Extending the Season

"Allows you to get the garden started earlier in the spring and prolong the harvest in the fall, or even compress the season."

Catherine Wissner
University of Wyoming
Cooperative Extension Service
Laramie County

Definition: Tunnels and Hoop houses

- "Although resembling traditional plastic –covered greenhouses, use a different set of growing technologies.
- In their purest form, they are considered nonpermanent structures because they lack electrical service or automated ventilation or heating systems.
- Tunnels are typically covered by a single layer of plastic …They can be used as season extenders in colder climates or as protection from the elements in warmer areas. "
- Karen Panter, PhD, University of Wyoming, Extension Horticulture Specialist. Hort Technology January-March 2009.

High Tunnel 26′ x 48′

Planted 2nd week of June. What it looked like the first week of July.

Last week of August.

High Tunnel 26′x48′

Third week of September.

High Tunnel 26′ x 48′

- Production numbers for that season ending late September early October:
  - Tomatoes total: 194.8 pounds.
  - Cucumbers total: 259 pounds.
  - Watermelon total: 18 fruits/ 67.5 pounds.
  - Peppers:
    - Ancho: 70
    - Jimmy Nardelo's 100 plus
    - Pimentos 30
    - Green Bell 39

Planning Your Greenhouse

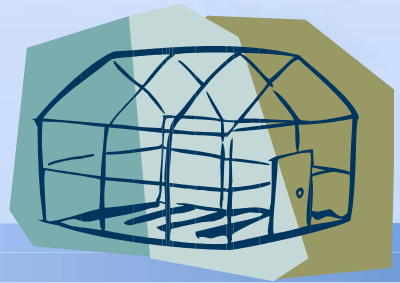
- **What will you be growing?**
- Size of your greenhouse?
  - measure first, build second.
- Location…do a site analysis.
- Water Quality. Have your water tested.
- Construction method, build your own or a kit.
- Style of greenhouse, many to chose from.
- Type of covering do you want? Plastic, glass, Poly.
- Greenhouse Insurance.

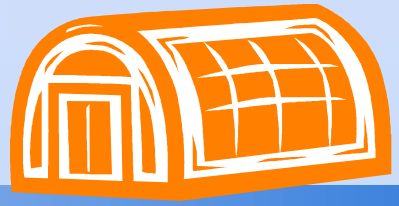
Planning your Greenhouse

- Size.
  - Tomatoes require from 4 to 5 square feet area per plant, outside.
  - Cucumbers require from 8 to 10 square feet area per plant outside.
    - BUT….Go vertical in stead of on the ground.
  - Get the biggest structure you can afford, will fit the site, fit your needs now and in the future.

Greenhouse Structures

- Frame types:
  - Wood (cedar), Aluminum or Galvanized Steel, PVC pipe are all possible materials.
  - The frame *must* withstand snow, wind, and live loads.
- Greenhouse styles are:
  - Peak roofed, Quonset style, Hoop house, Lean to Gothic Style, High Tunnel, Low Tunnel.

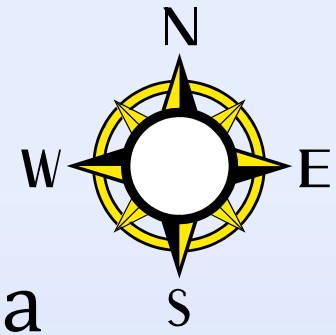




Getting Started

Location (in a perfect world)

•Single greenhouse with long axis facing south to south east.



Zoning are building permits needed? Is a greenhouse allowed in your neighborhood?

Getting Started - Cost

- Cost
- Very simple homemade hoop house $1/sq ft +/-.
- Tunnels or over-wintering structures without heat $2/sq. ft +/-.
- Basic greenhouse $6/sq. ft +/-.
- State-of-the-art greenhouse $10-15/sq. ft. +.
- PVC $3.50/sq. ft. (2015 prices)

Types of Materials - Covers

- Covering types are:
- Glass, which is very expensive and hard to maintain.
- Fiberglass, very flammable, can yellow, susceptible to hail damage, gathers dirt and debris and decays quickly.
- Acrylic, however, is very flammable but resistant to breakage.
- Polycarbonate or Lexan, can have a 10-year life span, easy to use for retrofitting a glass covered greenhouse, UV resistant and has a high impact resistance.
- Polyethylene film, major film used in U.S., UV inhibitor. Double thick to prevent heat loss and layers can be inflated.

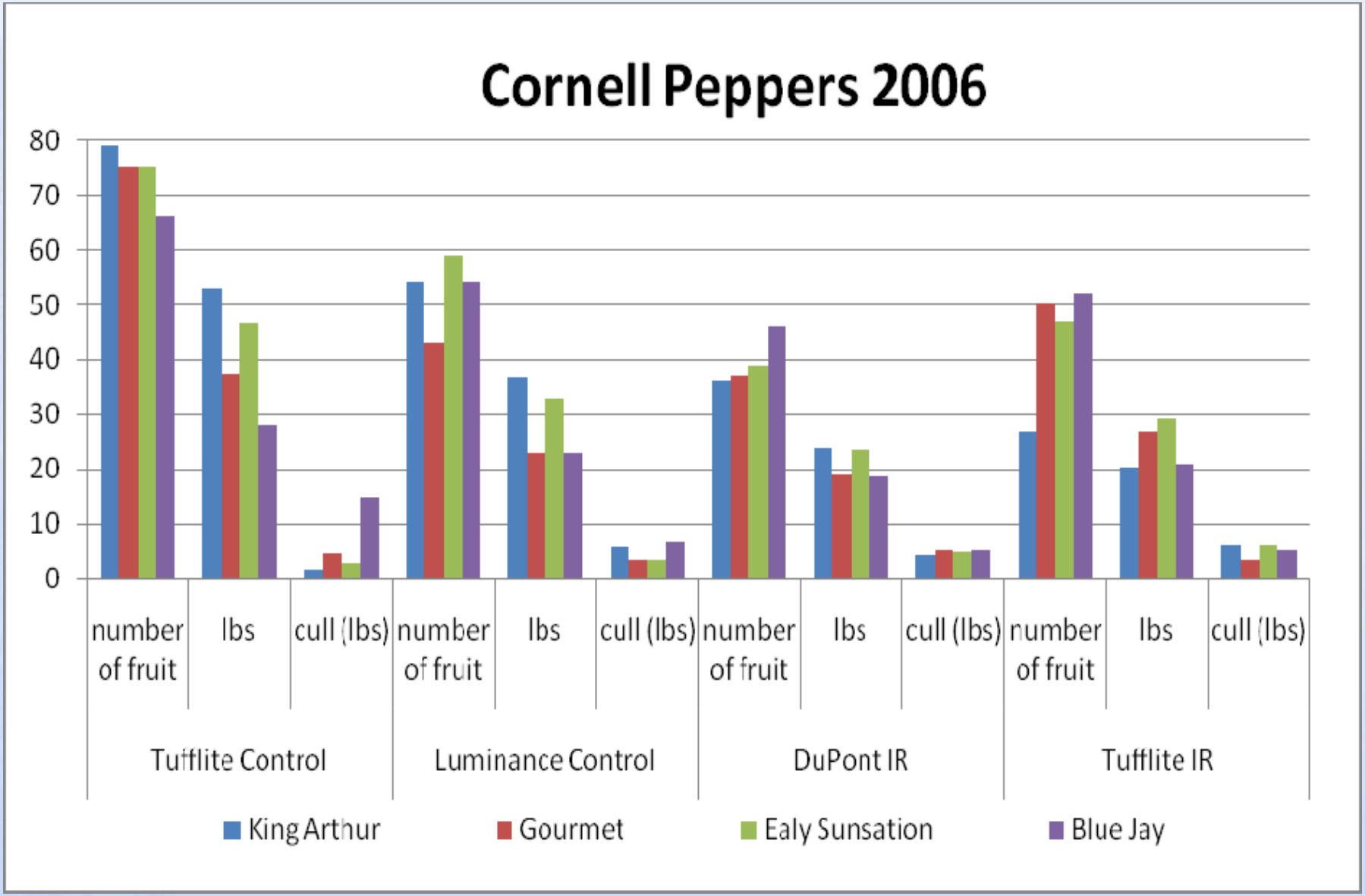
Types of Materials – Covers -Cost

- **Greenhouse Glass**
  - double strength.
  - $2.40 per square foot (fall 2008).
- **Twin Wall Polycarbonate Panels**
  - typically will have UV protection on the top side.
  - Typically have a 10 year warranty.
  - About $64/ 4'x6' panel (2015 gemplers).
- **Polyethylene film 6 mil**
  - 4 to 6 year use *with* UV protection.
  - Around $.15 to $.74/linear foot & depending on width (winter 2015 greenhouse maga store).

Covers

- Different poly covers allow different levels of light in.
  - Tufflite IV DuPont IR
  - Solarig 172 Luminance THP
  - How the plastic spreads the light onto the plants leaves can effect the growth.
  - Can also effect what the plant needs for N-P-K.

- **PENN STATE HIGH TUNNEL PLASTIC STUDY 2007-08,** Catie M. Rasmussen and Michael D. Orzolek
- Horticulture Department, Penn State University


Cornell Peppers 2006
80
70
60
50
40
30
20
10
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number of fruit
lbs
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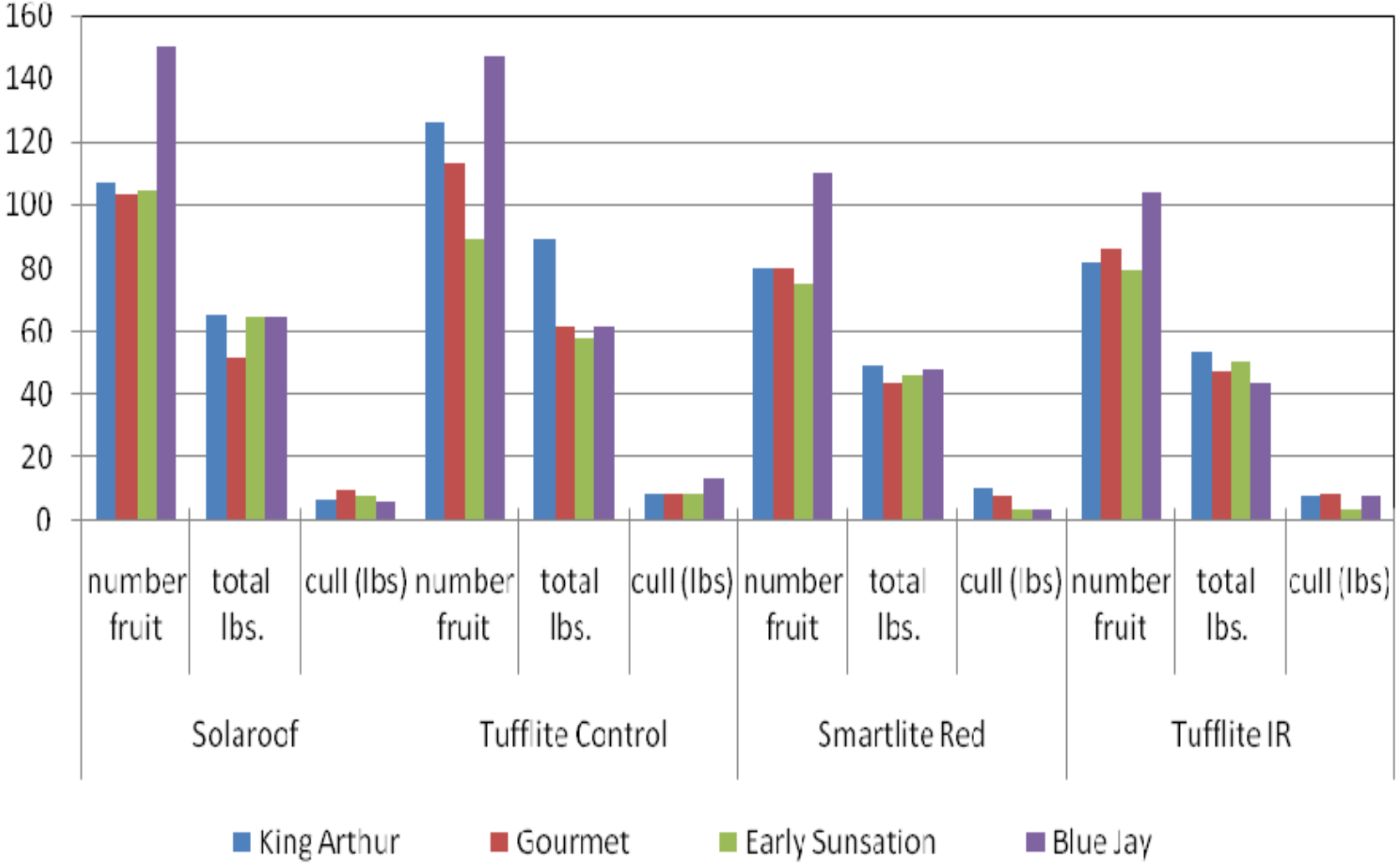
Tufflite Control
Luminance Control
DuPont IR
Tufflite IR
King Arthur
Gourmet
Ealy Sunsation
Blue Jay

Cornell Peppers 2007



Growing media for Containers

- pH for soil should be 5.5 to 7.
- Potting soil and any containers must be clean.
  - A known source of both.

  - Soil buffers pH, salt and fertilizer problems, where soil-less media does not.
  - Planting deeper is better than shallow; never pack the media into the container.

Water Quality is Key

- Water should be tested; pH 5-7, salts <.5.
- What is the source of the water? city or well?
- City of Cheyenne water pH of 8.
- Avoid soft water, removes cations (Calcium, Magnesium, Ammonium, Manganese, Iron) and replaces it with anion sodium and or potassium.
- Water treatment; reverse osmosis is the best.

Desirable Water Test numbers

- **EC <0.5 dS**
- **pH 5.0 to 7.0**
- **Alkalinity 40-100 ppm**
- Nitrate <5 ppm,
- Magnesium <24 ppm, Ammonium (N) <5 ppm, Phosphorus (P) <5 ppm, Potassium (K) <10 ppm, Calcium <120 ppm, Sulfates <240 ppm, Manganese <2 ppm, Iron <5 ppm, Boron <. 0.8 ppm, Copper <0.2, Zinc <5 ppm, Aluminum <5 ppm, Molybdenum, <. 02, Sodium <50 ppm, Chloride <140 ppm, Fluoride <1 ppm.

Watering

- It is better to keep the plants a little bit on the dry side. 
- Humidity should be kept as **low** as possible.
  - excess humidity breeds insect and disease problems.
  - *The dryer your greenhouse the healthier your plants.*

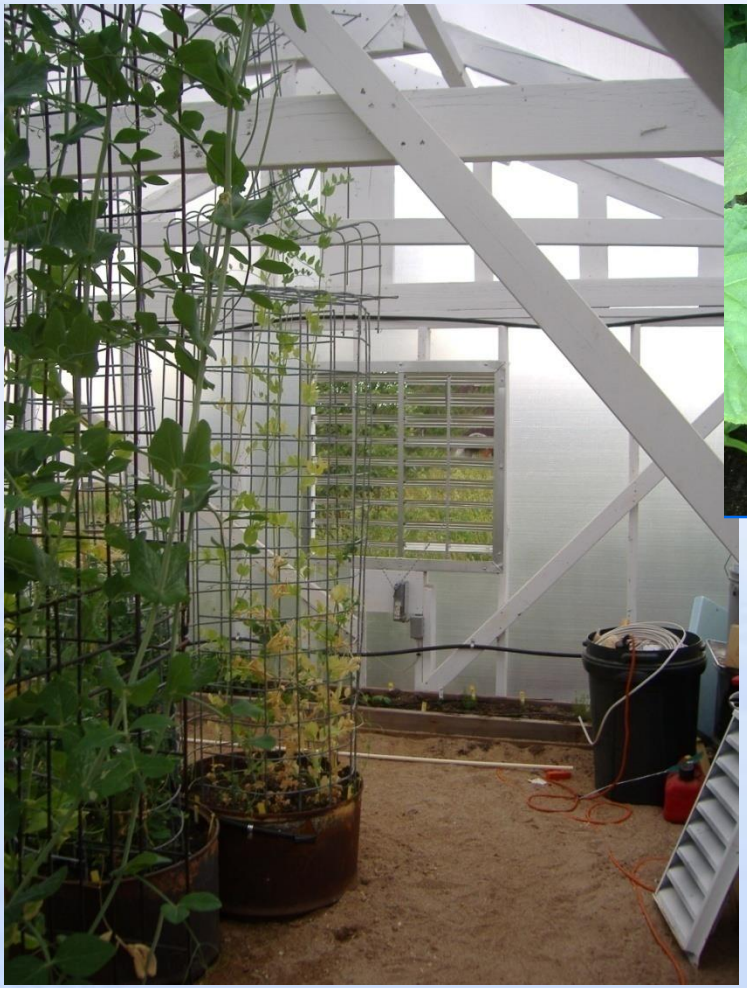
Watering

- Watering methods:
  - micro tube.
  - drip tape.
  - Over head sprinkler (avoid).

Watering

- Drip System.

Micro drip tubes



Fertilizers - plants under plastic

- Nitrogen: higher levels can create soft fruit, more foliage and fewer fruit.
- Potassium: levels too low = yellow shoulders gray walls, hard fruit, white internal tissues.

Steve Bogash, Penn State University.

- Leaf tissue test best for determining what is needed for an efficient fertilizer program.
- CSU lab 970.491.5061

Fertigation
(injected into the system)

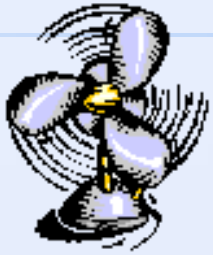
More efficient use of water, time and fertilizer.

Cooling

- The big challenge

Minus 10 degrees outside what is the temperature inside?

Environmental Controls-Cooling



- What is the cooling system?
  - Shade cloth, fan-jet, pad-fan, swamp coolers, **roll up sides**, top vents, box fans.
- If air circulation is active cooling such as horizontal airflow fans or vertical air fans, then the electricity needs to be considered.

Box fan w/shutters or Utility fan

Environmental Controls-Heating

- Is this going to be a year round greenhouse?
- **If yes**, then what is your heating source?

- **A word of caution** regarding a propane heated greenhouse.

  - incomplete combustion produces Ethylene gas and has the potential to wipe out certain vegetable crops (tomatoes).

Energy Conservation

- Consider insulating the north wall on a south facing greenhouse.
- Thermal screens (bubble wrap) for winter conservation.
- Sealing out air leaks around doors and coverings.
- Windbreaks on the west and north side to reduce wind impact.
- 55 gallon drums painted black, filled w/water.

What is needed in the Greenhouse?

- Floors, benches, workspace, staging area, a place to sit, climate control panel. (heating and cooling), lighting, and coffee maker.
  - Plan your space before you plant.

Diseases and Pests

- Greenhouse Disorders can be brought on by:
  - to cold, too hot, too humid, soil, pH, salt, water quality, fertilizer (do not use miracle grow) and pesticide misuse, in any combination.

- Correcting the above brings on disease controls.

Disease 

- Three major problem areas:
  - Fungi.
  - Bacteria.
  - Viral.

Fungi

- Fungi use their enzymes to break down plant cells and absorb nutrients.
- One major greenhouse fungus is Botrytis spp. A grey fuzzy “mold”, which likes high relative humidity, low temperatures <60, water on leaf surface and plant wounds.

Fungi

- Powdery Mildew.
- May be the number 1 greenhouse pest, it likes high relative humidity and plants under stress.
- Integrated pest management (IPM) solution is: proper fertilization, water correctly, low humidity and increased air circulation.

Bacteria

- Bacteria plant infections enter through wounds on the plant.
- Transmitted via tools.
- Avoid over watering.
- IPM solution involves good sanitation, watering and reduced plant stress.

Viruses

- Viruses are an obligate parasite (needs a host plant or insect).
- Yellow spots on leave, yellow rings/circles, mosics are all symptoms.
- They act systemically, affecting the whole plant.
- The plant must be destroyed.

bad bugs

Aphids

- Approximately 4,000 aphid species in the world.
- Yellow sticky cards to monitor.
- Biological control agents; green lacewings, aphid midges, parasitic wasps and lady beetles.
- Fungus *Beauveria bassiana,* insecticidal soap, horticultural oil, and Neem oil.

Mealy Bugs

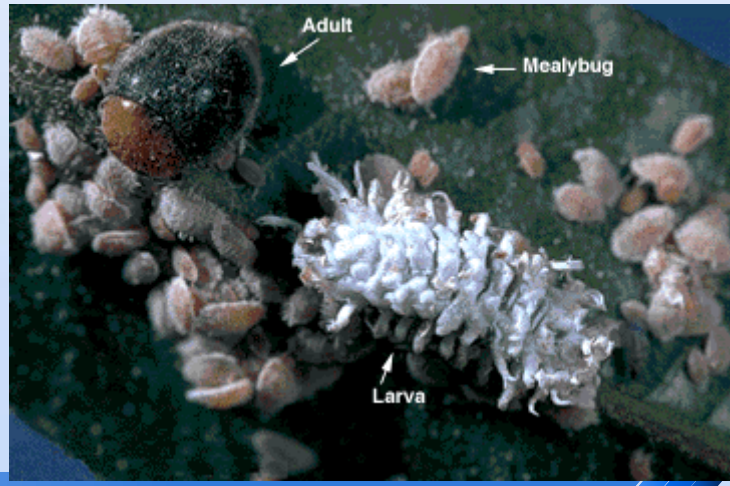
Difficult to Control, feed on leaves, roots and shoots of plants.

•Horticulture Oil, Neem Oil, soaps.
•Lower Temperature reduced humidity

•Mealybug destroyer, Cryptolaemus montrouzieri (lady beetle relative)
•Green Lacewing larvae (Chrysoperla sp.).

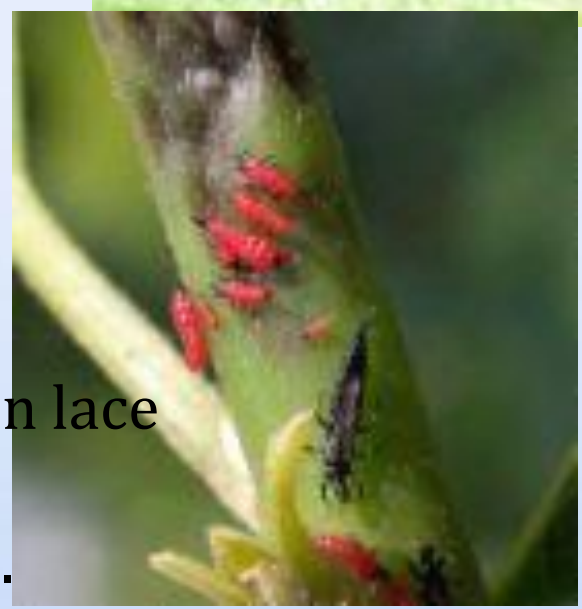
Long Tailed Mealy Bug

Mealy Bug Destroyer



Thrips

Like tight spaces, flower buds, or underside of leaves.
Sucking mouth parts, can fly.
Transmitter of viruses



Sticky Blue cards to monitor.
Neem Oil.
Predatory insects like: minute pirate bugs, green lace wings.
Reduce Nitrogen Fertilizer, Increase ventilation.

UC Davis http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7429.html

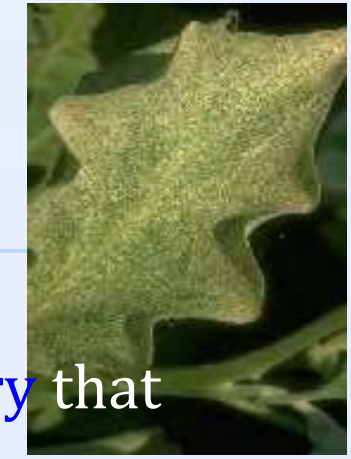
White Flies

- Like warm and humid environments.
- Suck phloem sap. Large populations can cause leaves to turn yellow, appear dry, or fall off plants. Excrete honeydew.
- Yellow Sticky Cards to Monitor.
- Parasitic Wasp Encarsia Formosa.
- Aluminum foil can repel.
- Insecticidal soap or an insecticidal oil.

Fungus Gnats

- Like Wet soil with organic matter.
- Larvae of these flies feed on roots, stunting plant growth.
- Can spread plant pathogens.
- Keep plant on dry side.
- Bacillus thuringiensis, isrealensis.
- Potato pieces.

Spider Mites



- Dry conditions greatly favor all spider mites.
- Drought stress can produce changes in their chemistry that make them more nutritious to spider mites.
- Horticultural oils; "Sun Spray" or -Ultra Fine Oil". The oil coats the insect, evaporates, and leaves a thin coat of parafin.
- Improve air circulation.
- Predatory mites works well if you have an existing infestation, that have not been treated with any chemicals to which they are sensitive.
  - Predatory mites need higher humidity to survive.
  - http://www.nysaes.cornell.edu/ent/biocontrol/predators/mitintro.html

Minute Pirate Bug

Pesticides

- Last Resort. 
- Any commercial pesticide used in a greenhouse, **must** be labeled for such use.
- **Neem Oil is best choice for insect control in a greenhouse situation.**

Integrated pest management (IPM)

- The best solution in the greenhouse.

RULES

RULE # 1

- "There are several management strategies, but by far the most successful is to increase air circulation."*

  - Increase air circulation, decrease humidity.

*Laura Pickett Pottroff, Karen L. Panter, Hort Technology January-March 2009, pg 63.

RULE #2

- Sanitation is everything in a greenhouse

- Don't leave dead plant all season.
- Don't let weeds grow.
- Used pots, tools, equipment, pruning shears must be cleaned before use.
- Disease is brought in via plants, soil, people, air, insects and equipment.

RULE #3

- Inspect new plants before they go into your greenhouse.

RULE #4

- Not all fertilizers work in a greenhouse situation.
- Read before you use any.
- Do Not Use Miracle Grow.
- Make your own!

RULE #5

- If planting direct into the soil like in a high tunnel.

- Do not use manures or high salt fertilizers.

Fertilizers - Manures

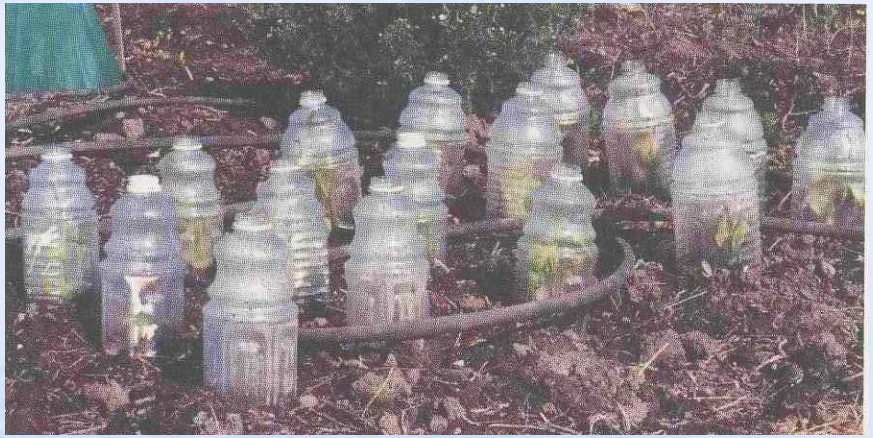
- Don’t use manure based compost or cow/sheep.
- EC level is unknown.
- Levels of NPK are unknown, may be high enough to damage plants.
- E-coli, Salmonella, Listeria.
- Weed Seeds.
- Tetanus.
- Soil born Bacteria and Fungi problems.

Extending the Season

Some Ideas

Extending the Season

- Cloches, clear glass or plastic for one plant.
- Miniature greenhouse.



Extending the Season, nothing fancy.

Raised bed low tunnels

Extending the Season

- What I have found in Cheyenne stores.

4 x 4 x 6 pop up

Light weight 6x6 plastic

Extending the Season

- What other people are doing in Laramie County.
- Greenhouses **with** electricity.

8 x 10 Greenhouse at 7,500'

8 x 10 Greenhouse

Greenhouse 8′ x 12′

8 x 12 Greenhouse

Greenhouse West of Cheyenne 7,200′

Raised beds, covered, hidden watering system.

July 7

Summer & Winter Squash harvest August 30.

Total Yield for 2008:
175 pounds of Winter Squash.
300 pounds of Summer Squash.

http://www.frugal-living-freedom.com/build-your-own-greenhouse.html

Chicken coop greenhouse

Chicken coop greenhouse

Chicken coop greenhouse

Greenhouse One watering system

July 7, 2008

Future heating system

Greenhouse North of Cheyenne

Greenhouse north of Cheyenne

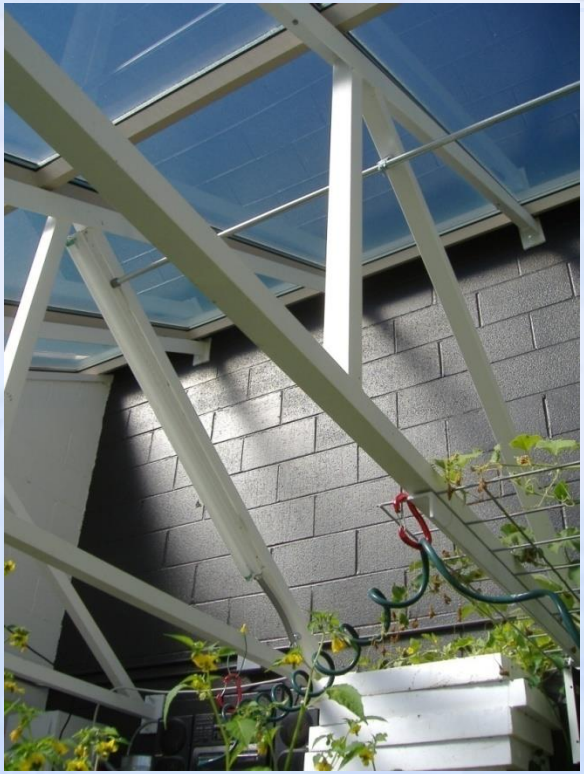
Greenhouse west of Cheyenne at 7,500′

Greenhouse west of Cheyenne at 7,500'

Greenhouse west of Cheyenne at 7,500′

Glass Greenhouse West of Cheyenne 7,800′

Glass Greenhouse West of Cheyenne 7,800′



2nd week of September

- Greenhouses and High Tunnels without electricity.

Flexible Cattle panel hoop-house 10′ x 20′

Flexible Cattle panel hoop-house 10′ x 20′

Flexible Cattle panel hoop-house 10′ x 20′

PVC Hoop house 10′ x 18′

PVC Hoop house

Early Summer first year

PVC Hoop house

Summer 2nd year

PVC Tunnel
10′ x 24′

PVC Tunnel 10'x24'

PVC Tunnel 10 x 24'

PVC Tunnel, July.

Fiberglass Greenhouse

Fiberglass Greenhouse

high tunnel 14′ x 20′

high tunnel 14′ x 20′

Murphy's Law

- As soon as you plant your greenhouse you will out grow it. So….
- Get the biggest structure you can afford and will fit the site.

High Tunnel 26′x 48′

High Tunnel 26′ x 48′

July 10.

High Tunnel 26′x48′

Third week of September.

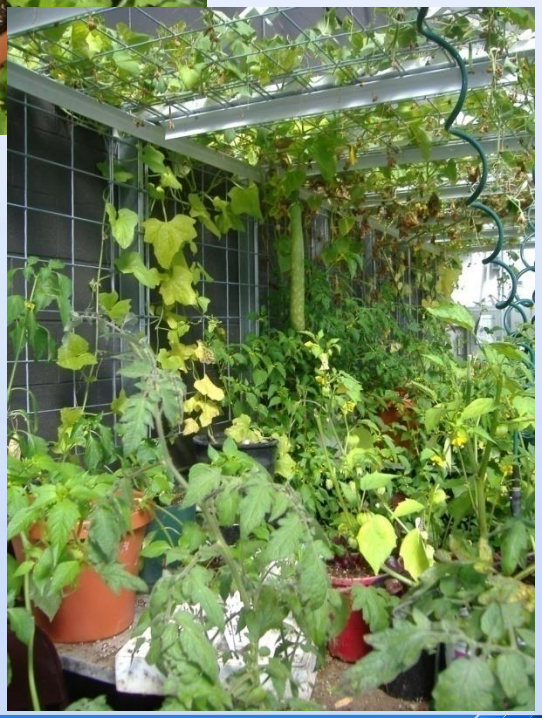
- Growing Methods, different approaches

Growing methods

Growing methods

keeping the coconut coir fiber too wet can create a series of root problems.

Growing Methods

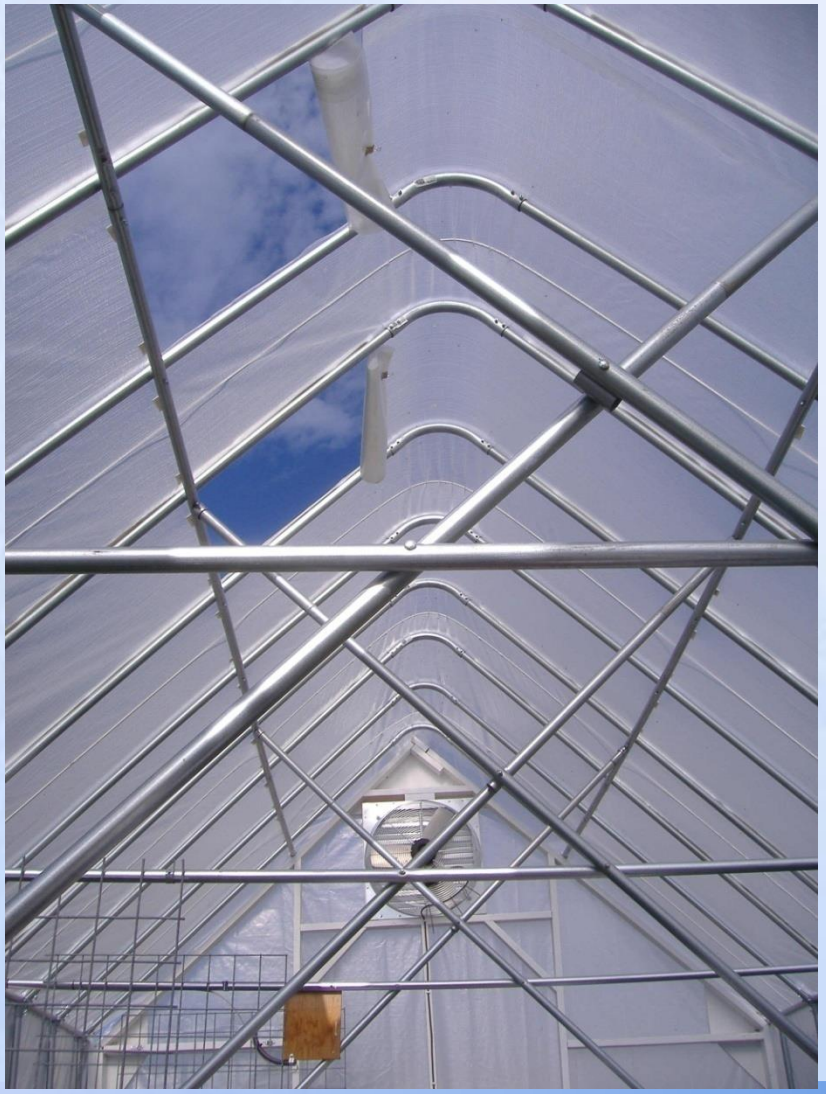


Growing Methods

Black plastic

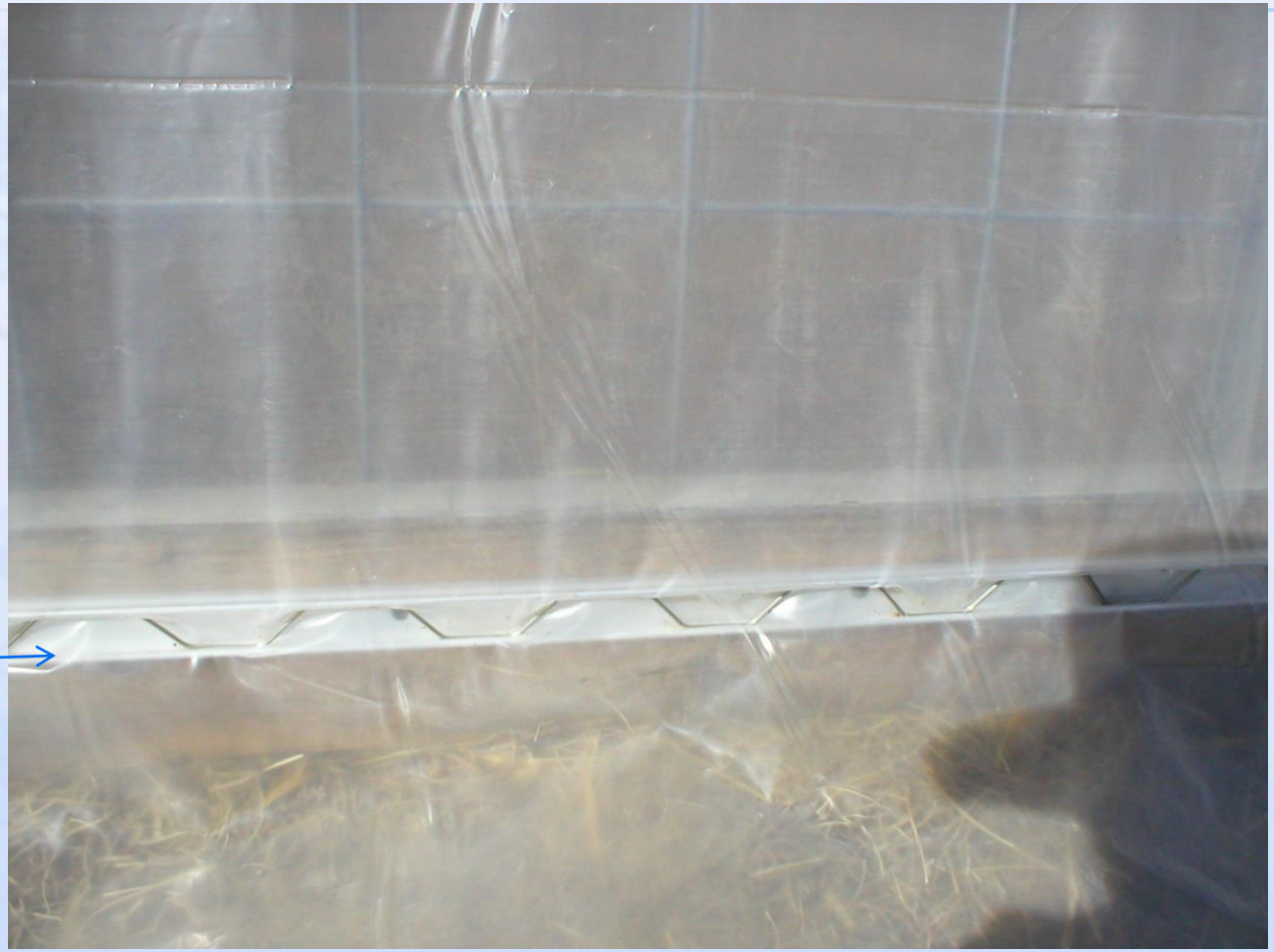
Construction details

Construction details

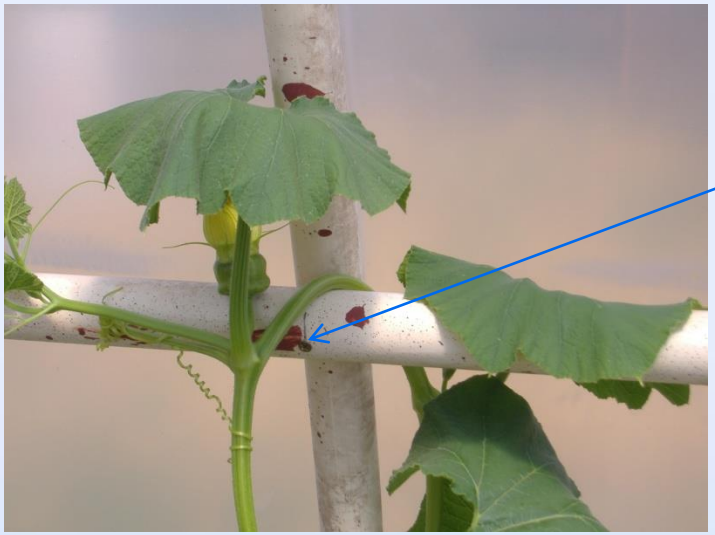


Construction details

Wiggle Wire holding down 6 mil plastic film.



Construction Details



Construction details

Construction details

Construction details

Construction details

Creature Comforts

Creature comforts

Hydroponics

- There is **NO** room for error;
  - On water quality, fertilizer, pH, or additives.
- Plant media is critical.
  - Rockwool, Coconut Coir, Perlite/Vermiculite, Oasis Cubes, Hardened Clay (like small pea gravel).
- Fertilizer type is critical.
  - Miracle Grow **does not** work.
- Sanitation is critical.

However:

- Helen Aquino, Village Farms, 232 acres of hydroponic greenhouses in north America. http://www.villagefarms.com
- “Pound –for- pound we can produce the same amount on 50 acres under glass as 1,500 acres outside.”
- Vegetable growers news, February 2011 issue page 39.

Nature Fresh Farms in Leamington, Ontario

- Has 225 acres under glass/hydroponic.
- 1,500,000 cartons of Beefsteak tomatoes are expected to be harvested in 2012 from their 32-acre greenhouse facility.
- Sweet colored bell peppers, cluster tomatoes, specialty tomatoes, seedless cucumbers, baby seedless cucumbers and eggplant,
- They are a full line supplier of greenhouse produce."

Many Thanks to Karen Panter PhD at UW.