High Tunnel Raspberries A to Z

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High Tunnels

- Widely used in California, Mexico for berry production
- Used on smaller scale in East
- More direct-marketers here
  - Diversified production with more crops

High Tunnels

- **Advantages**
  - **Extended harvest**
  - **Increased yield**
  - **Reduced pressure of certain diseases**
  - **Longer shelf-life**
  - **Improved fruit appearance**
- **Disadvantages**
  - **Cost**
  - **Time for mgt.**
  - **Increase in “greenhouse” pests**
  - **Powdery mildew**

Types of Tunnels Used for Raspberries

- **Multi-bay – usually covered only for part of the year or growing season**
- **Single-bay – *usually* covered year-round**

California

Photo courtesy of
M. Pritts

Multi-bay

- **Where protection from elements is a main objective and winter protection isn't needed**
  - **No tolerance of snow load**
  - **Usually for protection from rain or sun**
  - **Widely used on West Coast**
  - **Used here and there in other parts of the country**


Penn State
Rock Springs, PA


SE Pennsylvania
30’ x 50’
= 9.1 x 15.2 m

Single-bay

- **Where season extension and/or winter protection is needed**
  - **Can be kept closed for winter (usually)**
  - **Used mainly in colder areas with short growing season**
  - **Used where growers are smaller-scale**
  - **Quonset-style roof or peaked roof**

Environmental Changes Relative to Field

- No moisture on foliage from rain or irrigation
  - Placement and amount of water is controlled
- Higher (or lower) humidity
- Warmer air temperatures
  - Mild in winter
  - Can be hot in summer (or cooler)
- Warmer soil temperatures
  - Lack of soil freezing during winter

Resulting in…

- Plants generally grow much larger than in field
  - Higher yields
- Longer growing season – earlier and later yields
- Can grow some crops or varieties that we couldn’t otherwise due to short growing season or cool temps
- Changes in pest complexes

How is tunnel production working out?

- Conducted survey of potential, current, and former high tunnel berry growers (across U.S.)
  - 353 responses (252 paper, 101 via Internet)
  - 34 states represented

Potential Growers
(of 244 responses)

Strawberries, June-bearers (SD)	100	(41%)
Strawberries, Day-neutral	89	(36%)
Black raspberry	70	(29%)
Red raspberry, summer	106	(43%)
Red raspberry, fall (PF)	137	(56%)
Blackberry, summer	66	(27%)
Blackberry, fall (PF)	66	(27%)
Blueberry	45	(18%)

Current Growers (of 73 responses)	Currently Grow -- (no.)--	Dis-cont.	Future Plans ↑ acreage	Future Plans ↓ acreage
Strawberries, SD	22	7*	9	2
Strawberries, DN	29	2	19	3
Black rasp.	9	0	5	0
Red rasp., summer	22	1	8	2
Red rasp., fall (PF)	36	1	21	1
Blackberry, summer	19	2	9	2
Blackberry, fall (PF)	15	0	12	1
Blueberry	7	1	12	1

Current HT Berry Growers (Survey)

- 49% of current high tunnel berry growers grow primocane-fruiting varieties
- 30% grow summer-bearing varieties
- Some grow both (i.e., don't add %'s)
- About evenly divided between single-bay and multi-bay tunnels

- 8 growers with black raspberries (11%)

Why Are Growers Using Tunnels for Raspberries?

- **Same reasons for both types**
  - **Protect crop from rain (~65%)**
  - **Improve fruit appearance**
  - **Extend harvest later (PF only)**
  - **Promote increased yields**
  - **Allow harvest during rain**
  - **Lengthen shelf-life**
  - **Promote larger berries (~40%)**

Growing Raspberries

Raspberries

- Primocane-fruiters
  - Can manage for just fall crop, or also produce summer crop
  - 2-3 times the yield of field production
- Can also grow floricane-fruiters (summer)

Culture

- For the most part, used methods similar to field production with some changes due to tunnels

Planting

- As early in spring as possible
  - If tunnel up, could be late winter
- If using tissue-cultured plants, have row covers ready if <32 F
- Raised beds are best
- 1.5’ to 2’ between plants
- Minimum 7-8’ between rows

Landscape Fabric?

- For red raspberries, just have between rows
- Watch for buildup of rodents

Trellis

- **Simple supported hedgerow or narrow “V” works well**

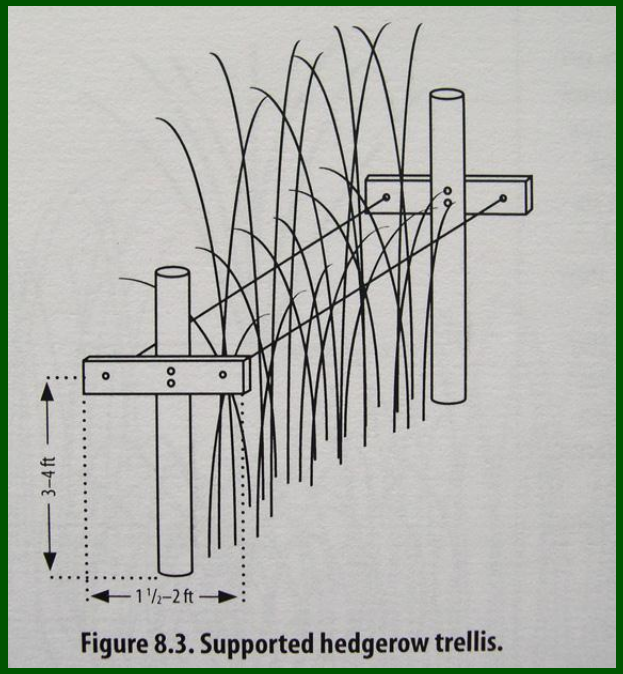

Figure 8.3. Supported hedgerow trellis.

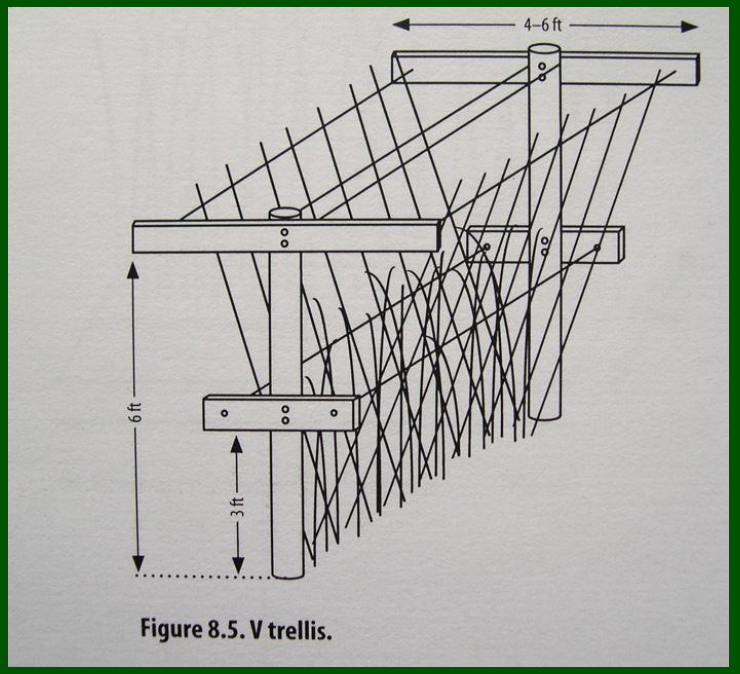

Figure 8.5. V trellis.

Trickle Irrigation

- 1x/week during early spring and late fall, increasing to 3x/week during summer
- About 2 hours each time if 0.45gal/100'/min trickle tape - unless uncovered (may get rain)
- Water quality an issue at Rock Springs
  - pH 8.6
  - High in calcium and magnesium

Irrigation

- Issues with water source?
  - If hard water from wells – test
  - Need to treat?
  - Better off with surface or rainwater?

Nutrition

- Are the same N fertilizer rates as for field production best?
  - Less leaching of nutrients
  - More growth and crop removal
  - Do these balance out? Seem to…
- Deficiencies observed only in raspberries so far
- Do tissue tests each year

Fertilization: Potassium

- Typically recommended only N yearly after planting for field production – other nutrients based on tissue tests
- Large amounts of potassium removed with crop
  - 17-35 lb/a just in fruit in tunnel
  - Wood (1962) 52 lb K/acre all plant parts

Potassium Issues

At Rock Springs and in grower planting

0.85% here

1.0 to 1.45% is considered deficient

The explanation?

- Soil was high in potassium
- Real issue was water source – not something we normally worry in the field
  - Source was well water
  - No rainfall - Bigger impact of water source in tunnel

Change in fertilizer recommendations

- Use N fertilizer balanced in N and K
- How to avoid buildup of Ca and Mg in our case??
  - Water softening with potassium instead of sodium or acidification

Temperature Issues

- Can be related to:
  - Lack of labor to vent at correct times
  - Using single bay tunnel type
  - Type of plastic
  - Lack of gable vents
  - Prompts some grower to automate venting
- Solvable

Venting

- **Raspberries grow well in cool temps.**
  - **Goal is to keep temperature around 70-80 degrees**

Venting

- Keeping rain off of the blossoms and fruit = major decrease in disease incidence = major decrease in fungicide use
- Wind makes plants shorter = lower yields; gentle breezes are good

Varieties

Summer-Bearers

- **Nova**
  - **Also produces a light fall crop in field, more substantial crop in tunnel**
  - **Good size and flavor**
  - **Must be fully ripe to release from receptacle**

Primocane-fruiters

Jaclyn

- Very early season
- Long, conic berries
- Difficult to pull from receptacle
- Excellent flavor

Caroline

- Early
- Very dense canes
  - May need to be thinned
- Variably-sized berries, mostly medium
- Excellent flavor
- Medium color
- Long harvest season

Autumn Britten

- Early-mid season
- One of the first cultivars tried
- Large berries with great flavor, uniform size
- May be susc. split receptacles in heat, viruses
- Sparse canes (plant closely)

Joan J

- Mid-season
- Productive
- Average flavor
- Fruit bright red, though some reports of darkening in heat (?)
- Growers seem to like this one

Himbo Top

- Mid-season
- Large berries
- Berries dark, some reports of becoming bland in hot weather
- Drooping laterals, needs to be trellised

Heritage

- Late season
- Old, durable
- Berries small, mild flavor
- Medium color
- Grows very tall in tunnels
- Very productive

Josephine

- Very late season
- Very large, firm berry
- Light-medium color
- Excellent flavor
- Moderate productivity

Anne

- Late season
- Light gold color
- Best in combination with red variety
- Very large
- Excellent flavor with banana overtones
- Sparse canes, so plant closely

Nantahala

- Late season
- Wonderful flavor
- Yields medium due to not harvesting entire crop
- Large berries

Tipping

- Not worked out for all cultivars
- Pinch tips when about 30” tall to delay fruiting (?)
- Delays yield differently with different varieties – 6 days (Nantahala) to 2 weeks (Heritage)
- Looks like it reduces yields to me…

Pruning

- For primocane-bearers, can prune to ground in late winter
- Or prune as for summer-bearers to get a summer crop, but may need to adjust canes/linear foot of row (start with 3-4)
  - Summer canes if too thick can compete with fall production

Diseases

- Much reduced
- Usually very little gray mold
- Longer shelf-life
- No cane diseases on raspberries
- Phytophthora root rot if in low spot

Raspberry Problems

More

- **Spider mites**
- **Whiteflies***
- ***Thrips****
- **Aphids***

*** = viral transmission**

Some growers (venting?)

- **Gray mold still a problem**
- **Sometimes powdery mildew**

Spider mites

- A problem on raspberries
- Very few miticides for caneberries even in the field
- Scout
- Need to release predators early
  - *N. fallacis* + *N. californicus*
  - *Galendromus* spp.

Two-Spotted Spider Mite and Eggs (Leaf Underside)

Two Spotted Spider Mites

- **Scouting**
  - **Oldest leaves get the most attention**
  - **Look for round eggs, besides mites**
  - **Sticky traps don't work (don't fly)**
  - **Watch for stippling (!!)**
- **Insecticidal soap only temporarily**
- **Release predators quickly**
  - **We use a *Neoseiulus* mix (*N. fallacis* and *N. californicus*), others work too**
  - **Others**

Aphids

- **Bigger issue (rather than feeding) is virus transmission**
- **Not confirmed, but viral symptoms (crinkled foliage, crumbly berries) were reason for raspberry removal**
- ***How to deal with this issue if using biological controls*?**

Aphids

- **Scouting for aphids –**
  - **Undersides of leaves**
  - **Curled shoot tips, new leaves a problem**
  - **Yellow sticky cards**
  - **Ants (*protect aphids*), honey dew, sooty mold**

How Did We Treat?

- Scouting
- Two-spotted spider mites
  - Predators: *Neoseiulus* mix (*N. fallacis* and *N. californicus*)
- Aphids – species dependent
  - Ladybugs, green lacewings and predatory midges (*Aphidoletes aphidimyza*), parasitoid wasps (various spp.)
- Soft insecticides when necessary

New Challenge – Spotted Wing Drosophila

Spotted Wing Drosophila

- **Problem on thin-skinned fruit**
  - ***Raspberries, blackberries,*** **strawberries, blueberries, peaches, plums, nectarines, wine grapes, currants, kiwi**

How It Differs from Other Vinegar (aka Fruit) Flies

Photo: D. Biddinger

- **“Normal” vinegar flies used to infest only overripe fruit**
- **SWD females can lay eggs in ripening fruit = larvae in fruit**

Photo: Alex Surcica

- **Why can it attack sound fruit?**

Unexpected SWD Observations – 2012

- Relatively low SWD populations in tunnels
  - But plenty of larvae in fruit – turned out to be mainly other species
- One H. T. raspberry grower reported no SWD issues with daily picking
- Others had plenty

Recommendations

- Keep fruit picked clean – every day or two if possible
- Do major trapping, possibly with more attractive bait (?)
- Do not let fruit drop on ground
- Watch surrounding vegetation/crops/food sources

Weeds

- Not much of a problem with landscape fabric
- If no landscape fabric, and always covered during rain, weeds only where moist (in rows, around edges)
- Otherwise, could be problem
  - Herbicide incorporation? Trickle tape?

Pesticides?

- Tunnels make organic production easier
  - Be aware - viruses may move in via insects
- When using pesticides, official EPA interpretation is that as long as the label doesn’t restrict the use from protected culture, it can be used

Do high tunnels pay?

- Big cost – labor
- Judging from grower plans to increase or maintain acreage…

What Are Grower ID'd Major Problems? (>30%)

	Current	Former
Cost of construction/maintenance	58.8	36.4
Temperature management	48.5	36.4
Finding market for off-season berries	8.8	45.5
Controlling spider mites	45.6	27.3
Controlling other mites/insects*	30.9	9.1
Environmental catastrophe	30.9	18.2

*without SWD yet on the scene

What's the Future?