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Labs & Technological Services

Plant Nutrient Management

Pitahaya Fertility Managment & Soil Analytical Reports

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for a better and safer world

Kenny Alberto Lam

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Labs & Technological Services

AGRONOMY

for a better and safer world

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AGQ Labs is a chemical technological center, with 20 years of experience, based on analysis laboratories, advanced assays and specialized chemical engineering. AGQ Labs provides solutions and services for agro-food, environmental, industrial and mining sectors. It is a synchronized process between technology and knowledge, between analytical chemistry and applied chemistry.

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- Health & Safety


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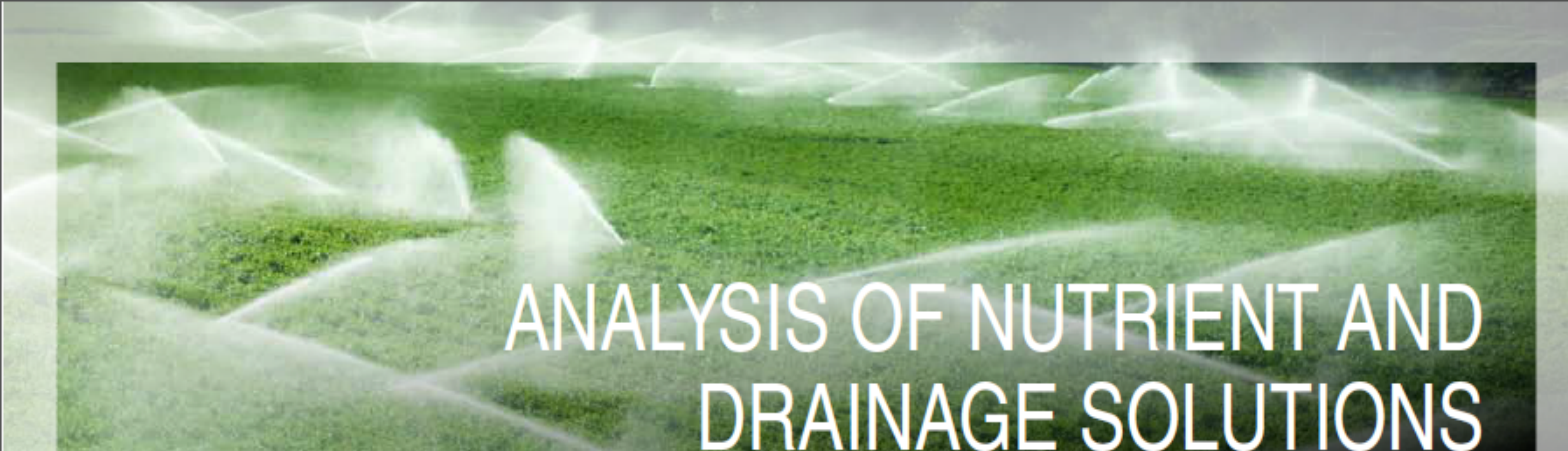
SOIL ANALYSIS

Comprehensive Soil Analysis

- Physical and chemical Parameters: Granulometric Fractions and Texture (clay, silt, fine sand, medium sand, coarse sand, etc.), pH (H20 and KCl), Electrical Conductivity, Active Lime and Total Carbonates, Oxidizable Organic Matter, C/N Ratio, Humidity,...
- Fertility: Nitrogen Forms (Total Nitrogen, Kjeldahl Nitrogen, Nitric Nitrogen, Ammonia Nitrogen and Organic Nitrogen), Phosphorus, Available Base Cations (Calcium, Magnesium, Potassium, Sodium)...
- Soil structure: Exchangeable Bases (Calcium, Magnesium, Potassium, Sodium), Cation exchange capacity
- Assimilable Fractions: Calcium, Magnesium, Potassium, Chloride, Sodium, Sulphur, Aluminium,...
- Saturated Paste Extract (SPE): Ammonia, Potassium, Phosphates, Potasium, Calcium, Magnesium, Sodium, Chloride,
- Microelements: Iron, Manganese, Copper, Zinc, Boron,...
- Heavy Metals: Lead, Cadmium, Mercury, Arsenic, Chromium, Nickel, Lithium, Beryllium, Cobalt, Titanium, Tin, Strontium, Barium, Silver,...
- Irrigation Parameters: Useful water, field capacity, wilting point, permeability...
- Compaction Risk.



ANALYSIS OF NUTRIENT AND DRAINAGE SOLUTIONS

Physical and Chemical Analysis

- pH, Electrical Conductivity, Nitrates, Chloride, Alkalinity/ Bicarbonates, Sulphates, Calcium, Magnesium, Sodium, Potassium, Iron, Manganese, Copper, Zinc, Boron, Aluminium, sodium adsorption ratio (SAR), Suspended Solids, Turbidity,...
- **Heavy metals:** Lead, Cadmium, Mercury, Arsenic, Chromium, Nickel, Lithium, Beryllium, Cobalt, Titanium, Tin, Strontium, Barium, Silver,...
- **Microbiology:** Salmonella, Coliforms, Escherichia, Total bacteria, Clostridium, Pseudomonas, Legionella,...
- **Other Parameters:** Neutralization curve of an acid.

Specific Analysis for Integrated Production and GLOBAL GAP

Analysis of Nutrient and Drainage Solutions
ph, Electrical Conductivity, Calcium, Magnesium, Sodium, Potassium, Phosphates, Sulfates, Nitrates, Ammonia, Chloride, Iron, Manganese, Copper, Zinc, Boron.

PLANT TISSUE ANALYSIS

Macronutrients
Nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur.

Micronutrients
boron, iron, manganese, copper and, zinc.

Toxic elements
Sodium, chloride and aluminum.

Heavy metals
Lead, cadmium, mercury, arsenic, chromium, nickel...

Specific Analysis for Integrated Production
Olive grove, potato field, cotton plantation, strawberry plantation, citrus grove, etc.

SPECIFIC ANALYSES

SPECIFIC PETIOLE/SAP ANALYSIS

pH, Electrical Conductivity, Organic Nitrogen, Ammonia, Nitrates, Phosphates, Potassium, Calcium, Iron, Manganese, Copper, Zinc, Boron, Chloride, Sodium, etc.

SPECIFIC FRUIT ANALYSES

Mineral Analysis: Nitrogen, Phosphorus, Potassium, Magnesium, Potassium, Sulphur, Boron, Iron, Manganese, Copper, Zinc.

Physical and chemical analyses: Moisture, Dry matter, pH, Degrees Brix (°Bx), Acidity, Total sugars, etc.

Bound Calcium and Calcium Fractions: Bound Calcium, Insoluble Calcium, Soluble Calcium, Total Calcium.

ANALYSIS OF ROOT RESERVES

Starch, Arginine, Protein, Dry matter, Nitrogen, Phosphorus, Potassium, et

ROOT HEALTH

Analysis of phosphites, fungicides, insecticides, etc.

FERTILIZERS EFFICIENCY AND LEACHING

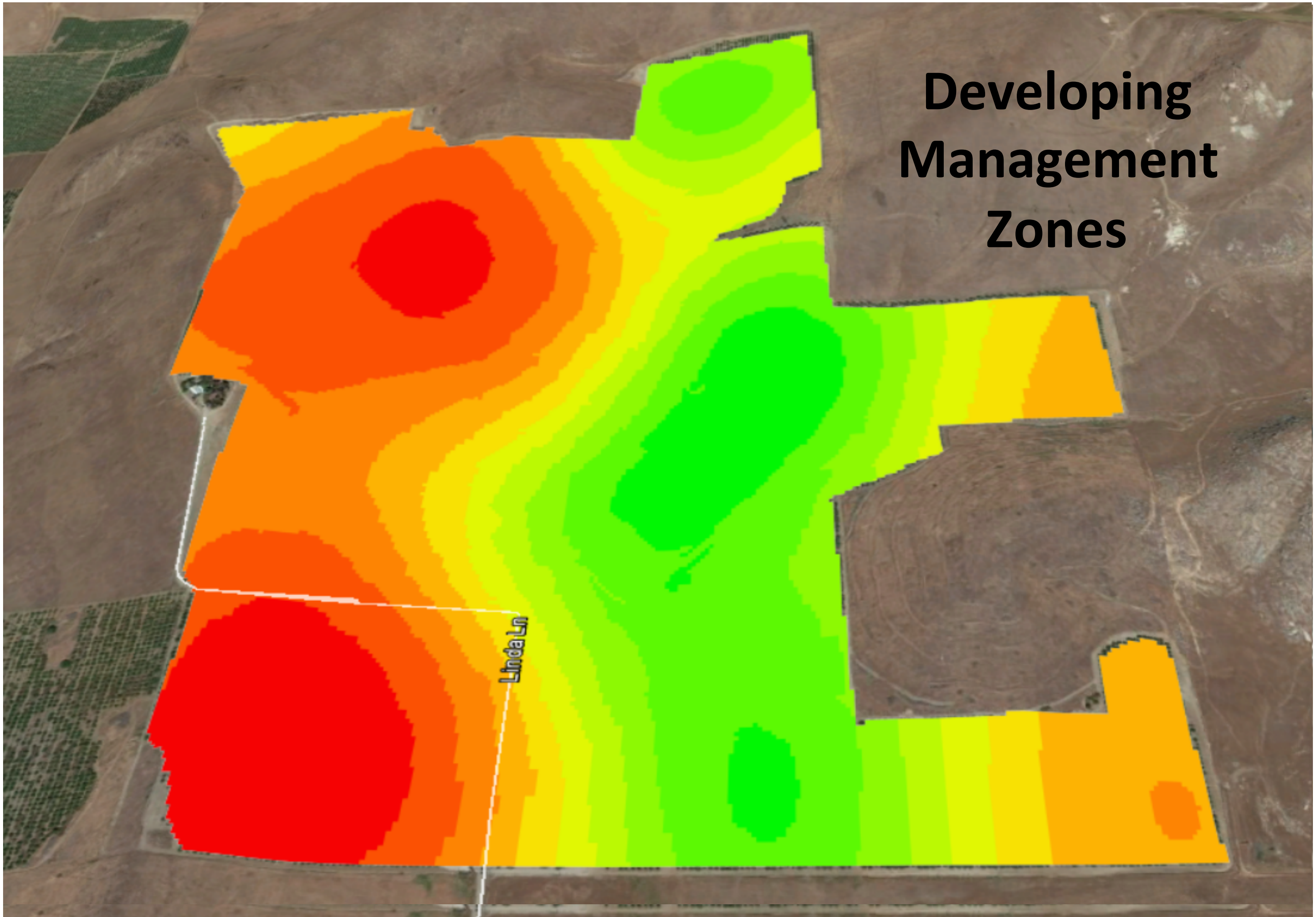
Traditional Analyses

Soil

Tissue

Water

Soil Sampling Methods



Sampling Point and Depth

- Pulled from beneath irrigation emitters where wet bulb is formed
- Depth varies depending on plant species; typically 16” or less

Soil Reporting Results

PHYSICAL PROPERTIES - GRANULOMETRY

Texture	Sandy Loam
Clay	15.0
Silt	23.0
Sand	62.0

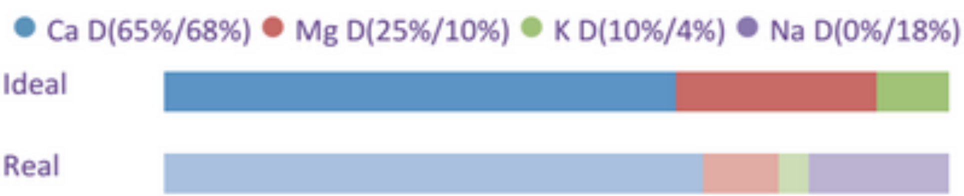
Soil compaction risk

MICRONUTRIENTS

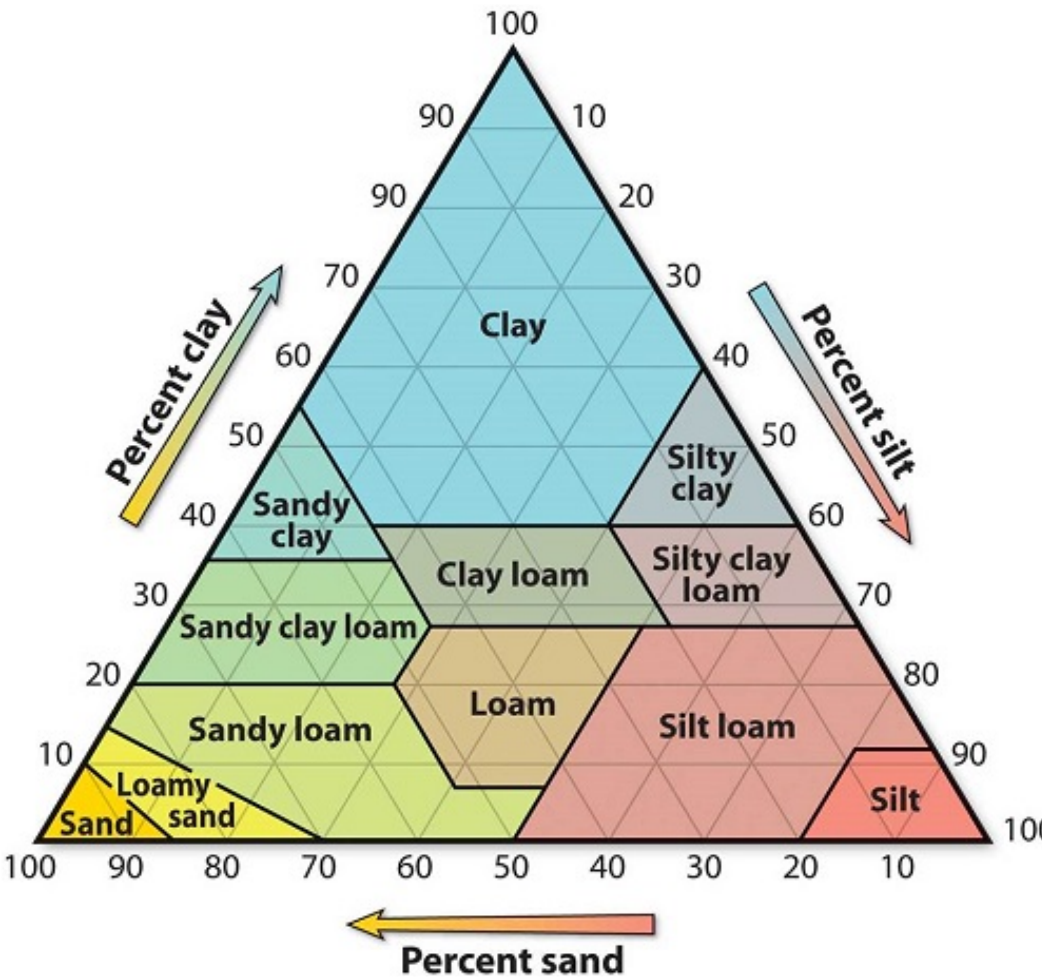
Parameter	Result	Units	Very low – Low	Normal – High – Very high	Method
Boron	< 0.50	mg/kg	0.60	1.00	Aqueous Ext.
Iron	10.4	mg/kg	4.00	10.0	DTPA
Manganese	3.28	mg/kg	1.00	5.00	DTPA
Copper	0.89	mg/kg	0.40	1.00	DTPA
Zinc	3.14	mg/kg	1.00	2.00	DTPA

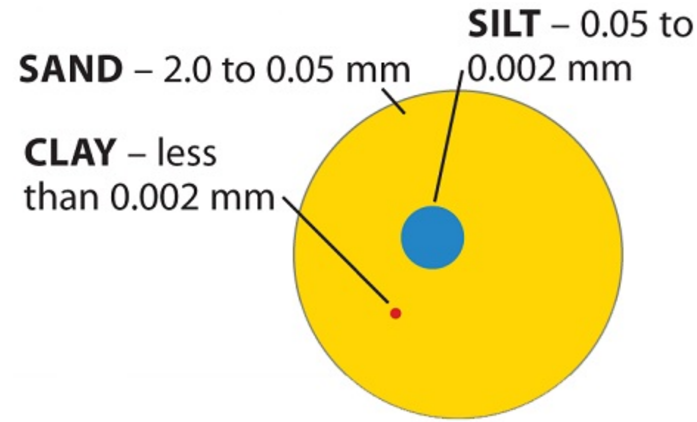
CATION RATIOS:

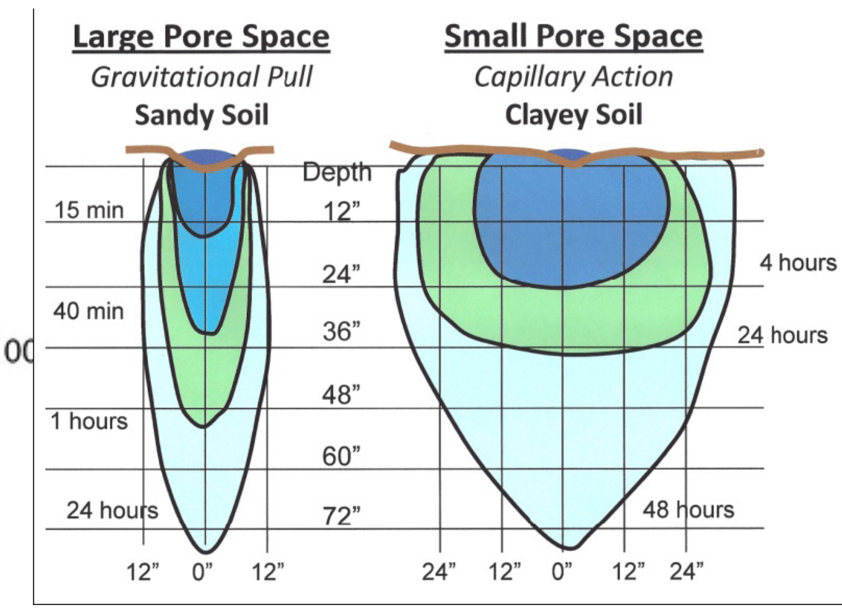
% Available Bases



Granulometry & Texture







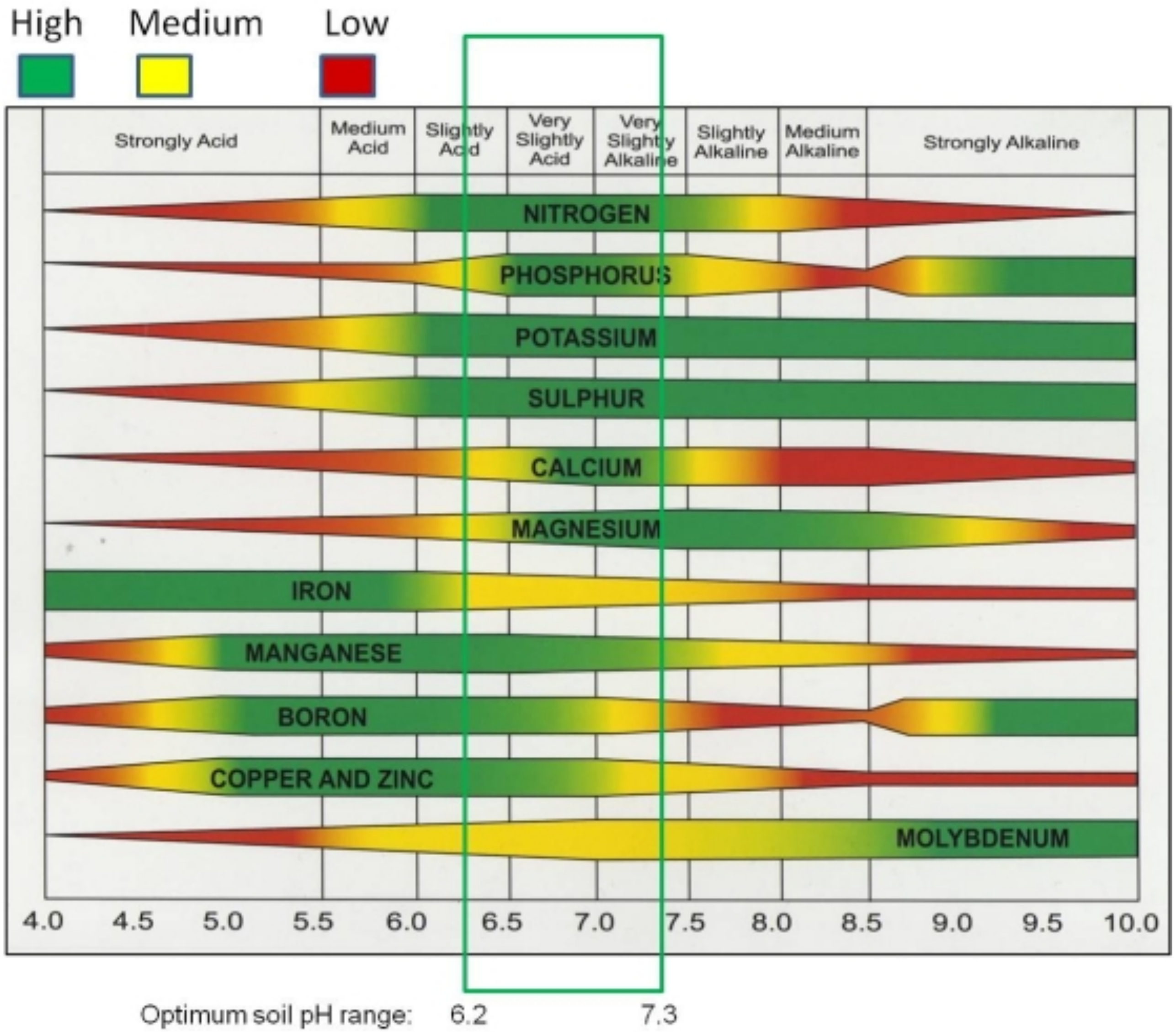
Electrical Conductivity (E.C.)

EC (dS/m at 25°C) 1:5 (w/w) extract	EC (dS/m at 25°C) Saturated Paste	Classification
< 0.35	< 2	Not Saline
0.35 - 0.65	2 - 4	Slightly Saline
0.65 - 1.15	4 - 8	Saline
1.15 - 2.00	8 - 16	Highly Saline
> 2.00	> 16	Extremely Saline

- Osmotic stress potential
- Phytotoxicity
- Structure degradation

pH

How soil pH affects availability of plant nutrients



Organic Matter

Organic Matter (%)	
< 1%	Very Low
1% - 1.9%	Low
2.0% - 2.5%	Normal
> 2.5%	High

- Soil Structure
- Water retention
- Aeration
- Microorganism Habitat

Exchange Complex

Cationes	Relative % Cations of Exchange Complex				
	Very Low	Low	Normal	High	Very High
Calcium	< 50	50 - 60	60 - 70	70 - 80	> 80
Magnesium	< 10	10 - 20	20 - 30	30 - 40	> 40
Potassium	< 2.5	2.5 - 5	5 - 10	10 - 20	> 20
Sodium	-	< 0.5	0.5 - 5	5 - 15	> 15

	Cation Antagonisms		
	Normal	Deficient Mg	Deficient K
K/Mg	0.2 - 0.3	> 0.5	< 0.2
Ca/Mg	-	> 10	-

Cation Ratios	Optimal
Ca/Mg	4.0 - 6.0
Mg/K	2.0 - 3.0
Ca + Mg/ K	10.0 - 20.0
Ca/K	10.0 - 15.0

Other Macronutrients

- Phosphorus
  - 20-40 mg/Kg optimal range with Olsen
  - P availability influenced by other factors, and results of traditional testing may be deceiving.
- Nitrogen

Total Nitrogen (mg/kg) Dumas Method (combustión)			
	Low	**Normal**	**High**
Sandy Soil	< 500	500 - 1000	> 1000
Loam Soil	< 1000	1000 - 1500	> 1500

Nitrate Nitrogen (NO3-N) with KCL Extraction (mg/Kg)			
Low	**Medium**	**High**	**Excessive**
<10	10-20	20-30	> 30

Micronutrients

Micronutrient	mg/Kg		
	Low	Medium	High
Manganese	4.00	4.0 - 10.0	10.00
Boron	0.50	0.5 - 6.0	6.00
Copper	1.00	1.0 - 5.0	5.00
Iron	5.00	5.0 - 15.0	15.00
Zinc	0.05	0.05 - 5.00	5.00

- DTPA developed for Midwestern soils
- Soil concentrations in CA always high
- Not always reliable in plant availability
- Foliar testing preferred for micronutrient assessment

Soil Reporting Results

PHYSICAL PROPERTIES - GRANULOMETRY

Texture	Sandy Loam
Clay	15.0
Silt	23.0
Sand	62.0

Soil compaction risk

MICRONUTRIENTS

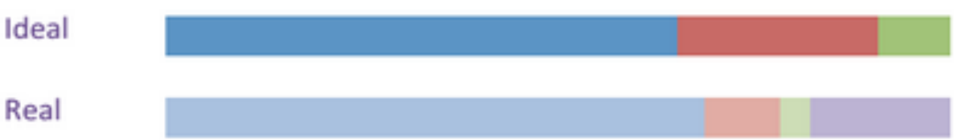
Parameter	Result	Units	Very low / Low	Normal / High	Method
Boron	< 0.50	mg/kg	0.60	1.00	Aqueous Ext.
Iron	10.4	mg/kg	4.00	10.0	DTPA
Manganese	3.28	mg/kg	1.00	5.00	DTPA
Copper	0.89	mg/kg	0.40	1.00	DTPA
Zinc	3.14	mg/kg	1.00	2.00	DTPA

Very low — Low — Normal — High — Very high

CATION RATIOS:

% Available Bases

● Ca D(65%/68%) ● Mg D(25%/10%) ● K D(10%/4%) ● Na D(0%/18%)



Water Reporting Results

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CHEMICAL PROPERTIES

Parameter	Result	Units	Low	High	Technique
Total Dissolved Solids (TD	499	mg/L	525	1,050	Calculated
pH	7.07		6.50	7.50	Potentiometry
Electrical Conductivity (E.	628	µS/cm	750	1,500	Potentiometry

Very low – Low – Normal – High – Very high

CATIONS

Parameter	mg/L	meq/L	Low	High	Technique
Calcium	60.6	3.03	2.00	6.00	ICP-OES
Magnesium	26.0	2.14	0.50	2.50	ICP-OES
Potassium	4.14	0.11	0.00	0.25	ICP-OES
Sodium	46.4	2.02	0.00	4.00	ICP-OES

ANIONS

Parameter	mg/L	meq/L	Low	High	Technique
Alkalinity	269	4.42	0.50	3.00	Seg. Flow Analyzer
Chlorides	13.5	0.38	0.00	4.00	Seg. Flow Analyzer
Nitrates	26.0	0.42	0.00	0.80	Seg. Flow Analyzer
Sulphates	53.3	1.11	0.00	6.00	ICP-OES

MICRONUTRIENTS

Parameter	Result	Units	Low	High	Technique
Boron	< 0.05	mg/L	0.00	0.80	ICP-OES

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pH & Alkalinity

- As with soil, irrigation pH has a great influence on nutrient availability, and has a direct relationship with soil solution pH.
- Buffering capacity of a soil is determined by HCO3 concentrations.

University of California

BICARBONATES (HCO_3) HAZARD LEVELS

Application	Units	None	Increasing	Significant	High	Severe
Field crops	me/l HCO_3	<1.0	1.0-2	2.0-3.0	3.0-4.0	>4.0
	ppm HCO_3	<61	61-122	122-183	183-244	>244
Greenhouse and Nurseries*	me/l HCO_3	<1.0	1.0-1.5	1.5-2.0	2.0-3.0	>3.0
	ppm HCO_3	<61	61-92	92-122	122-183	>183
Greenhouse "Plugs"	me/l HCO_3	<1.0	1.0-1.25	1.25-1.5	1.5-2.0	>2.0
	ppm HCO_3	<61	61-76	76-92	92-122	>122

University of California

SALINITY HAZARD LEVELS*

Application	Units	None	Increasing	Significant	High	Severe
All seedlings	mmho/cm	<0.2	0.2-0.7	0.8-1.0	1.1-1.5	>1.5
Container plants	mmho/cm	<0.5	0.5-0.7	0.8-1.0	1.1-2.0	>2.0
Nurseries**	mmho/cm	<0.2	0.2-0.7	0.8-1.25	1.26-3.0	>3.0
Field crops	mmho/cm	<0.75	0.75-1.0	1.1-2.0	2.1-3.0	>3.0
Hydroponics Field crops	mmho/cm	<0.75	0.75-1.0	1.1-2.0	2.1-3.0	>3.0
Soil Permeability***	mmho/cm	>0.5				<0.4

	ECw (mmhos/cm)			
	Yield potential[1]			
Vegetable and row crops	100%	90%	75%	50%
Radish	0.8	1.3	2.1	3.4
Spinach	1.3	2.2	3.5	5.7
Squash, scallop	2.1	2.6	3.2	4.2
Squash, zucchini	3.1	3.8	4.9	6.7
Strawberry	0.7	0.9	1.2	1.7

LF 1(

LF 1:

LF 3(

Sodium Adsorption Ratio (SAR)

$$\frac{[Na^+]}{\sqrt{\dfrac{[Ca^{2+}] + [Mg^{2+}]}{2}}}$$

SAR HAZARD LEVELS					
Application	**None**	**Increasing**	**Significant**	**High**	**Severe**
Most Production Systems	<1	1-2	2-4	4-5	>5
Hydroponics	<3	3-7	7-8	8-9	>9

Phytotoxic Ions (B & Cl)

Boron

mg/L	Classification
<0.2	Very low B content; excellent quality
0.0.3-0.4	Low B content; good quality
0.5-0.7	Moderate salinity; only sensitive crops affected
0.8-1.0	High B content; production at risk
1.1-2.0	Very high B; only tolerant plants can be cultivated.
>2.1	Excessive B; use not advisable.

Chloride

meq/L	Classification
<3	No risk; ideal conditions
3-5	Low Cl; generally low risk. Caution with foliar contact in sensitive crops.
6-10	Moderate-high Cl; caution with sensitive plants.
11-15	Very high Cl; production at risk but manageable with proper leaching.
>15	Excessive Cl; use not advisable in agriculture.

Water Reporting Results

CHEMICAL PROPERTIES

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pH	7.07		6.50	7.50	Potentiometry
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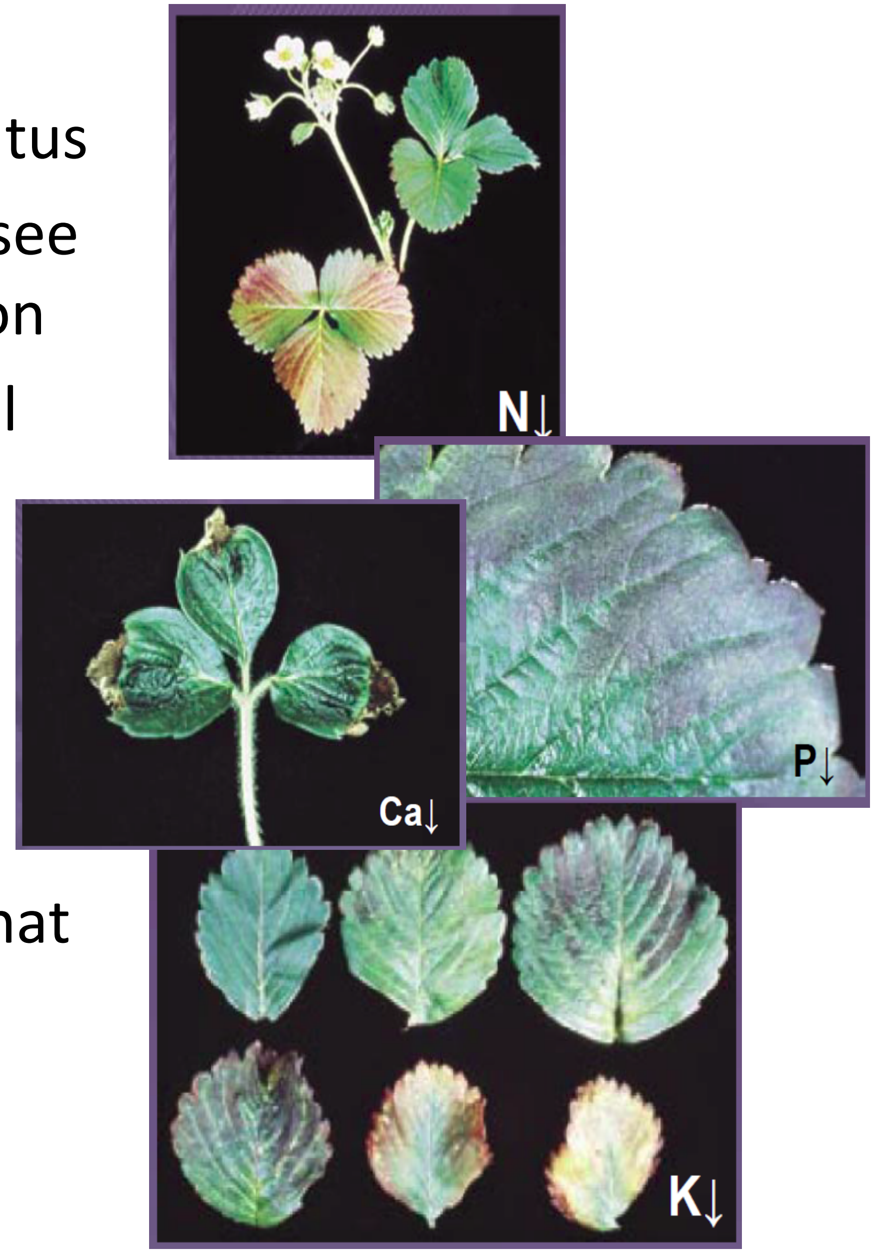
Sulphates	53.3	1.11	0.00	6.00	ICP-OES

MICRONUTRIENTS

Parameter	Result	Units	Low	High	Technique
Boron	< 0.05	mg/L	0.00	0.80	ICP-OES

Plant Tissue Analysis

- Help determine plant nutrient status
- Typically takes over 7-10 days to see response from fertilizer application
- Even prior to appearance of visual deficiency symptoms, plant metabolisms are damaged, which limits productivity
- Tool to confirm that nutrient management plan is correct
- Consequence of various factors that affect nutrient uptake
- *Reference values not updated*



Reporting Results

MACRONUTRIENTS

Parameter	Result	Units	Very low – Low	Normal	High – Very high	Technique
Nitrogen	2.93	%	2.50		3.10	Elemental Analyser
Phosphorus	0.14	%	0.15		0.20	ICP-OES
Potassium	1.33	%	0.90		1.80	ICP-OES
Calcium	3.43	%	3.10		5.00	ICP-OES
Magnesium	0.26	%	0.30		0.50	ICP-OES
Sulfur	0.30	%	0.20		0.30	ICP-OES

MICRONUTRIENTS

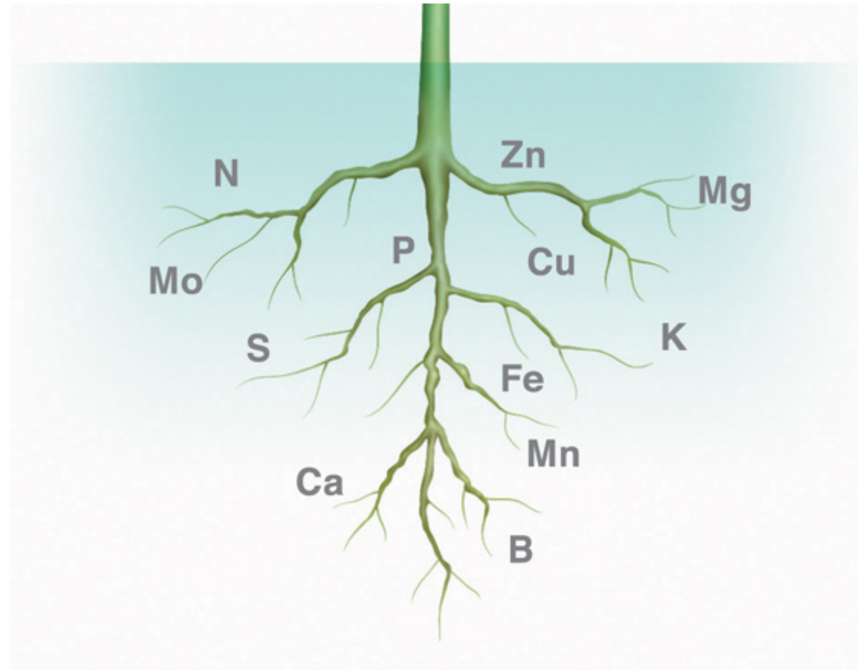
Parameter	Result	Units	Very low – Low	Normal	High – Very high	Technique
Boron	64.7	mg/kg	25.0		100	ICP-OES
Iron	173	mg/kg	60.0		150	ICP-OES
Manganese	49.3	mg/kg	25.0		200	ICP-OES
Copper	7.73	mg/kg	6.00		100	ICP-OES
Zinc	51.2	mg/kg	25.0		200	ICP-OES
Molybdenum	< 10.0	mg/kg				ICP-OES

OTHERS

Parameter	Result	Units	Very low – Low	Normal	High – Very high	Technique
Chlorides	457	mg/kg	844		1,125	CFA
Sodium	590	mg/kg	281		375	ICP-OES

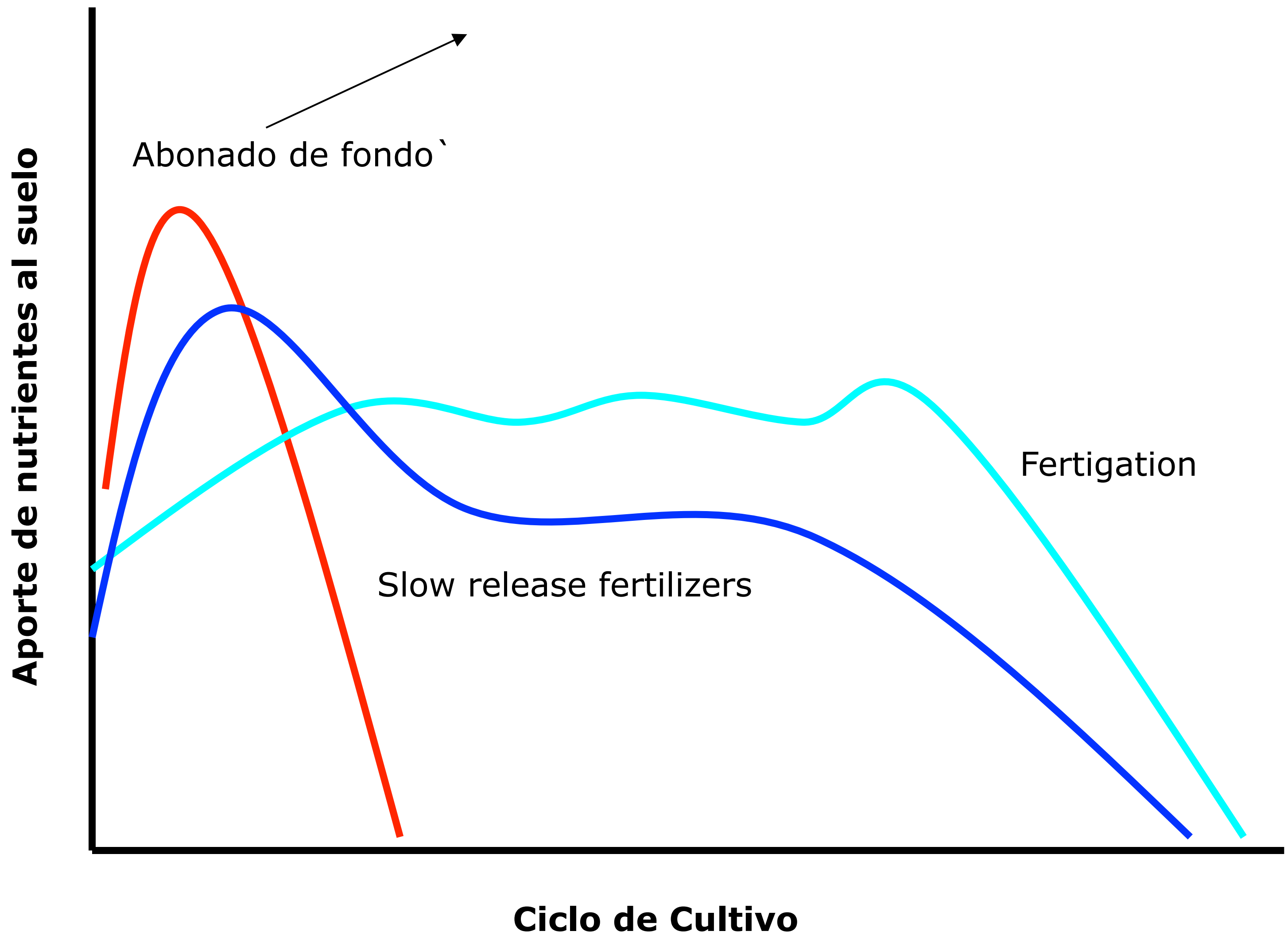
Essential Mineral Nutrients

- Macro Elements: required in large amounts (80 – hundreds Lbs/acre)
- Secondary Elements: required in large amounts (20-80 Lbs/acre)
- Micro Elements: required in small quantities (a few or less Lbs/acre)
- Others in study/discussion: Nickel, Chlorine, Cobalt, Vanadium



Macro Elements	Secondary Elements	Micro Elements
N - Nitrogen	**Ca** - Calcium	**Fe** - Iron
P - Phosphorous	**Mg** - Magnesium	**B** - Boron
K - Potassium	**S** - Sulphur	**Zn** - Zinc
		Cu - Copper
		Mn - Manganese
		Mo - Molybdenum

Comparación formas de abonado al cultivos

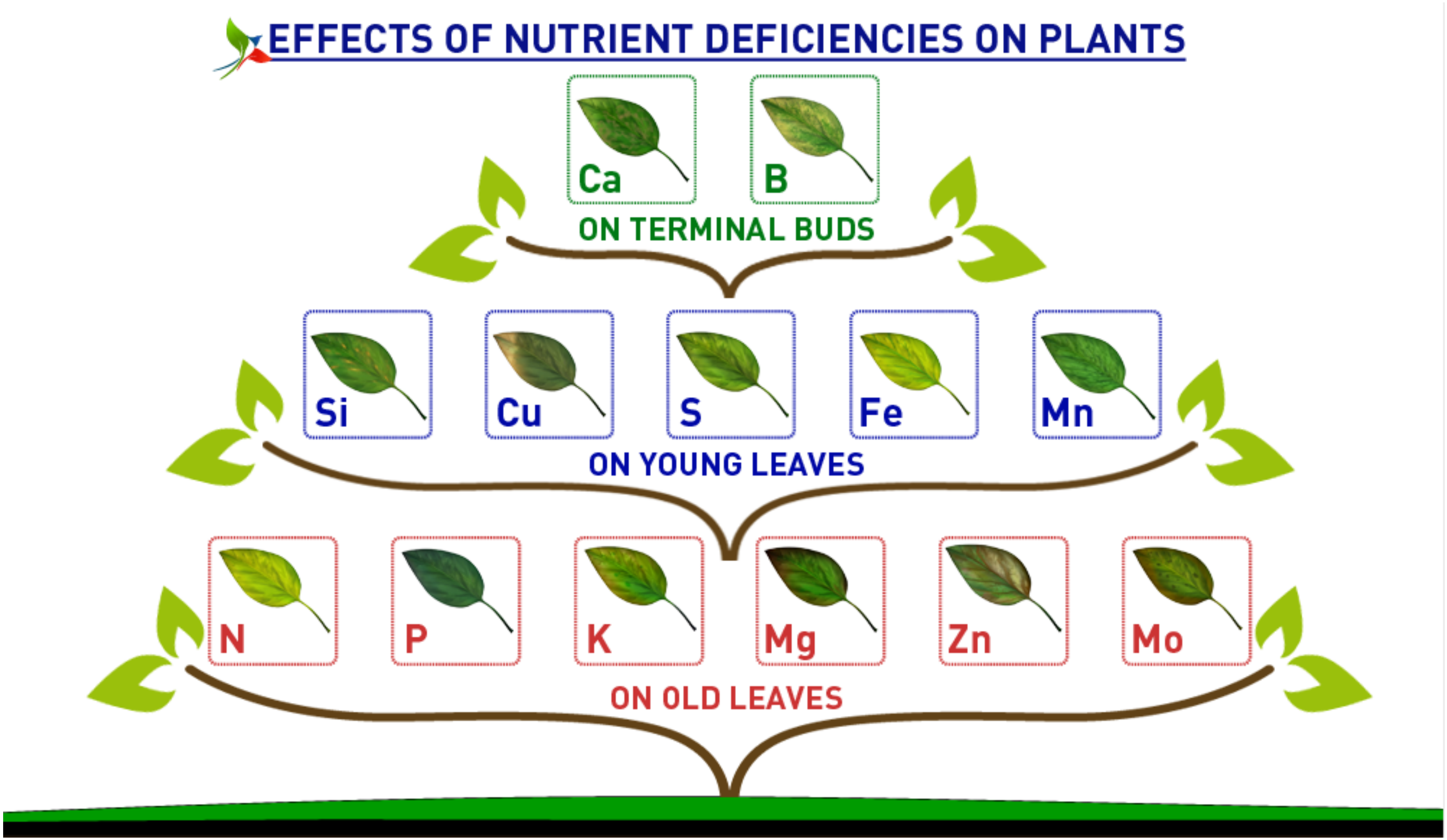


Adaptado de Cadahía, 2005

Nutrient mobility

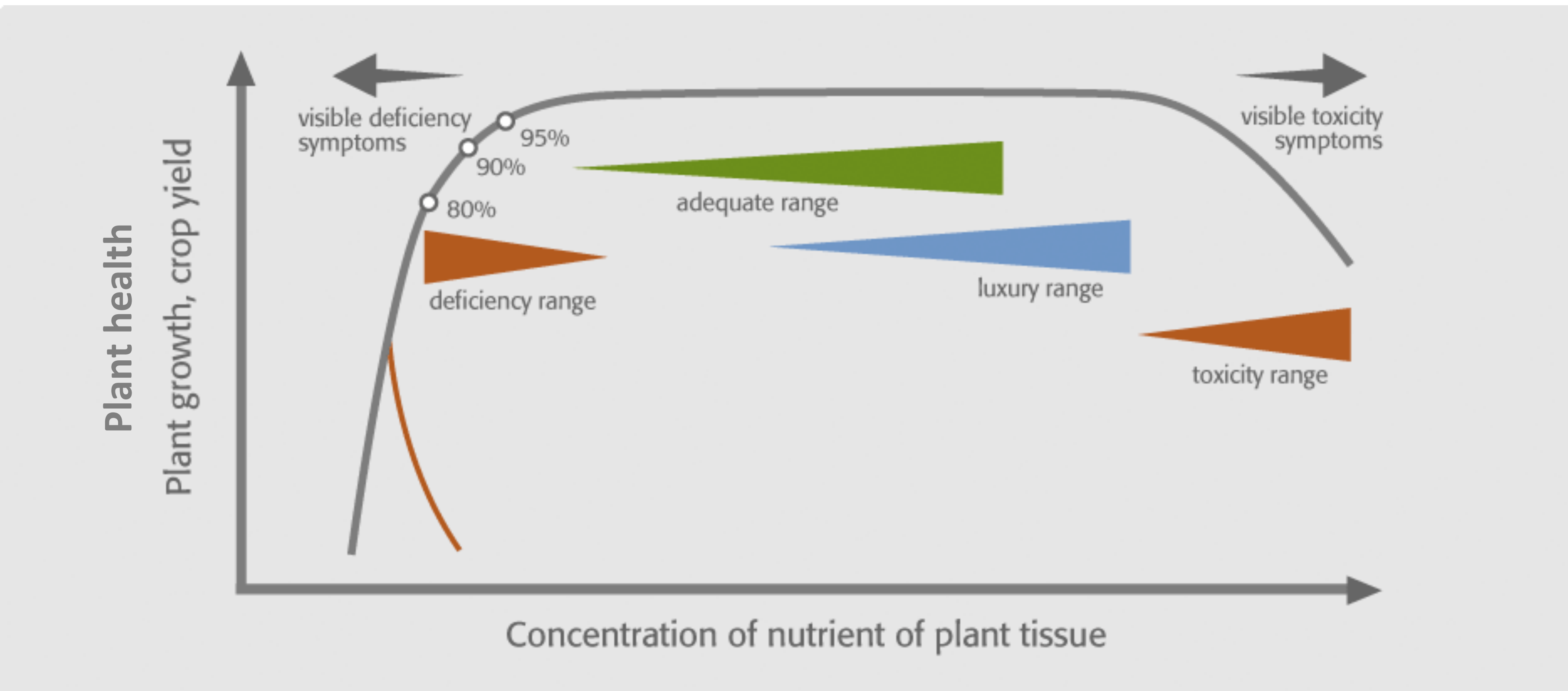
Nutrient	Type	Uptake form	Mobility in Plant	Mobility in Soil
Nitrogen	Macro	NO_3^-, NH_4^+	Mobile	Mobile as NO_3^-, immobile as NH_4^+
Phosphorus	Macro	HPO_4^{2-}, $H_2PO_4^-$	Somewhat mobile	Immobile
Potassium	Macro	K^+	Very mobile	Somewhat mobile
Calcium	Macro	Ca^{2+}	Immobile	Somewhat mobile
Magnesium	Macro	Mg^{2+}	Somewhat mobile	Immobile
Sulfur	Macro	SO_4^-	Mobile	Mobile
Boron	Micro	H_3BO_3, BO_3^-	Immobile	Very mobile
Copper	Micro	Cu^{2+}	Immobile	Immobile
Iron	Micro	Fe^{2+}, Fe^{3+}	Immobile	Immobile
Manganese	Micro	Mn^{2+}	Immobile	Mobile
Zinc	Micro	Zn^{2+}	Immobile	Immobile
Molybdenum	Micro	MoO_4^-	Mobile	Somewhat mobile

Visual Nutritional Diagnosis



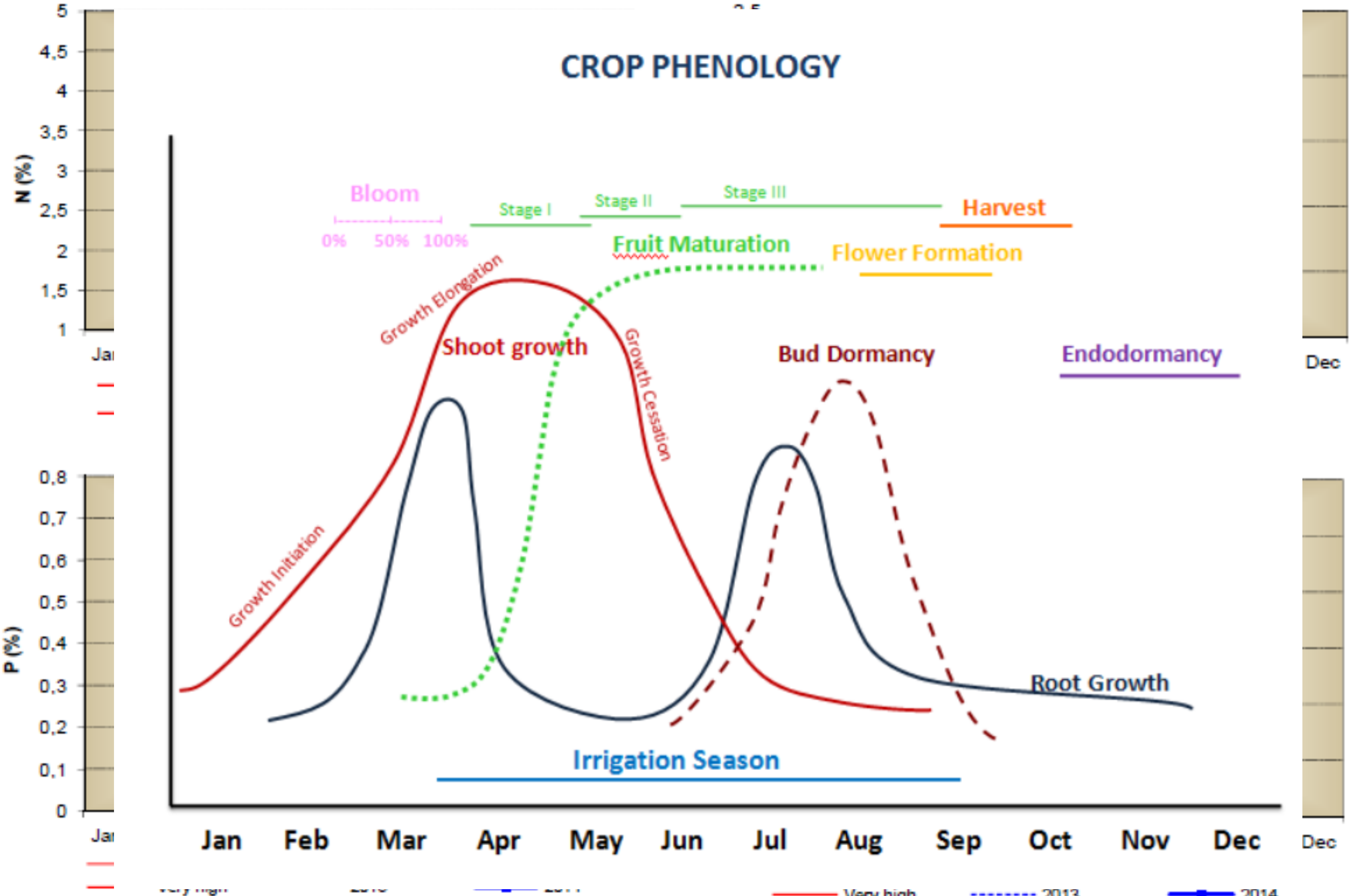
- Nutrient mobility drives deficiency symptom location in plant

How does nutrient concentration affect plants?



Sample Timing

Punctual vs. Dynamic



Soil Solution Sampling

- **Concentration of Soil Solution;** Generally the ions are absorbed against concentration gradient and rate of absorption depends on that concentration
- **Plant phenological stage;** nutrient demand seasonal changes
- **Ion-Ion interactions (balance);**
  - Antagonism/Synergism: Interference with other ion uptake
  - Facilitation: Enhancement of other ion uptake
  - Message to force plant into phenological stage

Nutrient removal (lbs/acre) by aerial growth biomass

Based on UCCE estimations for Physical graffity

-UCCE Irvine field plot 726 plants/acre

-Pruning 200 lbs/plant-year; 145,200 lbs/acre

N	P2O5	K2O
138	46	461

-Fillmore field plot 1452 plants/acre

-Pruning 200 lbs/plant; 290,400 lbs/acre

N	P2O5	K2O
276	92	922

Incorporate prunnings; plant health issue??

Nutrient removal (lbs/acre) by fruit

Based on UCCE estimations for Physical graffity

-UCCE Irvine field plot 726 plants/acre

-Conservative 20 lbs/plant; 14,520 lbs/acre

-Potential 50 lbs/plant; 36,300 lbs/acre

N	P2O5	K2O
29	8	57
73	20	142

-Fillmore field plot 1452 plants/acre

-Conservative 20 lbs/plant; 29,040 lbs/acre

-Potential 50 lbs/plant; 72,600 lbs/acre

N	P2O5	K2O
58	16	113
145.2	40	284

Thank you

klam@agq.us.com