Under Cover Veggies

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Definition: Tunnels and Hoop houses

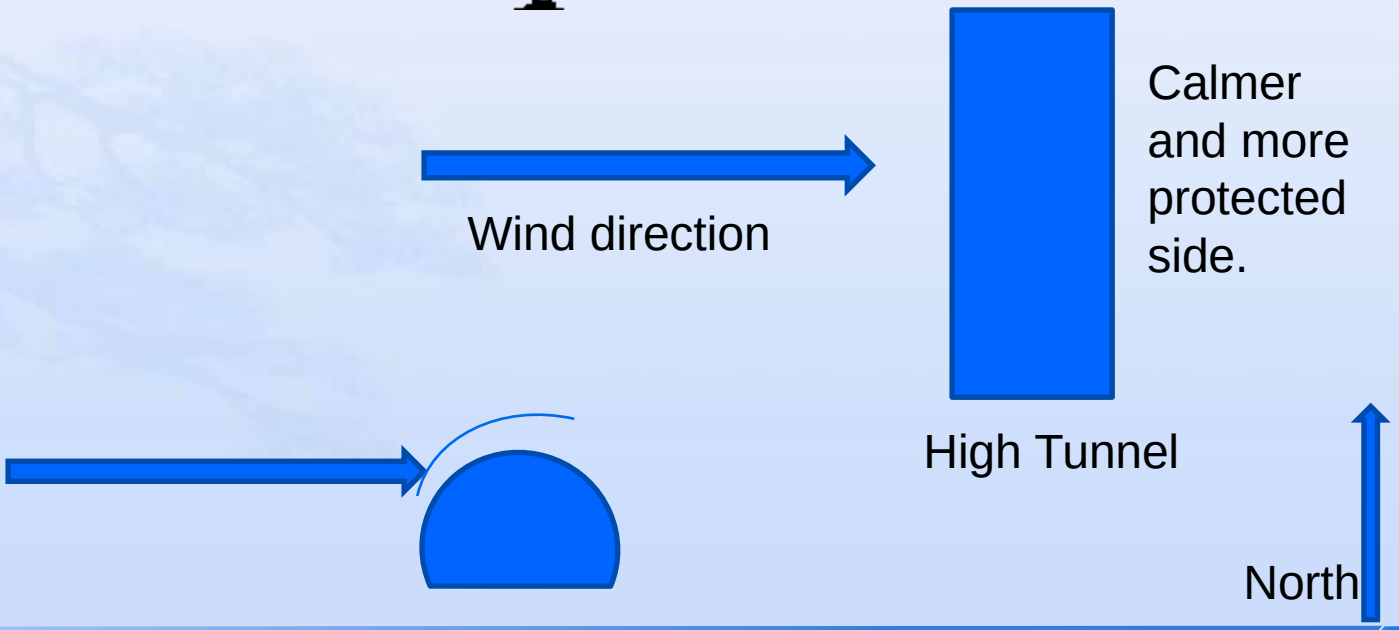
- "Although resembling traditional plastic – covered greenhouses, *use a different set of growing technologies.*
- In their purest form, they are considered nonpermanent structures because they lack electrical service or automated ventilation or heating systems.
- Tunnels are typically covered by a single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

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.
- Type of covering do you want? Plastic, glass, Poly.
- Greenhouse Insurance.

Location

- High Tunnel perpendicular to the prevailing winds for ventilation.



Greenhouse Structures

- The frame *must* withstand snow, wind, and other live loads.

Types of Materials – Covers -

- **Polycarbonate Panels**
  - Typically will have UV protection on the top side.
  - Typically have a 10 year warranty.
  - Best for end-walls.

  - **Glass**, risk of breakage during weather events.

Covering

- **Polyethylene film**
- **6 mil** 95% light transmission
  - Four to six year use with UV protection.
- **12 mill**, clear, woven fabric at 82% light transmission, longer life more durable handles heavy wind better.
- Six to Seven year life span.

Getting down to growing in the HT

What you do or don’t do will have an affect on your production.

General Myth Busting.

Myths and Pollination in HT

- Temps above 95 degrees decreases viability of pollen.
- Boron and or Nitrogen: excess or defiency results in poor quality pollen.
- Need pollinators with flowers when they are 5-10% opening.
- Neem Oil is a <u>non-selective</u> pesticide.

Bees in a Tunnel

- Honey bees just die in a tunnel.

- Best Bees for the Job.
  - Native
  - Bumble Bees

Soil in High Tunnels

- High Tunnel fertilizer recommendations not developed yet.
- What works outside can be very damaging inside a High Tunnel!
  - No manures ever.
- A more Holistic approach to soil management.

Testing

- Leaf tissue test best for determining what is needed for an efficient fertilizer program.
  - Develop a fertilizer plan.
  - Keep records.
  - Spring to fall requirements.
  - Local Labs to your area are the best.

Nitrogen - N

- Nitrate Nitrogen NO3-: more compact slow growth.
  - Can increase soil pH
- Ammoniacal NH4+ and Urea Nitrogen: lush soft fast growth.
  - Can lower soil pH and increase insect problems.
- Nitrogen: higher levels can create soft fruit, more foliage and fewer fruit.

- Cover Crop; 20% of organic Nitrogen source is used the first year
  - Plant use should be equal to application rate.
- Tomatoes can remove 15-30 pounds of N per acre per season.
- Matt Klenhenz OSU http://hcs.osu.edu

Phosphorus P

- Needed for roots, flowers and fruit development. But……
- Extremely high levels of P in soil can cause zinc deficiency in various crops.[1]
- Can increase soil pH over time.
- Excess can cause vegetable to be bitter.
- Vegetable typically remove 10-15 pounds of P per acre per season. [2]
- Needs Nitrogen to work best.

Potassium "K"

- Balanced with Nitrogen 1:1 = thicker stouter stems.
- Color and flavor to fruits.
- Cold and drought tolerance.
- Caution: Levels too high = soil salt problems.
- levels too low = yellow shoulders gray walls, hard fruit, white internal tissues of tomatoes.[1]
- Activates more than 60 plant enzyme systems. [2]

Potassium K

- Optimum potassium (K) level in soil is 3% to 5%.
- Too much can result tie up phosphorus, calcium and magnesium.
  - The combination of low magnesium (less than 6%) and excessive potassium can result in calcium deficiency problems in tomato, pepper, celery, cauliflower, melons and cucumbers.[1]

Organic Matter

- Because of higher temperatures (soil and air) under plastic - organic matter decomposes faster compared to field soil (1.5 to 3.0% loss).

- Dr. Mike Orzolek, Dept. of Horticulture, Pennsylvania State University

Organic Matter

- After harvesting each crop grown direct in the soil and before establishing the next crop, add organic matter.

- Generally a layer 1” deep is broadcast on top of the soil and incorporated. [1]

- <u>Do not</u> use manures, wood ash or bar-b-que ash. High salts (EC) and high pH.

Watering

- It is better to keep the plants 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.

  - All Diseases will become worse with over watering and high relative humidity.

Watering

- Vegetables & Fruits are NOT drought tolerant.

- Watering methods:
  - micro tube.
  - drip tape. 
  - Over head sprinkler to be(avoided).

  - **Don't** turn your high tunnel into a Petri dish.

Watering

- Drip System.

Plants to Control bad bugs

- Keep the bugs out!
  - Control the environment inside the HT.
- Plant pollinator islands to bring in the good bugs.
- However: Neem Oil is best choice for insect control in a greenhouse situation.
  - <u>non-selective.</u>

Trap crops

- (can) Improve yields and reduce pesticides, attracts beneficial insects.

- Trap crops are planted on the perimeter of a garden.
- Trials (at Missouri State) saw a 12% crop increase in the main crop of winter squash.

Trap crops

- Hubbard Squash and Buttercup Squash will attract-
  - Western and striped cucumber beetle.

Trap crops

- Cabbage butterfly
  - Collards to protect cabbage.
- Flea Beetles
  - Chinese Southern Giant Mustard protects, brassicas, may need to re-seed.

Trap Crops

- Small plantings of Buckwheat and/or a pollinator island attract both good and bad bugs.
  - Attracts stink bugs and leaf footed bugs.
  - Flowers are a source of pollen and nectar.
  - Buckwheat is an excellent green manure crop.

Dead End Trap Crop

- Barbarea vulgaris, Bittercress , Herb Barbara, Yellow Rocketcress, Garden Yellowrocket.
  - Member of the Brassicaceae family.
  - Annual in Wyoming.
  - Will self-sow.
  - Adaptive.

- Glucosinolates are used as a cue for egg-laying by female cabbage white butterflies, but the larvae die due to the content of saponins which are apparently not sensed by the female moths.

Watering Tomatoes

- Reduce watering at almost red fruit stage to reduce cracking and increase brix level.
- Smaller but sweeter fruit.
- Dryer is better.
- Prune for better air movement.

Tomatoes

- High Tunnel too hot will cause miss-shaped fruit.
- Blossom end rot caused by:
  - water problems - too dry than too wet.
  - high soil or water *salt (EC)*.
  - Possibly too little Calcium (get a soil test).
    - if needed use greenhouse grade calcium.

More on Tomatoes

- High RH possible off-flavor.
- Concentric Cracking: fertility problems, rapid growth, high temp + high humidity.
- Zippering: when the anthers become attached to the ovary wall, cool weather.

More on Tomatoes

- Radial Cracking: develops from the stem-scar, may develop fungal problems.
- Cause by wide swings in moisture.

Tomatoes

Covers at base increased the humidity and kept the tomatoes warmer at night, was able to harvest two weeks earlier.

Getting a Jump on the Season

- Start lettuce, spinach, Asian greens other cool season plants and transplant into HT
  - Transplant in September for December harvest.
  - Transplant in Feb/March for April/May harvest.
    - However greater insect pressures – aphids.
    - Spinach and Asian greens will be sweeter.
    - Need to hand water, but less frequently.

- Floating row covers to protect.
  - Keep the cover above the plants.

Soil Temp

- Data Loggers to keep track.
  - Cost of equipment.

- Or…Keep it simple with a meat thermometer and note paper.

Getting a Jump on the Season

Scott and Jackie Taylor's HT at 6,500' Walls–o-Water in February.

RULE # 1

- "There are several management strategies for pest & disease control, but by far the most successful is to:
  - Increase Air Circulation,
    Decrease Humidity."*

- Never use over head water (great for lawns, but not vegetables or High Tunnels).

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

RULE #2

- Sanitation is everything in a High Tunnel.
- Use the vacuum cleaner if necessary.

RULE #3

Inspect new plants before they go into your High Tunnel.

RULE #4

- Not all fertilizers work in a High Tunnel situation.
- **Never** use manures in your High Tunnel.
- Make your own fertilizer!
  - 5 gal H2O, 1# Alfalfa Pellets, 1 cups Sugar.

Diseases and Pests

- Greenhouse Disorders can be brought on by:
  - too cool, too hot, **too humid**, soil, pH, salt, water quality, the wrong fertilizer and pesticide misuse in any combination.

- Correcting the above brings on disease controls.

Keep Records

- How Much produce are you getting out of your High Tunnel.
  - Weights, number of fruits.
- Time
  - Harvest, cleaning, packaging.
- Map of your garden.
  - What worked what didn't.

More info

- Colorado State University Greenhouse extension site. http://ghex.colostate.edu/
- Mississippi State University http://msccares.com
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- Penn State http://plasticulture.psu.edu

Many Thanks to Karen Panter PhD at UW.

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.

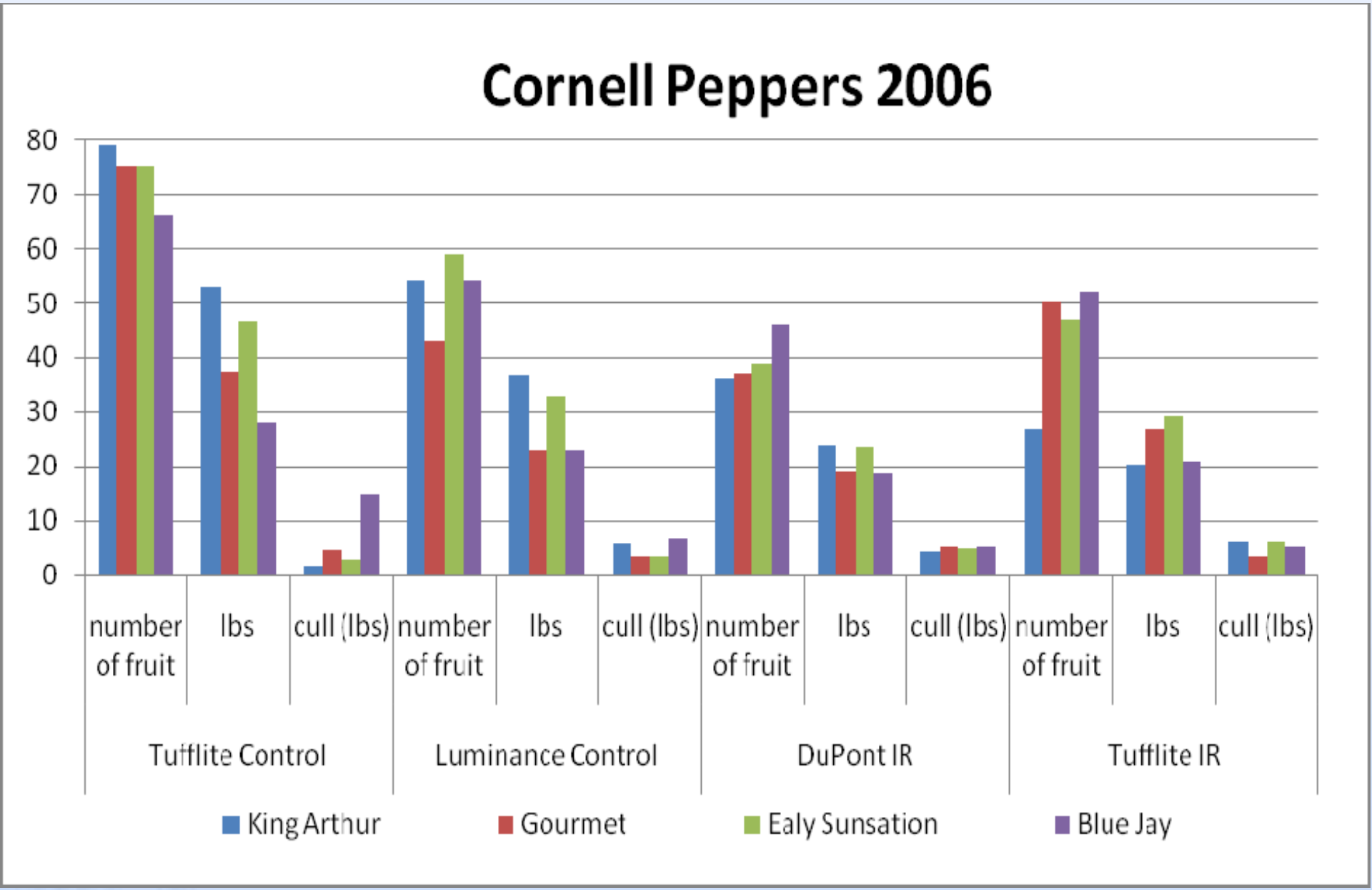
However:

- 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.

Covers-research

- 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
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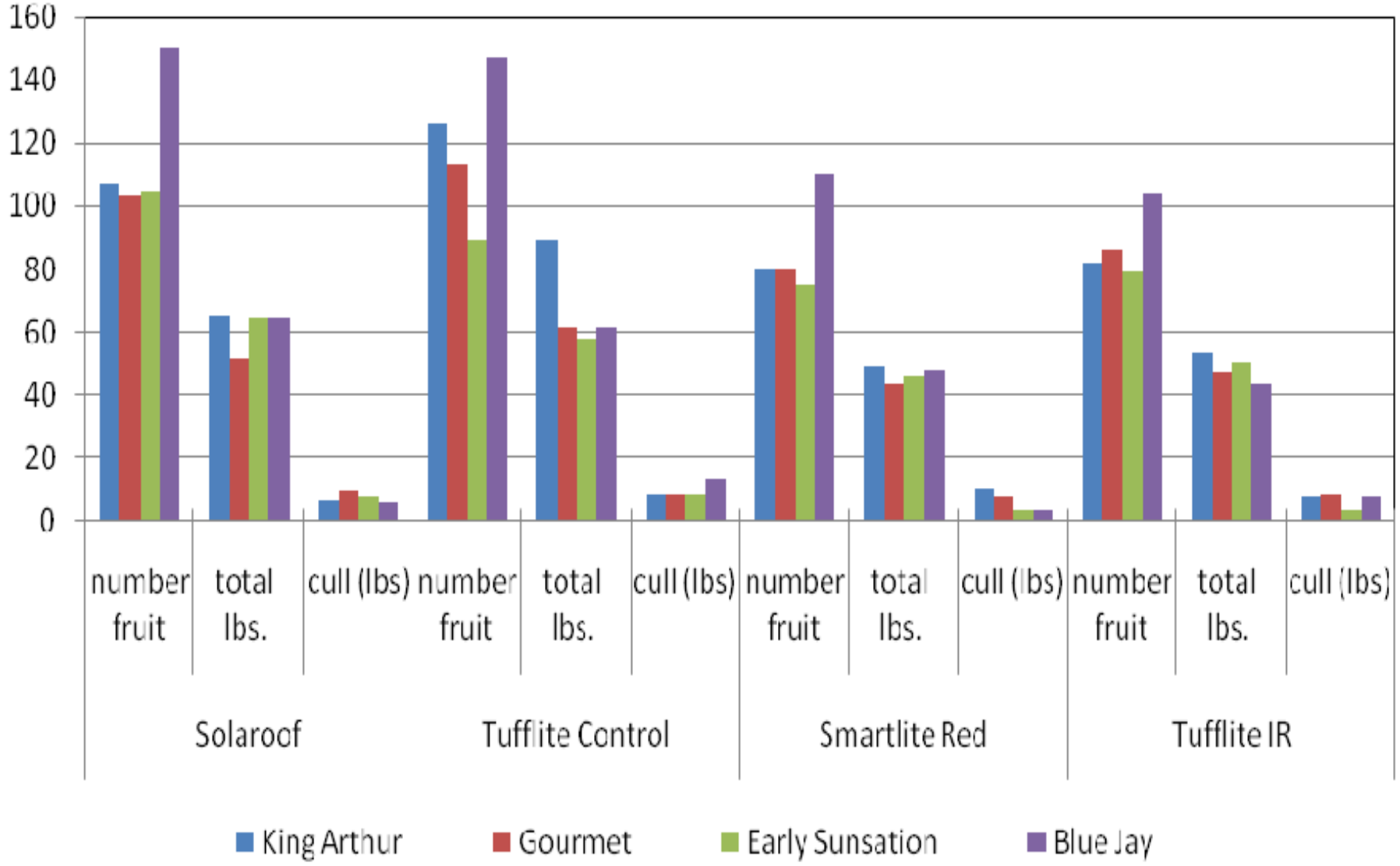
Luminance Control
DuPont IR
Tufflite IR
King Arthur
Gourmet
Ealy Sunsation
Blue Jay

Cornell Peppers 2007



Soil Fertility under Plastic

Fertigation (injected into the system)

More efficient use of water, time and fertilizer.

Aphids

- Approximately 4,000 aphid species in the world.
- Develop w/temps above 40 and to 89 degrees.
- 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.

- Jeanne Himmelein Michigan Extension Educator

Mealy Bugs

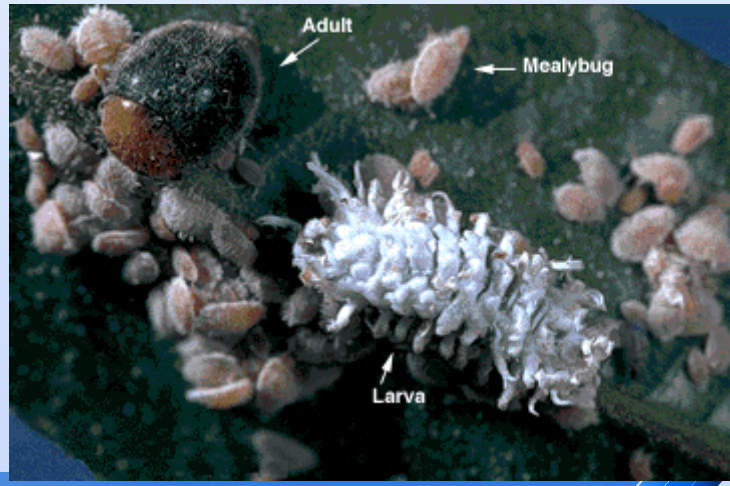
Difficult to Control, feed on leaves, roots and shoots of plants.

•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.
12-14 days to complete life cycle at 78-82 degrees.

- 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
Jeanne Himmelein Michigan Extension Educator

White Flies

- Like warm and humid environments, 70 degrees 7 days egg to adult.
- 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.

- Jeanne Himmelein Michigan Extension Educator

Fungus Gnats

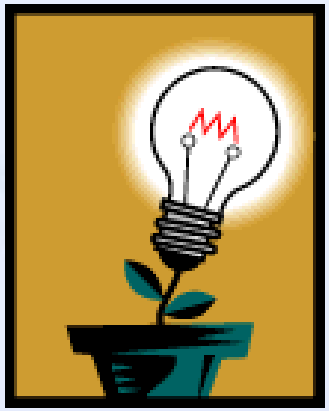
- Like Wet soil with organic matter.
- Larvae of these flies feed on roots, stunting plant growth.
- Can spread plant pathogens.
- Keep plant on dry side.
- <u>Bacillus thuringiensis, isrealensis</u>.
- Potato pieces.
- Yellow Sticky Cards.

Spider Mites

- Dry conditions and temps 85-95.
- Drought stress can produce changes in plant chemistry that make them more nutritious to spider mites.
- Horticultural oils; "Sun Spray" or "Prescription Treatment-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
  - Jeanne Himmelein Michigan Extension Educator

Minute Pirate Bug

Extending the Season



- Some Ideas

Low tunnels

8 x 10 Greenhouse

8′ x 12′ Greenhouse

Greenhouse west of Cheyenne

July 7

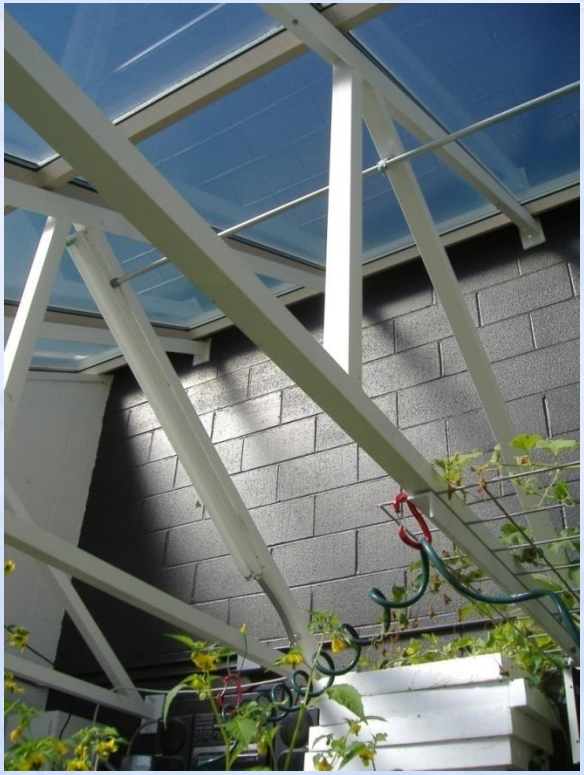
August 30

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

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

Glass Greenhouse West of Cheyenne at 7,500’

Glass Greenhouse West of Cheyenne 7,800'



2nd week of September

Simple Cattle Panel hoop-house 10′ x 20′

Inside the Hoop-house

PVC Hoophouse 10′ x 18′

PVC Hoop-house

PVC Tunnel
10′ x 24′

PVC 10′ x 24′ Tunnel

PVC Tunnel 10′x24′

PVC Tunnel in July

high tunnel 14′ x 20′

- Growing Methods, different approaches

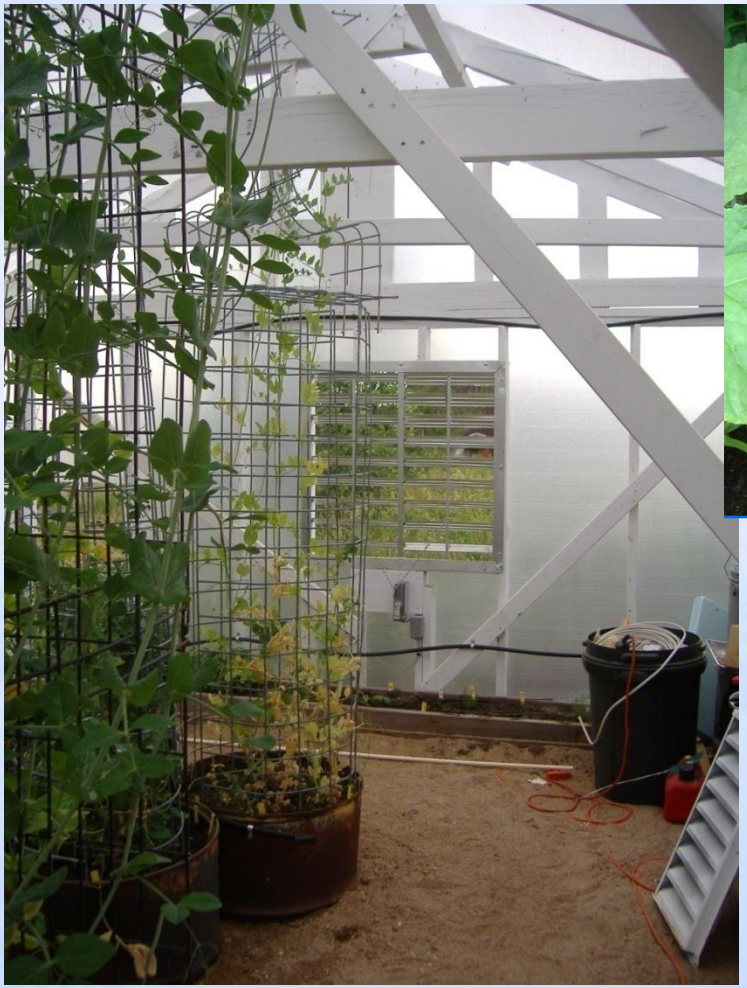
Growing methods

Growing methods

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

Growing Methods

Containers



Growing Methods

- Construction details

Construction details

Construction details

Construction details

Creature Comforts

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

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Cooling

- The big challenge

Minus 10 outside, what is the tempeture inside?

Environmental Controls-Cooling

- What is the cooling system?
  - Shade cloth, fan-jet, pad-fan, swamp coolers, **roll up sides**, top vents, box fans.

  - Why is this important?

bad bugs

Pepper plant