
Al (ppm) 450.00
Na (ppm) 151.00

Soil Results

pH: 5.8, target pH = 6.0
OM: 3.0%

Element		Optimum	
P (ppm)	10 L		
K (ppm)	30 VL		

Note: L = Low, VL = Very Low, H = High, VH = Very High, E = Excessive



KEY
- Plant result
- Soil result
- Soil pH target

High
Sufficient
Low

YIELD RESPONSE INTERPRETATION SYSTEMS

System		Almost certain	Possible	Remote	Unlikely
DRIS	Element	**P N**		**S**	**K Zn**
	Index	**-38 -37**		**-8**	**32 51**
PASS	Element	**N P S**	Ca Mg	**K** Cu Mn B **Zn**	Fe
	Index	**-59 -56 -21**	-22 -17	**-7** -6 -5 -4 **7**	18

PASS INI: N:-46 P:-42 Ca:-22 S:-19 Mg:-17 K:-7 Cu:-6 Mn:-5 B:-4 Zn:7 Fe:18

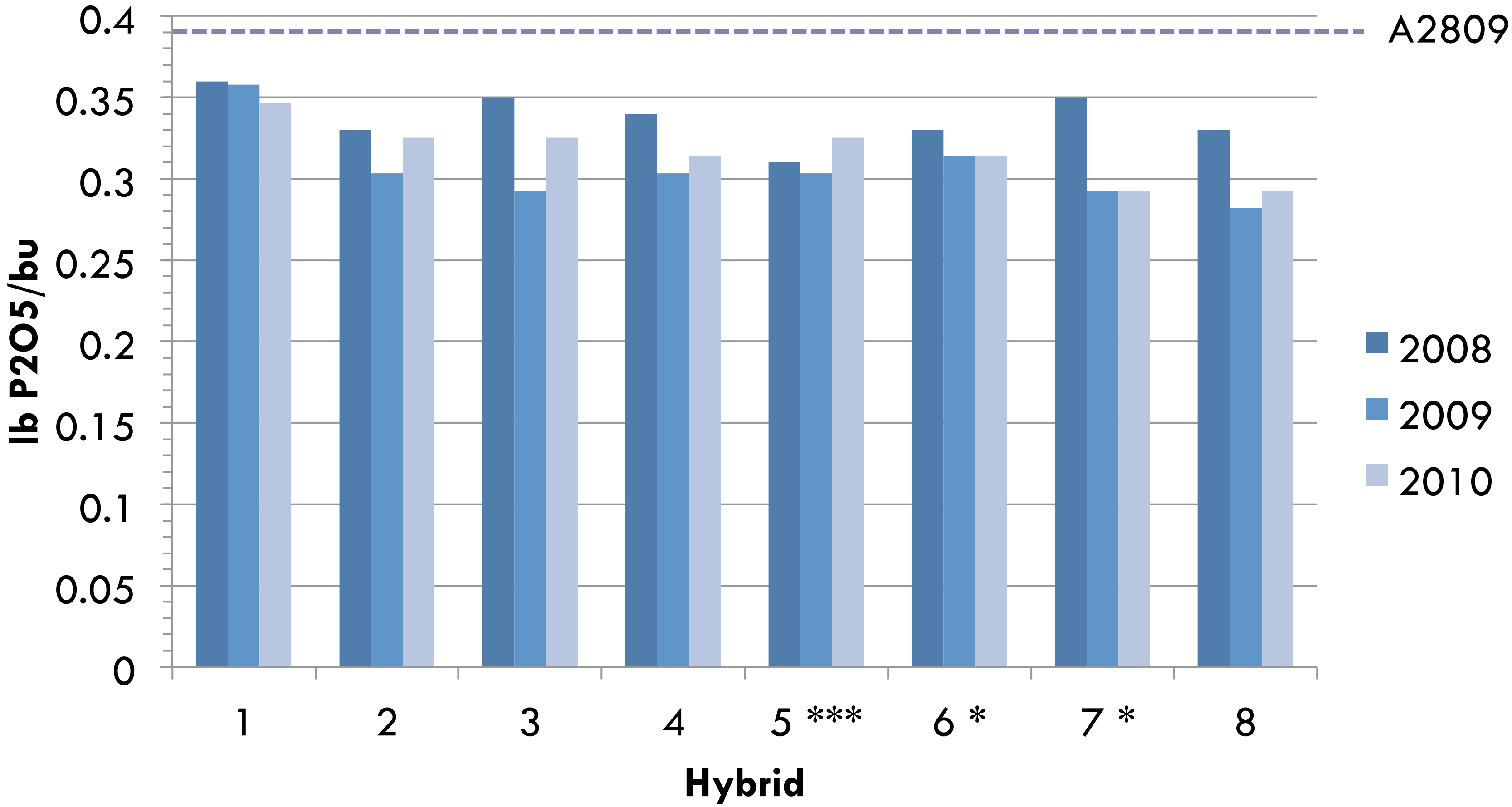
PASS DNI: P:-14 N:-13 S:-2 Zn:13 K:16

Note: DRIS = Diagnosis and Recommendation Integrated System, PASS = Plant Analysis with Standardized Scores, INI = Independent Nutrient Index, DNI = Dependent Nutrient Index
Common Response Elements are in BOLD and Rare Response Elements are NOT. DRIS yield response categories are computed as follows: "Almost Certain" - index < -20, "Possible" - -20 < index < -15, "Unlikely" - index > 25, "Remote" - any index not in any other category. PASS yield response categories are computed as follows: "Almost Certain" - common response elements with INI < -10, "Possible" - common response elements with INI+DNI < -10 and rare response elements with INI < -10, "Unlikely" - any element with INI > 10, "Remote" - any element not in any other category

Effect of 8 corn hybrids on grain and silage nutrient content at Arlington ARS

- Soil test P and K levels were H or greater in all years

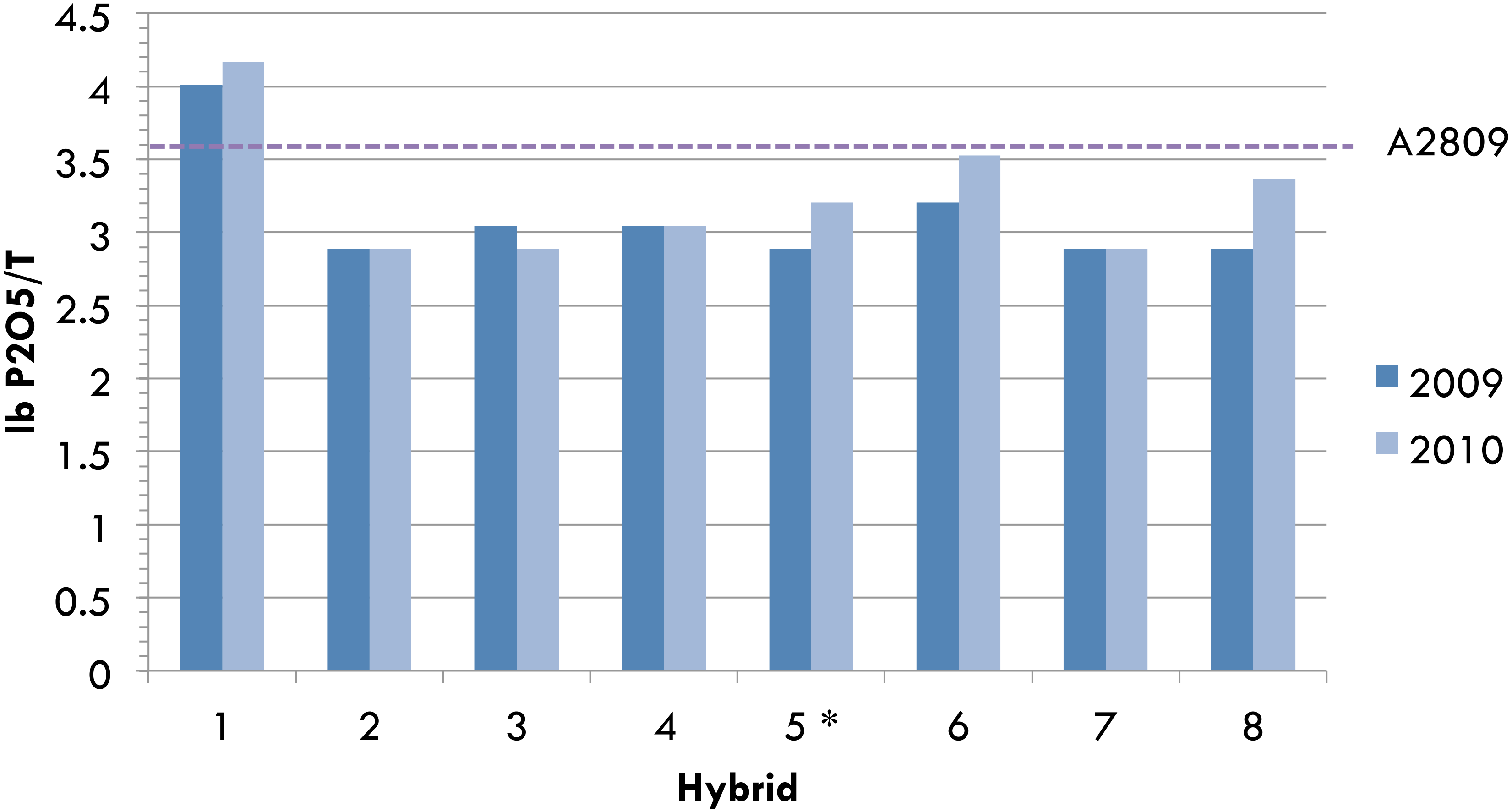
Effect of corn hybrid on GRAIN P_2O_5 content at Arlington ARS



* 2008 was a different hybrid than 2009 & 2010

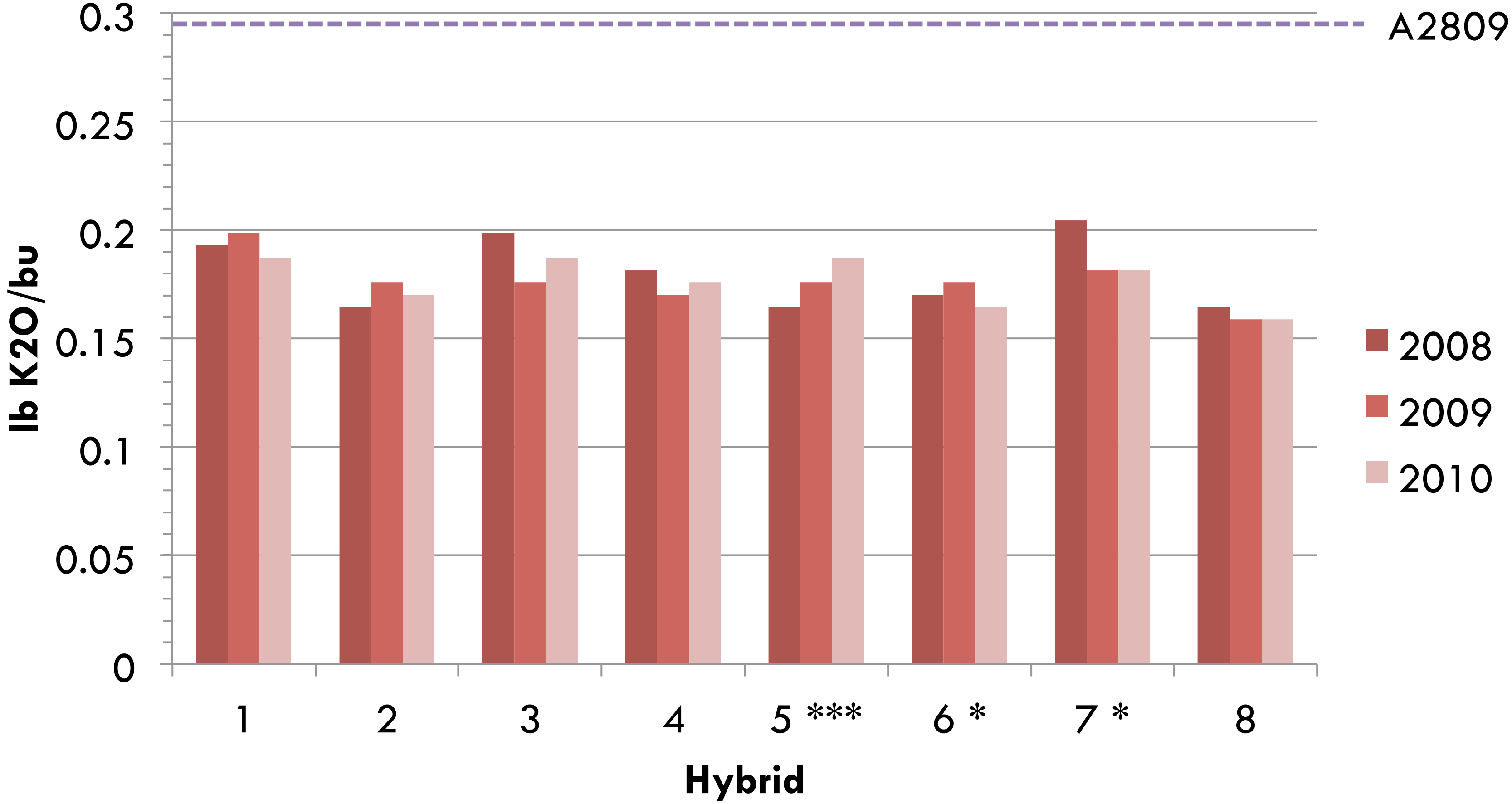
*** 2010 was a different hybrid than 2008 & 2009

Effect of corn hybrid on SILAGE P_2O_5 content at Arlington ARS



* Hybrid were different between 2009 and 2010

Effect of corn hybrid on GRAIN K_2O content at Arlington ARS



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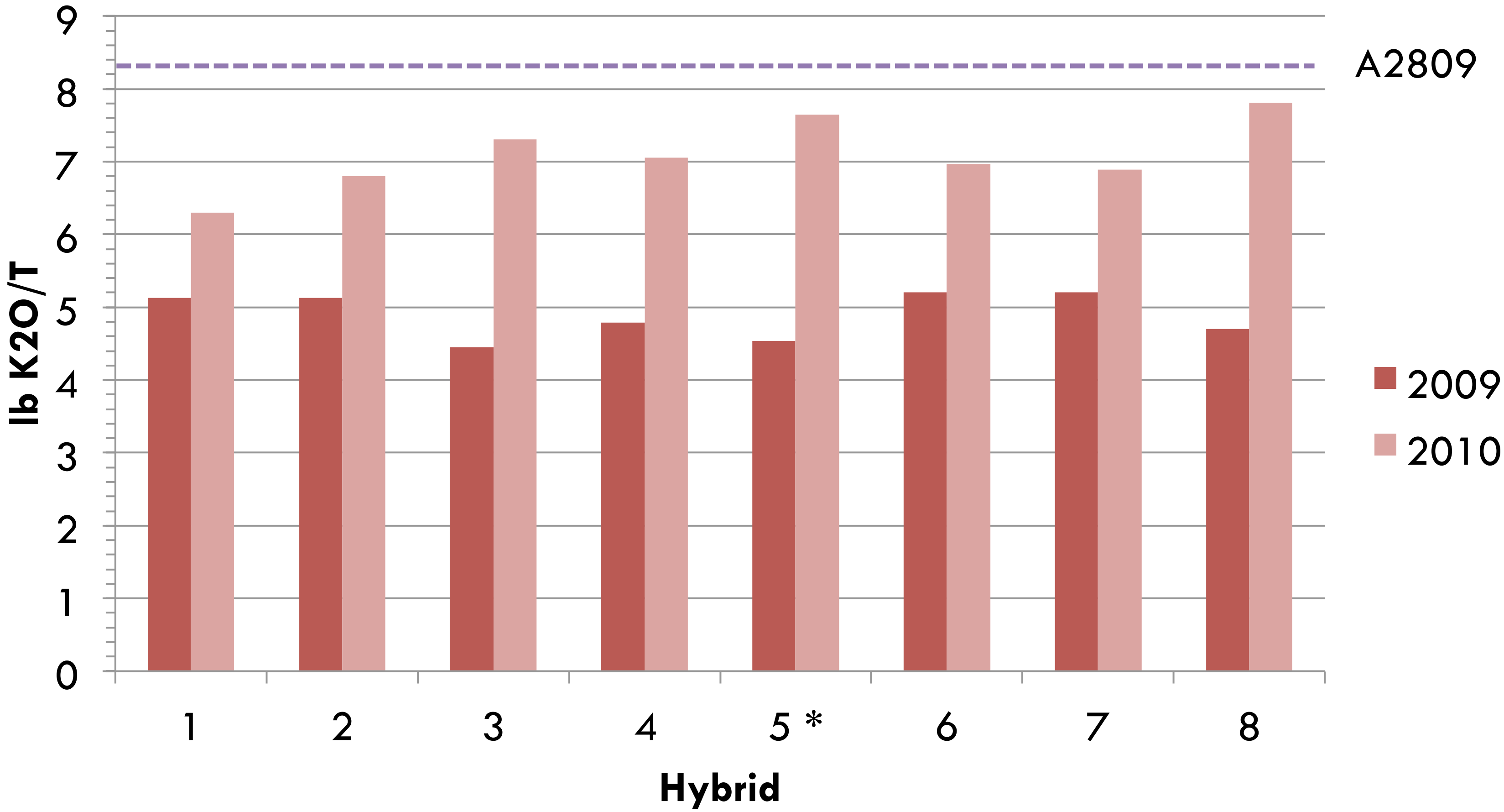
Effect of corn hybrid on SILAGE K_2O content at Arlington ARS



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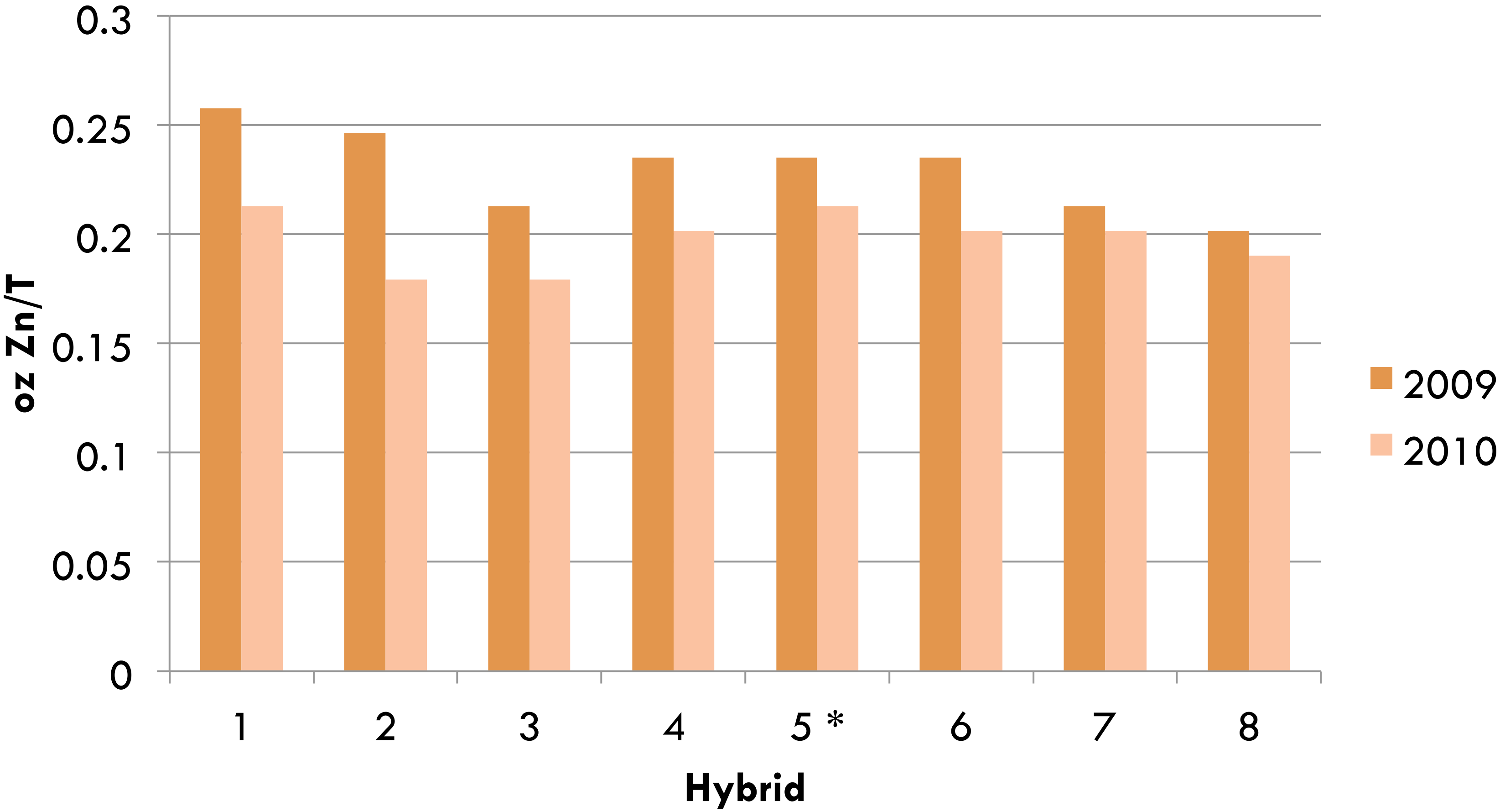
Effect of corn hybrid on SILAGE Zn content at Arlington ARS



* Hybrid were different between 2009 and 2010

Conclusions

- Corn grain and silage nutrient removals vary by:
  - Hybrid
  - Year/environment
- Nutrient removals are often less than book values
  - Even though yield levels were generally very good

Observations from 2008 & 2009

- Alfalfa
  - 81 and 41% of the abnormal & normal samples, respectively, were low in S
  - 35 % of abnormal & normal were low in K

Observations from 2008 & 2009

- Soybean
  - Nearly all low in S
  - 30-56% low in Mn
  - N and K often low
  - Normal appearing just as likely as abnormal to be low
- Recommended sampling time is prior to or at initial flowing, R1
  - Usually occurs in late June through early July
  - Majority of samples submitted in late July through Aug.

PA Survey of Alfalfa in Wisconsin

Objectives

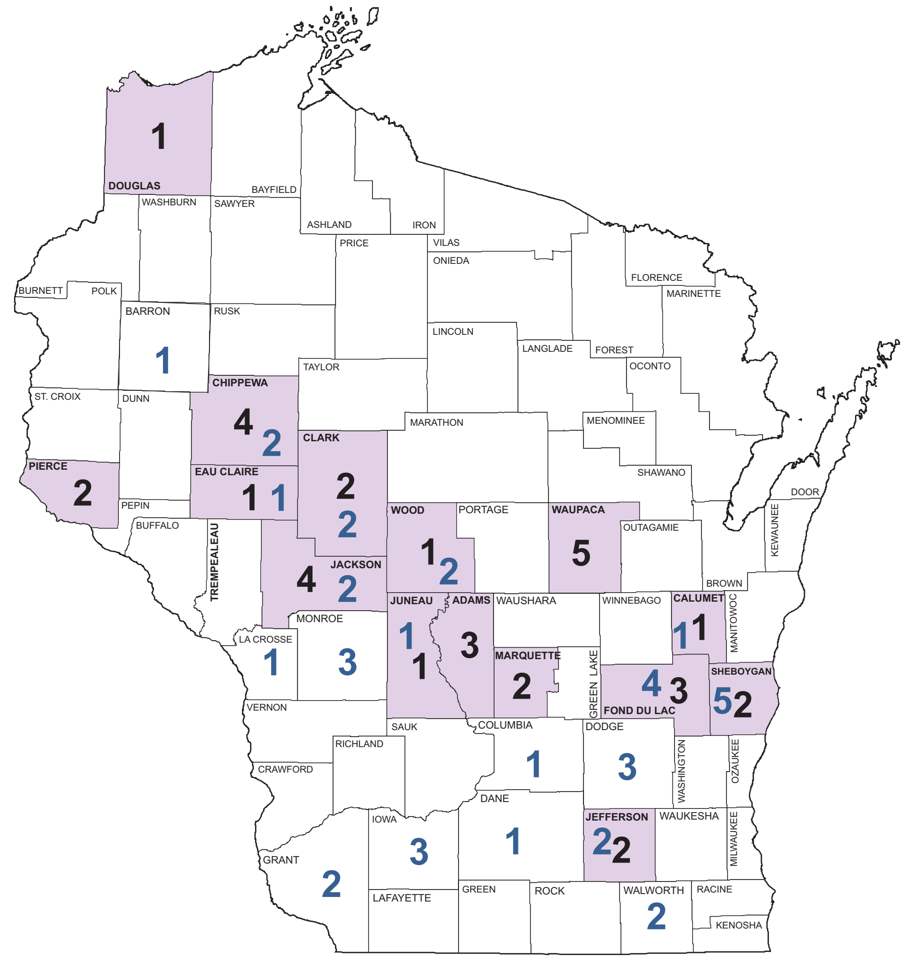
- To obtain info. on nutrition status of Wisconsin's alfalfa crop
- To determine if K and S deficiency are becoming more common throughout Wisconsin or in certain regions

Sampling protocol

- Alfalfa fields throughout Wisconsin
  - No manure or fertilizer S 18 months prior to sampling
  - Plant sample bud to 1st flower stage after 1st or 2nd cut
    - Top 6” from 30-40 plants
    - Analyzed to total N and total mineral content
  - 0-6” soil sample
    - 10 cores taken from same area as plant samples
    - Anaylzed for P, K, pH, buffer pH, OM, S, and B

Location of sample fields in 2010 & 2011

- Sampled by UWEX
  - 73 samples submitted
    - 60 normal appearing
    - 13 abnormal appearing
  - 6 fields had both normal & abnormal areas



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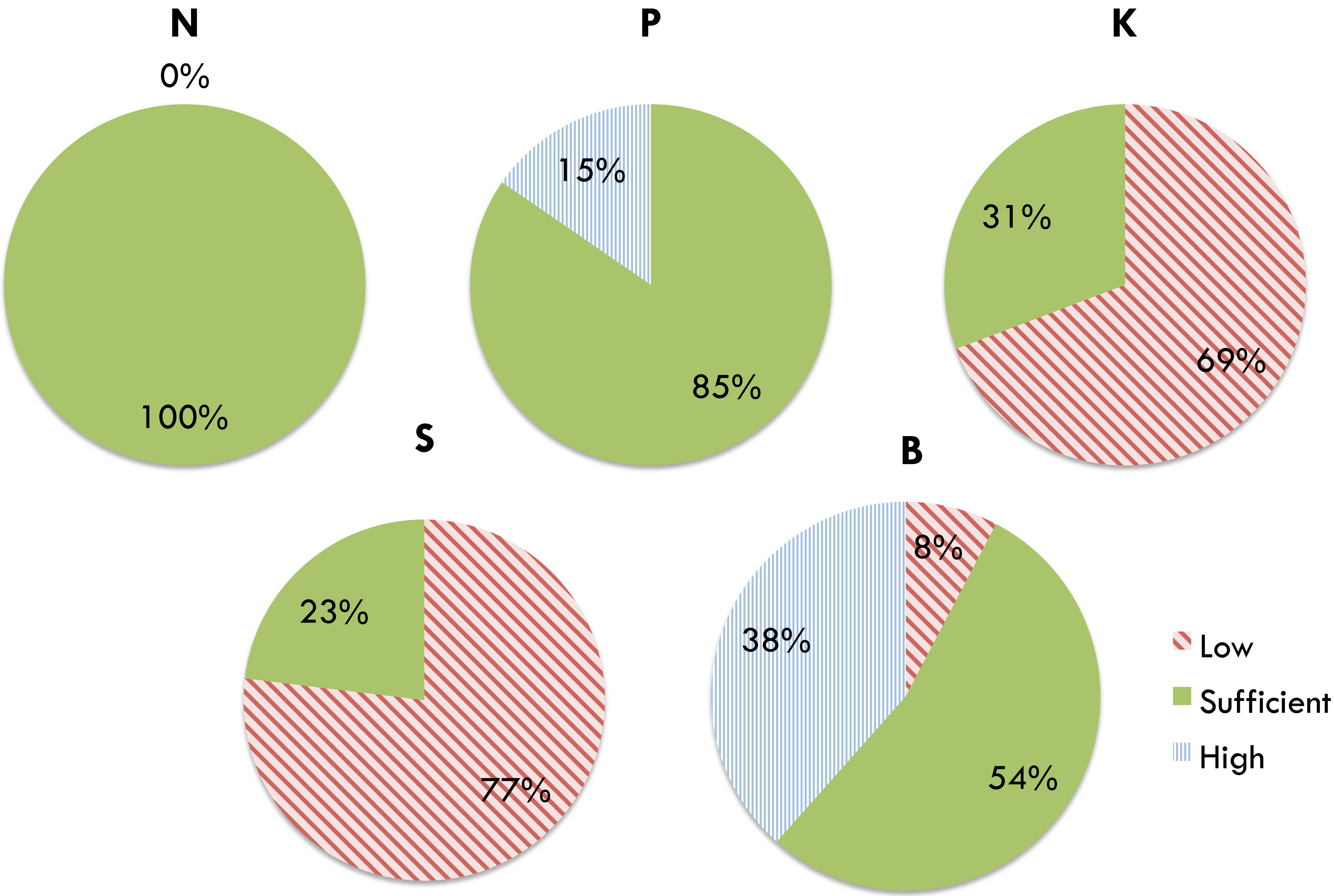
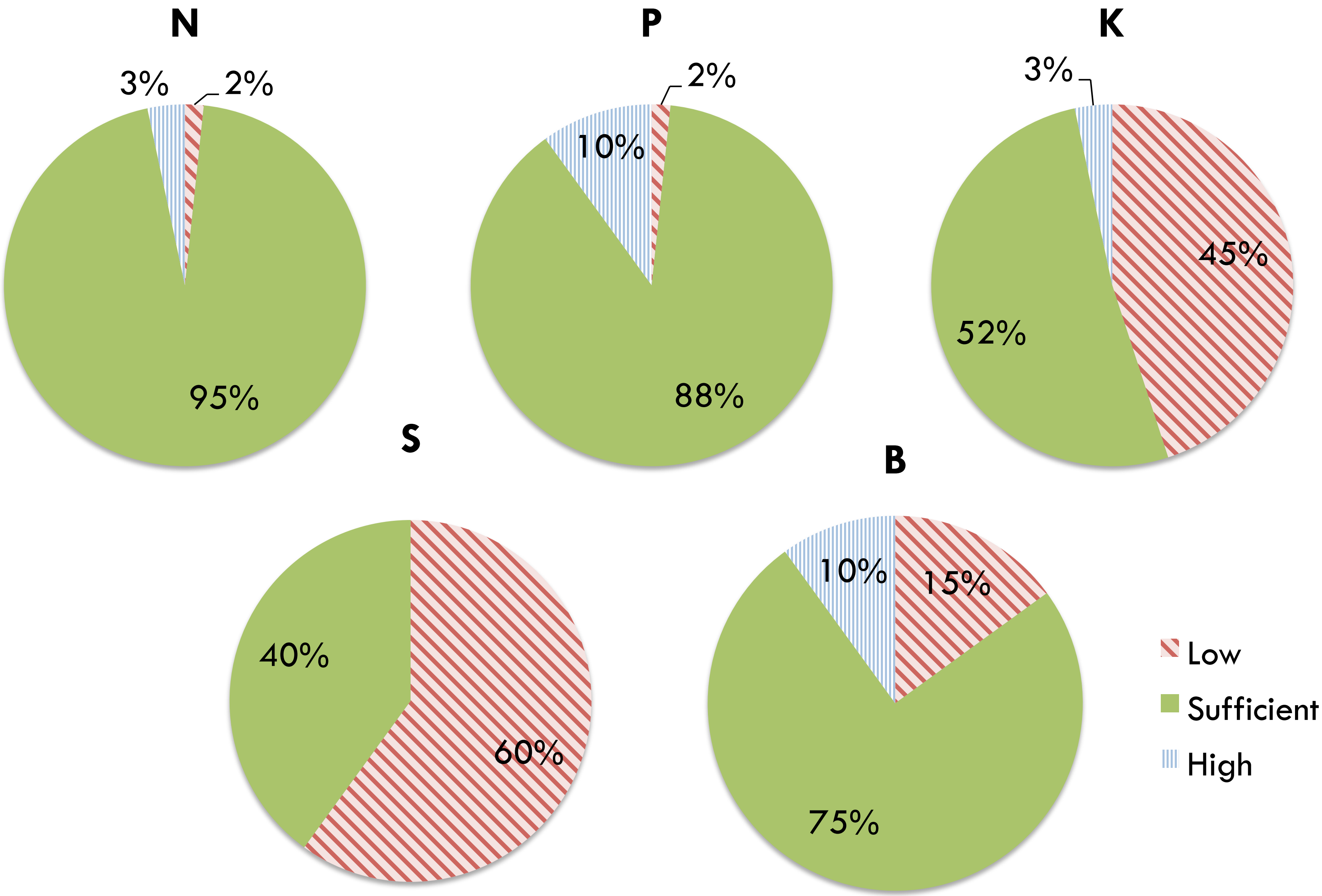
Results

Abnormal appearing fields or portions of fields (n=13)



Normal appearing fields or portions of fields (n=60)



For all samples (normal & abnormal) both years combined

- UWEX sampled
  - 49 % of all samples were low in K
  - 63 % of all samples were low in S
  - 28 % low in K and S

Potassium applications fall short on normal appearing fields, 2011

STK category (n)	Stand age †	2011 K_2O rec. (A2809)	2011 K_2O appl. rate
	yr	lb/a	lb/a
VL (5)	5.0 ± 2.2	338 ± 27	21 ± 49
L (10)	3.9 ± 1.0	322 ± 57	28 ± 59
O (4)	3.0 ± 0.8	300 ± 85	3 ± 6
H (4)	3.5 ± 1.7	135 ± 17	17 ± 29
VH (4)	3.3 ± 1.3	71 ± 19	7 ± 13
EH (2)	2.5 ± 0.7	0 ± 0	29 ± 3

† Includes establishment year to 2011.

Identical trends in 2010

Alfalfa field with patchy areas of yellow

Photo courtesy of Ted Bay, UWEX Grant/Lafayette Cos.

Alfalfa response to 25 lb S/a applied after 1st cutting in 2010, Lafayette Co., WI

		None	Calcium Sulfate	Ammonium Sulfate
		Dry Matter T/a		
2nd cut	Normal	1.23	1.29	1.30
	Abnormal	0.95	1.66	1.79
3rd cut	Normal	1.21	1.22	1.26
	Abnormal	0.90	1.49	1.58
2nd + 3rd	Normal	2.44	2.51	2.56
	Abnormal	1.85	3.15	3.37

	Tissue S	**Tissue K**	**Soil Test K**
	%		$mg\ kg^{-1}$
Normal	0.24 (L)	1.79 (L)	67 (VL)
Abnormal	0.14 (L)	2.46 (S)	117 (O)

Sufficiency range
Tissue K: 2.25 – 3.5%
Tissue S : 0.25 – 0.50%

Data courtesy of Ted Bay, UWEX Grant/Lafayette Cos.

2011 Soybean Plant Analysis Survey

Objectives

- To evaluate soybean nutrient concentrations relative to UW nutrient sufficiency ranges
  - At different growth stages
  - For different varieties
  - At several locations

2011 Soybean Plant Analysis Survey

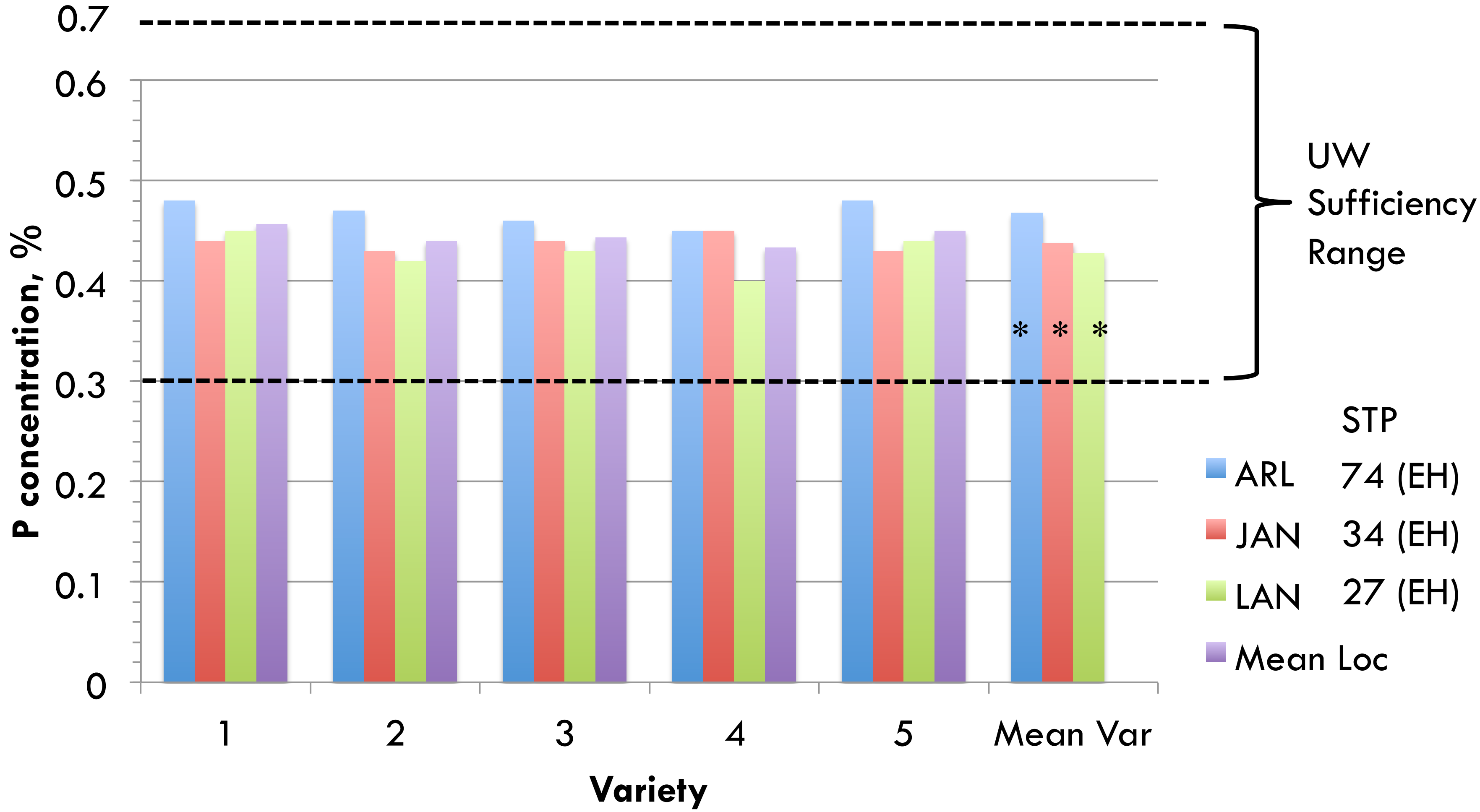
- Sampling details:
  - Uppermost fully developed leaf + petiole at R1& R3 sampled
  - Sampled in Soybean Variety Trial Plots (10 loc.)
    - Varieties sampled within a region are the same (n=5)
    - Varieties were different between regions
  - No visual deficiency symptoms
  - Some maturity differences were evident

Photo credits: Todd Andraski

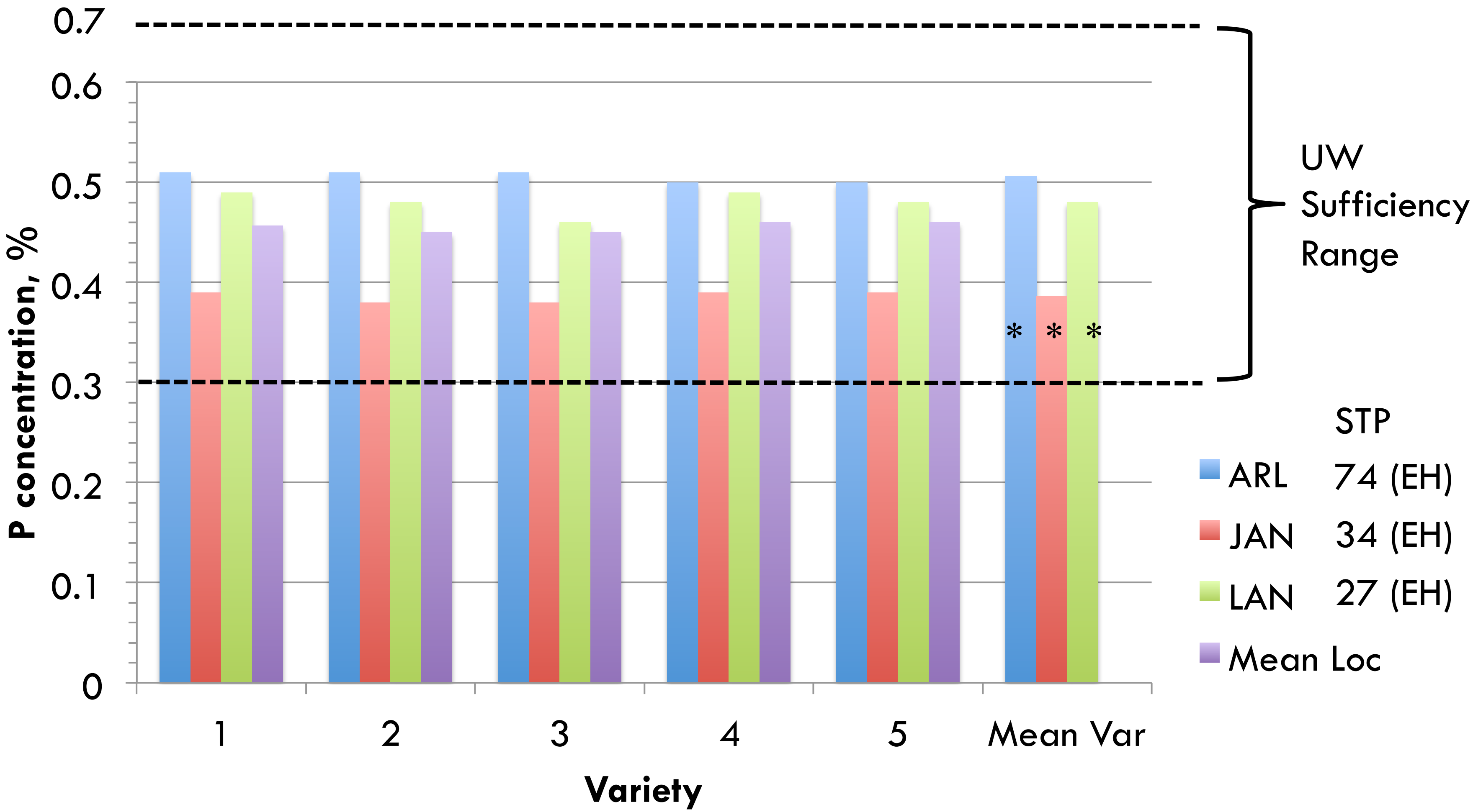
Effect of soybean variety on yield

Variety	Yield, bu/a								
	ARL	JAN	LAN	Mean		FdL	GAL	HAN	Mean
1	71	90	75	78 a		67	52	78	66 b
2	67	81	77	75 ab		66	62	79	69 ab
3	66	88	74	76 ab		68	61	86	72 a
4	58	84	69	70 c		65	66	83	71 a
5	72	76	69	70 bc		66	54	77	65 b
Mean	67 c	83 a	73 b			67 b	59 c	81 a	
	CF	MAR	SEY	Mean		SPO			
1	58	68	61	62 ab		51			
2	54	63	55	58 c		44			
3	61	65	63	63 a		45			
4	54	63	60	59 bc		50			
5	50	60	52	54 d		50			
Mean	55 b	64 a	58 b						

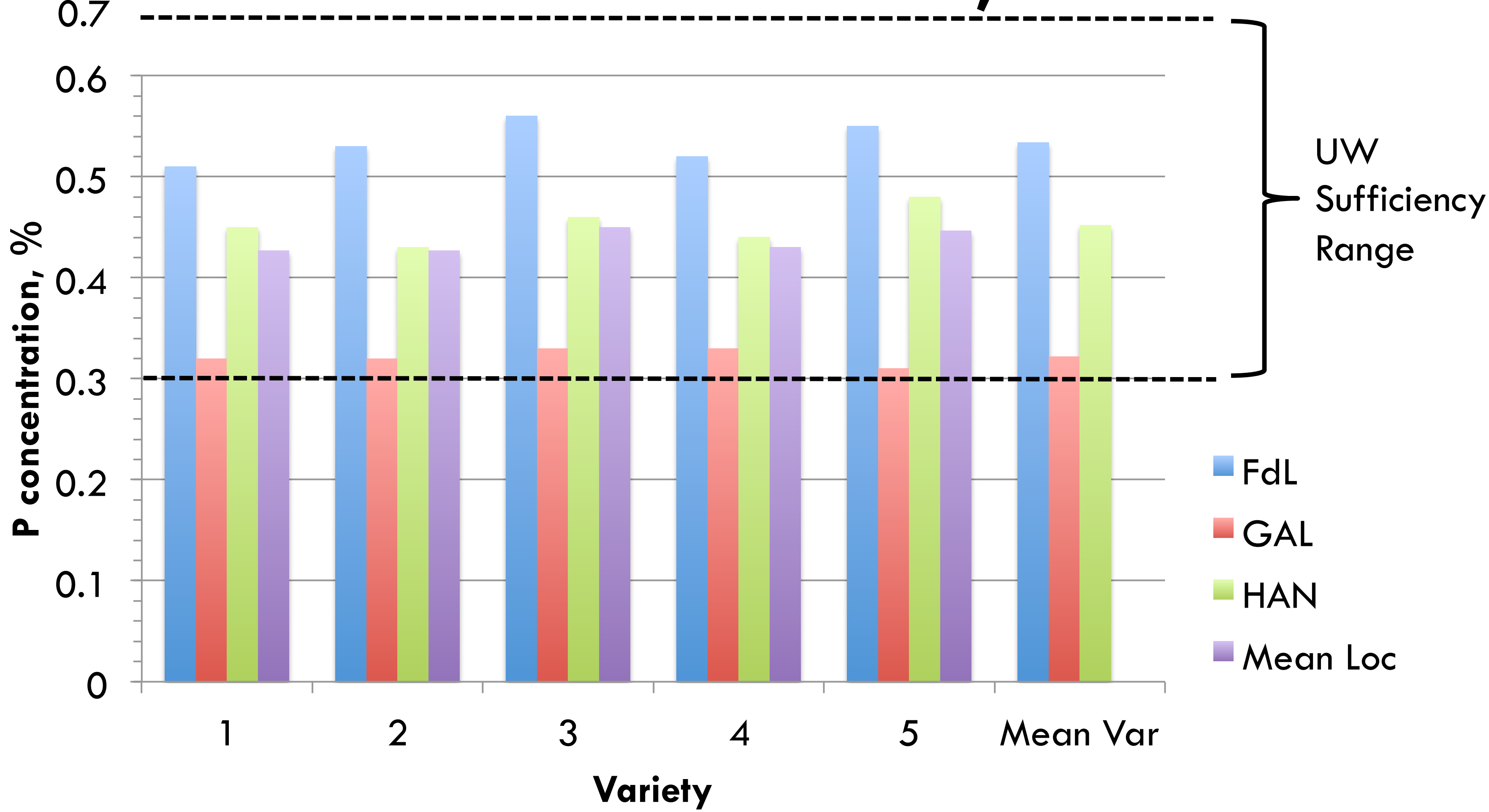
Effect of variety & location on soybean tissue P concentrations at R1, Southern WI



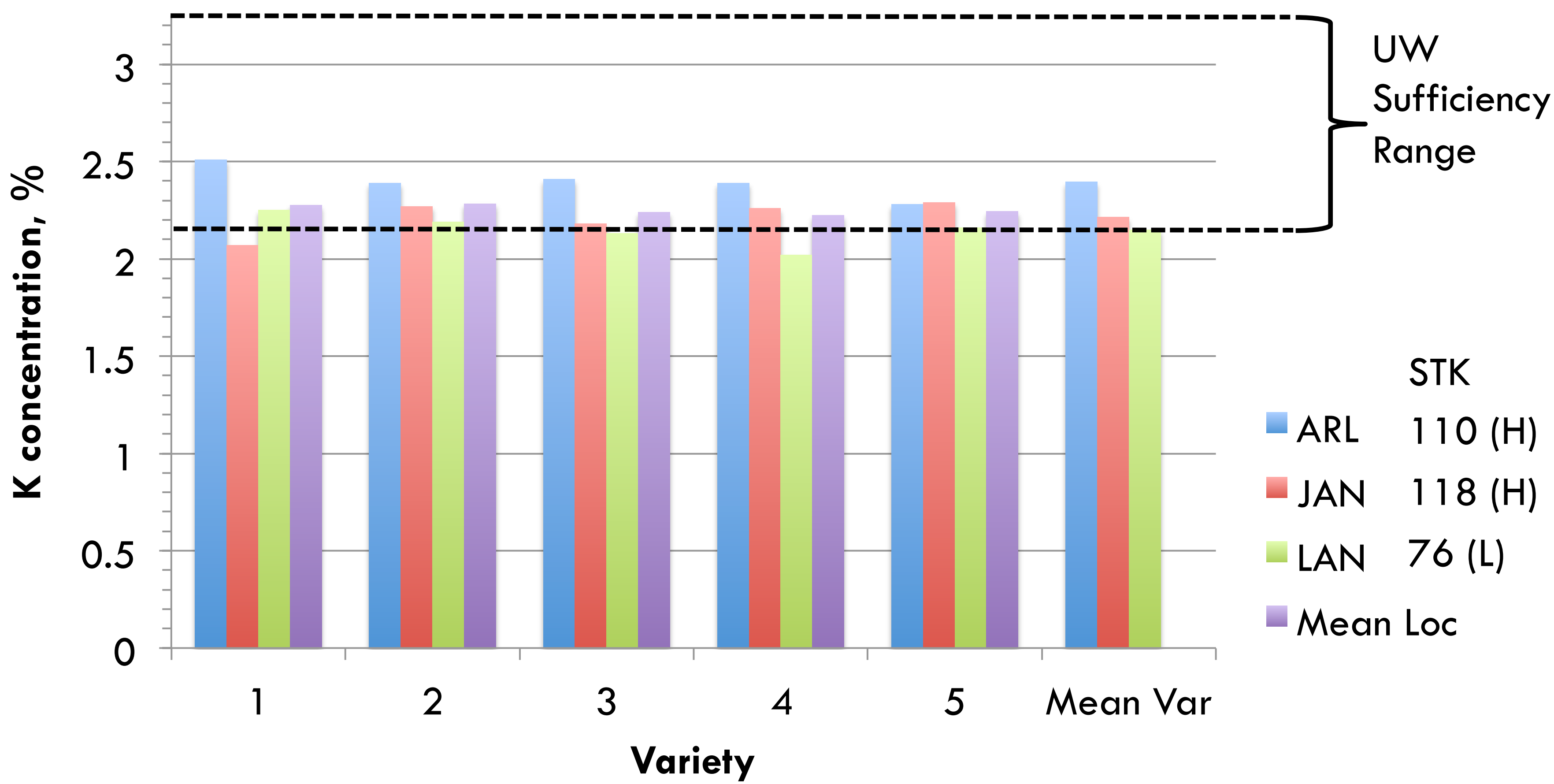
Effect of variety & location on soybean tissue P concentrations at R3, Southern WI



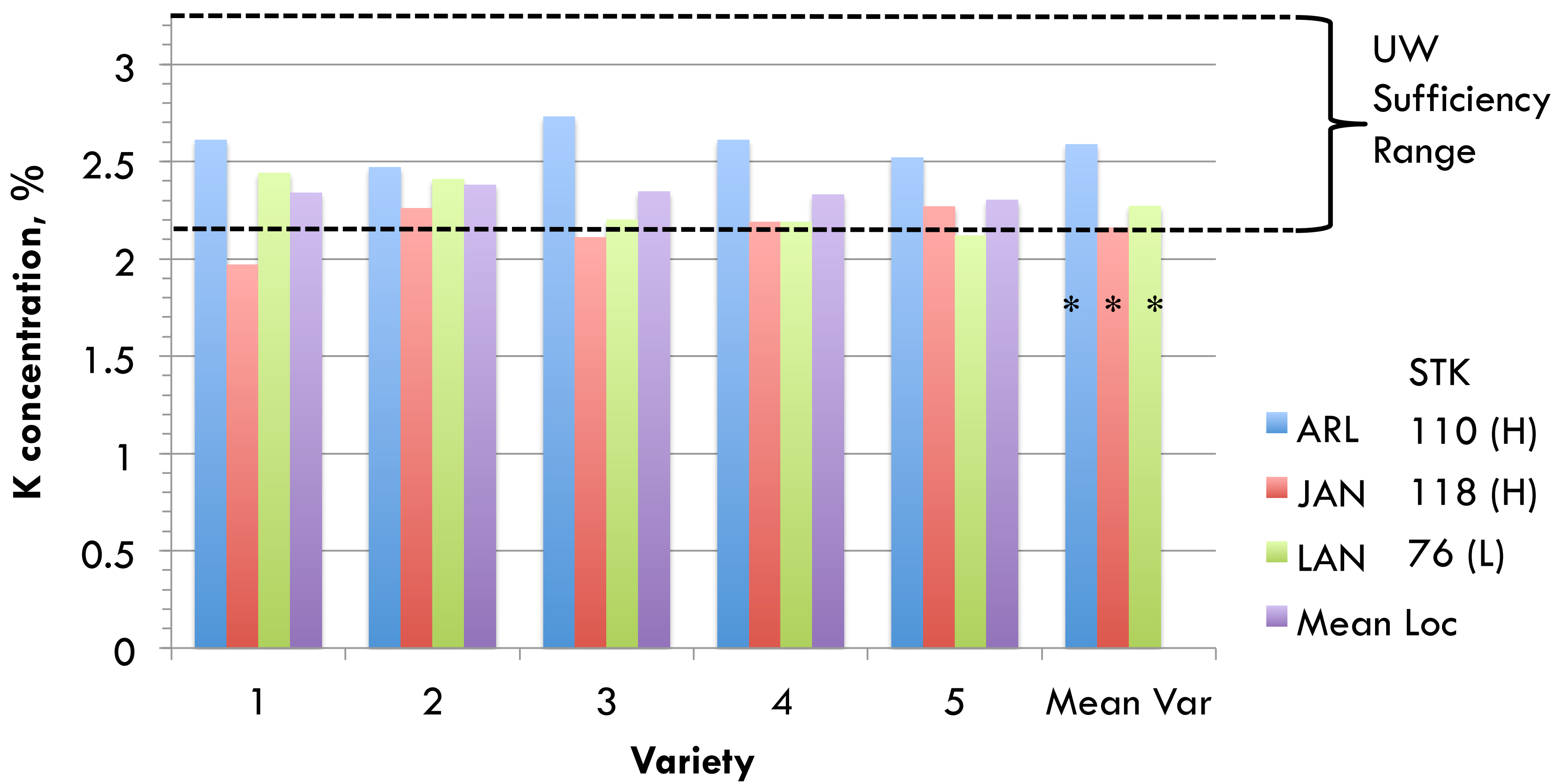
Effect of variety & location on soybean tissue P concentrations at R1, Central WI



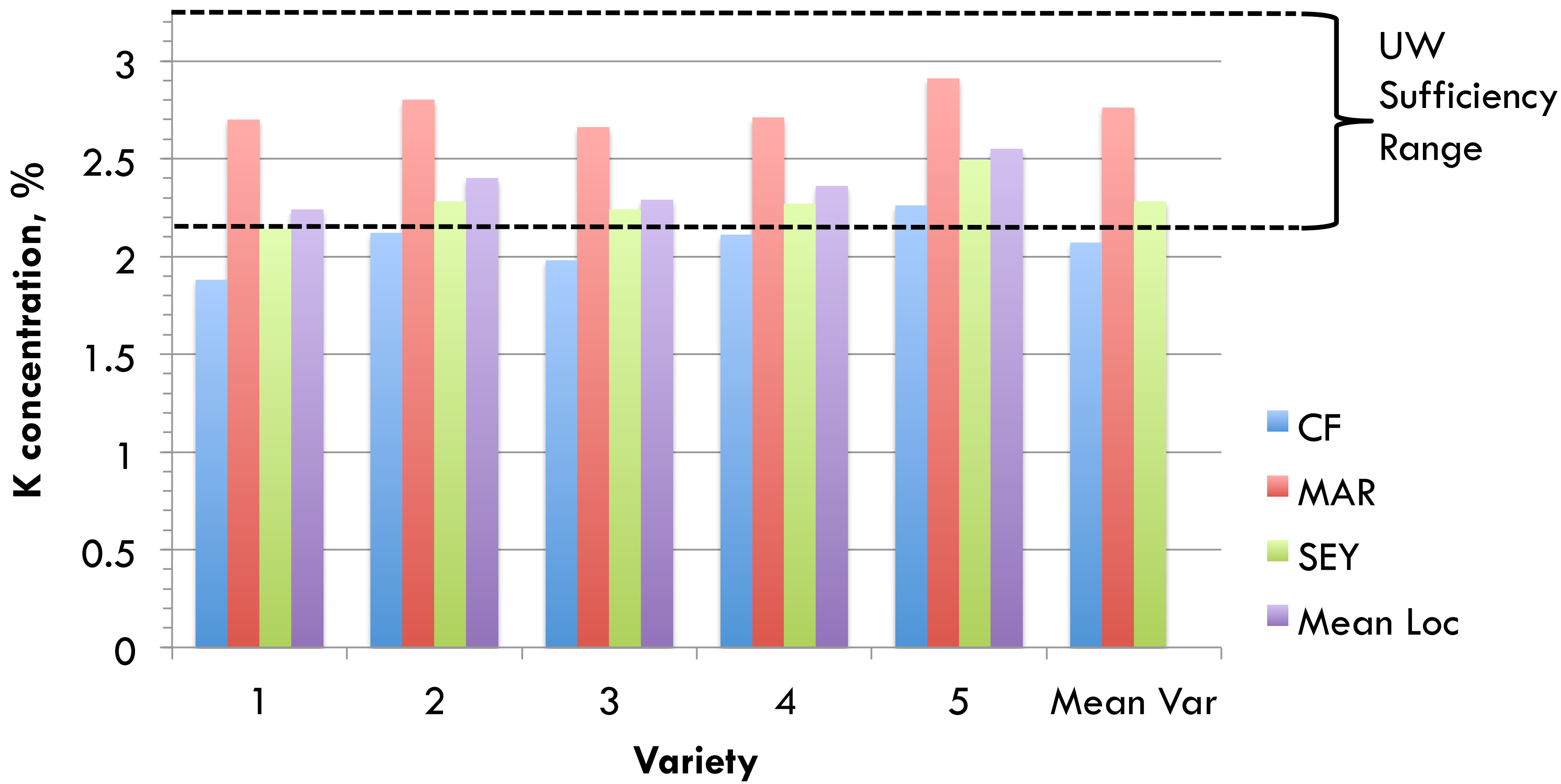
Effect of variety & location on soybean tissue K concentrations at R1, Southern WI



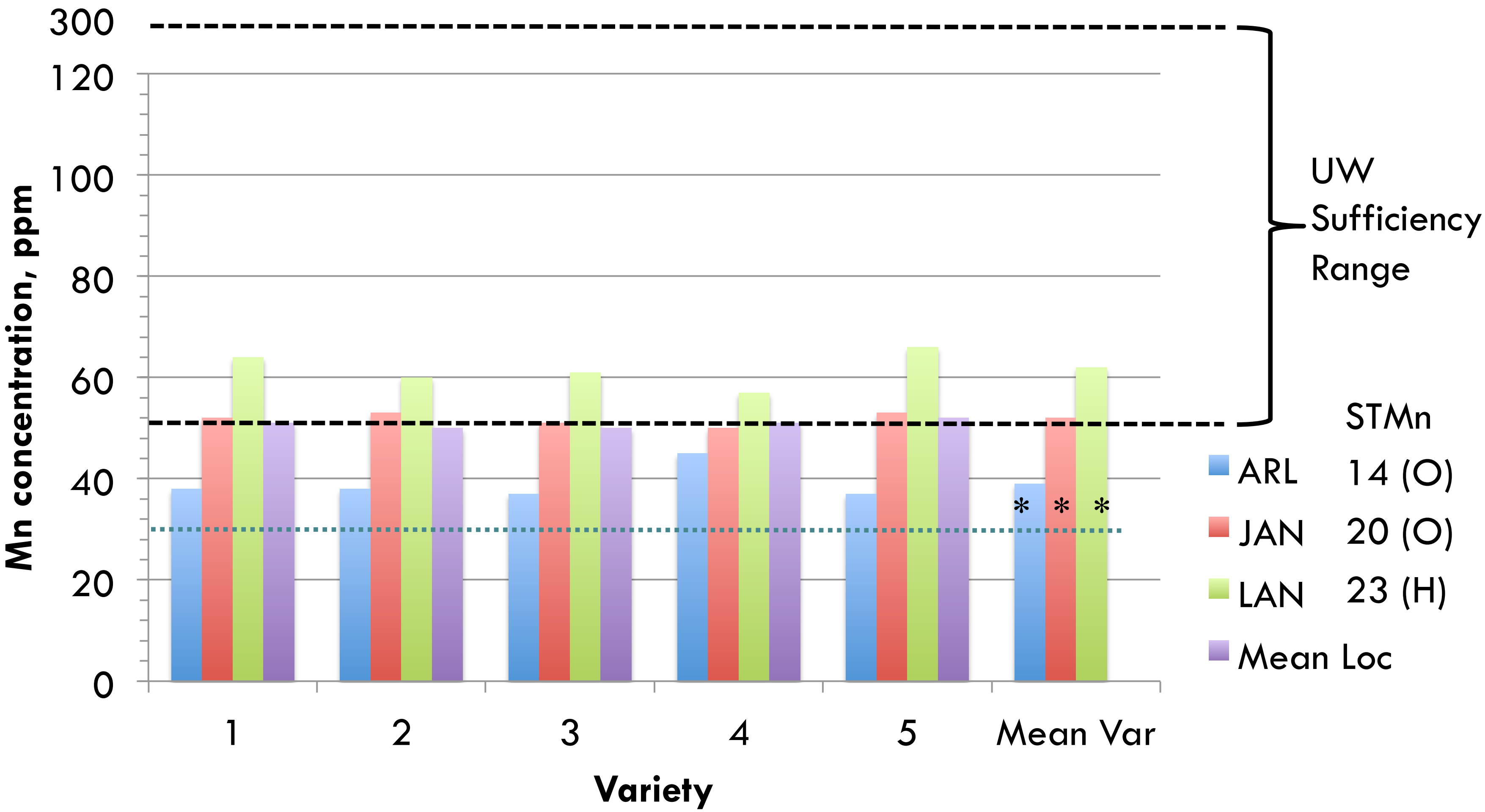
Effect of variety & location on soybean tissue K concentrations at R3, Southern WI



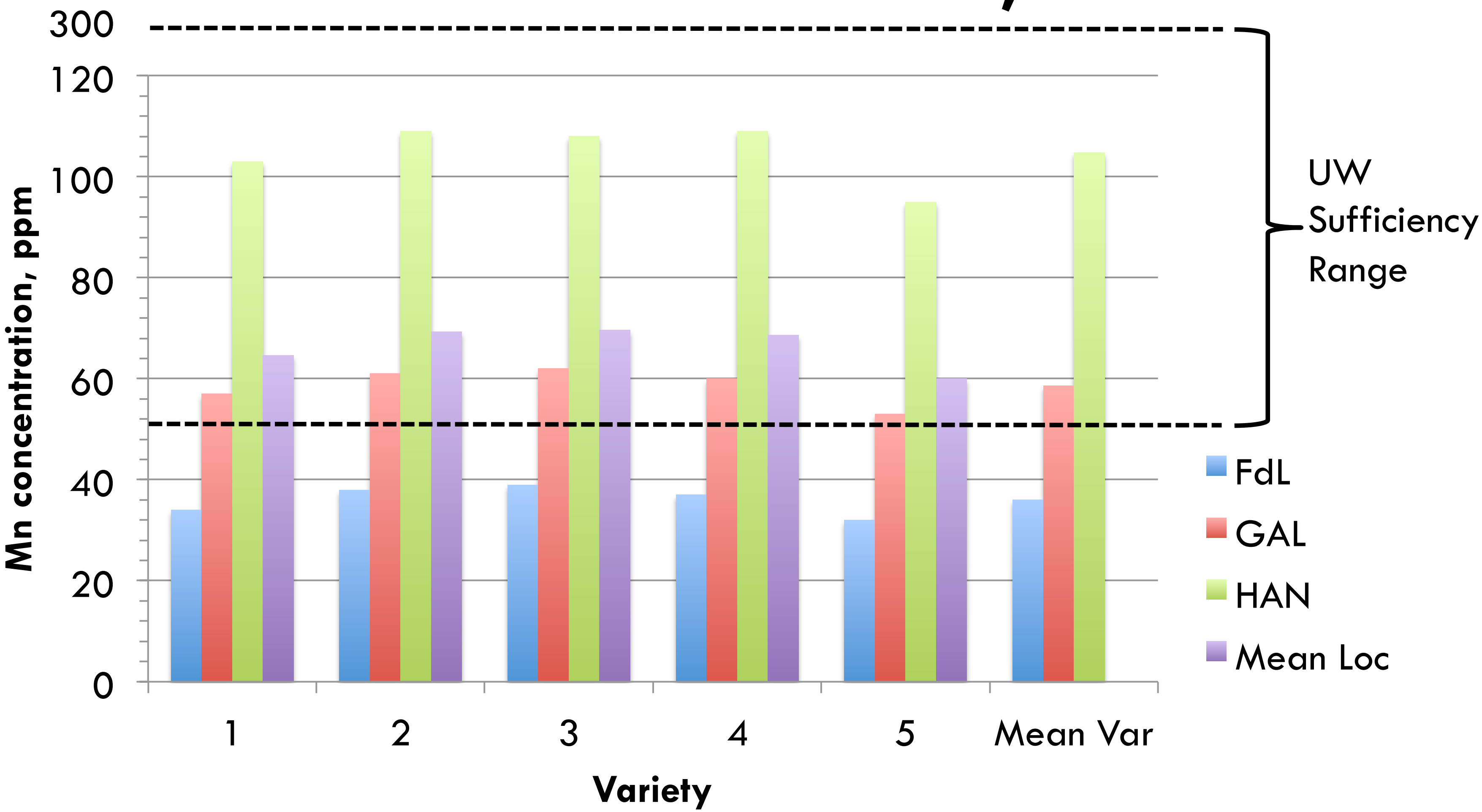
Effect of variety & location on soybean tissue K concentrations at R1, N. Central WI



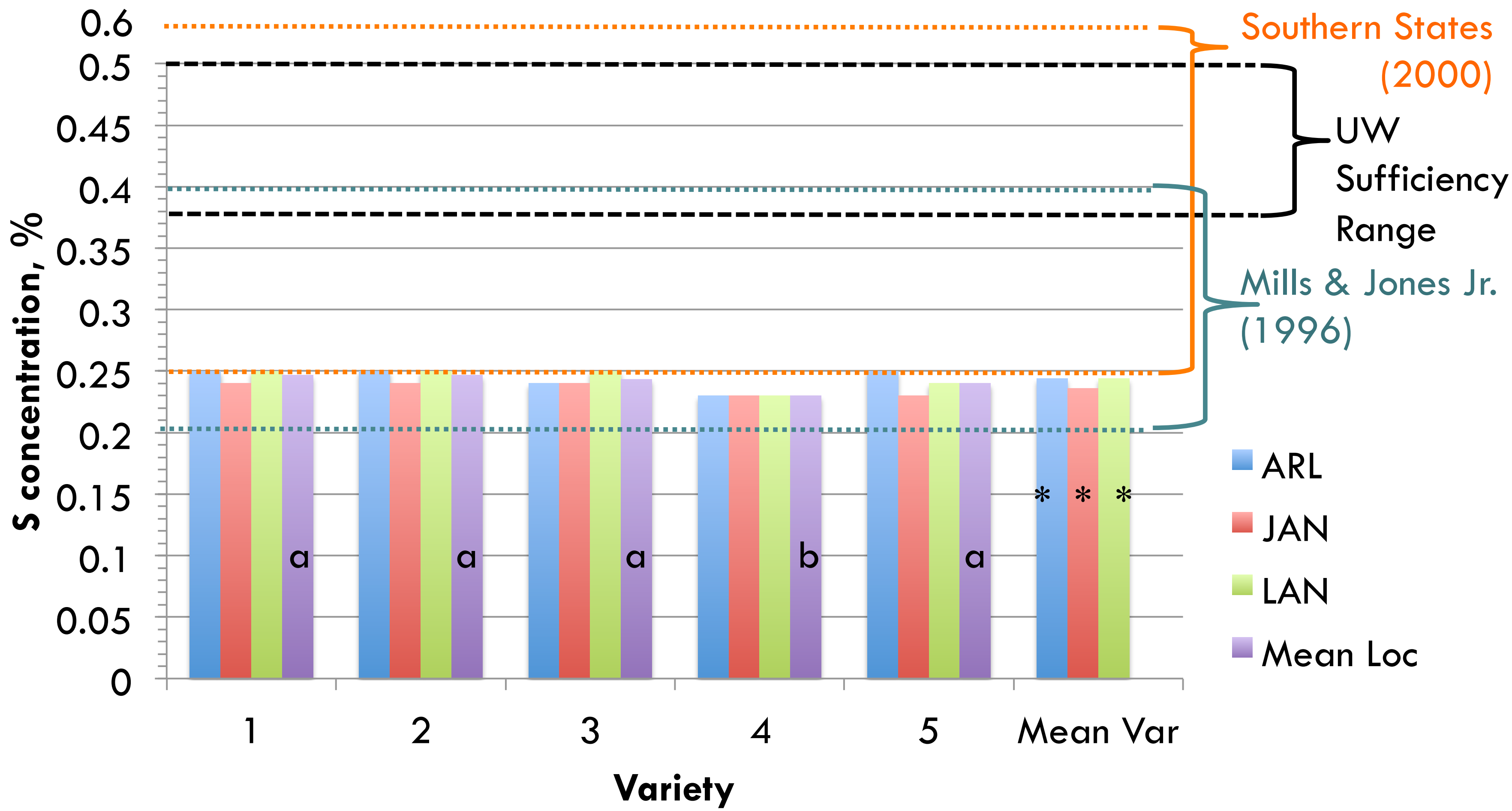
Effect of variety & location on soybean tissue Mn concentrations at R1, Southern WI



Effect of variety & location on soybean tissue Mn concentrations at R1, Central WI



Effect of variety & location on soybean tissue S concentrations at R1, Southern WI



Significant ($p<0.05$) differences in nutrient concentrations between R1& R3 at each location averaged across all varieties

Location	N	P	K	Mn	S
ARL	–	↑	↑	↑	↓
JAN	↓	↓	–	↓	↓
LAN	↑	↑	–	↓	↓

↑ Nutrient concentration at R3 significantly greater than R1
↓ Nutrient concentration at R3 significantly less than R1

Conclusions

- Using PA to assess the nutrient sufficiency status for crops where norms for one or more nutrients are well identified works & is helpful when soil test correlations are poor for that nutrient
  - Alfalfa and S
- Using PA as part of a broad survey to assess crop management practices can be useful
  - Alfalfa and K
  - Care needs to be taken not to extrapolate beyond the dataset
    - Inadequate field history and/or lack of testing yield response to applied nutrient(s)

Conclusions cont.

- Soybean variety may and location often affect tissue nutrient concentrations when sampled at either the R1 or R3 stage
- Tissue nutrient concentrations at a location are affected by time of sampling
- Choice of sufficiency ranges will affect interpretation
  - There are a number of choices available – which one is correct?
  - Much of the data is quite dated
  - It is difficult to have confidence without fertilizer response data
- Caution should be used when taking single plant samples from a field
  - Most states suggest comparing samples taken from good vs bad areas
  - Include soil samples and other information such as sensor readings
- There is a need for more research with modern varieties and production practices

What's ahead

- Most states in the upper Midwest have research work ongoing
- Field research and survey work will continue in Wisconsin for multiple crops and locations
- Interest in using tissue testing will likely continue to grow, especially for high value crops
- Remember it is just one more tool in the toolbox