Nutrient Management in Vegetable Crops

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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

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.

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

Plant Response to Inputs

What's Happening here?

A: The input was not needed
B: The input was needed
C: Another factor limiting growth

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
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.

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”

Soil Tests

Soil Tests

EC and Crop Growth

Soil Variability

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
Soil Tests

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

Measuring Nutrient Availability in Desert Soils

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Soil Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>2M KCl extract</td>
</tr>
<tr>
<td>P</td>
<td>0.5 M NaHCO₃ extract</td>
</tr>
<tr>
<td>K</td>
<td>Ammonium acetate ext.</td>
</tr>
<tr>
<td>B</td>
<td>Hot water extraction</td>
</tr>
<tr>
<td>Fe, Mn, Cu, Zn</td>
<td>DTPA extraction</td>
</tr>
</tbody>
</table>

Meaning of Soil Test Values

Crop Yield

Available Soil Nutrients

- Preplant available N
  - Due to mobility of N, take samples as close to planting
  - 0-10 ppm NO₃-N “Low”  - High probability of response to fertilizer
  - 10-20 ppm NO₃-N “Medium”  - Moderate probability of response to fertilizer
  - >20 ppm NO₃-N “High”  - Low probability of response to fertilizer

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
### Micronutrient Soil Tests

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>&lt;5</td>
<td>5 – 15</td>
<td>&gt;15</td>
</tr>
<tr>
<td>Mn</td>
<td>&lt;2</td>
<td>2 – 10</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Cu</td>
<td>&lt;0.8</td>
<td>0.8 – 1.2</td>
<td>&gt;1.2</td>
</tr>
<tr>
<td>Zn</td>
<td>&lt;0.7</td>
<td>0.7 – 1.5</td>
<td>&gt;1.5</td>
</tr>
<tr>
<td>B</td>
<td>&lt;0.5</td>
<td>0.5 – 1.2</td>
<td>&gt;1.2</td>
</tr>
</tbody>
</table>

All values in ppm

From Western Fertilizer Handbook

### Crop Nutrient Uptake

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield N Uptake</th>
<th>P₂O₅ uptake</th>
<th>K₂O uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lettuce</td>
<td>700</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>Broccoli</td>
<td>175 - 225</td>
<td>45 - 60</td>
<td>110 - 140</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>200 - 250</td>
<td>65 - 85</td>
<td>300 - 370</td>
</tr>
</tbody>
</table>

### Cauliflower Nitrogen Uptake

![Cauliflower Nitrogen Uptake Graph](image)

### 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

### 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.
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.

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.

Cardy Meter

NO$_3$-N in Broccoli Petiole Sap

NO$_3$-N in Cauliflower Petiole Sap

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
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