Nutrient Management in Vegetable Crops

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Presented at 14th Annual Desert Crops Workshop
Holtville, CA 3 December, 2003

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Objectives of Nutrient Management

- Optimize crop yield and quality
- Use inputs efficiently
  - Improve profits
  - Avoid pollution
- Improve soil quality and productivity

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Keys for Successful Nutrient Management

- Identification of potential yield-limiting factors.
- If possible, control yield-limiting factors.
- Understand soil nutrient status.
- Understand plant nutrient demand.
- Use soil and tissue testing.

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Yield-Limiting Factors

- Crop yield and quality will be limited by the most-limiting growth factor.
- Nutrients may not be the most-limiting factor:
  - Irrigation management
  - Salinity
  - Pests

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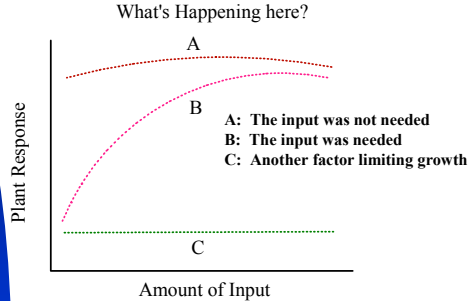
Plant Response to Inputs

What's Happening here?



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Tools for Soil/Crop Management

- Soil Knowledge
  - Soil pH, salts, sodium (potential limiting factors)
  - Available soil nutrients
  - Knowledge of soil variability
- Crop Knowledge
  - Salt tolerance
  - Nutrient requirements
  - Nutrient uptake pattern
  - Crop nutrient status from tissue tests

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Soil Sampling and Testing

- Soil sampling and testing is an excellent way to evaluate potential yield-limiting factors.
- Soil sampling is most often used for:
  - determining pre-season soil fertility and other potential soil problems (e.g. pH, salinity, etc.)
  - evaluating a wide range of potential soil problems simultaneously.

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Soil Sampling

- Soil samples should be collected in a random manner within areas that are approximately uniform with respect to soil properties and management history.
- Collect a minimum of 15-20 samples per uniform area. Composite the 15-20 samples to form one combined sample.
- Collect to a depth of 12”

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Soil Tests

Lab #	pH	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potash (K)	Iron (Fe)	Zinc (Zn)	Manganese (Mn)	Copper (Cu)	Salinity (EC x K) dS/m	Nitrate Nitrogen (NO3-N)	Phosphorus (Bicarb - Soluble P)	Computed % Sodium	Sulfur (SO4-S)	Boron (B)
		PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM		PPM	PPM	(ESP)	PPM	PPM
547	8.1	6300 VH	290 VH	420 VH	190 H	6.0 H	2.8 H	10.0 VH	1.2 VH	3.8 H	16.0 M	11.0 H	5.1	190 VH	.91
548	8.2	5000 VH	240 H	350 VH	240 H	4.6 M	2.8 H	9.5 VH	1.2 VH	4.4 H	30.0 H	11.0 H	6.8	150 VH	1.1 M
549	8.2	5800 VH	270 VH	700 VH	170 H	3.1 M	.44 L	11.0 VH	.37 M	8.2 VH	40.0 H	8.4 H	7.7	230 VH	1.2 M
550	8.2	8600 VH	280 VH	860 VH	190 H	5.1 H	.56 L	14.0 VH	.55 M	7.4 VH	71.0 VH	7.1 H	8.9	250 VH	1.4 M

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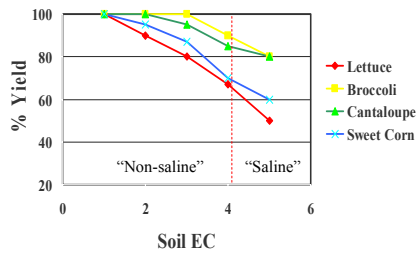
EC and Crop Growth



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ESP

- Exchangeable Sodium Percentage
- A measure of sodium to calcium ratio on soil clays
- Interpretation
  - Soil ESP >8 is severe for clay loam to clay textures
  - Soil ESP >13 is severe for other soil textures
  - High ESP can result in poor water infiltration

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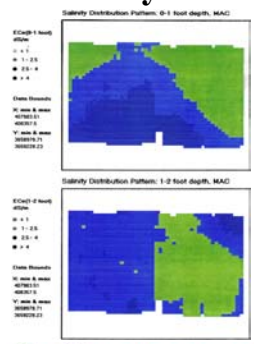
Soil Variability



Soil salinity (EC) with EM-38

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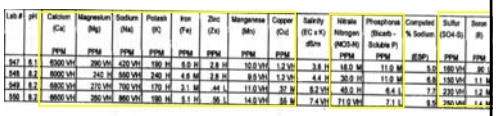
Soil Tests



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Essential Plant Nutrients Needed as Fertilizers in Desert Soils

"Macro" nutrients		"Micro" nutrients	
Nitrogen	*N*	Iron	*Fe*
Phosphorus	*P*	Manganese	Mn
Potassium	K	Copper	Cu
Calcium	Ca	Zinc	*Zn*
Magnesium	Mg	Molybdenum	Mo
Sulfur	S	Chlorine	Cl
		Boron	*B*
		Nickel	Ni

Red = usually
Green = occasionally
Black = seldom

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Measuring Nutrient Availability in Desert Soils

Nutrient	Soil Test
N	2M KCl extract
P	0.5 M $NaHCO_3$ extract
K	Ammonium acetate ext.
B	Hot water extraction
Fe, Mn, Cu, Zn	DTPA extraction

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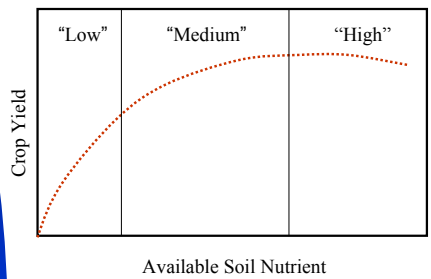
Meaning of Soil Test Values



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Available Soil Nutrients

- Preplant available N
  - Due to mobility of N, take samples as close to planting
  - 0-10 ppm NO_3-N "Low"
    - High probablility of response to fertilizer
  - 10-20 ppm NO_3-N "Medium"
    - Moderate probability of response to fertilizer
  - >20 ppm NO_3-N "High"
    - Low probability of response to fertilizer

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Available Soil Nutrients

- Preplant available P
  - 0-20 ppm "Low"
    - High probability of response to fertilizer
  - 20-40 ppm "Medium"
    - Moderate probability of response to fertilizer
  - >40 ppm "High"
    - Low probability of response to fertilizer
  - One preplant sample is usually sufficient

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Micronutrient Soil Tests

From Western Fertilizer Handbook — All values in ppm

Nutrient	Low	Medium	High
Fe	<5	5 – 15	>15
Mn	<2	2 – 10	>10
Cu	<0.8	0.8 – 1.2	>1.2
Zn	<0.7	0.7 – 1.5	>1.5
B	<0.5	0.5 – 1.2	>1.2

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Crop Nutrient Uptake

Crop	Yield	N Uptake	P_2O_5 uptake	K_2O uptake
	Ctn/ac	lb/ac	lb/ac	lb/ac
Lettuce	700	100	30	200
Broccoli	500	175 - 225	45 - 60	110 - 140
Cauliflower	750	200 - 250	65 - 85	300 - 370

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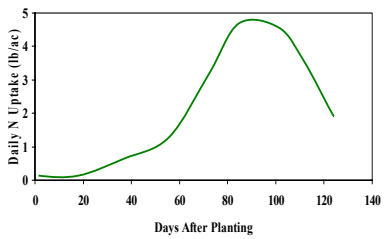
Cauliflower Nitrogen Uptake



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Plant Tissue Testing

- Uses the plant as an index of nutrient availability
- Advantages:
  - Direct measurement of nutrient uptake
  - Same tissue test can be used across many soils
- Disadvantage:
  - Nutrient content is a function of all factors affecting plant growth

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Tissue to Sample

Vegetable Crops: Midribs and Petioles

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Tissue Sampling for Vegetable Crops

- Petioles or midribs should be collected beginning at about the 4-6 leaf stage from the youngest fully-expanded leaf.
- Sample from >20 plants within uniform areas of the field.
- Avoid plants that are abnormally large or small, and diseased plants.
- Tissue samples are perishable--refrigerate or dry immediately.

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Standard Tissue Analysis

- Tissue Analysis usually involves several steps:
  - Sampling
  - Sample drying
  - Sample grinding
  - Sample extraction
  - Sample analysis
- Time from sampling to results is usually 2-3 days, delaying fertilization.

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Sap Testing

- A method that can allow immediate determination of plant N or K status.
- Sample petioles in the same manner as for petiole analysis, and extract sap.
- Sap nitrate or potassium is measured on a hand-held, calibrated meter.
- Guidelines are available for some, but not all, crops.

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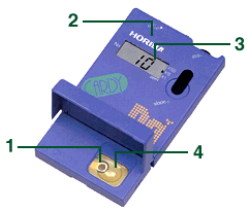
Cardy Meter



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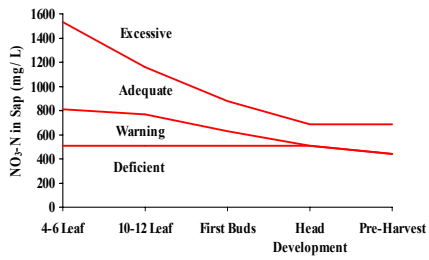
NO_3-N in Broccoli Petiole Sap



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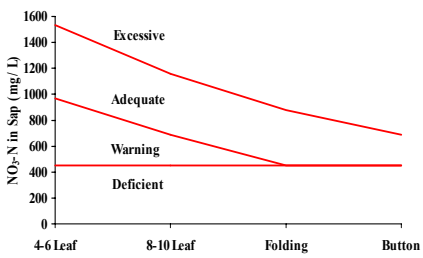
NO_3-N in Cauliflower Petiole Sap



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Sap Testing

- Quick plant sap tests are useful tools for monitoring plant N status. They will be most useful when:
  - Sap concentrations are monitored frequently
  - Combined with other evaluations of crop vigor

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Summary—Steps for Good Nutrient Management

- Understand limiting factors to growth.
- Collect, analyze, interpret pre-season soil samples. Apply appropriate management practices.
- Understand soil variability.
- Collect and analyze in-season plant tissue samples to guide side-dress fertilizer applications or fertigations.

Questions?

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Visit our subsurface drip irrigation website at:

http://ag.arizona.edu/azdrip