# Organic Hoophouse Fertility Challenges

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# Unique factors important to managing hoophouses

- Season extension = Longer season
  - unheated
- Producing during ‘off-season’
- Longer period requiring fertility
- Minimum rotation or rest periods
- Highly diverse crop mix
- Intensive management to maximize profit per square foot
- Water efficiency high

# Unique challenges related to Hoophouse Fertility

- Nitrate accumulation in winter grown greens
- Salt buildup in soils
- Soil pests- Garden symphyllan- similar plant symptoms to salt damage

# Fertility Approaches

- Add compost to build soil OM levels to 10-15%
- Add additional minerals, based on soil tests
- Occasionally incorporate green manures and cover crops
  - Particularly prior to establishing a hoophouse site
- Liquid feeds and sidedressing with other nutrient sources

# Compost Amendment

- Increase soil OM to 10%
  - Start with high rates of compost application
    - 1 inch on surface
    - 30 yards/1000 sq ft
  - Decrease rates in subsequent years
  - At 15% OM, problems with soil pest have been observed
- Compost quality
  - Animal-waste based compost higher EC than plant based composts
  - Avoid immature composts- ammonia gassing off

# Organic Greenhouse Tomato Growers, Canada

- 6.5 cu ft/100 sq ft added every 5-6 weeks
- Straw mulched after each application
- Repeat 5-6 times during season
- Rates reduced after two years
- OM levels range from 10-15% to 30% in beds

# Steve Moore’s Fertility Approach

- Start with 28 cu ft/100 sq ft to build fertility
  - 30 yds in 30 x 96 greenhouse
  - About 3” compost worked into soil 12 inches
- Reduce rate to 3-4 cu ft/100 sq ft after two year
- Animal based compost initially, then shifts to plant based composts
  - Avoid soil salt build up
- Other amendments: fish or kelp, only 5-8 oz per year
- Carefully monitor soil EC
- Penn State research found that half the initial rate (1.5 inch layer) supported similar yields to higher rate (3 inch layer) with reduced salt levels

# Dave Colson

- Compost made on farm
- Supplement, based on soil test, with Bloodmeal, Sulpomag and Colloidal P
- Recent salt problems in hoophouses
  - Adding Gyspum, to reduce salt levels in houses. Calcium will displace Na and cations in soil
  - Leaching one house per year, by removing covers over winter

# Monitoring Electrical Conductivity

- Soluble salts (K, Na, Cl, NO3, NH4)
- Symptoms of high EC- restricted water uptake and wilting, restricted root growth, poor germination, marginal burning on foliage, reduced flowering and yields
- Saturated paste, 1:2 dilution or 1:5 dilution, based upon dry wt soil

# EC levels

| Saturated Paste | 1:2 dilution | 1:5 dilution | Comments |
|---|---|---|---|
| 0-0.7 | 0-0.25 | 0-0.12 | Very low |
| .7-2.0 | 0.25-0.75 | 0.12-0.35 | Good for germination |
| 2.0-3.5 | 0.75-1.25 | 0.35-0.65 | Desirable for growth |
| 3.5-5.0 | 1.25-1.75 | 0.65-0.9 | Slightly high, too high for seedlings |
| 5.0-6.0 | 1.75-2.25 | 0.9-1.1 | Reduced growth, marginal burn |

1 dS/m= 1 mmho/cm= 1 mS/cm

# Relative salt tolerance

| Non Tolerant (0-2 dS/m)* | Slight Tolerant (2-4 dS/m) | Moderately Tolerant (4-8 dS/m) | Tolerant (8-16 dS/m) |
|---|---|---|---|
| carrot | Cabbage | broccoli | Swiss chard |
| onion | Celery | muskmelon | beet |
| Pea | Lettuce | spinach | |
| radish | Pepper | Squash | |
| Green bean | Sweet corn | tomato | |
| | potato | | |

*saturated paste extract

1 dS/m= 1 mmho/cm= 1 mS/cm;  irrigation water should be <0.75 dS/m

# Recommendations

- Do not add composts at greater than 1” per season
- Amendments with up to 10 dS/m salts OK if going into soil with less than 1 dS/m salt
- If soil has greater than 3 dS/m salt, avoid amendments with greater than 10 dS/m.
- Leach soils when levels climb
  - 6 inches of water reduces salts by 1/2
  - 12 inches water will reduce salts by about 4/5
  - 24 inches of water will reduce salts by 9/10
- Good drainage is essential

# Nitrate Accumulation in Vegetables

- Under short days and low light intensity, photosynthesis reduced
- Reduction in energy restricts conversion of NO3 to amino acids
  - Reduced activity of nitrate reductase
- High soil nitrate levels correlated to high tissue levels
- Nitrate accumulation varies by species
  - Higher in spinach, lettuce, broccoli, cabbage, celery, radish, and beetroot.
  - Lower in carrots, cauliflower, snap beans, parsnips, peas and potatoes.

# The Nitrate Dilemma

- Vegetables dominant source of nitrates in the diet (80-90%)
- Nitrate in the Body
  - Converted to nitrite, binds to hemoglobin to reduce blood oxygen levels (Methemoglobinemia)
  - Converted to nitrosamines in acid environment of stomach
    - Speculate cancerous compounds, but when eat with Vit. C, research shows decrease nitrosamine formation
    - Leafy vegetables have high Vit. C
  - Maximum daily intake = 220 mg for an 130 lb adult
    - 100 g of greens 2500 mg nitrate/kg= 250 mg nitrate
- However, increased consumption of fruits and vegetables associated with decreases in digestive tract cancers
  - Other antioxidants
  - Nitrate may have benefits - converted to nitric oxide in stomach, acts as antimicrobial on gut pathogens

# Maximum Nitrate Levels (mg/NO3/kg) in Europe*

| Crop | Dates | Nitrate mg/NO3/kg FW |
|---|---|---|
| Fresh Spinach | Nov 1 to March 31<br>Apr 1 to Oct 31 | 3000<br>2500 |
| Frozen Spinach | | 2000 |
| Fresh Lettuce- Grown Under Cover | Oct 1 to March 31<br>Apr 1 to Sept 30 | 4500<br>3500 |
| Fresh Lettuce- Grown in Open Field | Oct 1 to March 31<br>Apr 1 to Sept 30 | 4000<br>2500 |
| Iceberg Lettuce Under Cover | | 2500 |
| Iceberg Lettuce Field | | 2000 |

*European Commission Regulation EC No. 563/2002
www.food.gov.uk/multimedia/pdfs/wpcc20036.pdf

# Nitrate Conversion Units

| US EPA | Europe, CA | Chemical Units |
|---|---|---|
| 1 ppm Nitrate-N | 4.5 ppm Nitrate | 71 uM Nitrate |

1 ppm nitrate-N = 1 mg Nitrate-N/liter =4.5 mg Nitrate/liter= 71 uM Nitrate
1 ppm Nitrate= 0.22 ppm Nitrate N = 16 uM Nitrate
1 uM Nitrate= 0.014 uM Nitrate-N= 0.063 ppm Nitrate

**Drinking water standard: 10 mg Nitrate-N/Liter or 50 mg Nitrate/liter

# Nitrate Management

- Avoid excessive N applications
- Harvest in afternoon
  - After sunny day, nitrate in greens lower in some studies
  - Highest levels in early morning
  - Inconsistent research results about this practice
- Remove petioles (?)-highest nitrate content
- Maintain adequate moisture
- Watch leaf selection
  - Over mature or older leaves- higher level
  - Outer leaves higher than inner leaves
- Varieties show genetic variation in nitrate accumulation
- Accumulation increases with high temperatures and low light

# Garden symphylan
## *Scutigerella immaculata* (Newport),

- Small, white, centipede-like creatures, which are neither centipedes nor insects.
- Adults 1/4 inch long, soft-bodied creatures, with prominent antennae
- Adults overwinter deep in soil
- Lay eggs in upper 6 to 8 inches of soil
- Symphylan nymphs will feed and develop for about 2 months in field
  - Feed on roots and other underground portions
  - Numerous tiny holes or pits on the roots, and roots hairs pruned and have a blunt appearance.
- Large populations (>50 per plant) can cause economic injury to crops.

# Sampling and Biocontrol

- Oregon State sampling guidelines:
  - Take a square foot soil sample to a depth of 10 inches from several different sites (one site per 1.5 acre field).
  - Count the number of symphylans per sample and calculate an average number per sample.  If more than 4 symphylans per sample is found, control may be required.
- Cultural Control:
  - Tillage breaks up root channels and reduces populations.
  - Flooding the field prior to planting may control
  - Crabmeal fines being tested
- Biological control:
  - Not been well-studied.
  - *Pergamasus quisquiliarum*, appears to be an important mite predator (may consume up to 12 symphylans during one generation).
  - Pathogenic nematodes and soil bacteria may also infect