Walnut Nutrition from a Soil Perspective

by

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What do we expect from the soil?

- Water –in sandy soils we need to irrigate more frequently with lower amounts.

  In higher clay soils we need to irrigate less frequently with larger amounts.

What do we expect from the soil?

- Water –in sandy soils we need to irrigate more frequently with lower amounts.

  In higher clay soils we need to irrigate less frequently with larger amounts.
- Nutrients –Nitrogen (N), Potassium (K), Zinc (Zn), Boron (B), or perhaps for cover crops – Phosphorus (P), and Sulfur (S).

Finding out if your walnut or other tree crop

—Needs a certain nutrient is more reliably done with the aid of leaf tissue testing.

—Has nutrients or toxic elements in excess can also be done with the aid of leaf tissue testing **but** soil testing can be very helpful as well.

Soil evaluations are particularly helpful for determining the presence of excess salts (high EC) and toxic element concentrations (chloride-Cl, boron-B or sodium-Na), textural changes (sand, silt and clay layers), or physical layers such as compaction, or pans (hardpan, or cemented pan).


5308
case
case

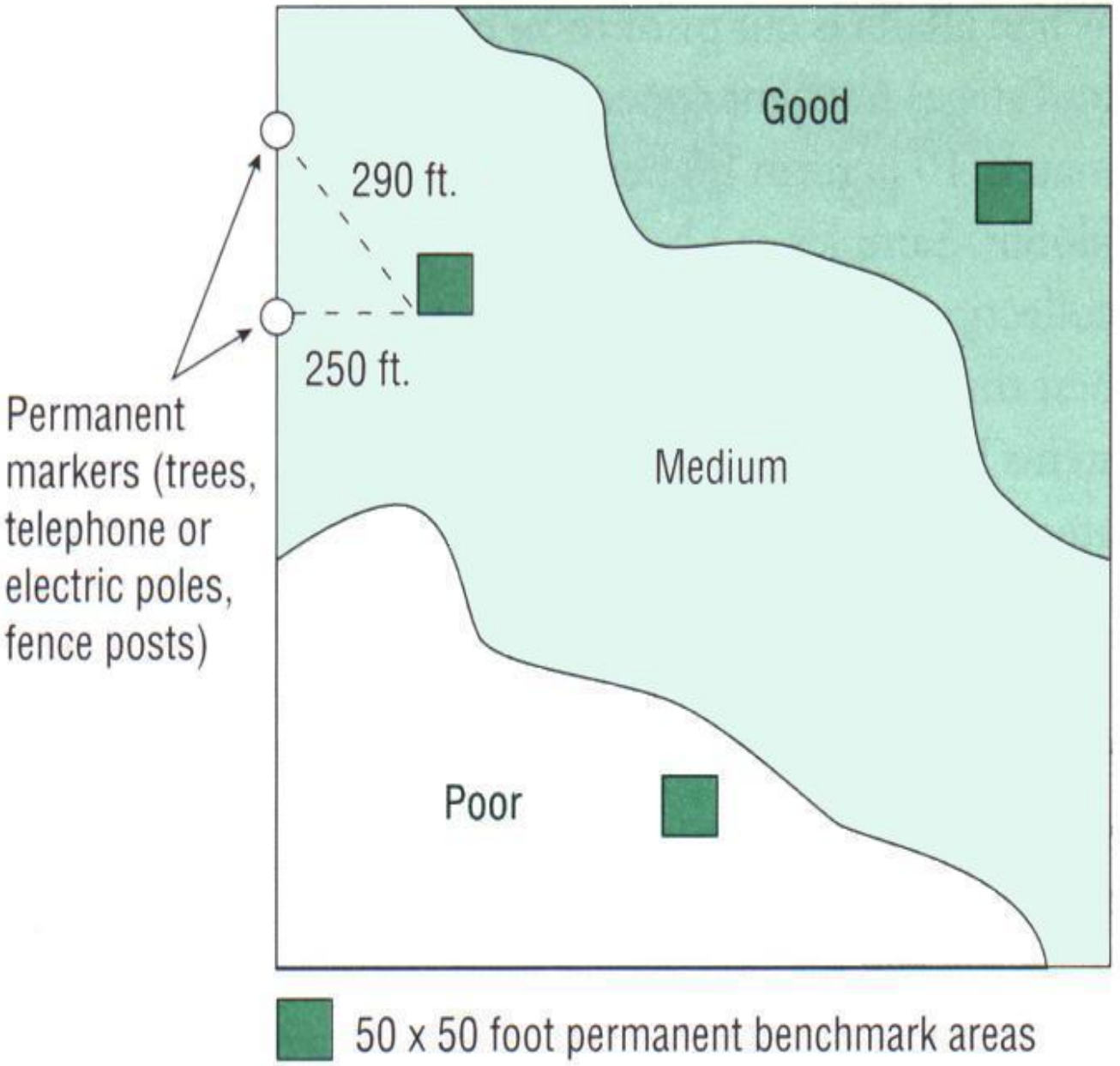
Soil and plant tissue sampling strategy for an orchard.

1. Select 2 or 3 areas having different yield or productivity levels in a field: low and high or low, medium and high.

A Field Example:

Soil and plant tissue sampling strategy for an orchard.

2. Establish benchmark areas (50 feet x 50 feet) in size within each of the yield or productivity levels that can be monitored over the next 10 years or longer.


Good
290 ft.
250 ft.
Permanent markers (trees, telephone or electric poles, fence posts)
Medium
Poor
50 x 50 foot permanent benchmark areas

Soil and plant tissue sampling strategy for an orchard.

3. Locate and measure how far these benchmark areas are from permanent markers—such as trees, power poles, or tags in fence rows.

Or, locate with the aid of a handheld GPS unit.

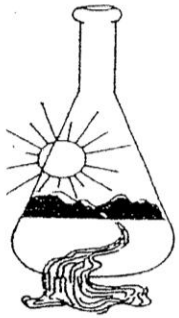
Soil and plant tissue sampling strategy for an orchard.

4. Take 8 to 12 random soil cores (0 – 6” and 6 –12” deep- two samples) from each benchmark area for several years, then every other year. They should be analyzed for pH, EC, OM, P, K, Zn, and saturated paste Ca, Mg, Na, Cl, and B.

   Initially, it is also desirable to sample from deeper depths—6 to 8 cores from the 12 – 24”, 24 –36”, 36 – 48”, and 48 –60” depths. The deeper depths should be analyzed for pH, EC, and saturated paste Ca, Mg, Na, Cl, and B. Perhaps nitrate (NO_3) as well.

Soil and plant tissue sampling strategy for an orchard.

4. Plant tissue samples should be taken from each of the different yield or productivity levels by collecting 20-25 leaves from each of the 9 to 12 trees. These samples should be analyzed for total N, P, K, Ca, Mg, S, Zn, Fe, Mn, Cu, Na, Cl, and B.



Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

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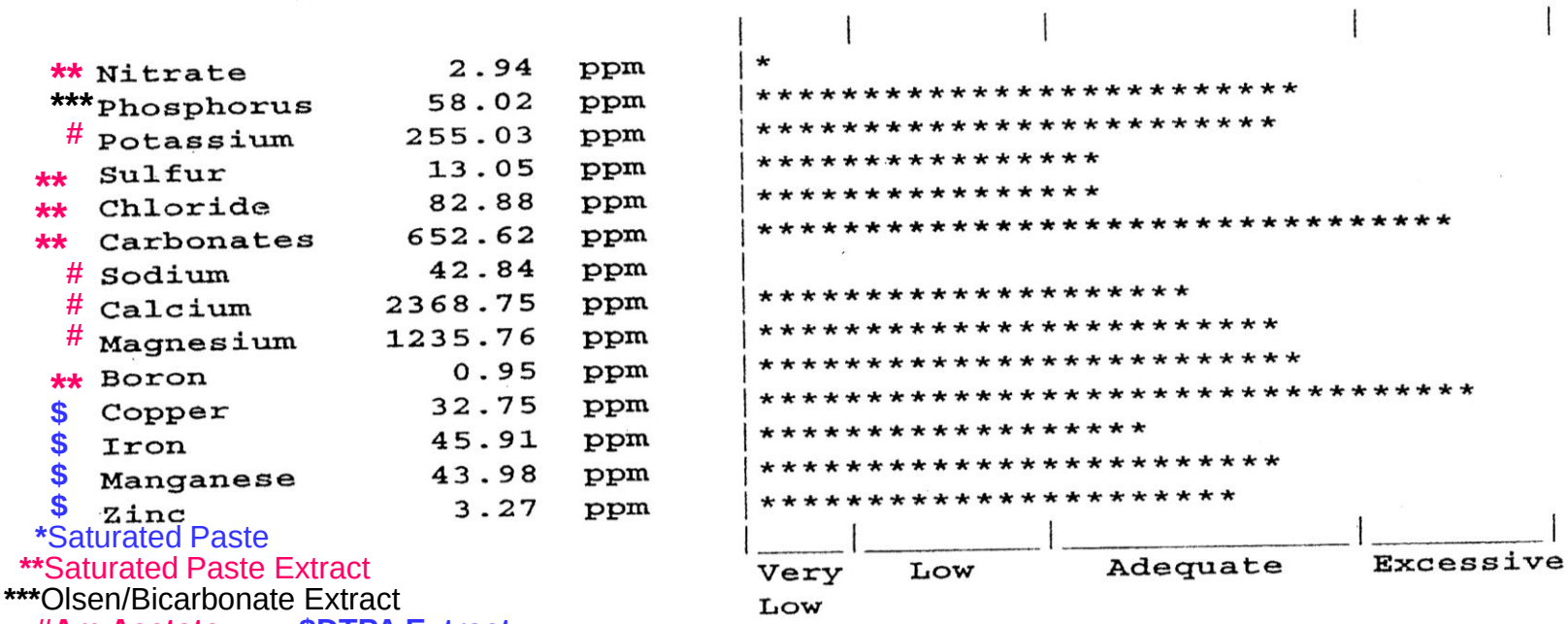
SOIL ANALYSIS

*	pH	6.93	
**	E.C.	1.38	mmho/cm
	Tot.Dissolved Salts (TDS)	883.2	ppm
#	C.E.C.	22.8	meq/100g
	Gypsum Req. (CaSO4*2H2O)	None Required	
	Sodium Absorption Ratio (SAR)	1.4	

% Organic Matter 1.0

TDS=EC X 640=1.38 X 640=883.2

**	Nitrate	2.94	ppm
***	Phosphorus	58.02	ppm
#	Potassium	255.03	ppm
**	Sulfur	13.05	ppm
**	Chloride	82.88	ppm
**	Carbonates	652.62	ppm
#	Sodium	42.84	ppm
#	Calcium	2368.75	ppm
#	Magnesium	1235.76	ppm
**	Boron	0.95	ppm
$	Copper	32.75	ppm
$	Iron	45.91	ppm
$	Manganese	43.98	ppm
$	Zinc	3.27	ppm

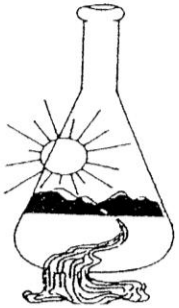


*Saturated Paste
**Saturated Paste Extract
***Olsen/Bicarbonate Extract
#Am Acetate $DTPA Extract

#BASE SATURATION	Potassium	Sodium	Calcium	Magnesium
Values Determined	2.9	0.8	51.9	44.4

What does the soil test tell us? Lets start with # 1

The methods of analysis are indicated with an *,**,***,# or $. Soil pH is determined on the saturated paste. The water is removed from the soil with vacuum to give the saturated paste extract. The soil electrical conductivity (EC), nitrate, sulfur, chloride, carbonate, bicarbonate and boron are determined on this extract with several different procedures. The Total Dissolved Salts (TDS) are usually calculated by multiplying the EC by 640. Calcium (Ca), magnesium (Mg), and sodium (Na) concentrations are also determined on the saturated paste extract for salinity evaluation. The SAR is calculated using the Ca, Mg, and Na concentrations. The soil phosphorus is determined using the Olsen's or bicarbonate method. If the soil pH is less than 6, the Bray #1 extractable P is also reported by some labs. The potassium, calcium, magnesium, and sodium are determined by the ammonium acetate procedure to determine the exchangeable cations (CEC). Soil base saturation is calculated from the total of these four cations or with the hydrogen concentration in the case of acid soils. The micronutrients copper, iron, manganese and zinc are determined with the use of the DTPA extract.



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SOIL ANALYSIS

pH	5.92		% Organic Matter 2.6
E.C.	1.02	mmho/cm	
Tot.Dissolved Salts	652.8	ppm	
C.E.C.	22.3	meq/100g	
Gypsum Req. (CaSO4*2H2O)	None Required		
Sodium Absorption Ratio (SAR)	1.0		

Nitrate	24.91	ppm	**********
Phosphorus	86.73	ppm	**************************
Potassium	1222.95	ppm	**************************
Sulfur	43.79	ppm	*****************************
Chloride	176.40	ppm	********************
Carbonates	215.94	ppm	**************************
Sodium	13.73	ppm	
Calcium	3221.88	ppm	**********************
Magnesium	364.74	ppm	**********
Boron	0.50	ppm	**********
Copper	5.05	ppm	**********
Iron	135.93	ppm	**********
Manganese	39.83	ppm	**********
Zinc	5.30	ppm	**********

Very Low	Low	Adequate	Excessive

BASE SATURATION	Potassium	Sodium	Calcium	Magnesium
Values Determined	14.1	0.3	72.3	13.4

What does the soil test tell us? Reports #1 & #2

In the upper right corner of the report is listed the organic matter (OM) content. A number of labs will indicate that for each 1% OM, approximately 20-40 lbs N/acre will become available over a growing season. Another approach to estimating N currently in the soil at any point in time is to sample the entire soil profile from 0-6”, 6-12”, 12-24”, 24-36” and 36-48” and adding the nitrate concentrations converted to lbs/acre 6” by multiplying ppm times 2 or lbs/acre foot by multiplying ppm times 4. This serves as a fairly good estimate of available nitrate-N if done just prior to rapid crop growth and about 1 week after an irrigation. This gives rather limited information for tree crops because several irrigations may move this nitrate into deeper depths in the soil prior to uptake by the trees particularly walnuts which start growing later in the spring.

DELLAVALLE® Laboratory, Inc.
Chemists and Consultants

Report of Soil Analysis

1910 W. McKinley, Suite 110, Fresno, CA 93728
FAX (559) 268-8174 - (800) 228-9896 - (559) 233-6129

Reference is "Soil, Plant and Water Reference Methods for the Western Region, 2003. 2nd Ed. WCC-103 Publication, WREP-125, 2nd Edition. Available from Dr. Janice Kotuby-Amacher, Utah State University.

Identification

No.	Description	% SP	pHs	EC dS/m	meq/l Ca	meq/l Mg	meq/l Na	meq/l Cl	% ESP	mg/l B
	Methods	S1.00	S1.10	S1.20	S1.60	S1.60	S1.60	S1.40		S1.50
1	Soil Amendment	199	6.5	45.67	23.0	68.1	126		20.8	17.6
2	Manure-Unscreened	168	6.4	42.44	22.3	54.7	106		19.4	13.9
3	Manure-Screened	143	6.4	46.98	21.3	52.4	103		19.1	12.7
4	Clean Rice Hulls	228	6.3	5.60	0.9	7.2	2.5		0.6	2.1

What does the soil test tell us? Reports #1, #2 & #3

The interpretation of test levels for EC, calcium, magnesium and sodium as well as SAR are for salinity evaluation, and toxic element evaluation of boron, chloride, and sodium. Also the nutritional guidelines for phosphorus with Olsen-P extract, potassium with exchangeable K, and micronutrients copper, manganese, iron and zinc with DTPA extract can be found in several crop based UC publications, the Western Fertilizer Handbook (WFH) and the Soil and plant tissue testing in California publication 1879. The WFH and Pub #1879 would be particularly helpful when establishing legume cover crops.

Resource Books

Western Fertilizer Handbook-9th Ed. 2002 (WFH) (8th and 7th Eds. are OK as well.)

Soil, Plant and Water Reference Methods for the Western Region, 2003. 2nd Ed. WCC-103 Publication, WREP-125, 2nd Edition. Available from Dr. Janice Kotuby-Amacher, Utah State University.

Calcium to Magnesium ratio considerations

(Use saturated paste extract concentrations—meq/L or exchangeable percentages to calculate the ratios)

Where Ca:Mg ratios are from 8 to 10 : 1 or higher Ca-- expect magnesium deficiencies.

Where Ca:Mg ratios are in the range of 6 : 1 to 1 : 1 – expect good growth of trees and other plants.

Where Ca:Mg ratios are higher in Mg than 1 : 2, it may be beneficial to add gypsum or in acid soils lime. If Mg is higher than 1 : 4 placement of gypsum in the plant root zone may be of economic benefit.

Alfalfa may be the only crop that will pay for a lime application if the soil pH is less than 5.8 to 6.0.

Nutrient efficiency and economic considerations in fertilizer applications

It might seem a bit strange but I would like to switch to another crop to illustrate the concept of nutrient efficiency and economic benefit.

Lets look at the nutrient efficiency and economic outcome of phosphorus applications in alfalfa

- Evaluate alfalfa yield response to one single 400 lb/A application in first year versus annual 100 lb/A applications for four years.

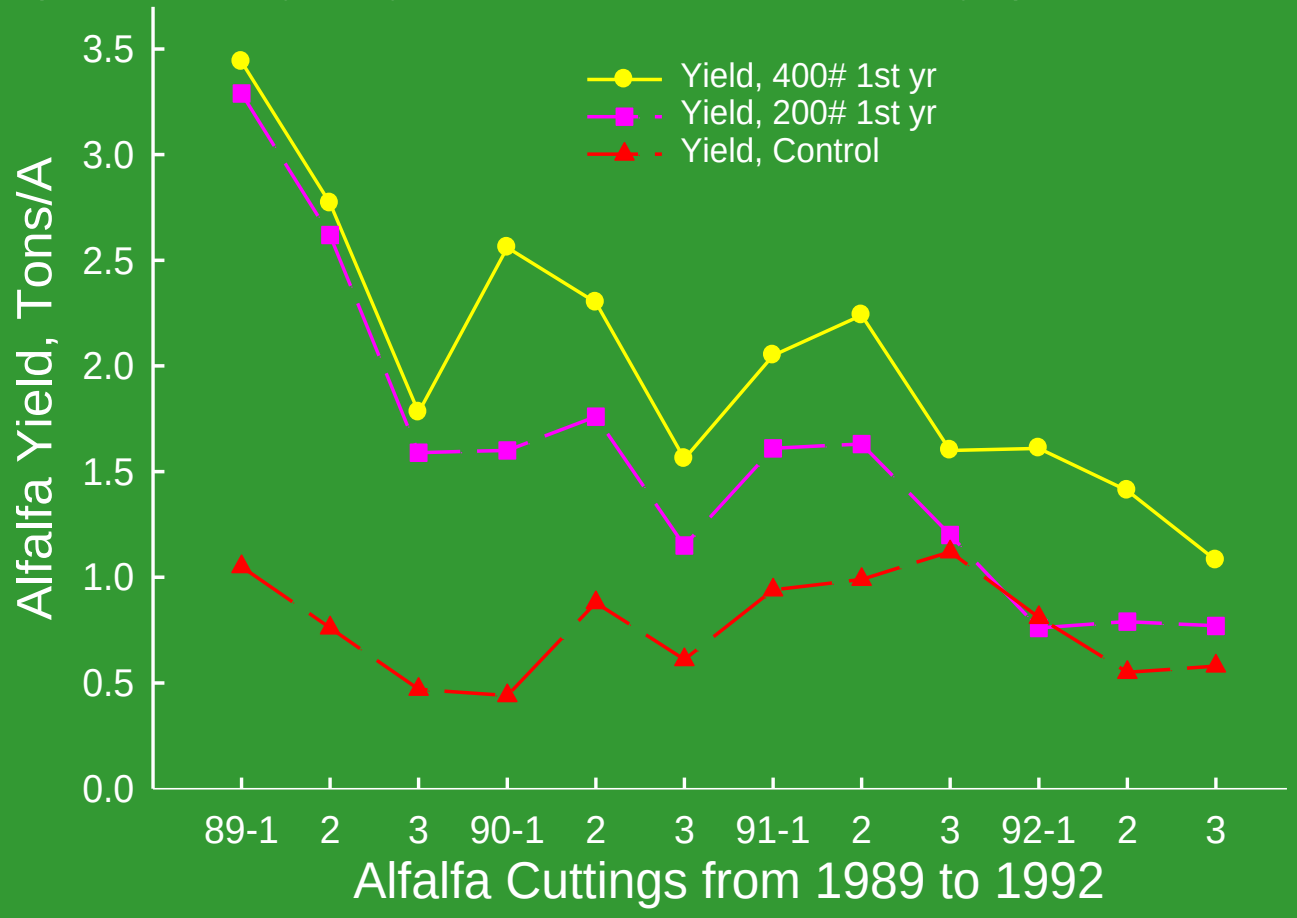
- Compare phosphorus plant tissue concentrations in first cutting each year.

Phosphorus Winter Applied to Soil Surface of a Two Year Old Stand of Alfalfa

Treatment	Applied P_2O_5, pounds per acre				
	1988	1989	1990	1991	Total
1. 0	0	0	0	0	0
2. 50 x 4 apps	50	50	50	50	200
3. 100 x 2 apps	100	0	100	0	200
4. 200 x 1 app	200	0	0	0	200
5. 100 x 4 apps	100	100	100	100	400
6. 200 x 2 apps	200	0	200	0	400
7. 400 x 1 app	400	0	0	0	400

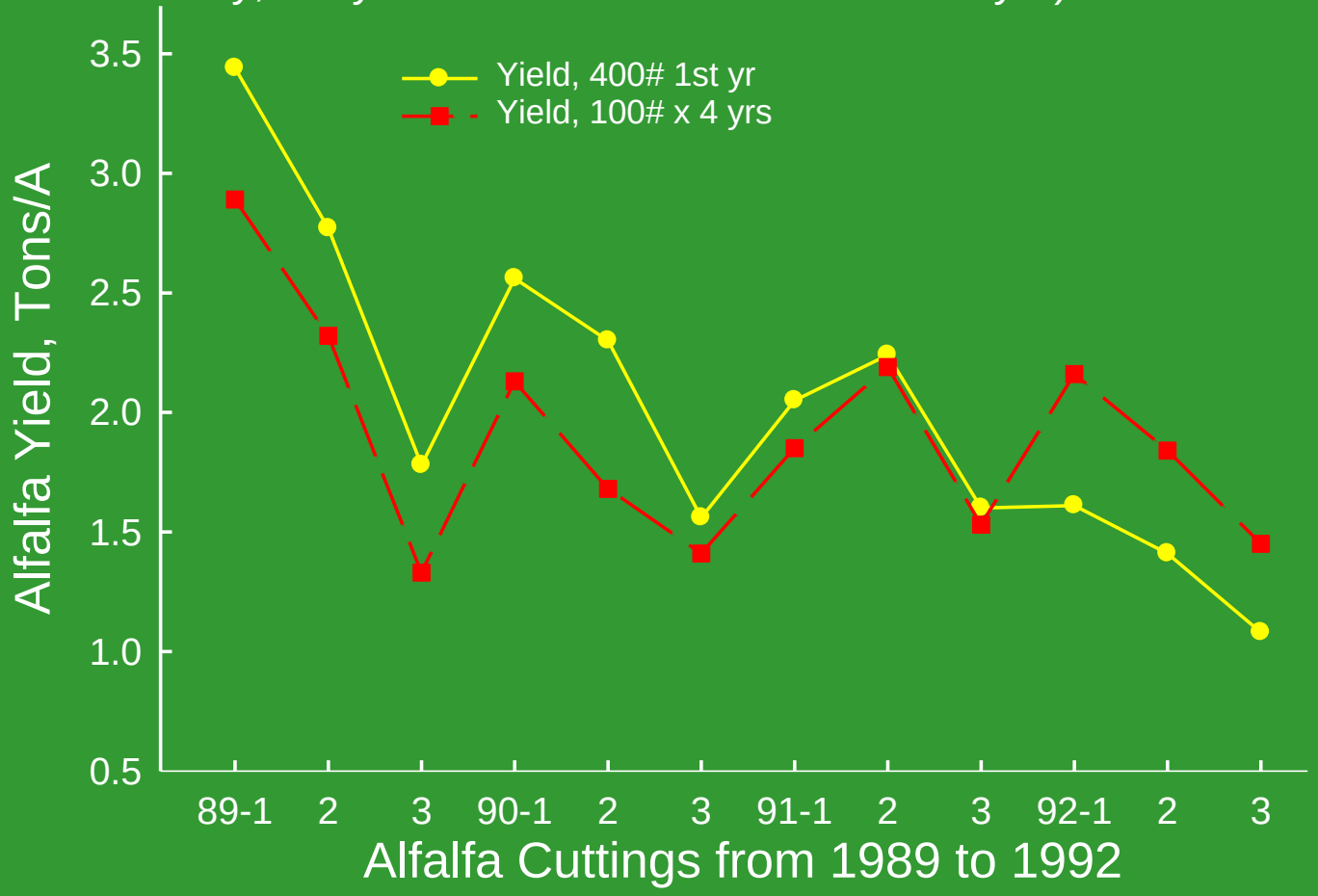
Alfalfa yields for three cuttings per year 1989-92 in response to phosphorus (400, 200, 0 lbs P_2O_5/A) applied the winter of 1988.

(Lassen County, Jerry L. Schmierer and Roland D. Meyer)



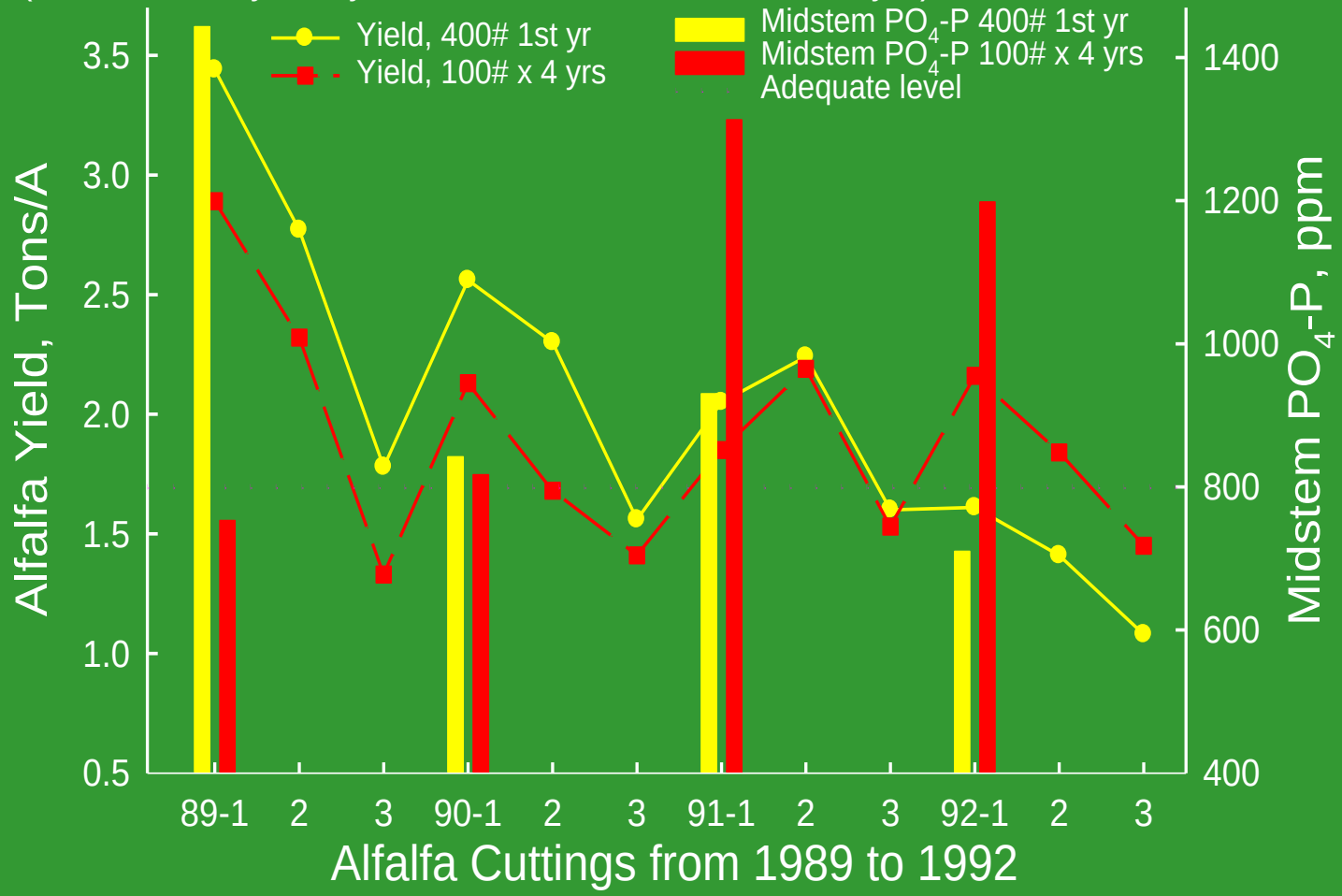
Alfalfa yields for three cuttings per year during 1989-92 in response to phosphorus applied as 400 lbs P_2O_5/A the first year only or 100 lbs P_2O_5/A annually for four years.

(Lassen County, Jerry L. Schmierer and Roland D. Meyer)



Alfalfa yields for three cuttings per year 1989-92, and midstem PO_4-P levels in the first cutting each year in response to phosphorus applied as 400 lbs P_2O_5/A the first year only or 100 lbs P_2O_5/A annually for four years.

(Lassen County, Jerry L. Schmierer and Roland D. Meyer)



Tips for using plant analysis to guide fertilizer applications in alfalfa

- Collect plant tissue samples early (first cutting) so that fertilizer can be applied mid to late season and sample mid season to guide winter-early spring fertilizer applications.

- Expect alfalfa growth response to phosphorus and potassium applied on the soil surface 60 to 90 days after fertilizer application.

The language of fertilizers—tips to use the correct terminology.

Learn to use pounds (lbs) of nutrient per acre and then identify the fertilizer material as 80 lbs N/A as urea or 80 lbs K_20/A as potassium sulfate.

The use of “units” per acre or lbs K/A leaves the reader uncertain as to what you really mean.

Some of the more economical fertilizers for nitrogen are dry granular urea (46-0-0) and liquid UN32 (32-0-0) (10.7 lbs/gal) or potassium—dry granular potassium chloride (0-0-60) costs about half or 60% of potassium sulfate (0-0-50 or 52) or liquid KTS, potassium thio-sulfate (0-0-25). Liquid fertilizers are often more expensive than dry, particularly considering cost/lb of nutrient. See Tables 5-5 and 5-6 in WFH.

Calculating cost per lb of nutrient from cost per ton of fertilizer.

Urea -- 46% nitrogen or (46-0-0)
(2000 lbs per ton)

2000 lbs/ton times 46% equals 920 lbs N/ton of urea.

If the cost is $350 per ton of urea, then
$350 divided by 920 lbs N/ton equals $0.38 per lb N or if the cost is $700/ton, then the cost is $0.76 per lb N and $0.60 per lb N as urea would cost $552 per ton.

If the cost of 11-52-0 is $650 per ton, then the cost of P_2O_5 is: 2000 lbs/ton X 52% or 1040 lbs P_2O_5/ton. Dividing $650 by 1040 gives $0.625 per lb of P_2O_5.

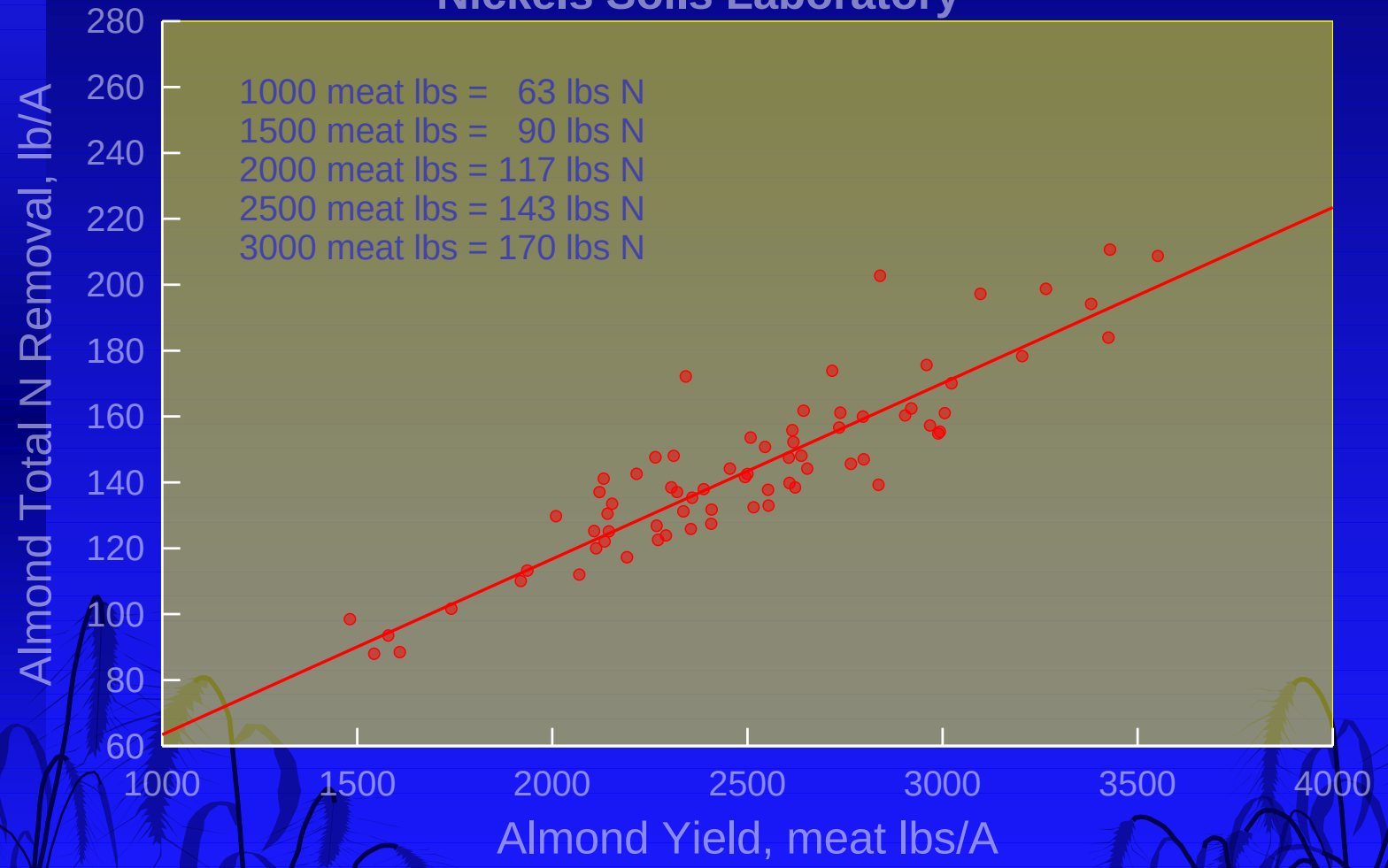
Concerns about increasing the plant tissue nutrient concentrations as a way of increasing yields of fruit or nuts.

The assumption is that as we increase the leaf tissue concentration we will increase the yield.

This is usually based indirectly on the fact that as we obtain higher yields more total nutrient removal will occur. Note the following graphs for N and K related to almond yields.

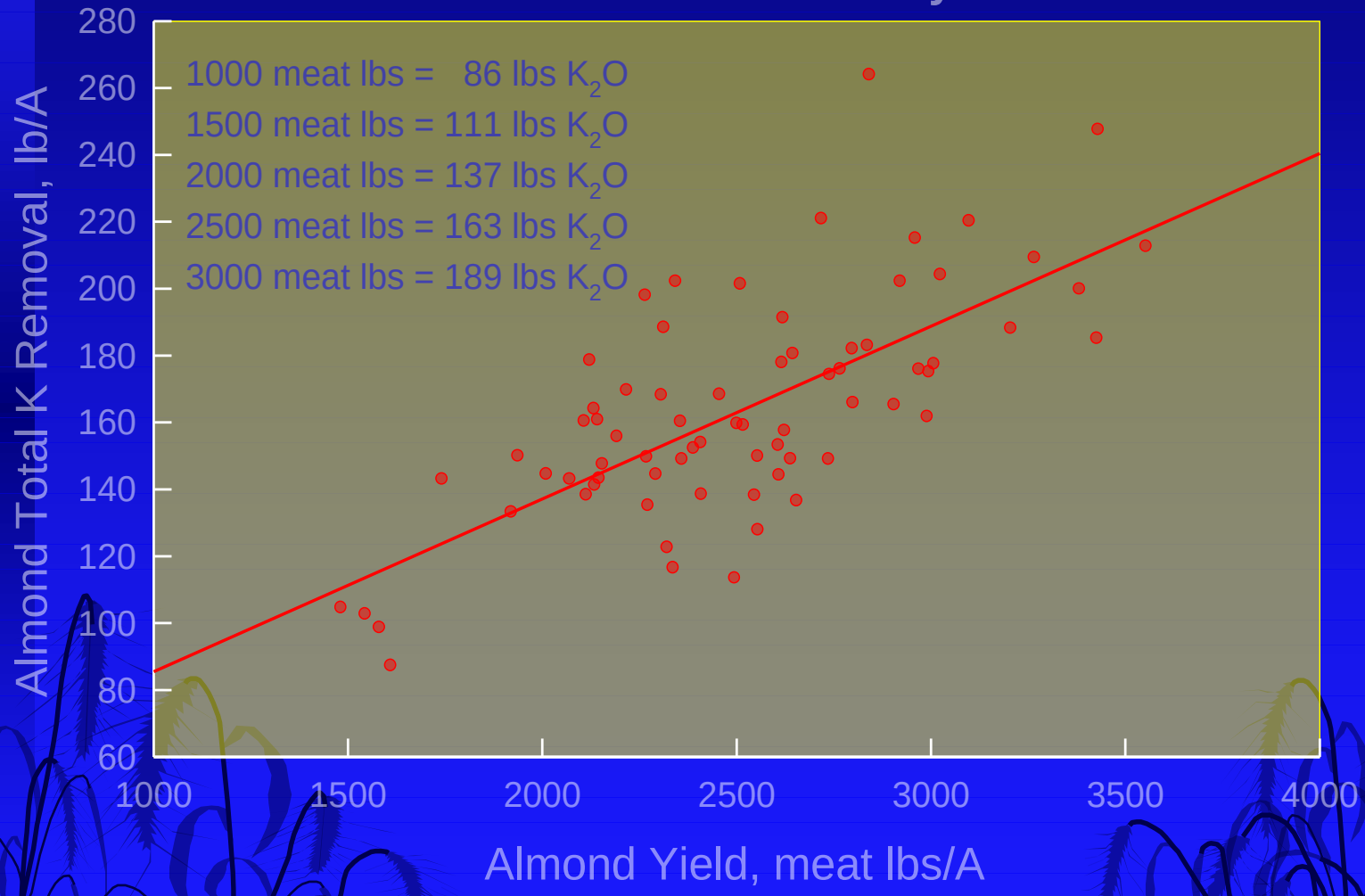
Almond Nitrogen Removal Versus Yield in 1998 for all Irrigation Systems

Nickels Soils Laboratory



Almond Potassium Removal Versus Yield in 1998 for all Irrigation Systems

Nickels Soils Laboratory



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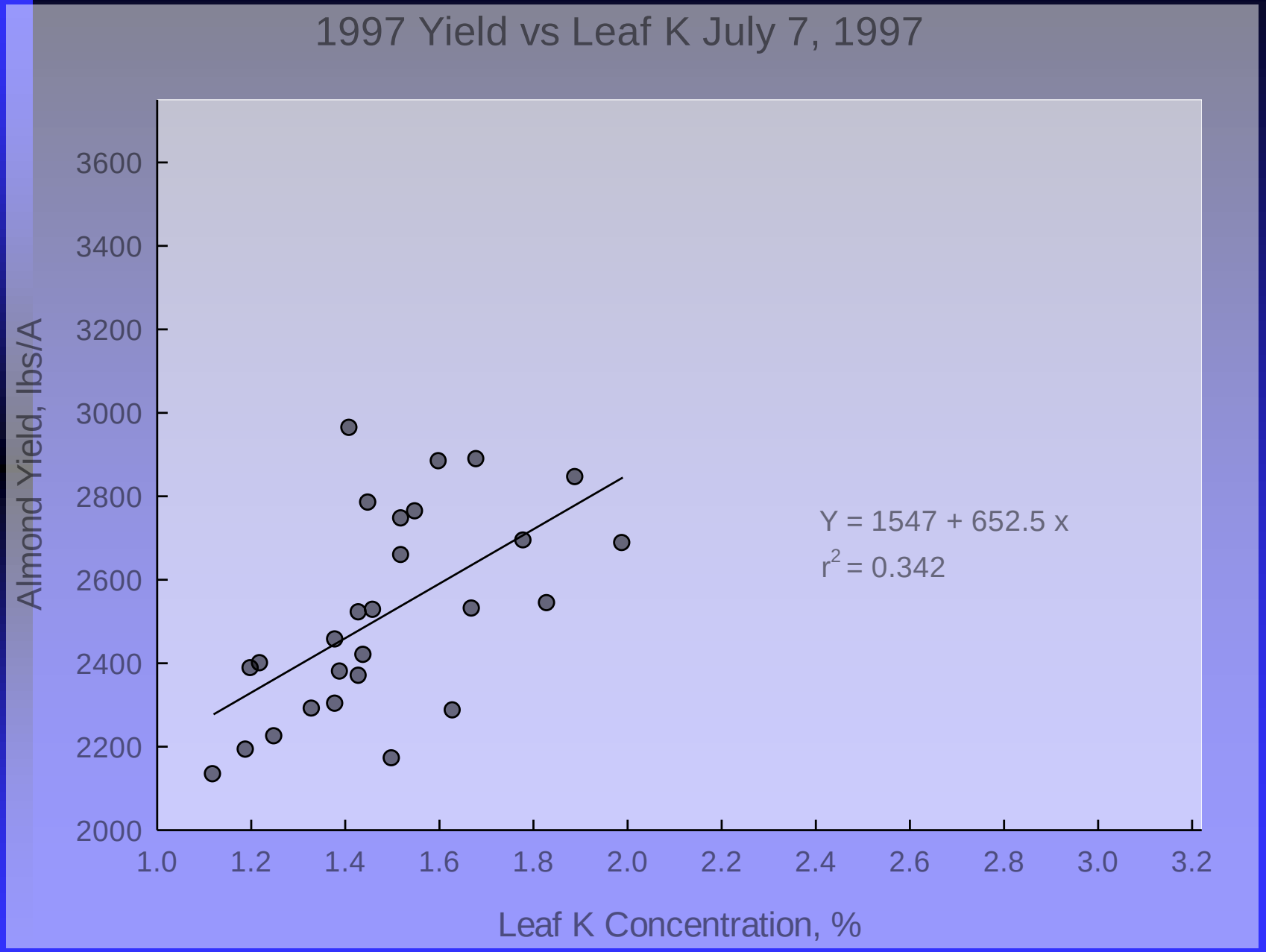
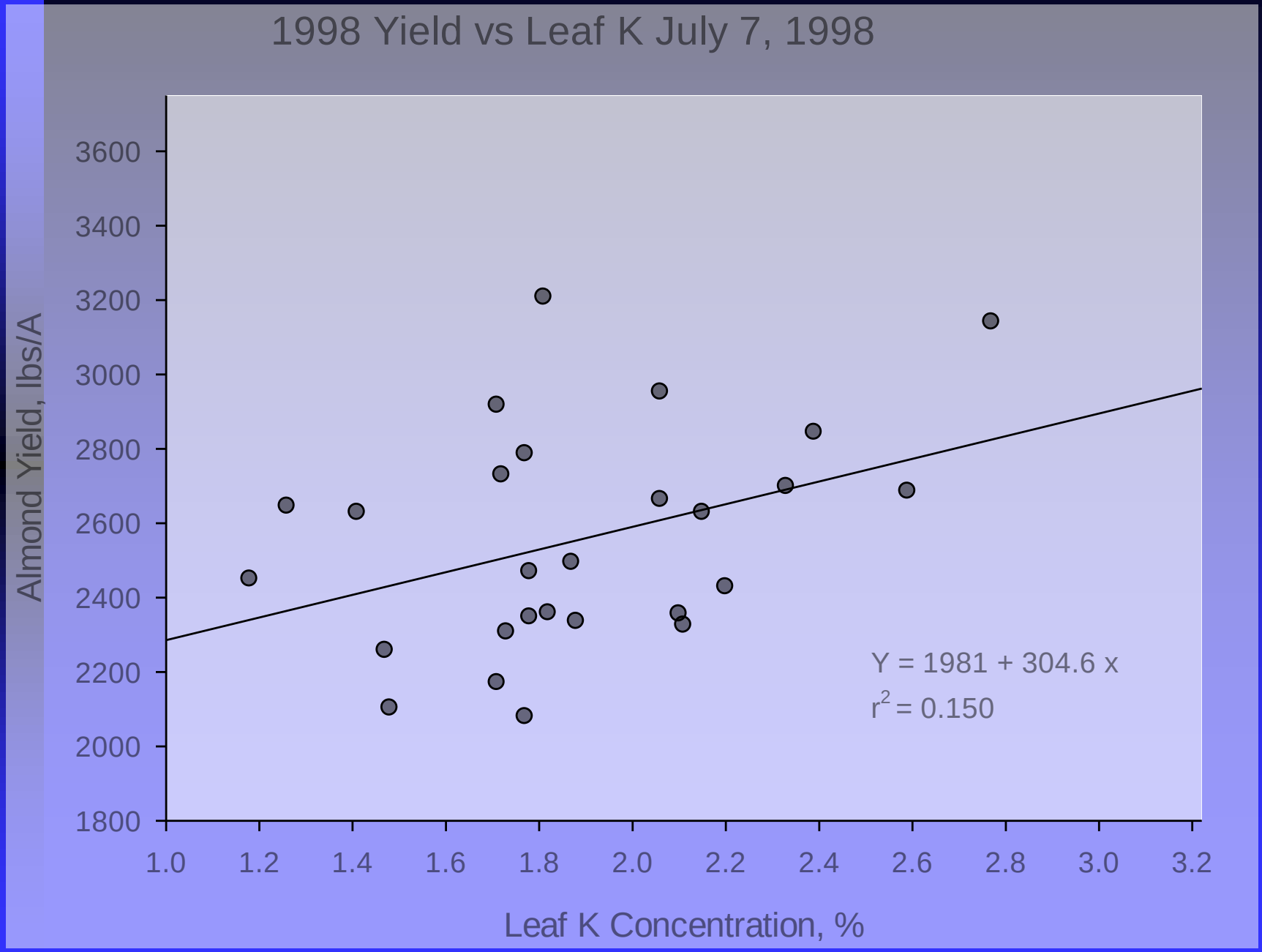
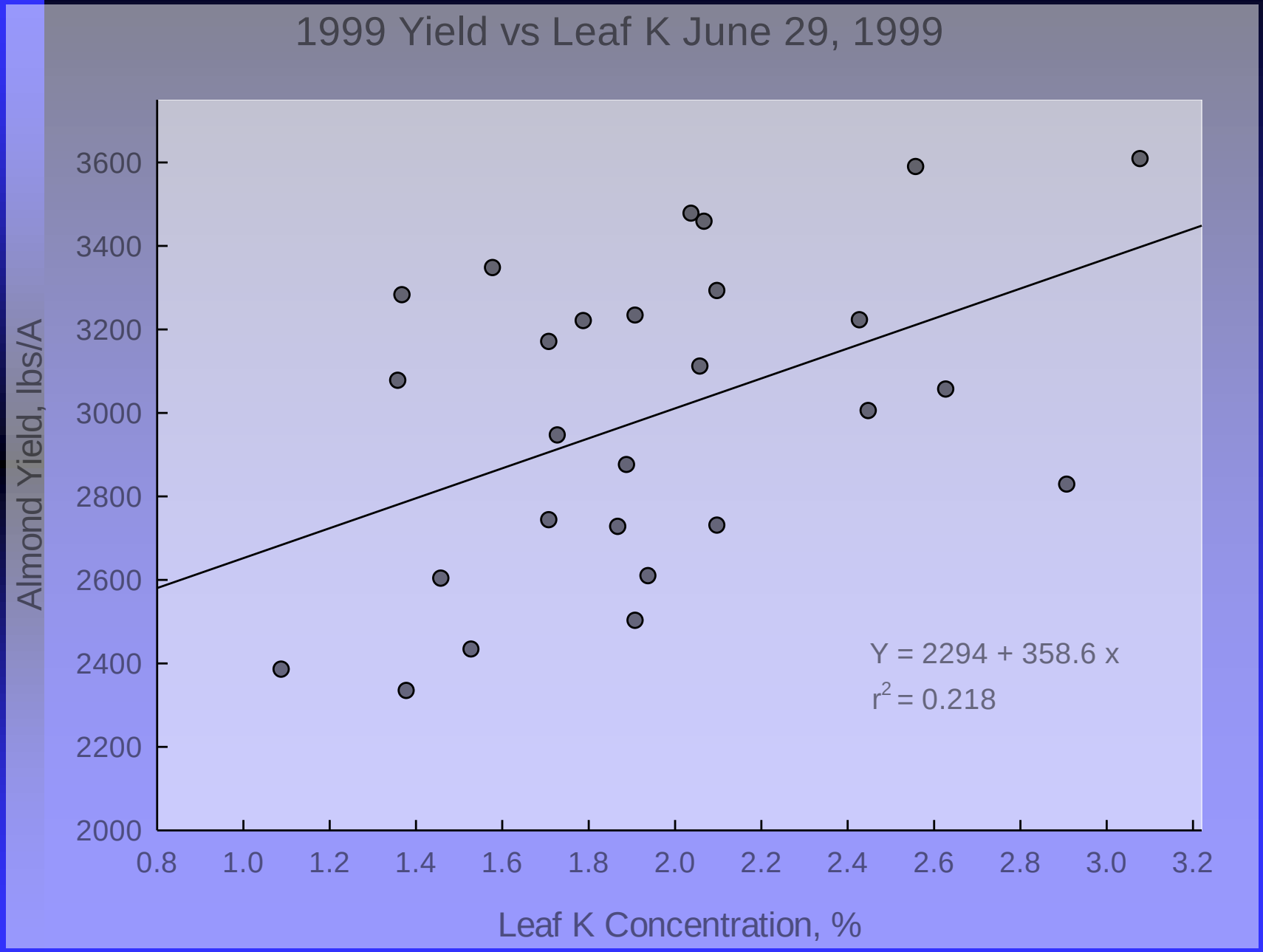
What does the data tell us about the increase in leaf tissue K versus an increase in almond yield over a three year period.


1997 Yield vs Leaf K July 7, 1997
Almond Yield, lbs/A
3600
3400
3200
3000
2800
2600
2400
2200
2000
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
Leaf K Concentration, %
Y = 1547 + 652.5 x
r2 = 0.342


1998 Yield vs Leaf K July 7, 1998
Almond Yield, lbs/A
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
Leaf K Concentration, %
Y = 1981 + 304.6 x
r2 = 0.150


1999 Yield vs Leaf K June 29, 1999
Almond Yield, lbs/A
3600
3400
3200
3000
2800
2600
2400
2200
2000
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
Leaf K Concentration, %
Y = 2294 + 358.6 x
r2 = 0.218

Concerns about increasing the plant tissue nutrient concentrations as a way of increasing yields of fruit or nuts.

The assumption is that as we increase the leaf tissue concentration we will increase the yield.

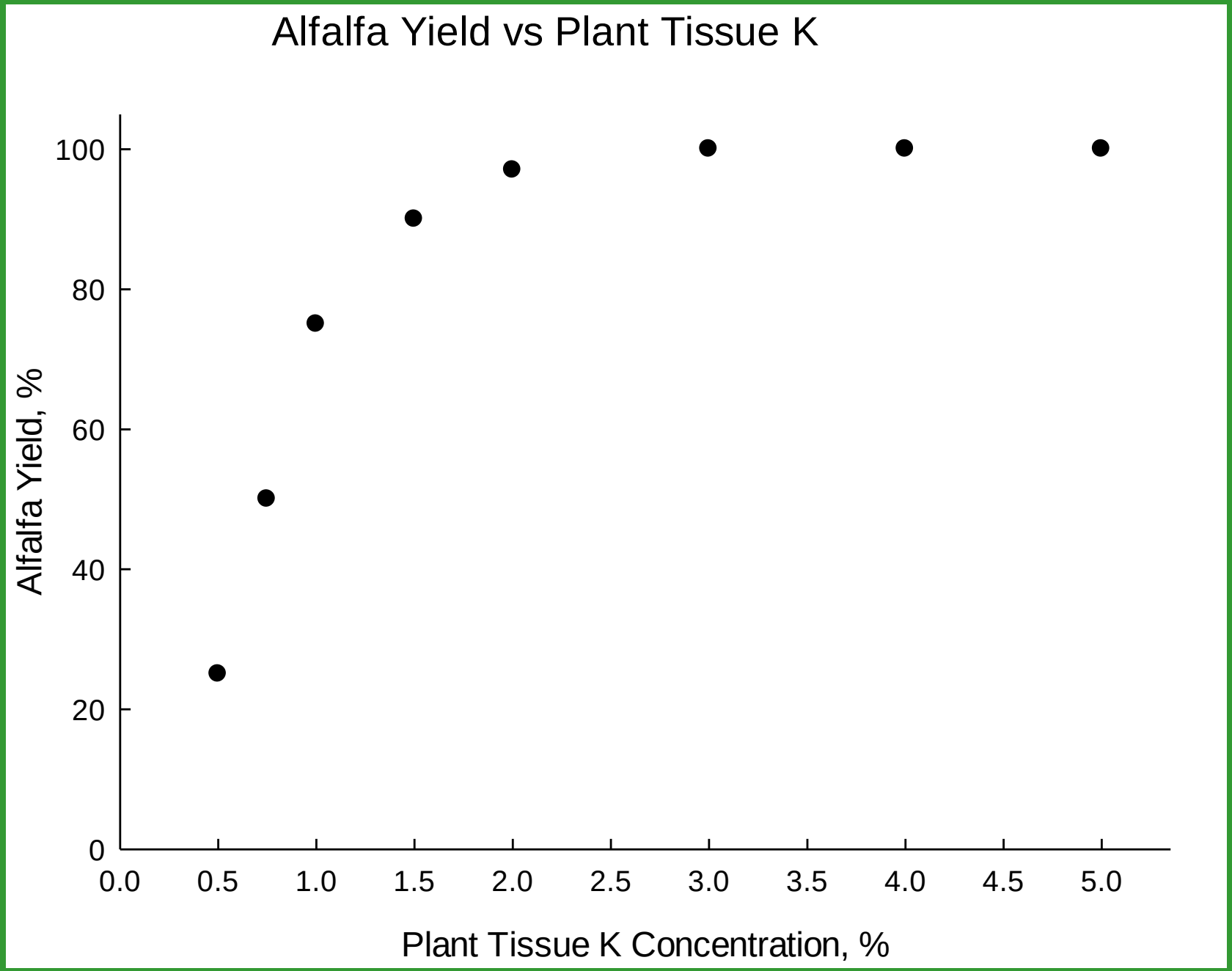
What does the data tell us about the increase in leaf tissue K versus an increase in almond yield over a three year period.

Four treatments received 4 lbs K_2O/tree for 3 years (Total of 1488 lbs K_2O/acre) with yields of 2601(1.46), 2826(2.58), 3002(2.16) and 3606(2.62) meat lbs/acre, (leaf K % follows yield).

Concerns about increasing the plant tissue nutrient concentrations as a way of increasing yields of fruit or nuts.

The assumption is that as we increase the leaf tissue concentration we will increase the yield.

In some plant species the concentration of K continues to increase as more is applied, but yields do not increase. Alfalfa is an example of this phenomena.


Alfalfa Yield vs Plant Tissue K
Alfalfa Yield, %
100
80
60
40
20
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Plant Tissue K Concentration, %

Other nutrients that exhibit the same characteristic as potassium in alfalfa and other crops.

- Besides potassium, the nutrients boron, manganese, iron, zinc and molybdenum continue to increase in concentration in plant tissue after maximum yield is attained.

The End

Organic grower considerations:

All sources of nutrients are much more expensive as fertilizing materials have lower concentration of the nutrients and perhaps high moisture content (spring purchases after winter rains may be 50% water).

Nitrogen needs are the most difficult to meet, especially for early tree growth and for high yielding nut crops.

-- Consider legumes—proper soil pH, P and K soil test levels. Subterranean clover is adapted in soils with pH less than 6.5 to 7.0.

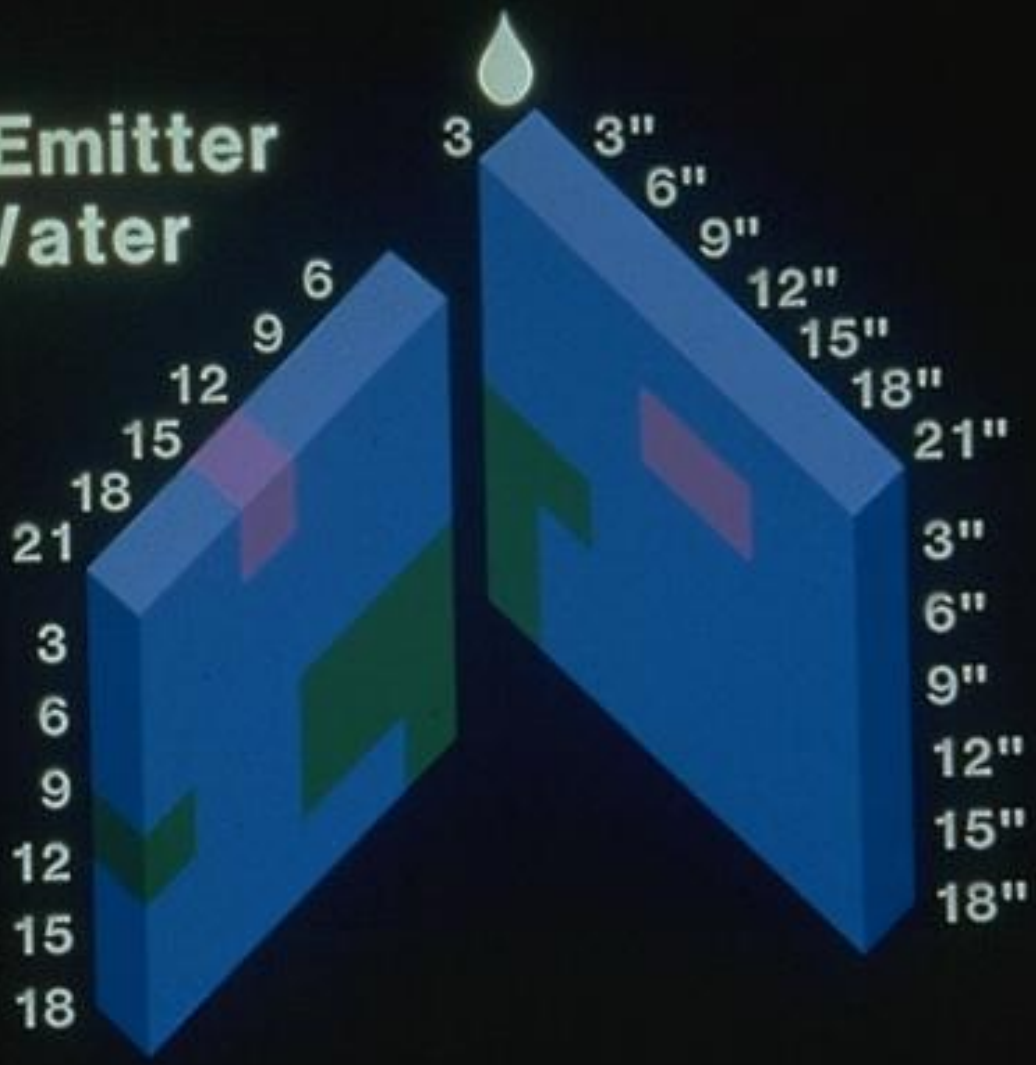
-- Manure based composts—Table B-15 in WFH—consider purchasing materials in the summer before winter rains, store in covered shed if possible and spread late winter after heavy rains. Sample and test before application to determine rate to apply. Also, remember only about 10-15% of the total N will become plant available the first year.

-- May want to consider sodium nitrate—limit of 20% of normal nitrogen rate. Many certifiers may not want to approve this but it is approved according to USDA-NOP rules.


RAM

Soil pH under Drip Emitter from Low N/Low Water Treatment

≥ 7.0
6.0 - 6.9
5.0 - 5.9



Soil pH under Drip Emitter from High N/High Water Treatment