



# *Utilizing Plant Tissue Testing & Application Methods to Maximize Fertilizer Efficiency*

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UC Cooperative Extension

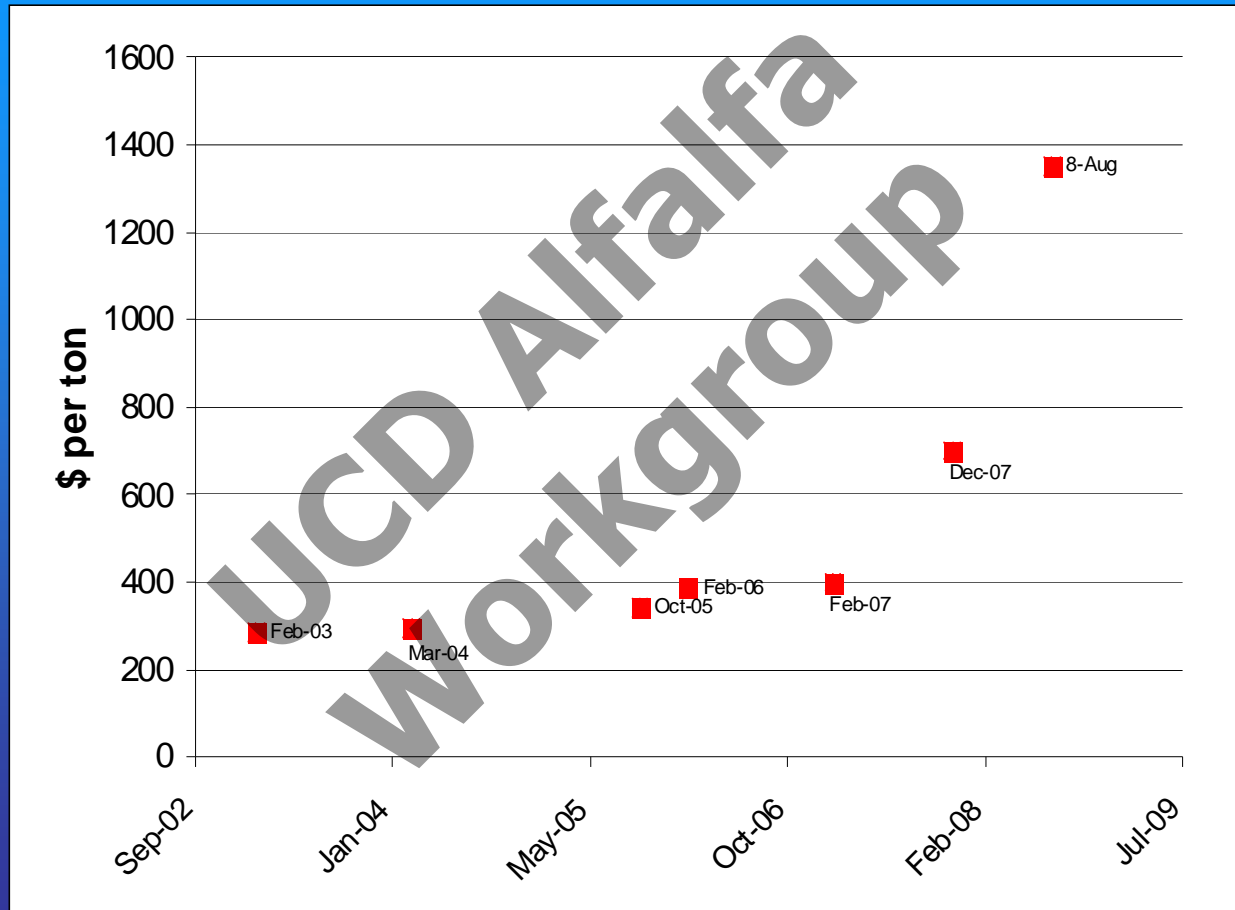
*Support from DANR Laboratory and International Plant Nutrition Institute*

## Favorite Quote

***“Last time I fertilized there was a government subsidy program to help pay for the fertilizer.”***

***“At that time I wasn’t sure it was worth it because when we fertilized, I had to spend so much more for baling wire”***

## Retail Price of 11-52-0 (Over Last 6 Years)



## Questions

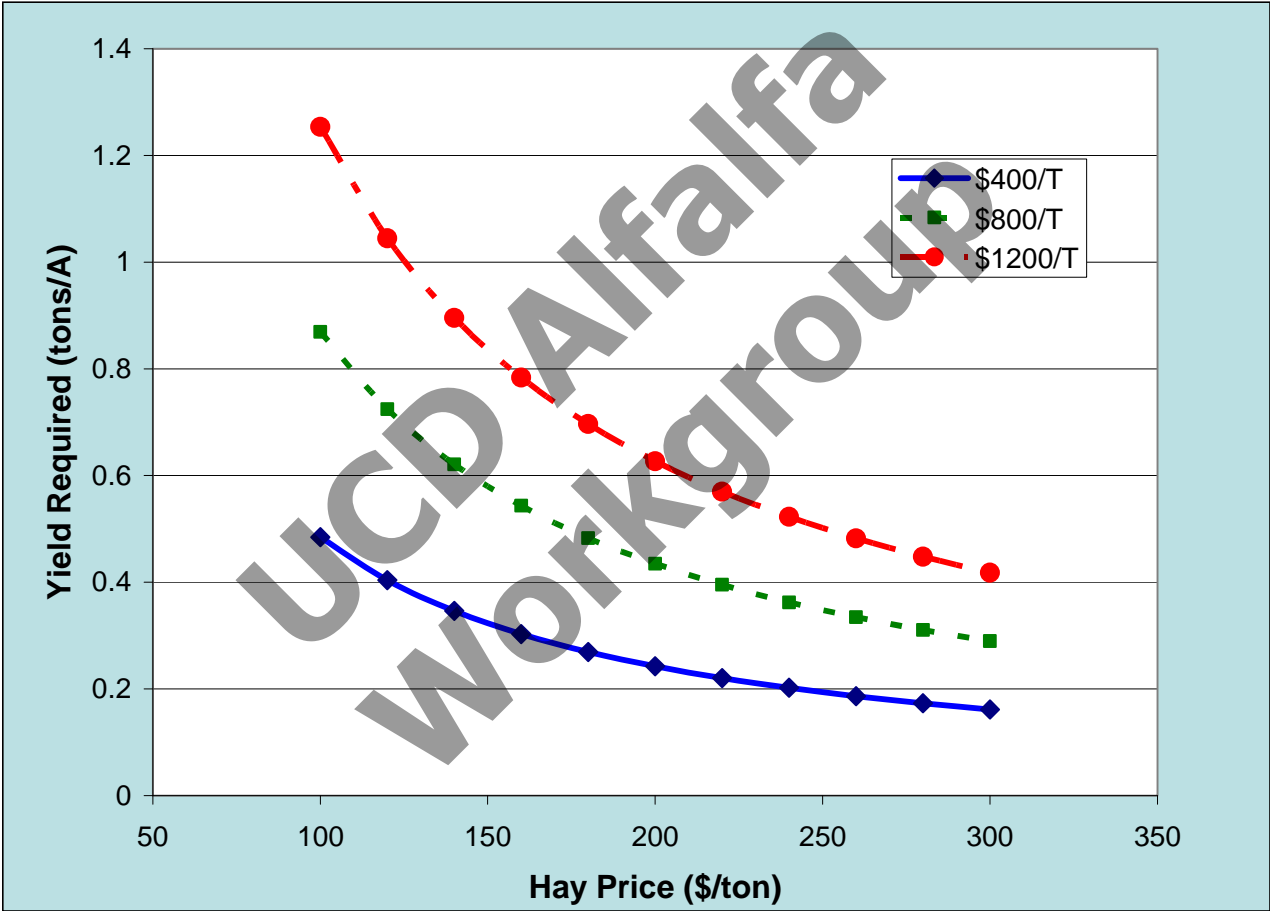
1. Does it pay to fertilize alfalfa with \$1,200 a ton 11-52-0?
2. Is banding more efficient than broadcasting phosphorus in established alfalfa?
3. Is it better to apply phosphorus over the winter or late in the season when the P might be running out?
4. Which is more accurate soil or plant tissue analysis?
5. Can cored-baled samples be used instead of fractionated stem samples and which one is better?
6. Which cutting is the preferred cutting to analyze?
7. Is there room for improvement with current fertilization practices?
8. UC critical levels for soil and plant tissue are lower than what many labs and consultants use. Which is correct?

## Questions

1. Does it pay to fertilize alfalfa with \$1,200 a ton 11-52-0?

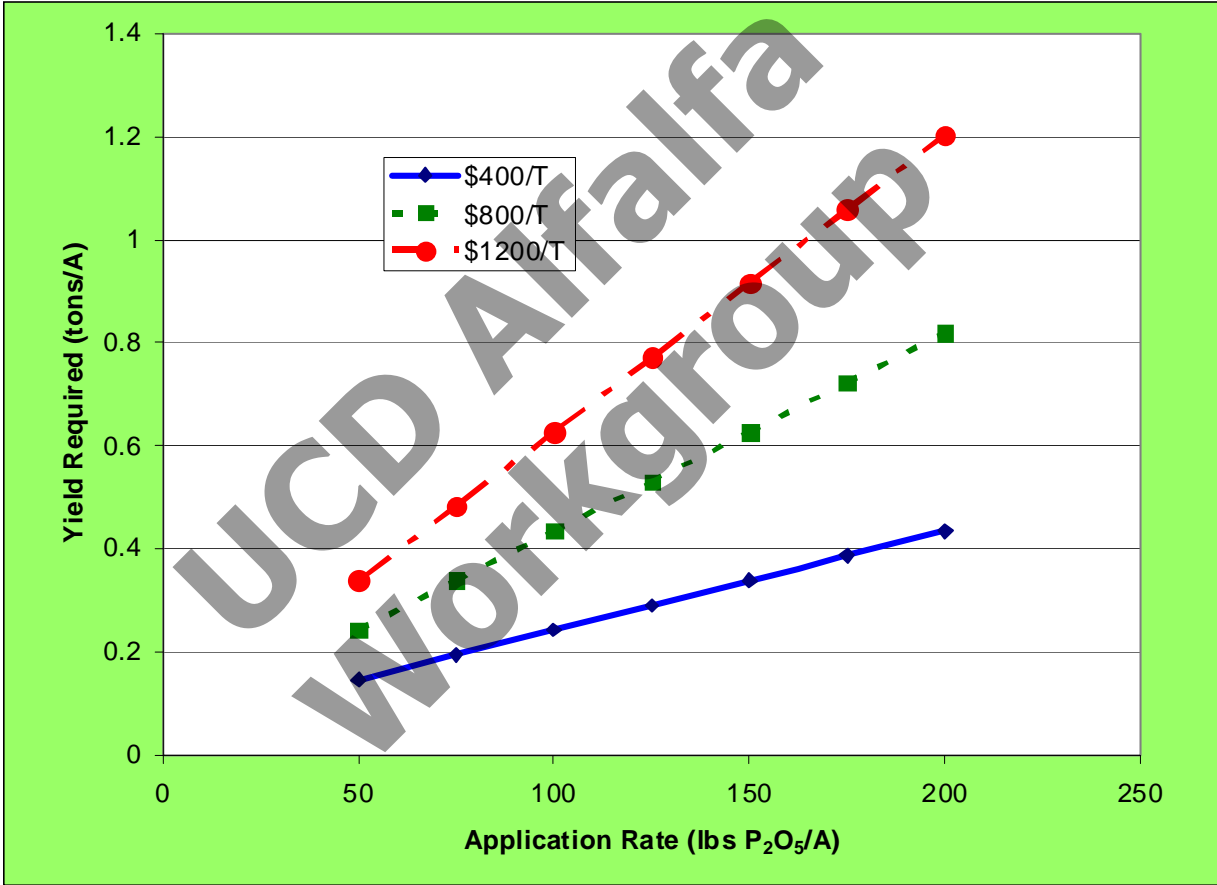
UCD Alfalfa  
Workgroup

Seasonal yield increase needed to cover cost of a 100 lb/acre  $P_2O_5$  application at three price levels of 11-52-0



Fertilization application cost of \$10 /A assumed

Seasonal yield increase needed to cover the cost of an application of 11-52-0 at three price levels (Hay @ \$200/ton)



Fertilization application cost of \$10 /A assumed

## The effect of phosphorus rate and source on alfalfa yield, Lancaster CA.

Lbs P <sub>2</sub> O <sub>5</sub> /A	Yield (tons/A)					
	Cut 1 4/30	Cut 2 6/10	Cut 3 7/14	Cut 4 8/21	Cut 5 10/2	Total
<b>Unfertilized</b>	1.56	1.65	1.57	1.60	1.13	7.51
<b>100</b>	1.90	1.84	1.71	1.74	1.19	8.38
<b>Increase</b>	0.34	0.19	0.14	0.14	0.06	0.87
<b>200</b>	1.94	1.85	1.76	1.75	1.27	8.57
<b>Increase</b>	0.38	0.20	0.19	0.15	0.14	1.06

## Fertilizer Application Method Research



- 1) Broadcast application of granular 11-52-0 to the soil surface;
- 2) Banded application of 11-52-0 below the soil surface using a drill;
- 3) Banded application of 10-34-0 to the soil surface using TeeJet StreamJet



## **Lassen County Sites**

- pH of 7.3 and an Olsen P 10.1 ppm
- pH of 7.7 and an Olsen P 17.3 ppm

## **Siskiyou County Sites**

- pH of 7.4 and an Olsen P 2.4 ppm
- pH of 6.7? and an Olsen P 8.4 ppm

## The effect of phosphorus rate on alfalfa yield

Scott Valley, CA. (Olsen P 2.4 ppm)

Rate (lbs P <sub>2</sub> O <sub>5</sub> /A)	Cut 1 6/12	Cut 2 7/21	Cut 3 8/28	Total	Increase over Unfert.
Untreated	1.94	1.44	1.25	4.63	—
40	2.25	1.79	1.49	5.53	0.90
80	2.43	1.75	1.39	5.56	0.93
120	2.68	1.79	1.46	5.93	1.30
160	2.61	1.81	1.46	5.88	1.25

## The effect of phosphorus rate on alfalfa yield

Butte Valley, CA. (Olsen P 8.4 ppm)

Rate (lbs P <sub>2</sub> O <sub>5</sub> /A)	Cut 1 6/19	Cut 2 7/24	Cut 3 8/29	Total	Increase over unfert.
Untreated	2.39	1.83	1.33	5.56	—
40	2.68	1.93	1.35	5.96	0.40
80	2.89	2.03	1.48	6.41	0.85
120	2.98	2.10	1.50	6.63	1.07
160	2.88	2.03	1.46	6.37	0.81



**Can you expect this kind of increase in yield in every alfalfa field?**

# Diagnosing Nutrient Status of Alfalfa Field

Visual Observation

Soil Testing

Plant Tissue Testing

Fertilizer Strips

# Deficiency Symptoms



## Nutrient Deficiency Symptoms in Alfalfa

<u>Nutrient</u>	<u>Deficiency Symptoms</u>
<b>Nitrogen</b>	Generally yellow, stunted plants.
<b>Phosphorus</b>	Stunted plants with small leaves; sometimes leaves are dark blue-green.
<b>Potassium</b>	Pinhead-sized yellow or white spots on margins of leaves: on more mature leaves, yellow turning to brown leaf tips and edges.
<b>Sulfur</b>	Generally yellow, stunted plants.
<b>Molybdenum</b>	Generally yellow, stunted plants.

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# Diagnosing Nutrient Deficiencies in Alfalfa

Visual Observation

Soil Testing



# Soil Test Interpretation

NUTRIENT	SOIL VALUE (PPM)			
	DEFICIENT	MARGINAL	ADEQUATE	HIGH
Phosphorus	<5	5-10	10-20	>20
Potassium ammon. acetate	<40	40-80	80-125	>125
Potassium Sulfuric acid	<300	300-500	500-800	>800
Boron	<0.1	0.1-0.2	0.2-0.4	>0.4

## Relative Reliability of Soil and Plant Tissue Tests

<u>Nutrient</u>	<u>Symbol</u>	<u>Soil Testing</u>	<u>Plant Tissue</u>
Phosphorus	P	Good	Excellent
Potassium	K	Good	Excellent
Sulfur	S	Very Poor	Excellent
Boron	B	Poor*	Excellent
Molybdenum	Mo	Not Done	Excellent

\*Good for evaluating toxicity of boron

How many growers currently do soil tests?  
Plant tissue tests?

# Traditional UC Recommended Plant Tissue Testing



## Interpretation of Test Results for Alfalfa Plant Tissue Samples Taken at 1/10<sup>th</sup> Bloom

Nutrient	Plant Part	Unit	Plant Tissue Value <sup>a</sup>			
			Deficient	Marginal	Adequate	High
Phosphorus (PO <sub>4</sub> -P)	Mid 3 <sup>rd</sup> stems	ppm	300-500	500-800	800-1500	Over 1500
Potassium	Mid 3 <sup>rd</sup> stems	%	0.40-0.65	0.65-0.80	0.80-1.5	Over 1.5
Sulfur (SO <sub>4</sub> -S)	Mid 3 <sup>rd</sup> leaves	ppm	0-400	400-800	800-1000	Over 1000
Boron	Top 3 <sup>rd</sup>	ppm	Under 15	15-20	20-40	Over 200
Molybdenum	Top 3 <sup>rd</sup>	ppm	Under 0.3	0.3-1.0	1-5	5-10

a) Phosphorus concentration should be higher if alfalfa is cut at bud stage, 1200 ppm at mid bud, and even higher, 1600 ppm, if cut at very early bud stage. Other nutrient concentrations should be approximately 10% higher than when sampled at the 1/10<sup>th</sup> bloom growth stage (multiply tabular values by 1.10).

## Recommended Phosphorus and Potassium Application Rates Based on Results of Soil or Plant Tissue Tests

Nutrient	Yield Level (ton/acre)	Soil or Plant Tissue Test Result		
		Deficient	Marginal	Adequate
		Application Rate, lb/acre		
Phosphorus (P <sub>2</sub> O <sub>5</sub> )	4	60-90	30-45	0-20
	8	120-180	60-90	0-45
Potassium (K <sub>2</sub> O)	4	100-200	50-100	0-50
	8	300-400	150-200	0-100



## Alternative Tissue Testing Technique Analyze Cored Bale Samples?

### Drawbacks to Current System

- Time to collect samples
- Must be taken prior to cutting
- Fractionating samples somewhat laborious
- Difficult to get representative sample





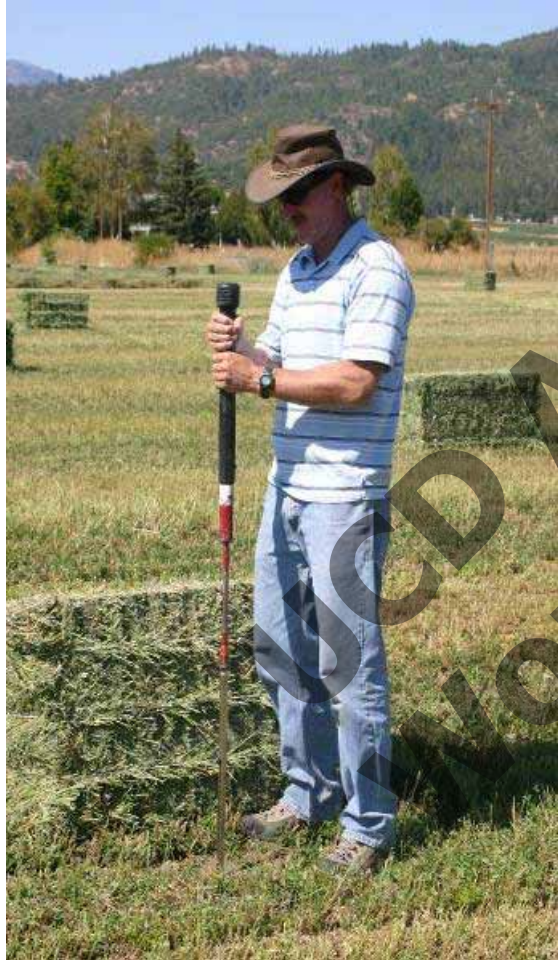
Two samples  
collected from area  
of each swath



One fractionated  
and one left as  
whole tops



**Bales from each windrow cored before removed from field**



Soil samples taken  
along each windrow  
(15 to 20 cores)

Compare results from  
fractionated tops,  
whole tops, cored  
bales, soil samples

**Average of 117 samples over 2 years**  
**Siskiyou and Lassen Counties**

	Soil		
	pH	Olsen P ppm	K ppm
<b>Average</b>	<b>7.2</b>	<b>17.1</b>	<b>192</b>
Deficient		<5	<40
Marginal		5–10	40-80
Adequate		10–20	80-125
High		>20	>125

**Average of 117 samples over 2 years**  
**Siskiyou and Lassen Counties**

	Mid-Stems		Mid-Stem Leaves
	PO <sub>4</sub> -P ppm	K %	SO <sub>4</sub> -S ppm
<b>Average</b>	<b>1327</b>	<b>2.03</b>	<b>2390</b>
Deficient	300–500	0.4–0.65	0–400
Marginal	500–800	0.65–0.80	400-800
Adequate	800–1500	0.80–1.50	800–1000
High	>1500	>1.50	>1000

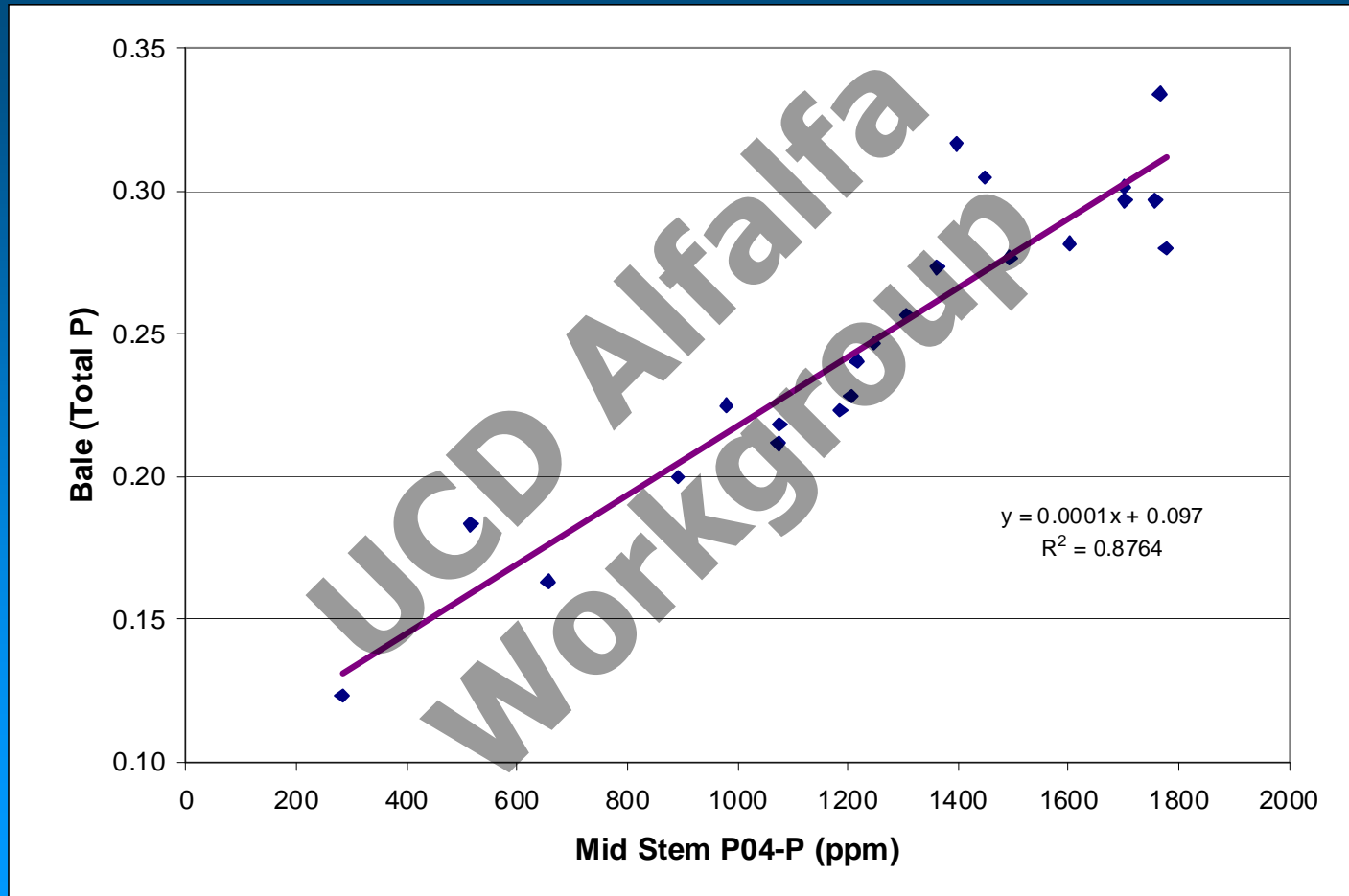
**Average of 117 samples over 2 years**  
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	Soil		
	pH	Olsen P ppm	K ppm
<b>Average</b>	<b>7.2</b>	<b>17.1</b>	<b>192</b>
<b>Deficient</b>		<b>&lt;5</b>	<b>&lt;40</b>
Marginal		5–10	40-80
<b>Adequate</b>		<b>10–20</b>	<b>80-125</b>
<b>High</b>		<b>&gt;20</b>	<b>&gt;125</b>
Low	5.6	<b>2.0</b>	<b>25</b>
High	8.1	<b>74.7</b>	<b>632</b>

**Average of 117 samples over 2 years**  
**Siskiyou and Lassen Counties**

	Mid-Stems		Mid-Stem Leaves
	PO <sub>4</sub> -P ppm	K %	SO <sub>4</sub> -S ppm
<b>Average</b>	<b>1327</b>	<b>2.03</b>	<b>2390</b>
Deficient	300–500	0.4–0.65	0–400
Marginal	500–800	0.65–0.80	400-800
Adequate	800–1500	0.80–1.50	800–1000
High	>1500	>1.50	>1000
Low	230	0.74	180
High	2220	4.18	5350

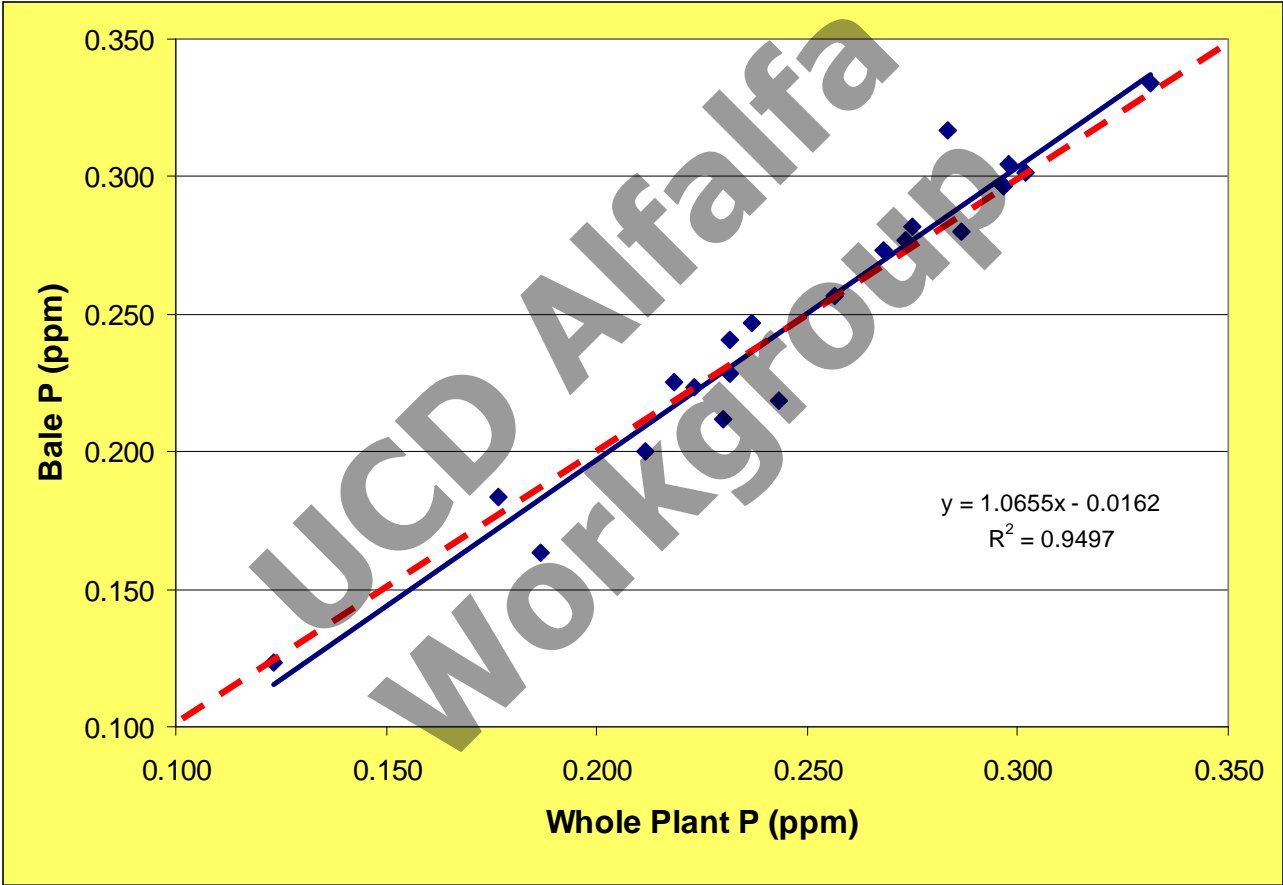
## Mid-Stem PO<sub>4</sub>-P vs. Bale Total P



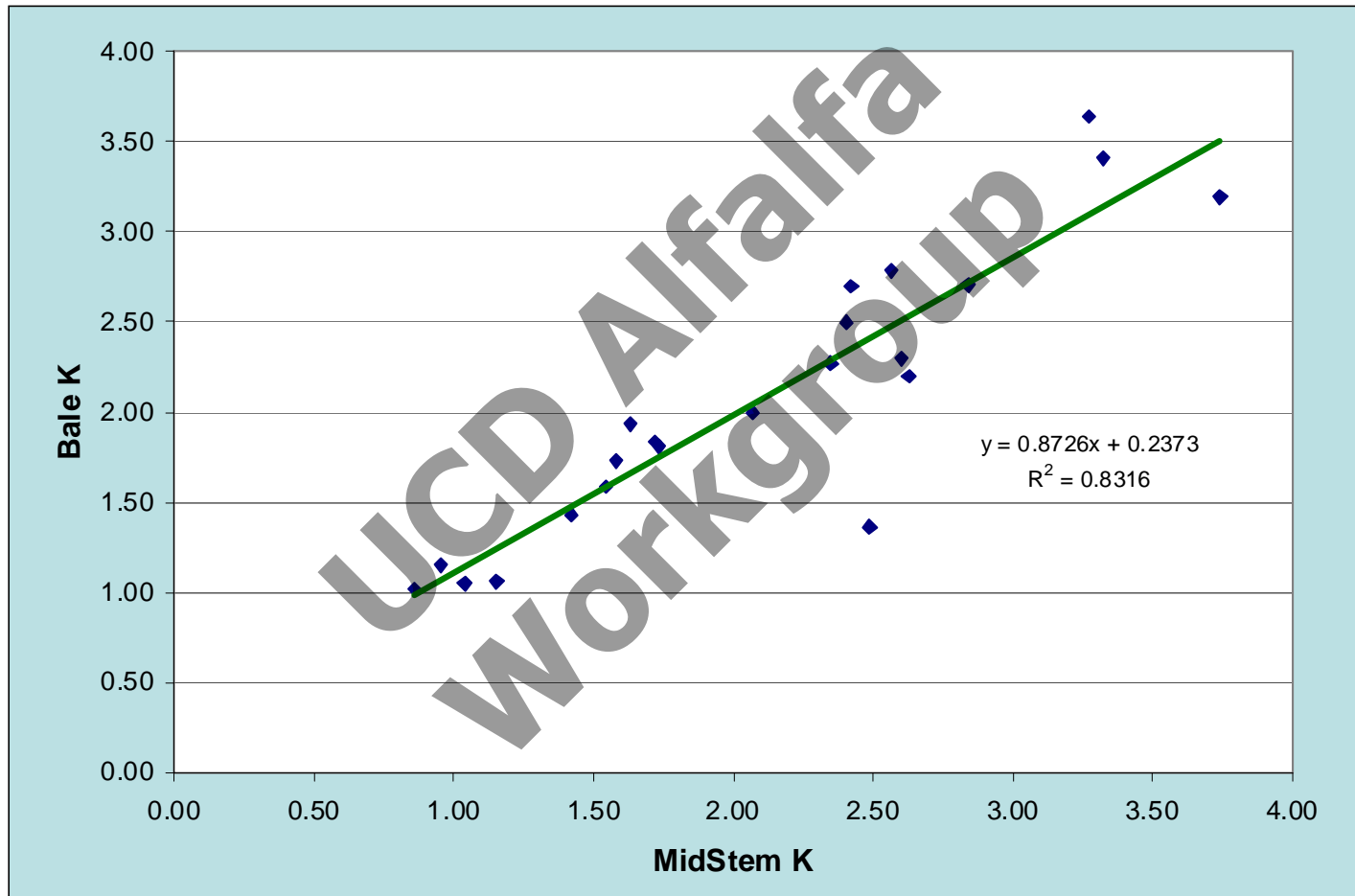
## Concern over leaf loss



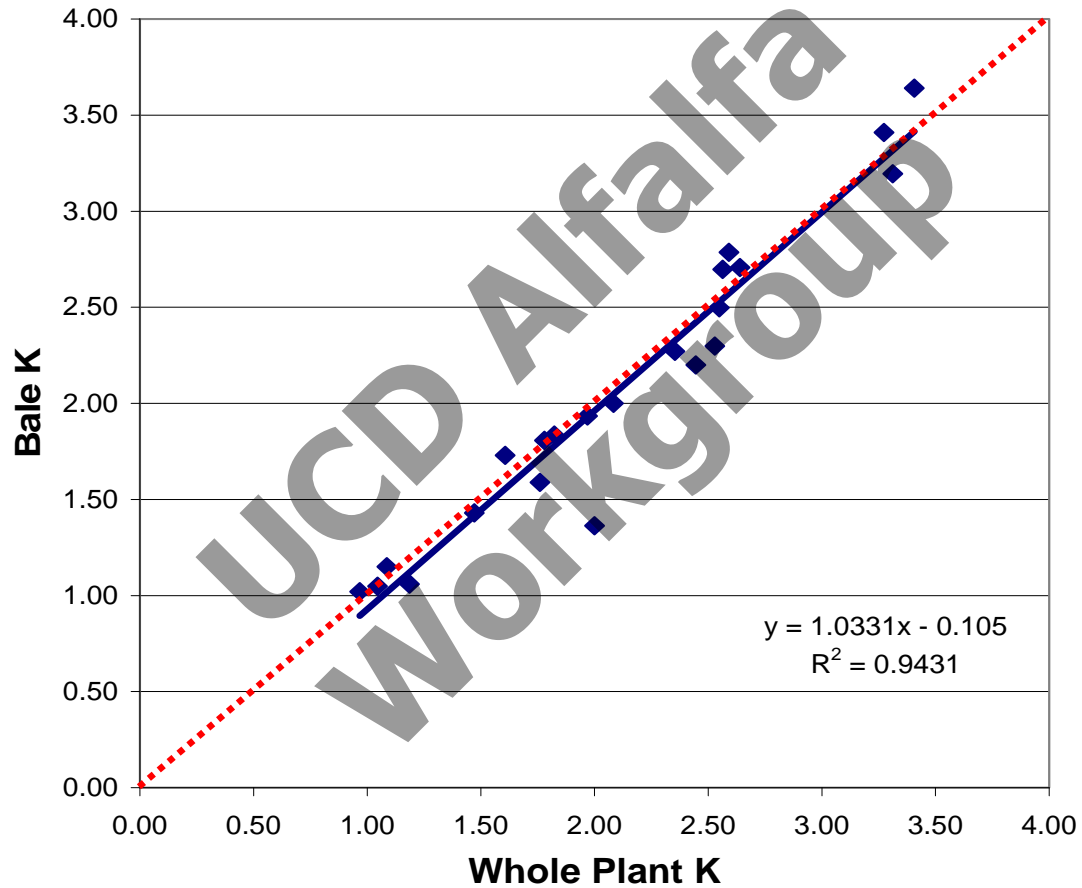
# Whole Plant vs. Bale P



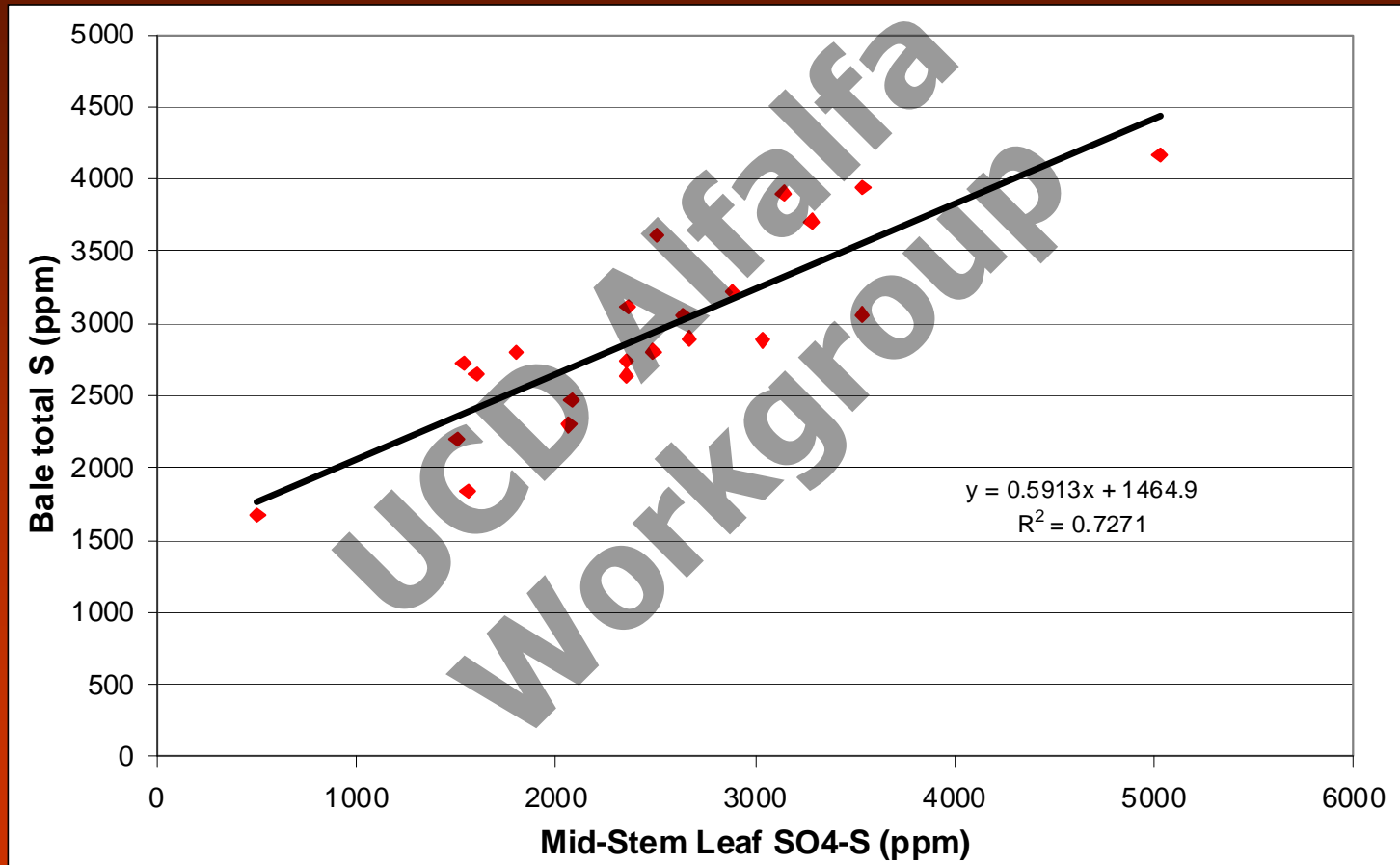
# Bale vs. Mid Stem K



# Whole Plant vs. Bale K



# Mid Stem Leaf SO4-S vs Bale S

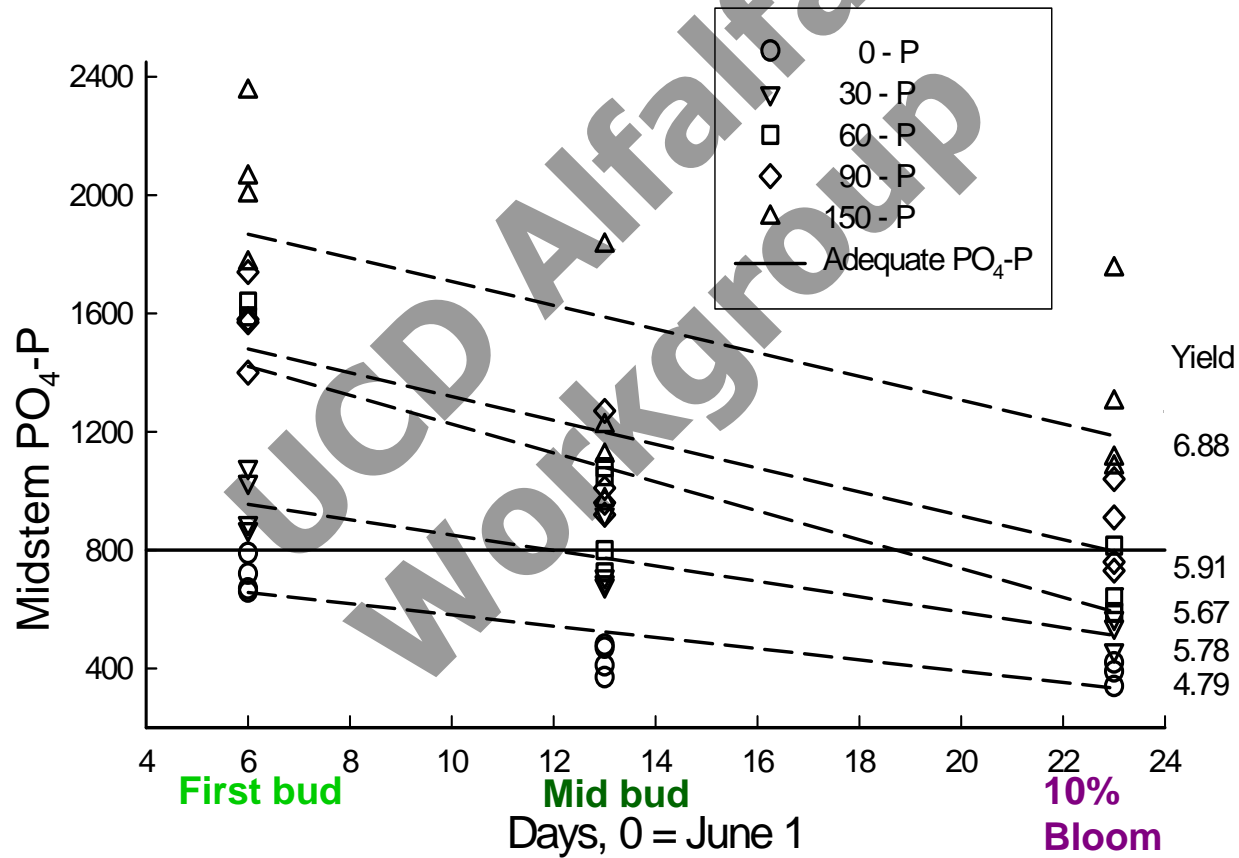




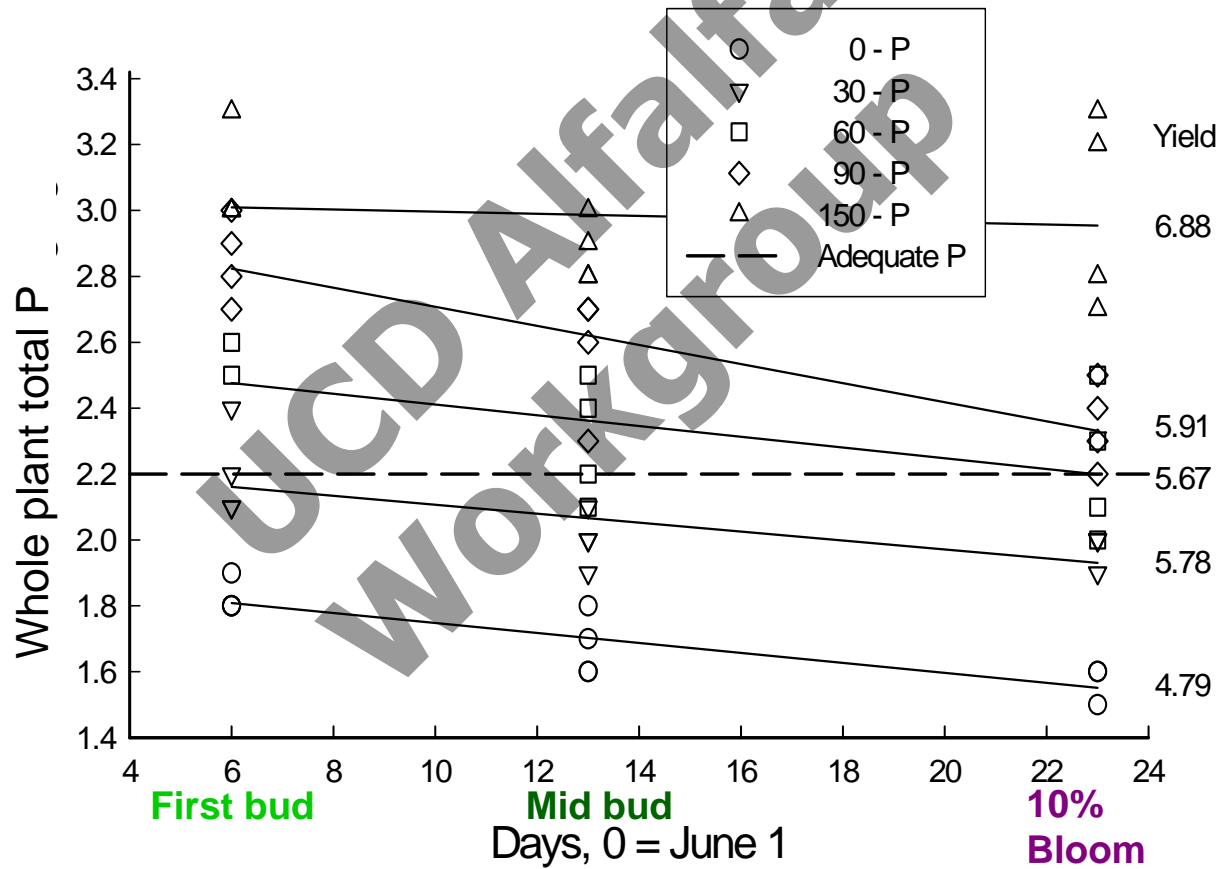
Phosphorus application rate studies to determine the effect of maturity and cutting on whole tops and mid stem phosphorus levels



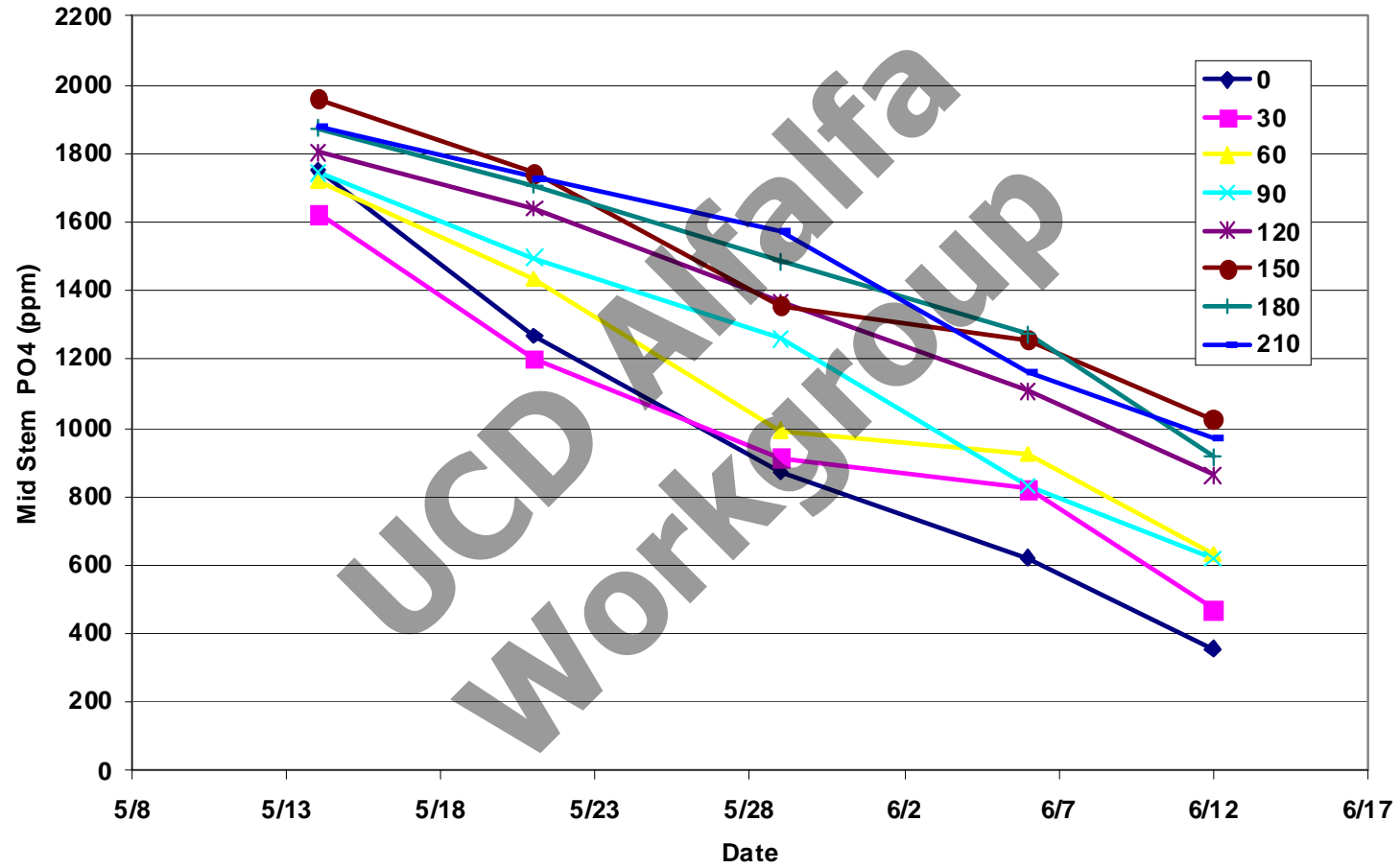
## Alfalfa Phosphorus Concentration in Midstems Change during First Harvest for 0, 30, 60, 90, and 150 lb/A rate



## Alfalfa Total Phosphorus Concentration in Whole Tops Change during First Harvest for 0, 30, 60, 90, and 150 lb/A rate



Effect of Maturity on P04 (Mid-stem Cut 1- Scott Valley, 2007))



## Effect of Maturity and Cutting on Mid-Stem PO<sub>4</sub>-P



## Interpretation of Alfalfa Plant Tissue Samples Taken at 1/10<sup>th</sup> Bloom for Whole Plant Samples Collected from Baled Hay

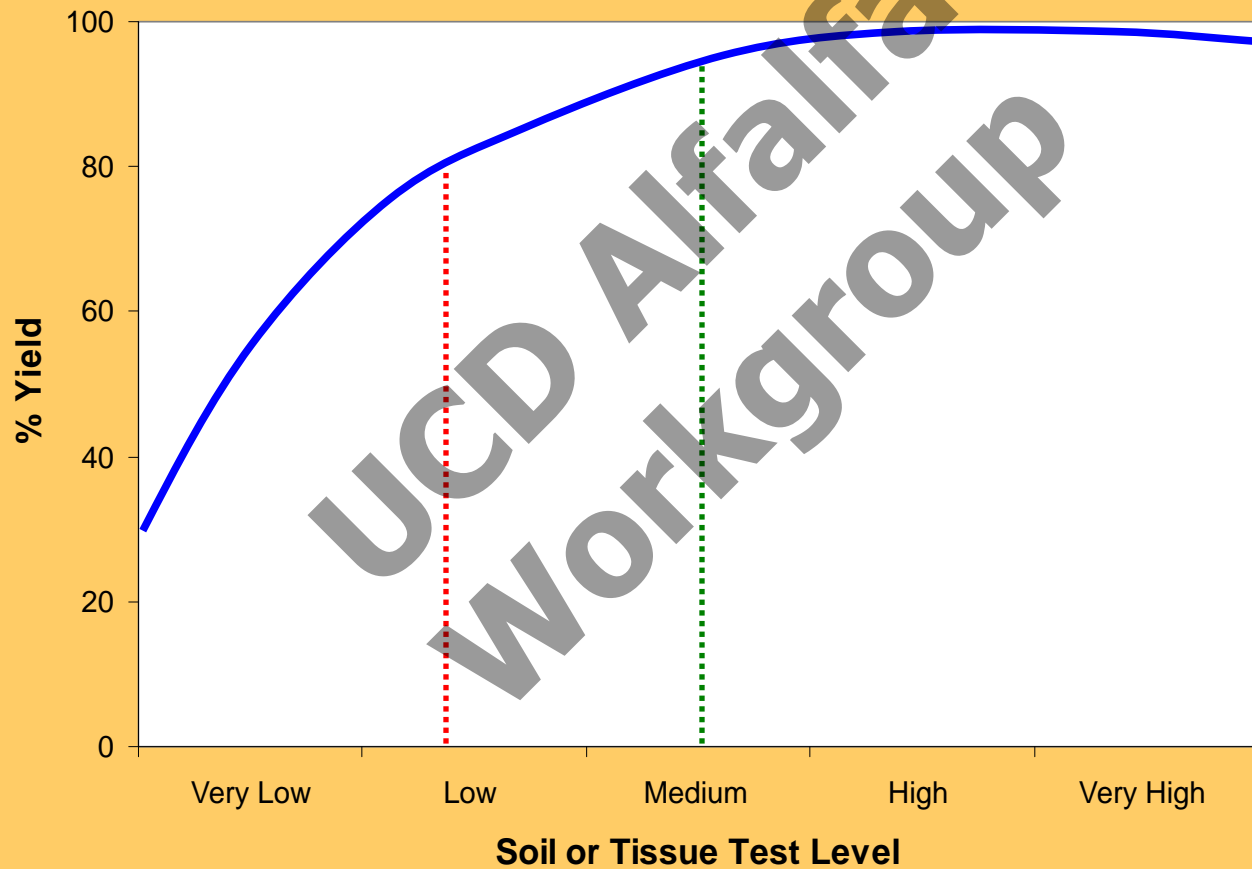
Nutrient	Unit	Plant Tissue Value <sup>a</sup>			
		Deficient	Marginal	Adequate	High
Phosphorus	%	<0.20	0.21-0.22	0.23-0.30	>0.30
Potassium	%	<0.80	0.81-1.09	1.10-1.40	1.40-3.00
Sulfur	%	<0.20	0.20-0.22	0.23-0.30	>0.40

a) Phosphorus concentration should be higher if alfalfa is cut at bud stage, 0.26% at mid bud, and even higher, 0.28% if cut at very early bud stage. Other nutrient concentrations should be approximately 10% higher than when sampled at the 1/10<sup>th</sup> bloom growth stage (multiply tabular values by 1.10).

## UC critical levels for soil and plant tissue sometimes lower than what many labs and consultants use.

- Some labs (mostly out of state use unreasonable numbers)
- May get an economic yield response slightly above UC values
- Field variability and composite samples
  - 1735, 1380, 1320, 1180, 985 (mean = 1320)
- Solution ???

## Potential Yield Increase from Fertilizer Application



## Questions

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2. Is it better to apply phosphorus over the winter or late in the season when the P might be running out?
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