Soil fertility management for fresh market tomato and pepper production
Typical nutrient uptake:
- 25 ton/acre pepper crop
- 40 ton/acre tomato crop

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P\textsubscript{2}O\textsubscript{5}</th>
<th>K\textsubscript{2}O</th>
</tr>
</thead>
<tbody>
<tr>
<td>pepper</td>
<td>200 - 260</td>
<td>40 - 60</td>
<td>240 - 320</td>
</tr>
<tr>
<td>tomato</td>
<td>200 - 250</td>
<td>60 - 80</td>
<td>300 - 350</td>
</tr>
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Each ton of additional fruit has approximately:
- 3 lb N
- 1 lb P\textsubscript{2}O\textsubscript{5}
- 4-5 lb K\textsubscript{2}O
Phosphorus requirement:

Common soil tests for P availability:

Olsen (bicarbonate) test - extraction in sodium bicarbonate at pH 8.5
best method if soil pH > 6.5

Bray test - extraction in dilute acid
useful in acidic soil (pH < 6.5)

Bray values much higher than Olsen in most cases
Is P application always necessary?  
What application rate is reasonable?

Soil P availability requirement:

<table>
<thead>
<tr>
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<tr>
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<td>60 PPM</td>
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Agronomic threshold (Olsen test)
Pepper:

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<td>positive crop response unlikely</td>
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</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>&lt; 10 PPM</td>
<td>positive response guaranteed</td>
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<td>10 - 20 PPM</td>
<td>positive response likely, especially in cold soil</td>
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<td>&gt; 20 PPM</td>
<td>positive crop response unlikely</td>
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**Application rate?**
- limit application to crop removal rate in fields with high soil P rates > 120-150 lb P$_2$O$_5$/acre questionable, regardless of soil test level
Nitrogen management:

- Crop N uptake is predictable by growth stage

lb N per acre per day:

< 1

4 - 5

< 3
Nitrogen management:

- Crop N uptake is predictable by growth stage

\[ \text{lb N per acre per day:} \]

- < 1
- 4 - 5
- < 3

- Not all N needs to come from fertilizer application:
  - residual soil NO\(_3\)-N can be substantial
Not all crop N comes from fertilizer:

2007-08 processing tomato field survey:

Soil N availability can be measured, or inferred.
Excessive N application can be both an agronomic problem, and an environmental problem:

- Environmental targets for N concentration in groundwater is 10 PPM NO$_3$-N; for surface water may be as low as 1 PPM.
- Any water that escapes a fertilized field is likely to greatly exceed environmental targets.
Irrigation efficiency and N management:
- at common soil NO₃-N levels during the season, one inch of leaching may carry 20-30 lb NO₃-N/acre out of the root zone.
Potassium management:

- Crop K uptake is predictable by growth stage

lb N per acre per day:

< 1   
4 - 7   
< 4
Potassium management:

- Crop K uptake is predictable by growth stage

  lb N per acre per day:

  `<1`  
  `<4 - 7`  
  `<4`

- Moderate (pepper) to high (tomato) K requirements
- Majority of K ends up in fruit
- Leaf K declines to ‘feed’ the fruit; that’s why deficiency shows late
Evaluating soil K supply:

- ‘exchangeable’ K, usually expressed as PPM
- K as a % of base exchange

\[ \text{[milliequivalent of K} \div \text{(meq Ca + Mg + Na + K)]} \times 100 \]
Soil test K interpretation:

- Fields > 200 PPM exchangeable K, and > 3% of base exchange, do not require K fertilization.
- Soils < 150 PPM, or < 2% of base exchange, should be fertilized.
- K fertilization is most effective during fruit set and early fruit development.
Crop monitoring options

In-season soil nitrate testing:

- high root zone soil NO$_3$-N concentration (> 20 PPM) indicate that additional N application can be postponed

Soil nitrate testing most useful early in the season
Petiole testing as a management tool?

- high NO₃-N or PO₄-P concentration guarantees current sufficiency, but does not project far into the future.
Petiole testing as a management tool?

- high NO\textsubscript{3}-N or PO\textsubscript{4}-P concentration guarantees *current* sufficiency, but does not project far into the future
- lower NO\textsubscript{3}-N or PO\textsubscript{4}-P concentration *does not prove deficiency*
2004-05 survey of 75 coastal lettuce fields
at early heading stage:

Leaf total N of the 20 highest yielding fields ...
at early heading stage:

Midrib NO$_3$-N of the 20 highest yielding fields …
Tissue sampling in processing tomato:
✓ 4 high yield commercial fields
✓ UCD fertilizer trial
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![Graph showing Leaf N (g kg⁻¹) over Growing degree days for different fields and UCD levels.](image-url)
Tissue sampling in processing tomato:

- 4 high yield commercial fields
- UCD fertilizer trial

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**Graph 1:**
- **Leaf N (g kg⁻¹):**
- **Growing degree days:**

**Legend:**
- field 1
- field 2
- field 3
- field 4
- UCD deficient
- UCD adequate
- UCD excessive

**Graph 2:**
- **Petiole NO₃-N (PPM):**
- **Growing degree days:**

**Legend:**
- field 1
- field 2
- field 3
- field 4
- UCD deficient
- UCD adequate
- UCD excessive
Calcium disorders:
- symptoms develop because insufficient Ca is moved into actively growing cells during fruit development
Calcium disorders:
- Symptoms develop because insufficient Ca is moved into actively growing cells during fruit development.
- Origin of the problem is the inefficient way plants move Ca into fruit; soil Ca limitation seldom the primary problem.
Calcium doesn’t move into fruit easily:

Processing tomato fruit quality survey, 140 fields:

- Ca moves in transpirational flow in xylem, so leaf Ca is high
- Ca does not move in phloem, so fruit Ca is low; surface wax on fruit makes foliar application questionable
What can be done to minimize calcium disorders?

- **prevent water stress**
- avoid high ammonium levels during early fruit development