Organic Vegetable Gardening
Frost Protection

Noontime Talks
Phillippi Farmhouse Market

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OUTLINE

- Overview of topics of nootime talks on organic vegetable gardening
- Introduction to organic vegetable gardening
- Basics of frost protection
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 11, 2012)
Topics of Noontime Talks for Organic Vegetable Gardening

- Composting – Part 2 (Feb 22, 2012)
- Irrigation (March 14, 2012)
- Beneficial Insects (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 vendor.
What is Agroecology?

• Recognition of the whole systems nature of food production

• Indicators of agroecosystem sustainability
  – Energy flow
  – Nutrient cycling
  – Population regulation mechanisms
  – Dynamic equilibrium

• Application and management
  – Identify the indicators in each system
  – Observe immediate and future impacts
  – Focus the search for alternatives or solutions to problems

Ecosystems and Plant Growth

Our model is the “ecosystem” w/ functional emergent properties & subsystems (e.g., nutrient cycling, etc)
How to Understand a Successful Organic Vegetable Garden Ecosystem
Organic Vegetable Garden Ecology

- Our model for organic vegetable gardening too is promote the “ecosystem” with functional subsystems from managed biodiversity.
Hierarchical Scale & Emergent Properties
What Is Organic Vegetable Gardening?
Organic Vegetable Gardening

• A science and art
• Incorporates the entire landscape design and environment to improve and maximize the garden soil's health, structure, & texture
• Maximizes the production and health of developing plants without using synthetic commercial fertilizers, pesticides, or fungicides

David Knauft, Horticulture Department, Univ. of GA
Organic Vegetable Gardening

• Differences to "conventional" gardening
  – mainly in the areas of fertilization and pest control
  – use natural and organic materials and methods
  – avoids using practices and synthetic chemicals that may be detrimental to his health or environment.

James Stephens, Horticultural Sciences Department, IFAS, Univ. of FL
http://edis.ifas.ufl.edu/VH019
Frost Protection: Basics

- Vegetable crop cold tolerance
- Frost/cold weather factors
- Strategies
  - passive (e.g., site selection)
  - active (e.g., row covers, water mgt)
First, Photos of Jan 5th Grand Opening of Englewood Community Garden

Location: Buchan Airport Community Park
1390, 1394 and 1398 Old Englewood Rd., Englewood, FL

http://www.scgov.net/parksandrecreation/Parks/BuchanAirport.asp
Vegetable Crop Cold Tolerance

• **Frost damage**
  - Low temperature (e.g. chilling and freezing) injury can occur in all plants, but the mechanisms and types of damage vary considerably among crops
  - Crops of tropical origin experience physiological damage when subjected to temperatures below about 54.5 °F (12.5 °C), hence well above freezing temperatures.
  - However, damage above 32 °F (0 °C) is chilling injury rather than freeze injury
  - Freeze injury occurs in all plants due to ice formation and damaged cells
Vegetable Crop Cold Tolerance

• **Frost temperature effects**
  - 31-33°F – will kill beans, cantaloupe, corn, cucumbers, eggplant, okra, peas, pepper, potatoes, sweet potatoes, squash, tomatoes, and watermelon
  - 26-31°F - may burn foliage but will not kill broccoli, cabbage, cauliflower, chard, lettuce, mustard, onion, radish, and turnip

• **Note:** cold tolerance depends on preconditioning, e.g., if broccoli has been growing in warm conditions & temperatures drop below 22 degrees F., it will be killed. If these same broccoli plants had experienced cool weather, they would probably survive the sudden cold
# Vegetable Crop Frost Damage

<table>
<thead>
<tr>
<th>CROP</th>
<th>SYMPTOMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artichoke</td>
<td>Epidermis becomes detached and forms whitish to light tan blisters. When blisters are broken, underlying tissue turns brown.</td>
</tr>
<tr>
<td>Asparagus</td>
<td>Tip becomes limp and dark and the rest of the spear is water soaked. Thawed spears become mushy.</td>
</tr>
<tr>
<td>Beet</td>
<td>External and internal water soaking and sometimes blackening of conductive tissue.</td>
</tr>
<tr>
<td>Broccoli</td>
<td>The youngest florets in the centre of the curd are most sensitive to freezing injury. They turn brown and give off strong odour.</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Leaves become water soaked, translucent and limp. Upon thawing the epidermis separates.</td>
</tr>
<tr>
<td>Carrot</td>
<td>Blistered appearance, jagged length-wise cracks. Interior becomes water soaked and darkens upon thawing.</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Curds turn brown and have a strong off-odour when cooked.</td>
</tr>
<tr>
<td>Celery</td>
<td>Leaves and petioles appear wilted and water soaked upon thawing. Petioles freeze more readily than leaves.</td>
</tr>
<tr>
<td>Garlic</td>
<td>Thawed cloves appear greyish yellow and water soaked.</td>
</tr>
</tbody>
</table>
## Vegetable Crop Frost Damage

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<tr>
<td>Lettuce</td>
<td>Blistering of dead cells of the separated epidermis on outer leaves, and become tan with increased susceptibility to physical damage and decay.</td>
</tr>
<tr>
<td>Onion</td>
<td>Thawed bulbs are soft, greyish yellow and water soaked in cross-section. Damage is often limited to individual scales.</td>
</tr>
<tr>
<td>Pepper, bell</td>
<td>Dead, water-soaked tissue in part or all of pericarp surface with pitting, shrivelling and decay follow thawing.</td>
</tr>
<tr>
<td>Potato</td>
<td>Freezing injury may not be externally evident, but shows as grey or bluish-grey patches beneath the skin. Thawed tubers become soft.</td>
</tr>
<tr>
<td>Radish</td>
<td>Thawed tissues appear translucent and the roots soften and shrivel.</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>A yellowish-brown discoloration of the vascular ring and a yellowish green, water-soaked appearance of other tissues. Roots soften and become susceptible to decay.</td>
</tr>
<tr>
<td>Tomato</td>
<td>Water soaked and soft upon thawing. In partially frozen fruits, the margin between healthy and dead tissue is distinct, especially in green fruits.</td>
</tr>
<tr>
<td>Turnip</td>
<td>Small water-soaked spots or pitting on the surface. Injured tissues appear tan or grey and give off an objectionable odour.</td>
</tr>
</tbody>
</table>
Crop Cold Protection - Temperature

USDA Plant Hardiness Zone Map
Crop Cold Protection - Temperature

USDA Plant Hardiness Zone Map for Florida

http://www.garden.bsewall.com/topics/hardiness/zone_9.htm

We are Here!

Zone 9
• While the winters are typically mild in Central Florida, there will usually be two or three frosts and some will last long enough to be a hard or killing frost.

• Central Florida is too hot and too cold. It is too hot for many of the plants that depend on mild summers and cold winters and too cold for many tropical plants that collapse with the first sign of freezing temperatures.

http://www.garden.bsewall.com/topics/hardiness/zone_9.htm
USDA Plant Hardiness Zone 9

• A schizophrenic climatic transition zone, neither tropical nor temperate, but some of each, and sometimes one or the other

• Experience that works in the tropics or even southern Florida and what works in cooler climates is largely irrelevant

http://www.garden.bsewall.com/topics/hardiness/zone_9.htm
Tampa Historical Crop Weather Dates

Growing Season: 338 days
First Frost in Fall: January 3
Last Frost in Spring: January 28

http://www.almanac.com/content/frost-chart-united-states
Tampa Historical Mean Temperatures
(1961-1990)*

Data source: NOAA
FL Mean Minimum Temperature (F) January

http://edis.ifas.ufl.edu/aa264
FL Average Day Number w/o Killing Frost

A--A  Killing frost liable annually
No record of killing frost below B--B

http://edis.ifas.ufl.edu/aa264
FL Average Date of Last Killing Frost

http://edis.ifas.ufl.edu/aa264
FL Average Date of First Killing Frost

A--A Killing frost liable annually
B--B Killing frost liable 1/2 the time
C--C Occasional killing frost
No record of killing frost below C--C

http://edis.ifas.ufl.edu/aa264
Florida Killing Frost Chronology

Timeline of Citrus Impact Freeze Events (a freeze so severe that it annihilates entire groves across the state, killing both mature and young citrus trees, while causing a profound economic impact on the citrus industry and usually prompting growers to replant farther south.

1835; 1894-95; 1899; 1917; 1934; 1940; 1957; 1962; 1977; 1977; 1981; 1983; 1985; 1989

Killing frosts have and will occur!

http://flcitrusmutual.com/industry-issues/weather/freeze_timeline.aspx
Frost/Cold Weather

Is freezing weather on the way?

- Be on the alert from late Nov. through March. Be prepared by mid-Nov.
- Jet stream pattern moving cold air from NW to SE.
- Low pressure system over the SE, around the Carolinas and W. Virginia.

- Large Arctic high pressure system - large cold air mass.
- Snow cover over mid-west and central US.
- A high pressure center just west of Minnesota.
- A high pressure center west of Tallahassee, FL.
Frost/Cold Weather

Is freezing weather on the way?

Jet stream

Snow cover

Cold air mass

ALASKA

H

Puerto Rico & Misc Stations

HAWAII

Copyright © 1995 by K. Steiner, Johns Hopkins University Applied Physics Laboratory
Frost/Cold Weather

Is freezing weather on the way?

- Cold high pressure systems which move out of Canada to the south. These systems cross the US-Canadian border anywhere from Montana to Wisconsin.
- They take 2-4 days to reach Florida.
- Normally we experience two days (nights) of freezing weather. The first night is usually an advective freeze and the second night an radiation freeze.
- Caution: both types of freeze may occur on the same night.
Frost/Cold Weather

Types of freezing weather

- **Advection freeze**es are freezes where a large cold air mass brings freezing and subfreezing temperatures to Florida. They are characterized by **windy** conditions.

- No inversion layer is established.
- The heat from all exposed objects is constantly removed by the windy conditions.
- Is a more difficult type freeze to protect trees from.
Advection is the transfer of heat in the horizontal direction.

The wind transfers heat by advection

Happens frequently on Earth

Two types:

- **Warm air advection (WAA):** wind blows warm air toward a region of colder air

- **Cold air advection (CAA):** wind blows cold air toward a region of warmer air
Frost/Cold Weather

Types of freezing weather

- Radiational freezes – occur when there is little or no cloud cover and little or no wind.

  Heat from all surfaces radiate to outer space - there is nothing to block the escape of heat waves from the earth’s surface.

- A temperature inversion (TI) may occur during a radiational freeze.

  Warmer air (usually 30-50 ft up) layer exists above a cold/freezing layer of air along the ground.

  When there is a difference of at least 5 degrees between these layers, mixing them can raise the air temperature.
Frost/Cold Weather

• **Radiation** allows heat to be transferred through wave energy called **electromagnetic waves**

• All things with a temperature above absolute zero emit radiation

• The wavelengths of the radiation emitted by an object depends on the temperature of that object (i.e., the sun mainly emits radiative energy in the visible spectrum, and the earth emits radiative energy in the infrared spectrum).
Frost/Cold Weather

Radiation freeze

Mix air layers by wind machine or helicopter

Warm air mass, 38°F

Cold air mass, 24°F

Ground surface
Frost/Cold Weather

Rules of thumb and what to watch for...

- In advance of predicted cold weather we experience one or may days when the temperature does not exceed 65°F.
- Days when the temperature is at or below 60°F at 3:00 PM or earlier in the afternoon.

- We experience 2 or more days and/or nights of cold but nonfreezing weather, especially if they are accompanied by wind.
- Snow cover over the northwest, midwest, and middle US.
- The forecast calls for a low night-time dew point temperature below 30°F or less.
Frost/Cold Weather

Other rules of thumb...

- Record low temperatures are reported for the midwestern US states.
- Winds at the surface (low level winds) are blowing from the north-northwest.
- Florida is the predicted target of a cold high pressure system.

- A fair estimation of the lowest temperature can be estimated by subtracting 20 degrees off the air (°F) temperature taken at sunset.
- The predicted night time dew point low is a fair estimate of the lowest temperature (caution: dry air may cause dew points to fall further).
Online Crop Weather Resources

- Florida Automated Weather Network (FAWN)
  - freeze warnings and email alerts
  - temperature data and forecasts

http://fawn.ifas.ufl.edu/
Strategies: Site Selection Factors

• Environment and Natural Resources
  – Temperature
  – Soil type, depth, and texture
  – Rainfall and access to water

• Cultivar selection and planting dates

• Planting in the garden and/or home landscape
Homestead Site Temperature Factors

- The warmest to coolest sides adjacent to your home are generally the south, west, east, and north.

- The warmest and coolest locations in the landscape are similar.

- In general, the tops of slopes are warmer than the lower areas in your landscape. **Note**, even a few inches can make a difference.
Homestead Environment Example

Site selection - temperature

- Warmest areas
- South
- West
- Moderately warm area
- North
- Coldest area
- East
Strategies: Windbreaks

• Fences, buildings, and temporary coverings, as well as adjacent plantings, can protect plants from cold winds.

• Windbreaks are especially helpful in reducing the effects of short-lived advective freezes and their accompanying winds.

• Injury due to radiational freezes is influenced little by windbreaks. The height, density, and location of a windbreak will affect the degree of wind speed reduction at a given site.

http://edis.ifas.ufl.edu/mg025
Strategies: Windbreaks

• Planting recommendations:
  – Plant on northside of garden area or typical direction of cold front winds
  – Trees
  – Shrubs
  – Tall grasses

http://edis.ifas.ufl.edu/fr253
Strategies: Plant Windbreaks

http://edis.ifas.ufl.edu/fr289
Strategies: Row Covers

- Row covers are flexible, transparent or semitransparent materials used to enclose single or multiple rows of plants so as to enhance crop growth and yield by increasing soil and air temperature and reducing wind damage.

- Two major types of row-cover materials: polyethylene and porous, floating, nonwoven materials.

- Row covers provide canopy over vegetable crops that can reduce cold injury caused by radiational freezes.
Row covers can be anchored with bricks, boards, rebar, soil...

‘Low Tunnel’ Design
Strategies: Floating Row Cover

Jessica’s Organic Farm, Sarasota, FL

http://edis.ifas.ufl.edu/cv201
Strategies: Vented Plastic Covers
Row cover weight

• Light
  – Excellent light and water transmission
  – Pest exclusion
  – Little frost protection
  – Tear easily (single season use)

• Medium
  – Good light transmission (75-85%)
  – Good frost protection
  – Durable (several seasons)

• Heavy
  – Poor light transmission (50%)
  – Excellent frost protection
  – Very durable (4+ years)
Strategies: Vented Plastic Covers
Strategies: Cloche Covers
Strategies: Soil Water Mgt

• **Use Your Soil As A Heat Reservoir**
  - Irrigate before the frost - a moist soil can hold 4 times more heat than a dry soil.
  - A moist soil will conduct heat to soil surface faster than a dry soil, aiding in frost prevention.
  - A more compacted soil, typical of a field near the end of the season, will lose heat more quickly to the air, protecting the plants from frost. The bottom line - do not cultivate when a frost threatens.

Strategies: Soil Management

- **Enhance Your Soil Potential As A Heat Reservoir via Watering**
  - ✓ Increase organic matter of soil with regular compost additions & cover cropping
  - ✓ Soil organic matter increases water holding capacity
  - ✓ Range of values
    - • Temperate soils have higher OM levels (5-10%)
    - • Tropical soils generally have 0.5-1.0% (e.g., FL upland soils in native condition)
Strategies: Crop Water Mgt

- **Cold protection**
  - ✔ mist and overhead foliar watering
  - ✔ evaporative cooling (ice formation = heat transfer to plant)
Citrus Production Example

• An orange crop is destroyed if temperatures drop below freezing for a few hours.
• To prevent this, farmers spray water on the orange trees. Why?

• When the temperature drops below 32°F, liquid water freezes into ice.
• This liquid to solid phase change causes energy to be released to the fruit.
• Thus, the temperature of the orange remains warm enough to prevent ruin.
Strategies: Mulching

✓ Soil Benefits:
  • Cooling
    – Reduce high soil temperatures
    – Especially for cool season crops
    – Usually loose materials as hay, chips, dry grass clippings, leaves
  • Heating
    – Warm soil to critical growth temperature
    – Usually black or clear plastics
      • Black plastics raise soil temperatures = 5 degrees
      • Clear greater impact

✓ Frost Management:
  • Temporarily remove mulch to promote soil water heat release for aboveground plant protection
Sources of Mulch

- Newspaper/wheat straw
- Pine straw
- Hardwood mulch
- Chopped leaves
- Plastic
- Cover crops
If anything can protect that plant against the frost, it's my wife's best coat.

from
CHRIS MADDEN