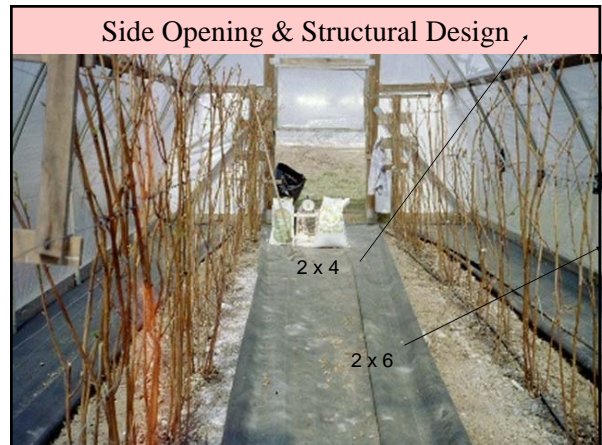




## High Tunnels

- **High tunnel**
  - No heat source
  - Passive ventilation by raising sides and opening ends of tunnel
  - Essential: minimum of 5 ft. opening for raising plastic



## High Tunnels

- **High tunnel**
  - Any width, but length is something to consider
    - We have two tunnels 160 ft long and one tunnel 180 ft long. We made a walk through half way down the tunnel so we could go from one side of the row to the other.



## High Tunnels

- Use 50% shade cloth to minimize heat buildup in summer
- New plastics available that diffuse the light reducing temperature within the tunnel without the use of shade cloth
  - Klerk's Kool Lite 380
- Use for season extension
  - Spring - We have raspberries in May where outdoor berries in our area aren't available until the end of June
  - Late fall - we consistently have berries until the end of Nov; some years into Dec.

## How high tunnels capture heat for season extension

- Clear polyethylene film
  - Good light transmission
  - IR treated blocks and traps heat
- Dark mulch soil covering
  - Absorbs heat during day, warms soil = keeps roots warm
- Row covers
  - Reduce heat loss around plant

## Size of tunnels on our farm

- (2) 14' by 96'                      2 rows
- (1) 20' by 96'                      3 rows
- (2) 14' by 160'                    2 rows
- (1) 14' by 180'                    2 rows

Tunnels longer than 100' in length need a break or walk through

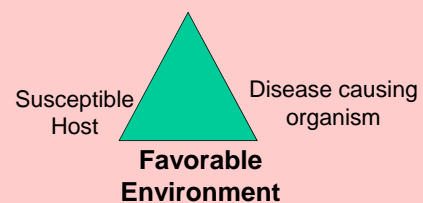
## High tunnels or greenhouse production?

- Greenhouse
  - Heat source
  - Mechanical ventilation (exhaust fans)
  - Best use: winter production or very early spring production if you have a market that will pay for the berries.

## Why I like high tunnels?

- Longer shelf life
- Higher quality
- No rain or dew ever strikes the berry
- Less disease

## Factors required for disease development



Most disease causing organisms, ie. fungi and bacteria require free water to germinate and penetrate the cell wall of your crop plant.

High tunnels alter disease development by creating an environment that is less than favorable for the disease causing organism.

## Why I like high tunnels?

- Longer harvest period
  - May through November for high tunnels
  - Outdoors: late June through October in Southern NJ

High tunnel  
Raspberries  
Second week  
November



Outdoor raspberries  
Second week in Nov.



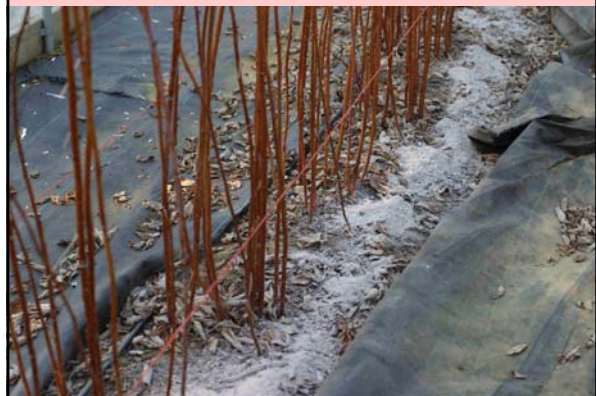
## Lime and Fertilizer

- Test soil and apply lime as recommended
  - pH 6.5 – 6.8 recommended
- Spring fertilizer recommendations (general)
  - 50 lbs. N/A
  - We've used Chicks Mix – a pelletized sterilized chicken manure approved for organic production
  - Supplement through the drip irrigation system
- Check nutrient levels with tissue analysis at flowering

## Applying Lime



Using wood ashes to raise pH



## Planting in Soil in High Tunnels

- Planted virus free bare root stock plants as early in the spring as possible (March)
- 5 ft. minimum between rows.
- 18 to 24 inches between plants
- Do NOT plant Titan raspberries in the soil because this variety is very susceptible to Phytophthora.

## Varieties

### • High Tunnel Production

- Autumn Britten – earliest bears mid-July
- Caroline - August
- Heritage – mid August - November
- Josephine – November – December
- Himbo Top – trial, new this year. Maturity falls between Autumn Britten and Caroline.

## Culture

- Pinch growing point of new canes when they reach 18 to 24" to encourage branching. This promotes more fruiting area.
- Remove small, unthrifty canes emerging late.
- Keep pinching growing point of new canes as the old canes are harvested to control height.

Tall canes in tunnels due to increased heat buildup under plastic in summer.



## Pruning for Manipulating Harvest Date

- Check a few plants of the variety you want to alter harvest date on
- When rapid growth ceases (~ end of June in South Jersey), prune 1 inch from canes that you want to delay harvest one week
- Prune 2 inches from canes that you want to delay harvest three weeks

## Caution

Remember when delaying harvest, (especially the late varieties) that you may have cold temperatures to deal with before all the berries mature.

## Irrigation

- Drip irrigation
  - We've gone to a drip line on each side of the row – sandy soils.
  - Raspberries need at least an inch of water per week
  - Need to run drip for at least a half hour/day every day in high tunnels.

## Trellising

- Use treated wood posts at the ends of the run.
- Can use metal posts in the middle of runs
- Place a post every 20 to 25 ft.
- We use wire to support canes. We found baling twine did not keep canes within the row area.
- 24, 42 and 60 inches from ground level

## Trellis Supports



## Lower cane leaf removal

- Remove the bottom leaves on canes
- Don't receive much light so they do not produce much photosynthate for the plant
  - Helps to reduce cane diseases
  - Improves air circulation
  - Makes pruning late emerging canes easier

## Shade

- Raspberries grow naturally in transition zones - from woods to open fields - areas where they receive both sunlight and shade.
- We have tried both 30% and 50% shade for raspberries and find the 50% works better in Southern NJ.
- Reduces temperature in high tunnels and prevents sunburn



## Wind Control for Sides

- Storm or cold weather approaching
- Lower sides
- For control of plastic, create a “X” system with baler twine or clothes line to hold plastic in place. Line must have a UV inhibitor.
- Useful before closing sides for winter.



## Pruning for Height Control

- Pinch growing point when canes reach ~ 5 ft.
- In high tunnels, canes can reach heights of 10 – 12 feet. Control height by pinching or pruning every two weeks. Pruning cuts can leave openings for Botrytis cane blight to start.



## Disinfecting Pruning Shears



## Dormant Pruning

- After canes have gone through the winter, prune canes back to soil surface if you don't want the summer crop
- If you plan to harvest the summer crop, prune dead wood out and limit height of canes to 5 feet.

## Before pruning



## After pruning



## Harvest

- Harvest daily into one half pint containers
- Provide a cull receptacle for "good" berries that are deformed, insect damaged, sunburned, mechanically damaged, etc.
- Refrigerate berries promptly.

## Low Cost Refrigeration

- Cool Bot + Standard room size air conditioner
  - CoolBot over rides the temperature controls of your air conditioner while controlling the defrost so that the refrigeration coils do not freeze up.
  - Size of AC unit depends on size of room

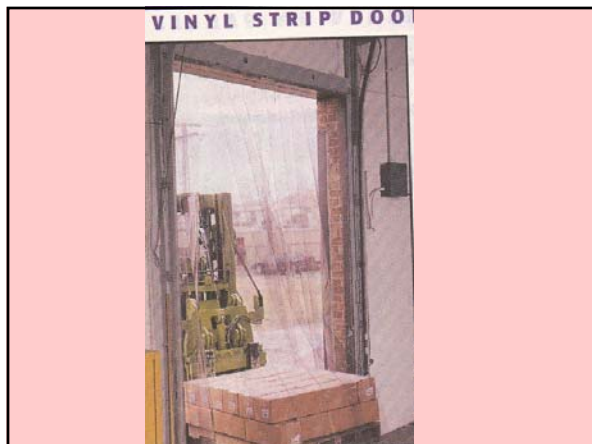
Dimensions of Cooler	Size of AC Unit
6' x 8'	10,000 BTU
8' x 8'	12,000 BTU
8' x 10'	15,000 BTU
8' x 12'	18,000 BTU
10' x 12'	21,000 BTU
10' x 14'	25,000 BTU

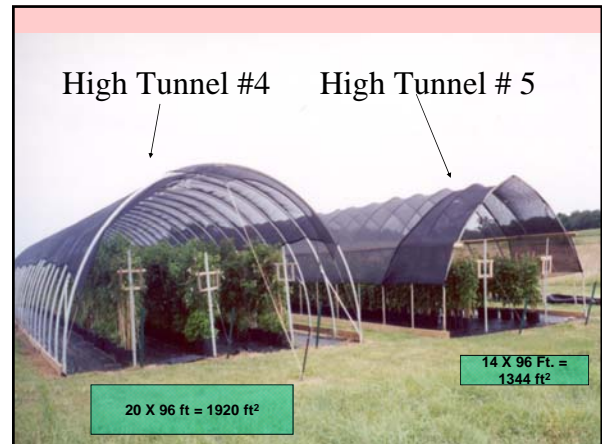
## Cost

- Estimated cost of refrigeration for walk-in cooler for our 12' x 12' room = \$3500
- Cost of Cool Bot plus air conditioner = \$750
  - Installation was easy.
  - Cool Bot uses a standard 110 outlet as did the 10,000 BTU air conditioner we had on hand.
  - Temperature setting 36°F – 50°F for all types of produce

## Cost

- Cost to run last year = \$150/month with temperature set to cool to 40°F
- Lower energy costs by
  - Insulating walls – 4"
  - Insulating floors – bare floors are a great sink for cooled air
  - Seal holes – use “Great Stuff” foam to seal any leaks
  - Use energy curtains at entrance



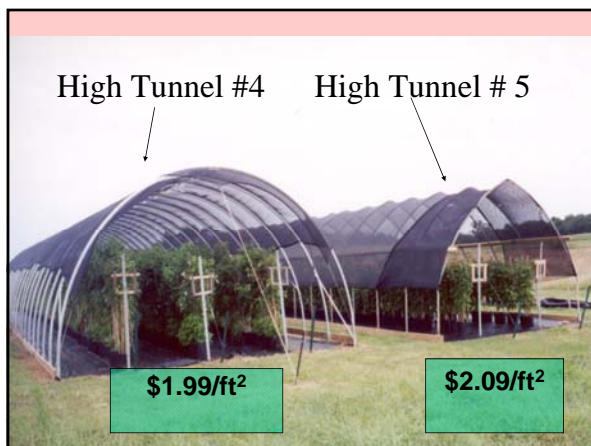


**High Tunnel # 4 (2004 prices)**

Atlas 20' x 96' cold frame	\$1572.18
Wood for base (2" x 6")	146.08
Hardware, hinges, poultry netting	59.15
Poly lock for side (384' @ \$7.80/8')	249.60
Poly (4 yr)	272.84
Wood, poly lock for ends	117.16
Labor (40 hrs @ \$10/hr for 2)	800.00
Ground Cover	165.38
Shade cloth	430.00
<b>Total</b>	<b>\$3812.39</b>

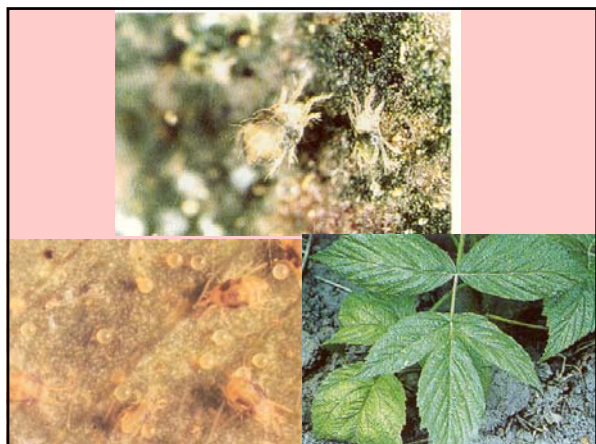
**High Tunnel # 5 (2004 prices)**

Ground Stakes	\$418.30
Bows	900.00
Hardware, hinges, poultry netting	89.65
Poly lock for side (384' @ \$7.80/8')	374.40
Poly (4 yr)	165.89
2 x 6's (222 ft); 2 x 4's (236 ft.)	86.31
Labor (32 hrs @ \$10/hr for 2)	640.00
Ground Cover	66.97
Shade cloth	71.67
<b>Total</b>	<b>\$2813.19</b>



**Pests**

- Two spotted spider mites
  - Overwinter on bud scales
  - Use dormant oil to reduce overwintering population
  - Use predatory mites
    - Originally started with *Phytoseiulus persimilis* with poor control
    - Two years ago, changed to *Neoseiulus fallacis* released in May
      - works great
    - Use a full vial per high tunnel (5000)

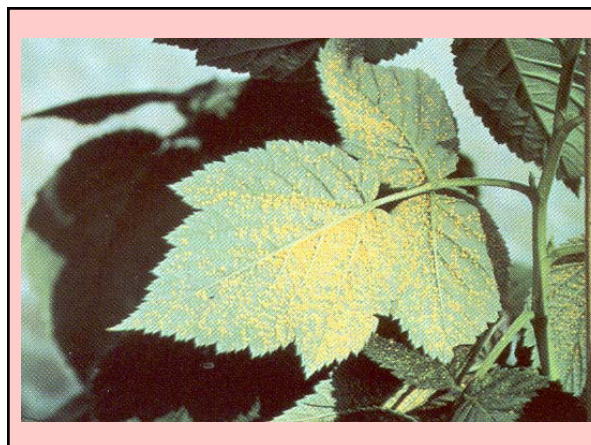


## Pests

- Thrips
  - Feed on flowers
  - Can be found on fruit if populations are high
- Oriental beetles
- Japanese beetles
  - Not a problem in tunnels – do not seem to want to enter.

## Diseases

- Botrytis cane blight – occasional problem if rainy season and many, many canes crowded together.
- Late rust
  - Nova fungicide controls very well
    - Start application in mid July
  - Susceptible varieties: Caroline, Tulameen



## *Bramble Production Guide*



## Available from:

Northeast Regional Agricultural Engineering  
Service  
152 Riley-Robb Hall  
Cornell University  
Cooperative Extension  
Ithaca, NY 14853



Questions?