Organic Vegetable Gardening

* Irrigation *

Noontime Talks
Phillippi Farmhouse Market

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UF/IFAS Sarasota County Extension
OUTLINE

- Overview of topics of noontime talks on organic vegetable gardening
- Introduction to organic vegetable gardening
- Advanced and new techniques of compost making and use
Topics of Noontime Talks for Organic Vegetable Gardening

• Introduction (Nov 23, 2011)
• Edible Flowers (Dec 7, 2011)
• Container Gardening (Dec 21, 2011)
• Worm Composting (Jan 4, 2012)
• Frost Protection (Jan 11, 2012)
• Composting – Part 1 (Jan 25, 2012)
• Transplants (Feb 8, 2012)
Topics of Noontime Talks for Organic Vegetable Gardening

- Composting – Part 2 (Feb 22, 2012)
- Irrigation (March 14, 2012)
- Raising Honey Bees (March 28, 2012)
- Companion Planting (April 11, 2012)
- Cover crops (April 22, 2012)
Goals for Noontime Talks on Organic Vegetable Gardening

– Food for your freshest nutrition
– Food for expanding benefits of backyard vegetable gardening
– Food for thought
– Food for your soul
Approach of Noontime Talks on Organic Vegetable Gardening

- Promote the practice of the guidelines in the reference “Vegetable Gardening in Florida” by James M. Stephens. 1999. Univ. of FL, IFAS

- Provide background information on the science and principles from agroecology for successful organic vegetable gardening.

- Provide additional resources available for successful organic vegetable gardening.
- Available from UF/IFAS bookstore, see http://ifasbooks.ufl.edu/merchant2/
  Also available from your favorite book vender.
Agroecosystem Concept

• An approach that looks at your vegetable garden as a functional whole of interacting living and non living components, i.e. “whole is more than sum of parts”

• A science-based management using models from natural ecosystems

Three processes connect all the parts of the ecosystem:

- Energy Flow is the "power" of the system.
- Water Cycling and Nutrient Cycling are the movements of the elements and compounds that plants and animals need to live and grow.
Irrigation System Examples

• **Types**
  – Overhead/Sprinklers
  – Drip/Emitter Irrigation
Irrigation Management

Water Requirements

- Evapotranspiration: amount of water transpired & utilized by the crop + evaporation from the soil
- Some crops require 500 lbs of water to make 1 pound of dry matter
- This water can come from stored water in the soil, supplied by rain, groundwater within reach of the roots, or from irrigation

Crop Evapotranspiration

- Measures the water used by the crop including evaporation and transpiration (ETc)
- Need to know:
  - Reference Evapotranspiration (ETo)
  - Crop Coefficient (Kc)

\[ \text{ETc} = \text{ETo} \times \text{Kc} \]
Water Evapotranspiration

North Florida Reference Evapotranspiration

Reference ET (inches per day)

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
## Water Evapotranspiration

Average water use for **BEAN (SNAP)** in inches/day.

<table>
<thead>
<tr>
<th>Month</th>
<th>Small plants</th>
<th>Growing plants</th>
<th>Pods enlarge</th>
<th>Pods mature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar</td>
<td>0.04</td>
<td>0.05</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td>0.05</td>
<td>0.07</td>
<td>0.10</td>
<td>0.14</td>
</tr>
<tr>
<td>May</td>
<td>0.05</td>
<td>0.07</td>
<td>0.11</td>
<td>0.13</td>
</tr>
<tr>
<td>Jun</td>
<td></td>
<td>0.13</td>
<td>0.17</td>
<td>0.17</td>
</tr>
<tr>
<td>Jul</td>
<td></td>
<td></td>
<td></td>
<td>0.16</td>
</tr>
<tr>
<td>Aug</td>
<td>0.05</td>
<td>0.07</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td>0.04</td>
<td>0.06</td>
<td>0.09</td>
<td>0.12</td>
</tr>
<tr>
<td>Oct</td>
<td>0.04</td>
<td>0.05</td>
<td>0.07</td>
<td>0.09</td>
</tr>
<tr>
<td>Nov</td>
<td></td>
<td>0.07</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Dec</td>
<td></td>
<td></td>
<td></td>
<td>0.06</td>
</tr>
</tbody>
</table>

Early bloom: 1-2 weeks after planting. Approximate weeks after planting.
## Water Evapotranspiration

Average water use for **CABBAGE** in inches/day.

<table>
<thead>
<tr>
<th>Month</th>
<th>Small plants</th>
<th>Growing plants</th>
<th>Head development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug</td>
<td>0.05</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td>0.04</td>
<td>0.06</td>
<td>0.09</td>
</tr>
<tr>
<td>Oct</td>
<td>0.02</td>
<td>0.05</td>
<td>0.08</td>
</tr>
<tr>
<td>Nov</td>
<td>0.02</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>Dec</td>
<td>0.01</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Jan</td>
<td>0.01</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Feb</td>
<td>0.02</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>Mar</td>
<td>0.02</td>
<td>0.06</td>
<td>0.09</td>
</tr>
<tr>
<td>Apr</td>
<td>0.10</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>0.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weeks after planting</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
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</tr>
</tbody>
</table>
Water Evapotranspiration

Average water use for **BERMUDAGRASS** (full ground cover) in inches/day.

<table>
<thead>
<tr>
<th>Month</th>
<th>inches/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar</td>
<td>0.13</td>
</tr>
<tr>
<td>Apr</td>
<td>0.16</td>
</tr>
<tr>
<td>May</td>
<td>0.18</td>
</tr>
<tr>
<td>Jun</td>
<td>0.18</td>
</tr>
<tr>
<td>Jul</td>
<td>0.17</td>
</tr>
<tr>
<td>Aug</td>
<td>0.16</td>
</tr>
<tr>
<td>Sep</td>
<td>0.14</td>
</tr>
<tr>
<td>Oct</td>
<td>0.11</td>
</tr>
<tr>
<td>Nov</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Water Evapotranspiration

- Difficult to measure water loss to evaporation and transpiration separately
  - Grouped together as evapotranspiration (ET)
- Potential evapotranspiration (PET) estimates water loss from densely vegetated soil if optimum soil water content were maintained
- PET depends on solar radiation (latitude), temperature, humidity, cloud cover, wind speed
Critical Plant Processes

- Photosynthesis - “food” production
- Respiration - converts “food” into energy
- Transpiration - cools plants; transports minerals, sugars and plant chemicals; maintains cell turgor; must occur for plants to absorb CO2
Watering the Garden

- **Rooting Depth Rule**
  - Tall = Deep roots
  - Short = Shallow

- **Critical Periods**
  - Vegetative
  - Flowering

- **Water Conservation**
  - Drip vs Other

[Image: Watering the Garden with plants and irrigation system]

VEGIES GROUPED BY ROOTING

<table>
<thead>
<tr>
<th>Shallow (12-18”)</th>
<th>Moderate (24-36”)</th>
<th>Deep (&gt;36”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>Bean</td>
<td>Asparagus</td>
</tr>
<tr>
<td>Celery</td>
<td>Carrot</td>
<td>Pumpkin</td>
</tr>
<tr>
<td>Lettuce</td>
<td>Corn</td>
<td>W. Squash</td>
</tr>
<tr>
<td>Onion</td>
<td>Cantaloupe</td>
<td>Sw. Potato</td>
</tr>
<tr>
<td>Potato</td>
<td>Pepper</td>
<td>Tomato</td>
</tr>
<tr>
<td>Spinach</td>
<td>Su. Squash</td>
<td>Watermelon</td>
</tr>
<tr>
<td>Radish</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Management goal = promotion of optimum root depths of crops
Irrigation Management

• Best Management Practices
  – Water efficiency example
Water Management

• Best Management Practices
  - Irrigation Water efficiency
    • proper timing
    • proper amount
    • proper depth

Tensiometers indicate soil water status for irrigation timing
Water Management

- Best Management Practices
  - Irrigation scheduling & application measurement

Dye Indicator

Measuring cups

Water percolation demonstration for irrigation depth

Water application measurement demonstration for irrigation amount
Irrigation Management

- Distribution of applied irrigation water

Soaker Hose VS Drip Tape
Irrigation Management

Irrigation

- Place water at the root zone
- Rotating & oscillating sprinklers inefficient, can promote disease
- Soaker hoses & drip irrigation efficient
Irrigation Management

Soaker Hose Allows More Nonlinear Plantings
Gravity Drip Irrigation Example

Small Kit
(100 ft total length
3.5 ft bucket height)

Large Kit
(330 ft total length
3.5 ft bucket height)

http://www.chapinlivingwaters.org/
Bucket Drip Irrigation Demo

Warm Mineral Springs Community Garden
Crop Water & Nutrient Needs: Critical Times

- Vegetative
- Establishment
- Reproductive/Maturity
- Fruiting Veggies
- Fruiting & Leafy Veggies

Dry Weight Increase

Time Period

Irrigation Mgt - Crop Examples

- Transplants
  - Water before and after
- **Do not water stress**
  - Salad crops
  - Bulb crops
  - Root crops
  - Cabbage family
- **Do not overwater**
  - At ripening will cause fruit cracking – tomatoes
  - Cracks & poor flavor - melon
- **Uniform water**
  - potato
- Water especially at critical growth stages
  - Flowering – legumes
  - Pollination - corn
Crop Weather Resources

• Florida Automated Weather Network
  ✓ evapotranspiration data
  ✓ freeze warnings and email alerts
  ✓ temperature data and forecasts

http://fawn.ifas.ufl.edu/
Mulch: Soil Water and Temperature Control For Optimal Crop Growth

• **Cooling**
  - Reduce high soil temperatures
  - Especially for cool season crops
  - Usually loose materials as hay, chips, dry grass clippings, leaves
Crop Water and Temperature Mgt

- **Heat protection**
  - overhead foliar watering
  - evaporative cooling
  (evaporation = heat transfer from plant)

- **Cold protection**
  ✓ mist and overhead foliar watering
  ✓ evaporative cooling (ice formation = heat transfer to plant)
Foliar Fertilization Water Mgt

Supplies supplemental doses of
- minor/major nutrients
- plant hormones
- stimulants
- other beneficial substances

(diagram drawn to scale; bacterial cells are 1 μm long)

ATTRA, ‘Foliar Fertilization’
http://attra.ncat.org/attra-pub/foliar.html#intro
Soil Water

- It’s Part of the Mixture of Soil Components
- Pore Space 50% (v)
  - air
  - water
- Solids 50% (v)
  - minerals
  - organic matter

Soil Water

• Manage soil as a ‘bank’ for water storage against gravity pull
  ➢ improve structure
  ➢ increase capillarity and adhesion
Soil Texture and Water Holding Capacity

- SAND
- CLAY
- LOAM
Water Infiltration

- Movement into soil
  - Stem flow
  - Soil surface
    - Prevent crusting
    - Add organic matter
    - Use mulch

Mulching

Water Placement At Plant

Stem flow
Water Percolation

• The movement of water after infiltration through the soil that contributes to soil and ground water replenishment.

• Process steps
  – movement thru soil pores
  – storage as soil water
Soil Pore Sizes

Pore size & soil texture:
- Sand – macropore
- Loam – mesopore
- Clay - micropore

www.homepage.montana.edu/~ueswl/307%2008A.ppt
# Soil Water Content Ranges

<table>
<thead>
<tr>
<th>Textural class</th>
<th>@ FC</th>
<th>@ WP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>.07-.17</td>
<td>.02-.07</td>
</tr>
<tr>
<td>Loam</td>
<td>.20-.30</td>
<td>.07-.17</td>
</tr>
<tr>
<td>Silt loam</td>
<td>.22-.36</td>
<td>.09-.21</td>
</tr>
<tr>
<td>Clay</td>
<td>.32-.40</td>
<td>.20-.24</td>
</tr>
</tbody>
</table>

Available Water = (@ FC) – (@ WP)

* inches of soil = inches of water in soil
Soil Organic Matter & Soil Water

- Improves soil structure & aggregation (i.e., mesopores)
- Holds water & increases soil water holding capacity
- Enhances root growth & access
  - Increase microbe activity
  - Stored and releases nutrients
- Stable organic matter (called humus) maintains constant moisture conditions
Water Sources
For Organic Vegetable Gardening

• Precipitation
  – Rainfall
  – Collection, e.g., rainbarrels
• **Underground water**
  – wells
• **Surface water**
  – Rivers, streams
• **Treated water**
  – Potable water
  – Reuse water
WATER QUALITY AND HYDROLOGY

WELL WATER

Domestic use

irrigation

Different aquifer water sources
Well Water Quality and Hydrology
Water Quality and Quantity Is Dynamic!
Southern Water Use Caution Area

Water Salts Tests

- Composites of positive and negative ions which can damage organisms at high levels.
- Contributed to by soil mineral components, organic matter components, fertilizers, and added salts from salt water.
- Salts are an issue in areas where salt water flooding occurs or where irrigation water is from a salt-intruded source (salty well, brackish canal, etc.).
Water Salts Tests Examples

- Two most important measures for determining irrigation water quality are:
  - Total amount of dissolved salts
  - Amount of sodium (Na) compared to calcium (Ca)
- Liming potential
  - Amounts of carbonates
- Salinity
  - fresh water $< 1500$ mg/L TDS
  - brackish water $< 1500$ to $5000$ mg/L TDS
  - saline water $> 5000$ mg/L TDS
UF/IFAS Water Quality Tests

- Water Tests by UF/IFAS Soil Test Lab for Irrigation Problems (including micro irrigation)
  - Ca, Mg, & Total carbonates
  - liming potential / plugging problems
  - hardness
  - Fe & Mn
  - foliage stains / plugging problems
  - staining, taste
  - Na & Cl
  - salt water intrusion, plant damage
  - salt water intrusion & landscape plant damage
  - Electrical conductivity
  - plant damage from high salt content
  - plant damage from high salt content
  - pH
  - corrosion potential / plugging
  - corrosion
  - Suspended solids
  - plugging problems
Salinity and Plant Water Availability

- **Nonsaline soil**: Available water
- **Moderately saline soil**: Available water
- **Highly saline soil**: Unavailable water

Plant wilts as water becomes unavailable in the soil.
**Water Quality Ratings**

- **Water Hardness (Ca + Mg salts only)**

<table>
<thead>
<tr>
<th>ppm Range</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-60</td>
<td>Soft</td>
</tr>
<tr>
<td>61-120</td>
<td>Moderately hard</td>
</tr>
<tr>
<td>121-180</td>
<td>Hard</td>
</tr>
<tr>
<td>&gt; 180</td>
<td>Very hard</td>
</tr>
</tbody>
</table>

**Salinity Assessment**

<table>
<thead>
<tr>
<th>Irrigation Water Quality</th>
<th>EC mmho/cm or dS/m</th>
<th>TDS ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>&lt; 0.25</td>
<td>&lt; 175</td>
</tr>
<tr>
<td>Good</td>
<td>0.25 – 0.75</td>
<td>175 – 525</td>
</tr>
<tr>
<td>Permissible</td>
<td>0.75 – 2.00</td>
<td>525 – 1400</td>
</tr>
<tr>
<td>Doubtful</td>
<td>2.00 – 3.00</td>
<td>1400 – 2100</td>
</tr>
<tr>
<td>Unsuitable</td>
<td>&gt; 3.00</td>
<td>&gt; 2100</td>
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# Water Quality & Crop Tolerance

<table>
<thead>
<tr>
<th>ppm</th>
<th>Sensitive</th>
<th>Moderately sensitive</th>
<th>Moderately tolerant</th>
<th>Tolerant</th>
</tr>
</thead>
<tbody>
<tr>
<td>980</td>
<td>almond</td>
<td>alfalfa</td>
<td>red beet</td>
<td>sugarbeet</td>
</tr>
<tr>
<td></td>
<td>apple</td>
<td>broccoli</td>
<td>safflower</td>
<td>cotton</td>
</tr>
<tr>
<td></td>
<td>avocado</td>
<td>cabbage</td>
<td>olive</td>
<td>date palm</td>
</tr>
<tr>
<td></td>
<td>bean</td>
<td>tomato</td>
<td>soybean</td>
<td>bermuda-grass</td>
</tr>
<tr>
<td></td>
<td>carrot</td>
<td>lettuce</td>
<td>wheat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>grapefruit</td>
<td>corn</td>
<td>ryegrass</td>
<td></td>
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<tr>
<td></td>
<td>orange</td>
<td>cucumber</td>
<td>wheatgrass</td>
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<td>grape</td>
<td>wildrye</td>
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<td></td>
<td>okra</td>
<td>peanut</td>
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<td>onion</td>
<td>potato</td>
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<td></td>
<td>strawberry</td>
<td>radish</td>
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<td></td>
<td>peach</td>
<td>rice</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>plum</td>
<td>sugarcane</td>
<td></td>
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</tr>
</tbody>
</table>

(adopted from Jensen, 1980)
“Water flows from high in the mountains
Water runs deep in the Earth.
Miraculously, water comes to us,
And sustains all life.

Water flows over these hands.
May I use them skillfully
To preserve our precious planet.”

Meditations by
Thich Nhat Hanh
Online Resources

• EDIS Publications on Irrigation Water Management
  http://edis.ifas.ufl.edu/topic_water_quality_and_quantity
  http://edis.ifas.ufl.edu/AE111
  http://edis.ifas.ufl.edu/HS388