Plant Nutrition
Considerations and Tools

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Key Points

- All crops require 17 essential plant nutrients.
- Soil and plant analysis are tools to assist in identifying yield limiting nutrients.
- Maintaining productivity of agricultural lands requires an understanding of where nutrients are derived and where they are exported, and taking action to preserve productivity.

What are the Criteria for Plant Nutrients to be Essential?

Plant cannot complete its life cycle without the element

No other element can perform the function of the element

The element has a direct impact on metabolism or growth of the plant

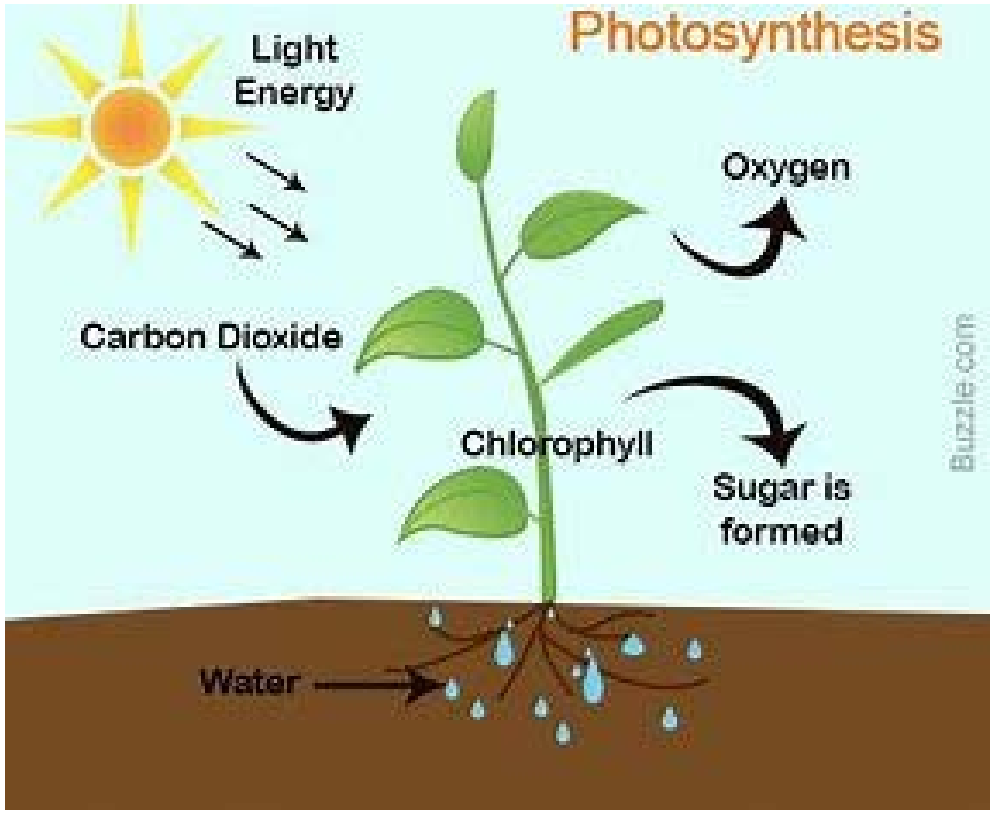
Essential Plant Nutrients

Carbon (C)

Hydrogen (C)

Oxygen (O)

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$



Essential Plant Nutrients

Primary Macro-

- Nitrogen (N)
- Phosphorus (P)
- Potassium (K)

Secondary Macro-

- Calcium (Ca)
- Magnesium (Mg)
- Sulfur (S)

Micro-

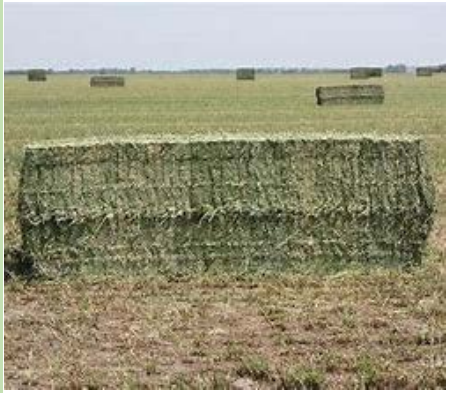
- Boron (B)
- Copper (Cu)
- Iron (Fe)
- Manganese (Mn)
- Zinc (Zn)
- Molybdenum (Mo)
- Chlorine (Cl)
- Nickel (Ni

Alfalfa Nutrient Removal

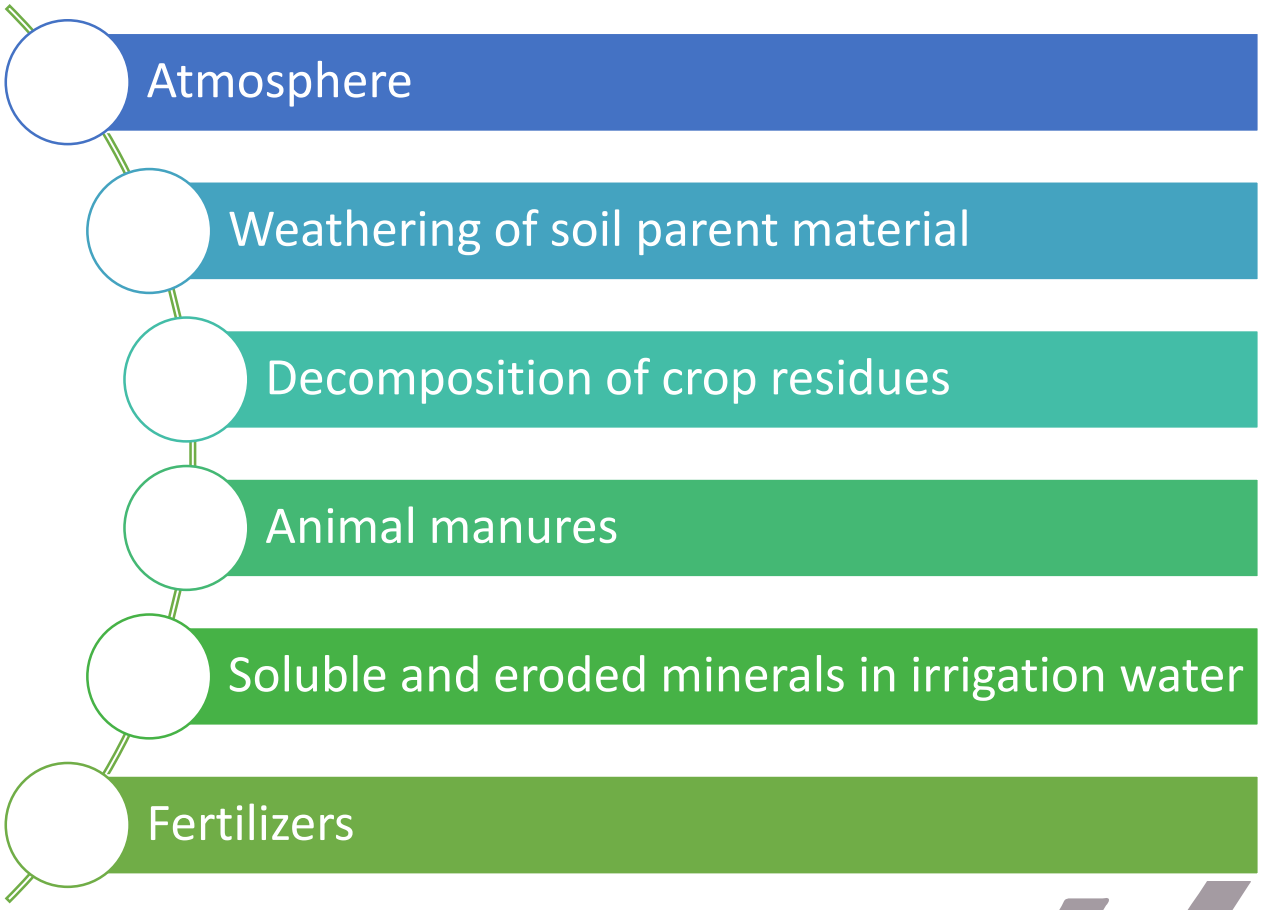
Nutrient	Lbs/Ton
Potassium (K_2O)	60
Nitrogen	48
Phosphorus (P_2O_5)	12
Calcium	30
Magnesium	6
Sulfur	6
Iron	0.3
Manganese	0.1
Boron	0.08
Zinc	0.05
Copper	0.01
Molybdenum	0.002

Macro-nutrients

Micro-nutrients



Sources of Plant Nutrients



Crop Nutrient Removal (lbs)

Crop	UOM	N	P2O5	K2O	S
Alfalfa	ton	48	12	60	6
Timothy	ton	25	11	42	2
Brome	ton	32	10	46	5
Wheat, grain	100 bu	116	48	29	10
Wheat, straw	5 ton	76	19	148	28
Rice, grain*	bu	0.6	0.3	0.2	
Rice, straw*	ton	17	5.5	41	
**May not be accurate for wild rice*					

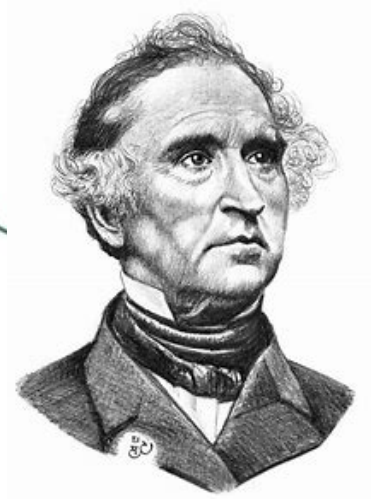
Soil Analysis

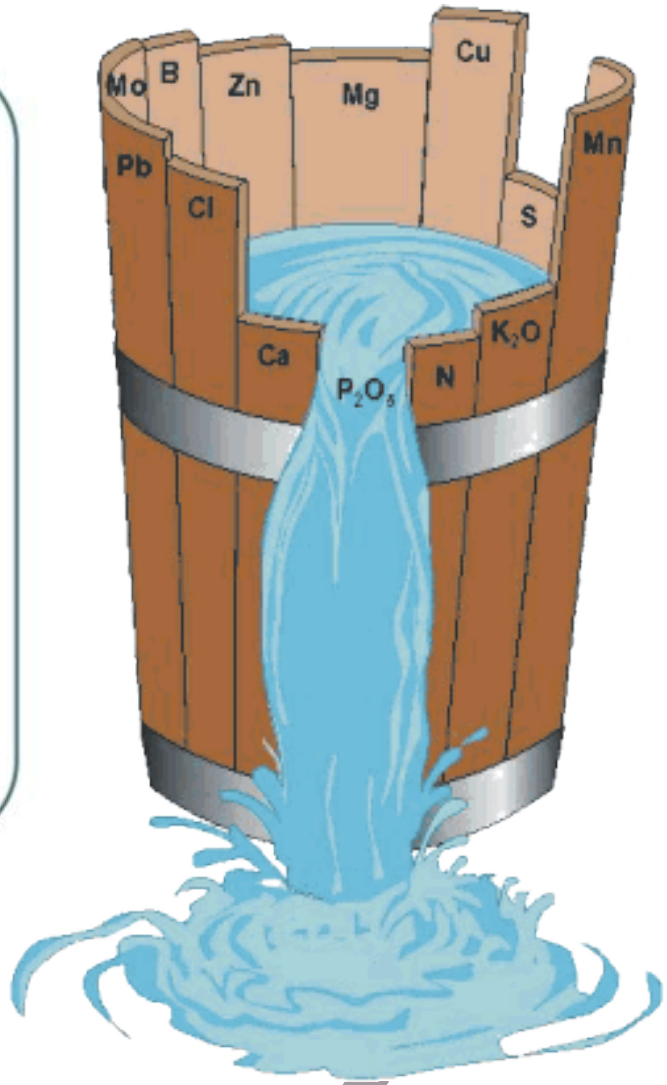
- Identifies soil quality concerns:
  - pH
  - Salinity
  - Excess sodium
  - Nutrient imbalances
- Provides an index of nutrient availability.
  - Indicates probability of response to applied fertilizer.
  - Correlated to a recommended application rate.

Law of the Minimum

"Plant production can be no greater than that level allowed by the growth factor present in the lowest amount relative to the optimum amount for that factor."

Justus von Liebig, 1862





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Example Soil Report

AGRICULTURAL SOIL REPORT 2015 Field ID: East Mini Pivot

ELEMENT	ANSWER	INTERP	SHOULD BE
pH-Soil	8.4	Moderately Basic	
pH-SMP			
Soluble Salts	0.35	Optimum	< 1.5
% Lime	H	over 5.5% lime	
% Organic Matter	3.08	Medium	
Nitrates-ppm	4	Very Low	10 - 35
Ammonium-ppm	1	Low	5 +
Phosphorus-ppm	8	Very Low	25 - 40
Phos-ppm-Bray			50 - 100
Potassium-ppm	762	Very High	300 +

ELEMENT	ANSWER	INTERP	SHOULD BE
Sulfur-ppm	18	Low	20 +
Calcium-ppm	4252	High	1,800 +
Magnesium-ppm	417	Optimum	250 +
Sodium-ppm	407	Very High	< 225
Zinc-ppm	0.2	Very Low	1.0 - 3.0
Copper-ppm	0.2	Very Low	0.8 - 2.5
Manganese-ppm	5	Low	6 - 30
Iron-ppm	2	Very Low	7 +
Boron-ppm	0.2	Very Low	0.7 - 1.5
TBS%	53		

Texture	Loam	Water Holding Capacity/foot	2.09	Bulk Density	1.4

Cation Exchange Capacity - CEC	18
Percent Base Saturation	153

BASES	IDEAL	YOURS
Calcium-% of CEC	65-80	115
Magnesium-% of CEC	10-20	19
Potassium-% of CEC	2-6	11
Sodium-% of CEC (ESP)	< 5	10
Hydrogen-% of CEC	< 15	

P Index	100

	NO3 ppm	NH4 ppm
1 Ft	4	1
2 Ft		
3 Ft		
Total N PPM		5
Lbs N / Acre		15

Fertilizer Suggestions in Pounds per Acre for the whole season		
Crop	Alfalfa	Alfalfa
Yield Goal	5 Tons	7 Tons
Past Crop		
Acres		
Nitrogen	55	83
Phosphate	234	350

Example Soil Report

					Report No.:		26119,
SUGAR CITY ID 83448					Date Received:		4/10/16
GROWER: KERBS, BRUCE					Date Reported:		4/11/16
Soil Test Data	Sample 1		Sample 2		Sample 1		Sample 2
pH	8.0	H		SAMPLE IDENTITY	RIV.PIECE LIGHT		
SALTS, mmhos/cm	0.5	VL		CROP	MALT BARLEY		
CHLORIDES, ppm	3	VL		YEILD GOAL	110 BU		
SODIUM, meq/100g	0.1	VL		ACRES			
CEC, meq/100g	8.8	L		Past Crop T/Acre	POTATOES		
EXCESS LIME, %	5.1	H		MANURE T/Acre	0		
ORGANIC MATTER,%	1.27	M		PREV. APPLIED NUTRIENTS	0		
ORGANIC N, lb/Acre	30	L		**RECOMMENDATIONS , lbs or Units Actual Nutrients per Acre**			
AMMONIUM-N,ppm	4.2	VL					
NITRATE-N, ppm	7	L		NITROGEN	90		
PHOSPHORUS, ppm	24	M		P_2O_5 - PHOSPHATE	70		
POTASSIUM	95	L		K_2O - POTASH	75		
CALCIUM, meq/100g	7.4	VH		CALCIUM	0		
MAGNESIUM, meq/100g	1.0	M		MAGNESIUM	0		
SULFATE-S, ppm	8	L		SULFATE - SULFUR	30		
ZINC, ppm	1.6	M		ZINC	0		
IRON, ppm	9.3	M		IRON	0		
MANGANESE, ppm	4.3	M		MANGANESE	0		
COPPER, ppm	0.3	V		COPPER	1.5		
BORON, ppm	0.60	L		BORON	1		
SOIL TEXTURE	See Table		See Table	ELEMENTAL SULFUR	0		
RATINGS:	VL - Very Low		L - Low	M - Medium	H - High		VH - Very High

ACTUAL AND RECOMMENDED PERCENT OF CEC

SAMPLE	Actual % Potassium	Recom. Potassium	Actual % Calcium	Recom. Calcium	Actual % Magnesium	Recom. Magnesium	Actual % Sodium	Recom. Sodium
1	3.6		84.1		11.4		1.1	
		3.0-6.0%		65-80%		15-25%		< 3.0%
2								

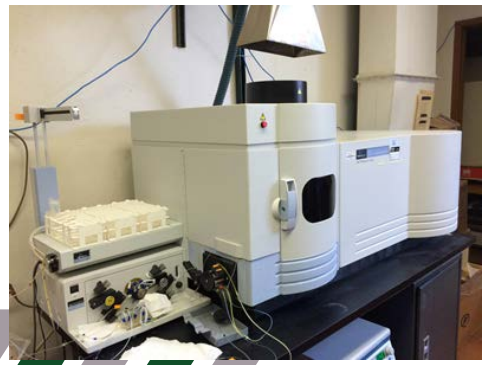
CEC / SOIL TEXTURE

0-5	Sand
5-12	Loamy Sand
12-18	Sandy Loam
18-24	Silt Loam
24-36	Clay Loam
36+	Clay

HELENA®

Plant Analysis

- Aids in determining nutrient-supplying ability of the soil.
- Used to identify potential nutrient deficiencies.
- Allows you to monitor fertility programs.
- Can correlate relationships between crop performance and plant nutrient status.



ENFORM

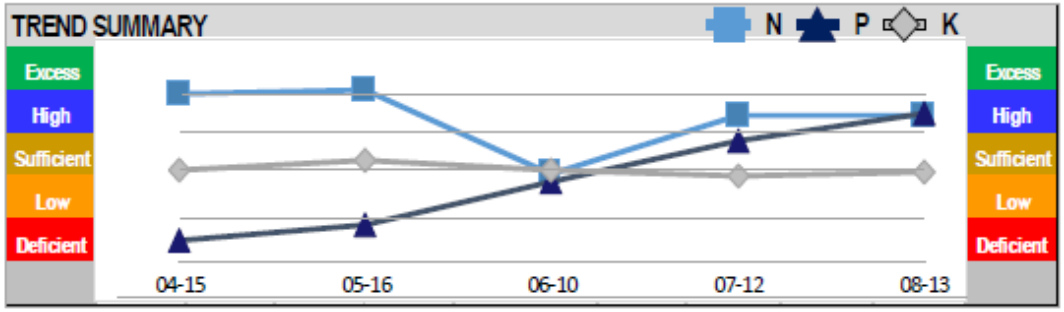
Powered by: AGRintelligence

Grower:	Michael Larkin	Enform ID:	4312117-00001	Lab Name:	JM Lord
Farm:	Larkin Orchard Development	Date Sampled:	8/13/2016	Lab Log #:	216605
Field:	Madera Home	Crop:	Almond	Date Reported:	8/14/2016
Block:	Not Specified	Growth Stage:	August		
Sample Description:	Not Specified				
Helena Location:	Kerman				
Field Rep:	Zachary Treasure				

Always read and follow label directions

Excess / High / Sufficient / Low / Deficient	Plant Nutrient	Current Results	Recommendations Lbs/A	Method	Product	Rate	Units/A	Previous Results 7/12	6/10	5/16	4/15
	N (%)	2.8						3.2	3.6	4.2	4.5
	P (%)	0.22						0.18	0.16	0.13	0.12
	K (%)	1.8						1.9	2.2	2.6	2.5
	Ca (%)	1.8						1.65	1.6	1.4	1.1
	Mg (%)	0.4						0.43	0.48	0.5	0.6
	S (%)	0.11						0.15	0.15	0.14	0.12
	B (ppm)	35						30	28	23	21
	Cu (ppm)	3						4	7	8	7
	Fe (ppm)	58						67	89	70	68
	Mn (ppm)	77						67	58	49	43
	Zn (ppm)	22						25	32	28	21
	NO3-N (ppm)										
	PO4-P (ppm)										
	K Ext (%)										
High / Moderate / Low											
	Cl (%)	0.13						0.12	0.09	0.07	0.06
	Na (%)	0.1						0.08	0.07	0.07	0.05
	Additional Products										
	Additional Products										

TREND SUMMARY



NOTES:

Managing Fertility is a Season-Long Process

HyGround® Soil Management Services

- Preplant: add to liquid and dry blends or impregnate on dry blends
- At Plant: add starter or pop-up fertilizer
- In Season: include foliar nutrition with pesticide applications
- In Season: use water-run and sidedress applications to supplement needs.
- Pre Harvest: consider nutrition to in influence quality.

ENFORM™

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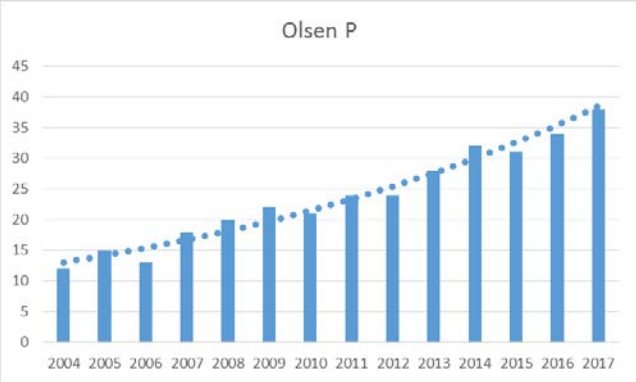
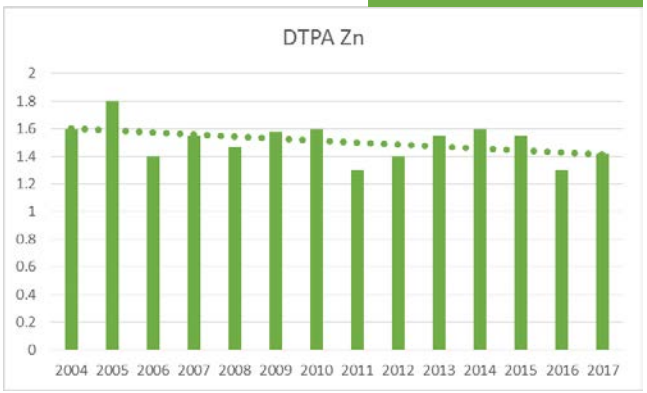
Multi-Year Soil Analysis Trends

Building



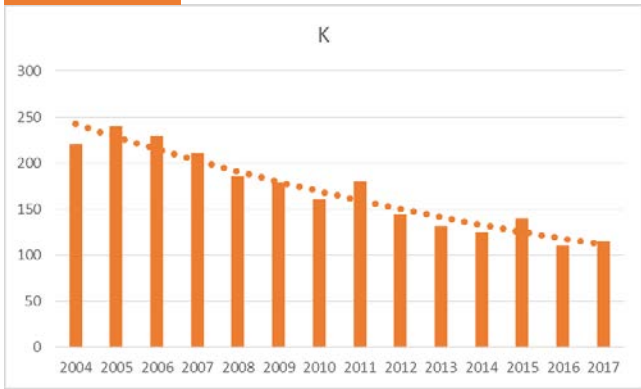
Soil test levels ↑

Maintaining



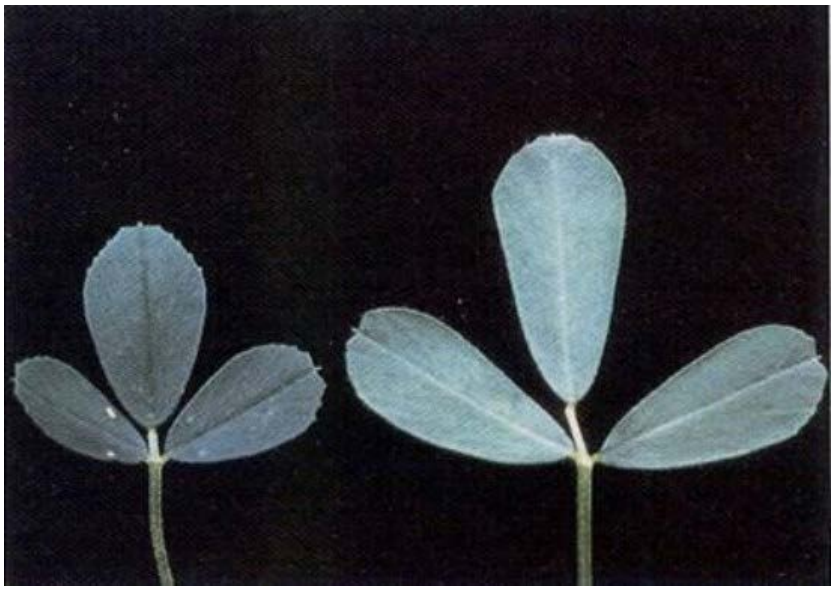
Soil test levels ⇄

Mining

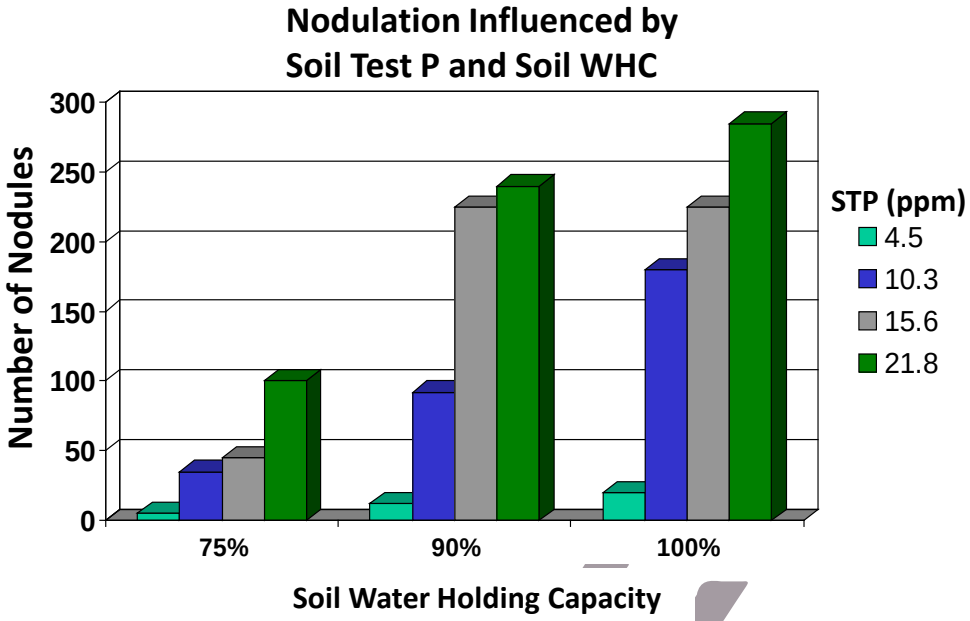


Soil test levels ↓

Phosphorus Deficiency in Alfalfa

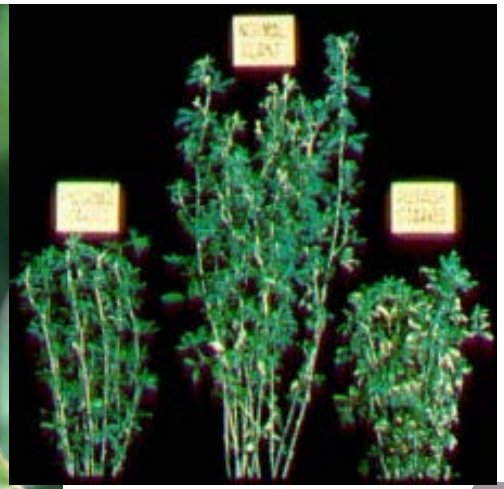


Phosphorus deficiency in alfalfa simply manifests itself as a smaller, often darker green leaves. Plants will be shorter. Low soil test P may negatively affect nodulation.



Potassium Deficiency in Alfalfa

Symptoms usually first appear on the lower leaves as small, white spots along the margins of leaflets. The areas between the spots eventually turn yellow and die. The margins of older leaves may also turn a pinkish cinnamon color before turning brown.



Sulfur Deficiency in Alfalfa

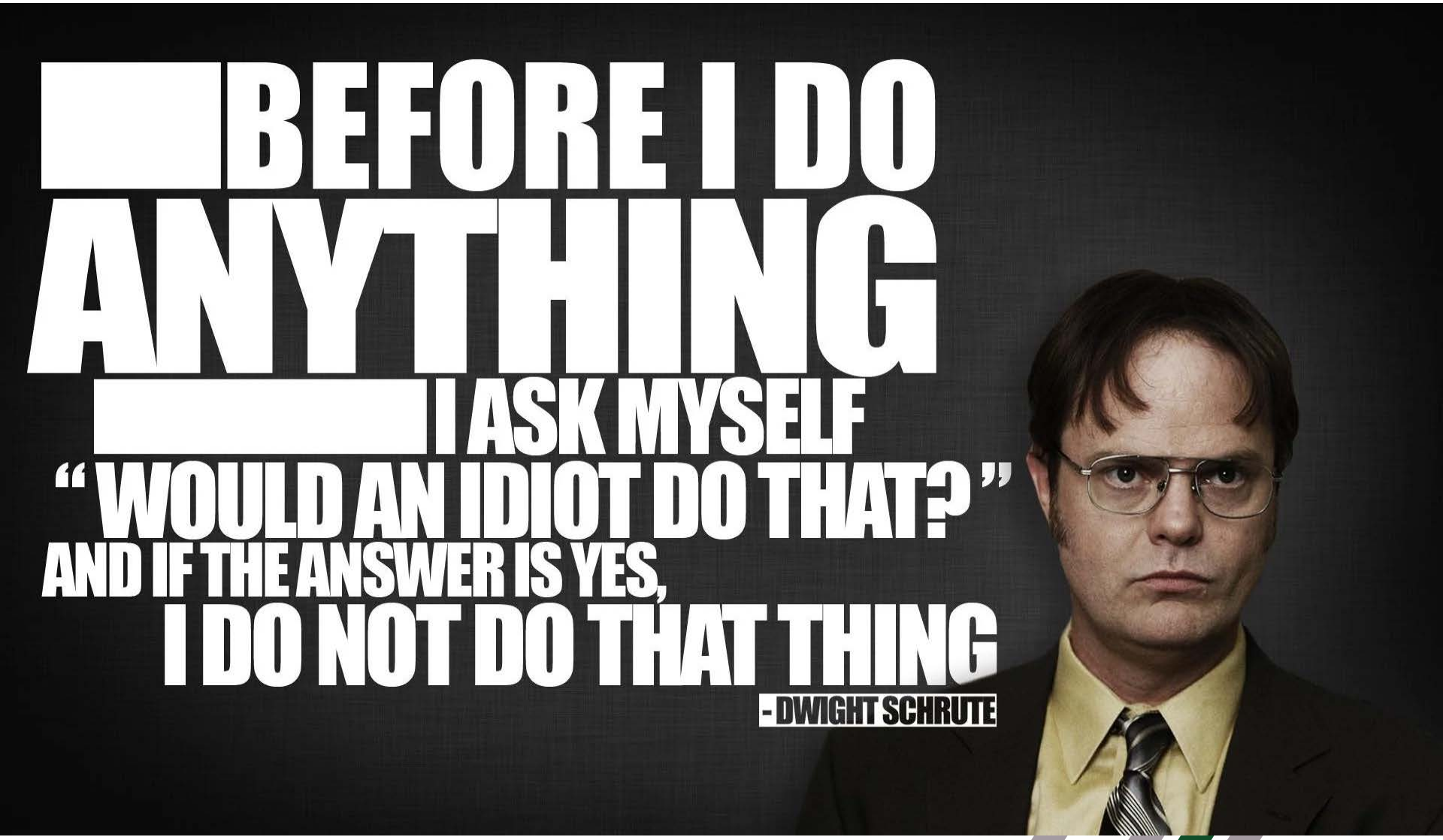
Leaves are pale green or yellowish. The yellowing may affect the new growth or the whole plant, while nitrogen deficiency tends to the affect the older leaves first. Sulfur deficiency reduces nitrogen fixation and protein production.

Boron Deficiency in Alfalfa

Symptoms of boron deficiency include yellowing or bronzing of leaves followed by reddish discoloration along the leaflet margins and undersides of the youngest fully developed leaves. Eventually the upper leaf surface also turns red or reddish yellow. The lower leaves remain green. Plant tops become bunched due to shortened internodes and the growing point may die.

Remember the Key Points

- All crops require 17 essential plant nutrients.
- Soil and plant analysis are tools to assist in identifying yield limiting nutrients.
- Maintaining productivity of agricultural lands requires an understanding of where nutrients are derived and where they are exported, and taking action to preserve productivity.


BEFORE I DO
ANYTHING
I ASK MYSELF
" WOULD AN IDIOT DO THAT? "
AND IF THE ANSWER IS YES,
I DO NOT DO THAT THING
- DWIGHT SCHRUTE