Urban Small Farms Conference 2019

Wednesday, February 20th, 2019

Time	Beginning Farmer - Berries
1:00	Strawberry Basics - Brent Black, USU **pg. 105**
1:30	Protected Cultivation of Strawberries - Tiffany Maughan, USU **pg. 110**
2:00	Rasberry Production 101 - Sheriden Hansen, USU **pg. 116**
	2:30 - 3:00 Break
3:00	Blackberry Basics - Brent Black, USU **pg. 123**
3:30	Insect Basics - Diane Alston, USU **pg. 128**
4:00	The Basics of Berry Diseases - Marion Murray, USU **pg. 134**
4:30	Speaker Pannel Q&A

Click on the session you would like to view and it will take you there!

Strawberry Basics

Introduction to strawberry management systems.

Brent Black
Professor and Extension Fruit Specialist
Utah State University
Brent.black@usu.edu

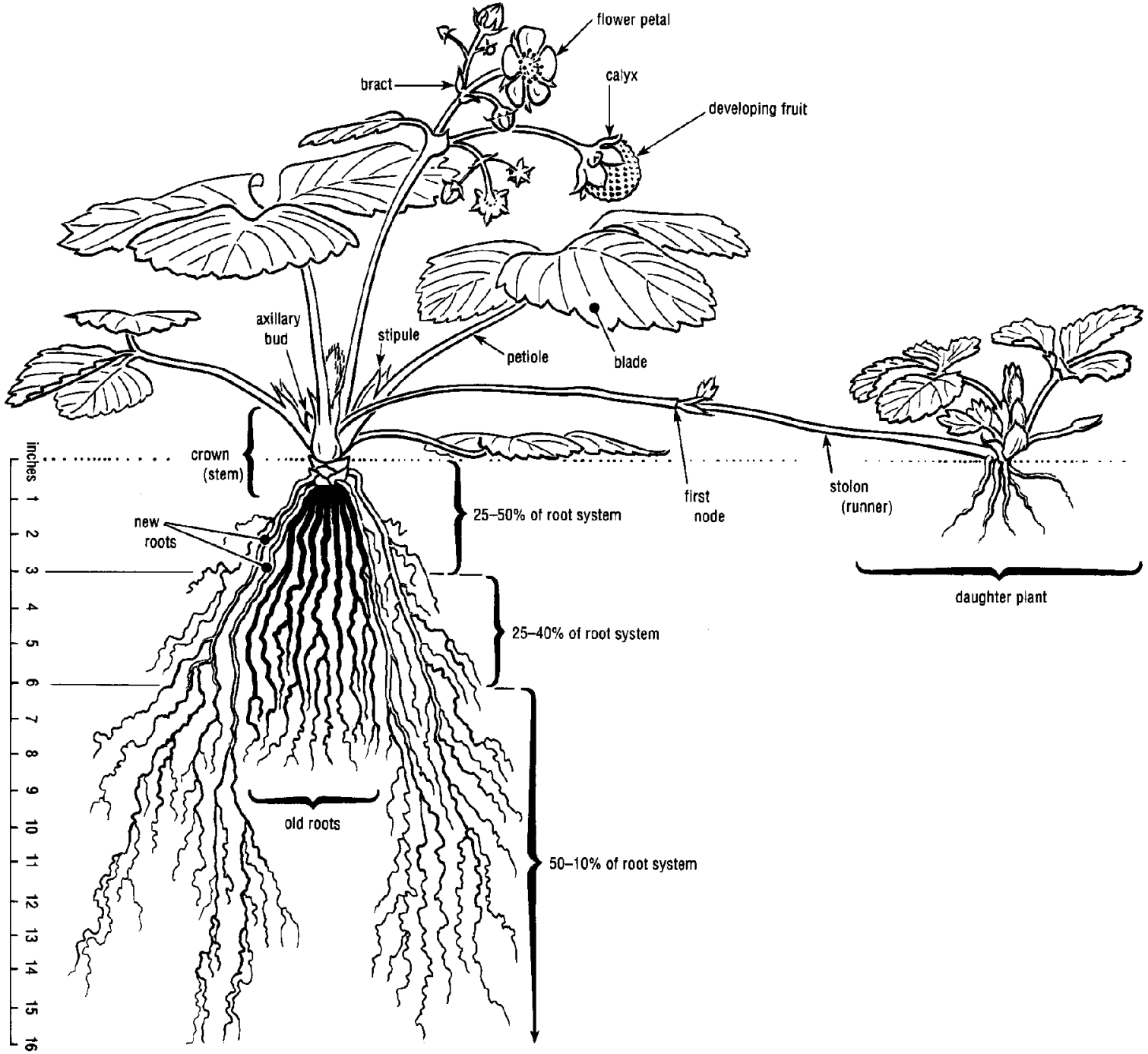
Dr. Brent Black is Professor and Extension Fruit Specialist at Utah State University. Prior to coming to USU in 2005, Dr. Black was a research scientist with the USDA Agriculture Research Service in Beltsville, Maryland, where he worked on production systems of strawberry and blueberry. Prior to USDA, he studied tree nitrogen metabolism at the University of Maryland in College Park. He holds a B.S. degree from Utah State University in Plant and Soil Science, an M.S. degree in Horticulture from Michigan State University, and a Ph.D. in Plant Physiology from Oregon State University. His current research interests are in high density orchard management, precision orchard irrigation, and strategies for extending the production season of berry crops.

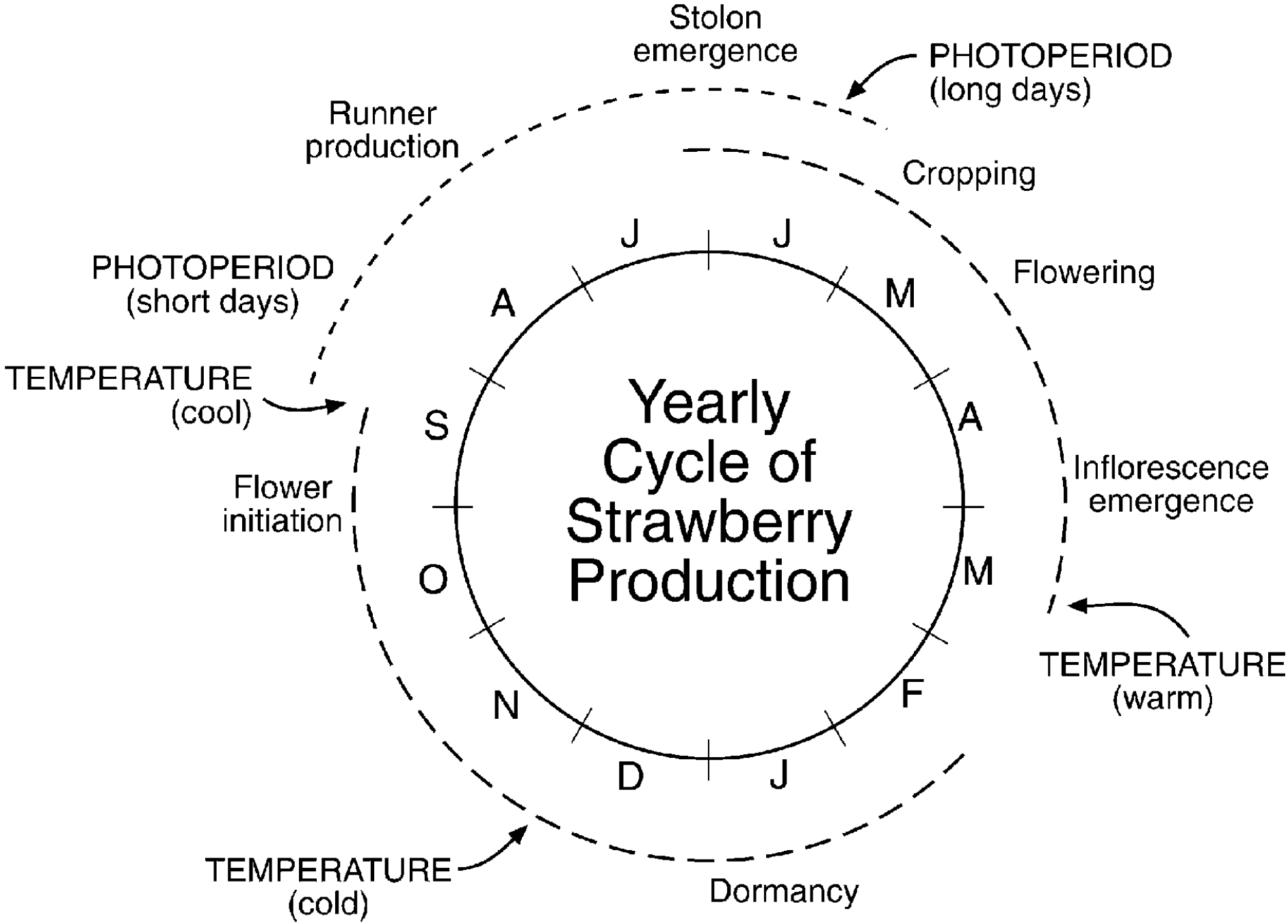
Strawberry Basics

Dr. Brent Black
Extension Fruit Specialist
Utah State University

Why Strawberries?

- Yields: 6,000 to 20,000 pounds per acre
- $1.00 to $2.50 per pound PYO
- $2.00 to $3.50 pre-picked
- Attracts customers


flower petal
bract
calyx
developing fruit
axillary bud
stipule
petiole
blade
crown (stem)
inches
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
new roots
25–50% of root system
25–40% of root system
50–10% of root system
old roots
first node
stolon (runner)
daughter plant


Stolon emergence
PHOTOPERIOD (long days)
Runner production
Cropping
PHOTOPERIOD (short days)
Flowering
TEMPERATURE (cool)
Yearly Cycle of Strawberry Production
Flower initiation
Inflorescence emergence
TEMPERATURE (warm)
TEMPERATURE (cold)
Dormancy
J
J
M
A
A
M
F
J
D
N
O
S

Strawberry: Types

- June Bearing (short day)
- Ever Bearing (long day)
- Day Neutral (day length insensitive)

Matted Row

- Spring planted
- Cold-stored dormant plants
- Low initial plant density
  - 1-2’ within row
  - 3-5’ row spacing
- Runners fill in rows
- Yields related to plant density

Matted Row: Plant density

- Close rows
  - 8” row width
  - Row spacing 3 to 3.5’ on centers
- Typical
  - 18” row width
  - Row spacing 4 to 5’ on centers

Matted Row: Weed control

- Between row
  - Cultivation
  - Directed herbicide application (shielded spray)
- Within row
  - Hand weeding
  - Selective herbicides
    - dormant or at renovation
    - Pre-emergent for broad-leaf weeds

- Pacific Northwest Weed Management Handbook

Matted Row: Seasonal cycle

- Year 1
  - Plant early spring
  - Establishment fertilizer application
  - Frequent irrigation to promote “pegging”
  - Cultivation and hand weeding
  - Fall/winter pre-emergent herbicide and mulching

Matted Row: Frost/freeze protection

- Winter protection
  - –Straw mulch
- Spring protection

Methods of frost protection

- Winter mulch (bloom delay)

- Sprinklers?
- Row covers

- Tunnels

Matted Row: Seasonal cycle

- Year 2
  - Early spring – remove straw to row middles
  - Post bloom fertilizer application
  - May-June crop (1st crop for the planting)
  - Summer renovation
  - Late fall mulching and herbicide application

Matted Row: Renovation

- Just after harvest ends
- Narrow rows
- Mow off leaves
- Break out old crowns
- Control weeds
- Fertilize to stimulate new daughters
- Throw soil up on to row to encourage new root formation

Matted Row

Advantages

- Low planting costs
- Nursery plants readily available
- Adapted to colder climates

Disadvantages

- Weed problems
- Smaller fruit and lower yields in successive years
- Soil-borne pathogens
- More difficult to harvest

Annual Hill

- Developed for warm climates to compensate for poor runnering
- Fall planted at close spacing
- Fresh-dug nursery plants
- Runners removed
- Yield depends on the number of crowns per plant
- Usually kept for only one year (annual)

Annual Hill

Advantages

- weed control
- ease of harvest
- cleaner fruit
- annual crop - short rotation
- Better adapted to warm climates

Disadvantages

- higher establishment costs
- some pathogens may be favored (anthracnose)
- plastic disposal
- not as well suited to cold climates

Annual Hill - Cold climate adaptation

- Timing of planting is critical

- Goal: 4 to 6 branch crowns
- No runners

- Early planting results in excessive runnering
- Late planting = insufficient branch crown formation

Annual Hill - Cold climate adaptation

- Nursery plants
  - Greenhouse plugs
  - Cold-stored dormant plants
- Planting date (N Utah)
  - September 1st for plugs
  - Late July for dormant plants
- Straw or floating row covers for winter protection
- Spring frost protection is more challenging

Annual Hill - Cold climate adaptation

Potential problems

- Increased risk of frost damage
- Adapted varieties?
- Availability of nursery plants
- Economics?
  - Increased crop value
    - Yield?, fruit quality, price
  - Increased establishment costs
  - Reduced labor required
  - Increased risk

Perennial Plasticulture?

- Renovate
  - Mow leaves
  - Break out old crowns
  - Fertilizer and irrigate to promote new branch crowns
  - Keep runners removed
- Probably good for a 2nd year

Comparing systems: Eastern US

Comparison of harvest data among conventional matted row, advanced matted row and plasticulture. There were 8 total harvests in 2003, and 6 in 2004.

Treatment	Marketable Yield	Fruit Size	Culls
2003	(lbs/acre)	(g)	(%)
Matted Row	19,484a[z]	18.3a	33.1a
Advanced Matted Row	14,818b	16.8a	32.0ab
Plasticulture	13,212b	22.9b	21.4b
2004			
Matted Row	11,233a	11.9a	23.9a
Advanced Matted Row	10,056a	11.0a	25.9ab
Plasticulture	6,781b	11.0a	32.5b

[z]Means followed by different letters are significantly different at 5% level

Conclusions

Without sprinklers or tunnels for frost protection (only floating row covers), annual hill plasticulture was not profitable in northern Utah.

Recommendation (pick an extreme):

1. Low-input matted row in the field
2. High input plasticulture in high tunnels.

Which cultivar? – From western experience (NM)

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January 2019 Horticulture/Fruit/2019-01

Strawberry Cultivars for the Intermountain West – Research Report

Tiffany Maughan and ***Brent Black***
Utah State University

Shengrui Yao and ***Robert Flynn***
New Mexico State University

There are many challenges facing strawberry growers in the Intermountain West. High pH soils,

which equates to approximately 1.13 lbs/plant in a black plastic hill planting system, and about 16,700

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Protected Cultivation of Strawberry

In this talk we will be going over low tunnel, high tunnel, and soil heating as protected cultivation methods used in Utah strawberry production. Brief methodology of each system and presentation of research findings will be included.

Tiffany Maughan
USU Extension Research Associate
Utah State University Extension
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Tiffany is an extension research associate for Utah State University. Her work primarily includes composing fruit, vegetable, and flower fact sheets, collaborating on horticultural research projects, and maintaining the Production Horticulture website. She is also the owner of a small cut flower farm, Hammock & Spade Flowers. Tiffany graduated from USU with a B.S. in horticulture in 2012 and a M.S. in plant science in 2013.

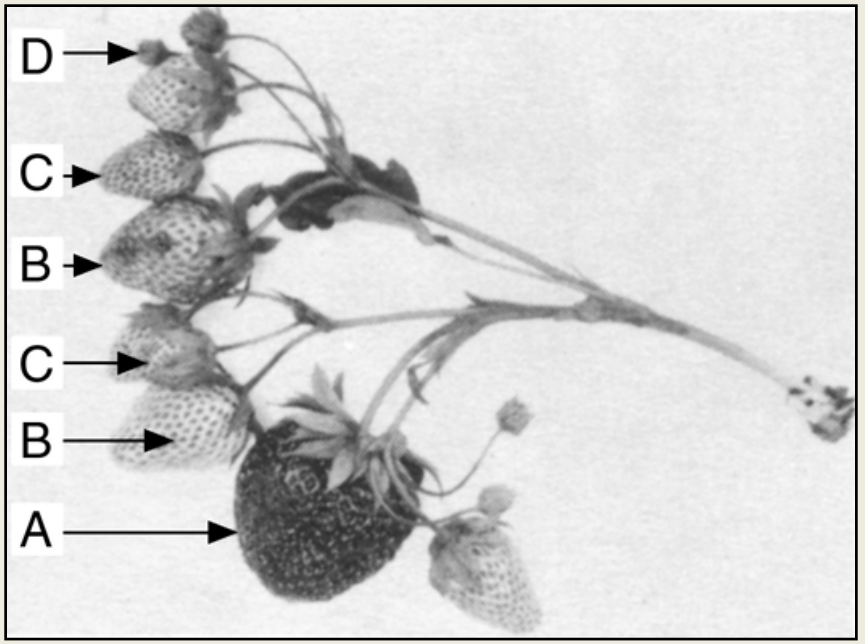
Protected Strawberry Cultivation

Tiffany Maughan

Utah State University

Spring Frosts

- Blossoms damaged at 30 ˚F
  - Once they’re gone, they’re gone
  - Find way to provide frost protection
  - Increase yield to compensate for extra costs



Frost Protection Options

- Sprinklers
- Floating Row covers
- Low Tunnels

- High Tunnels
- High + Low Tunnels
- Supplemental Heat

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High Tunnel Site Selection: Factors to consider

- Size/Shape
- Sunlight
- Accessibility
- Soil
- Wind

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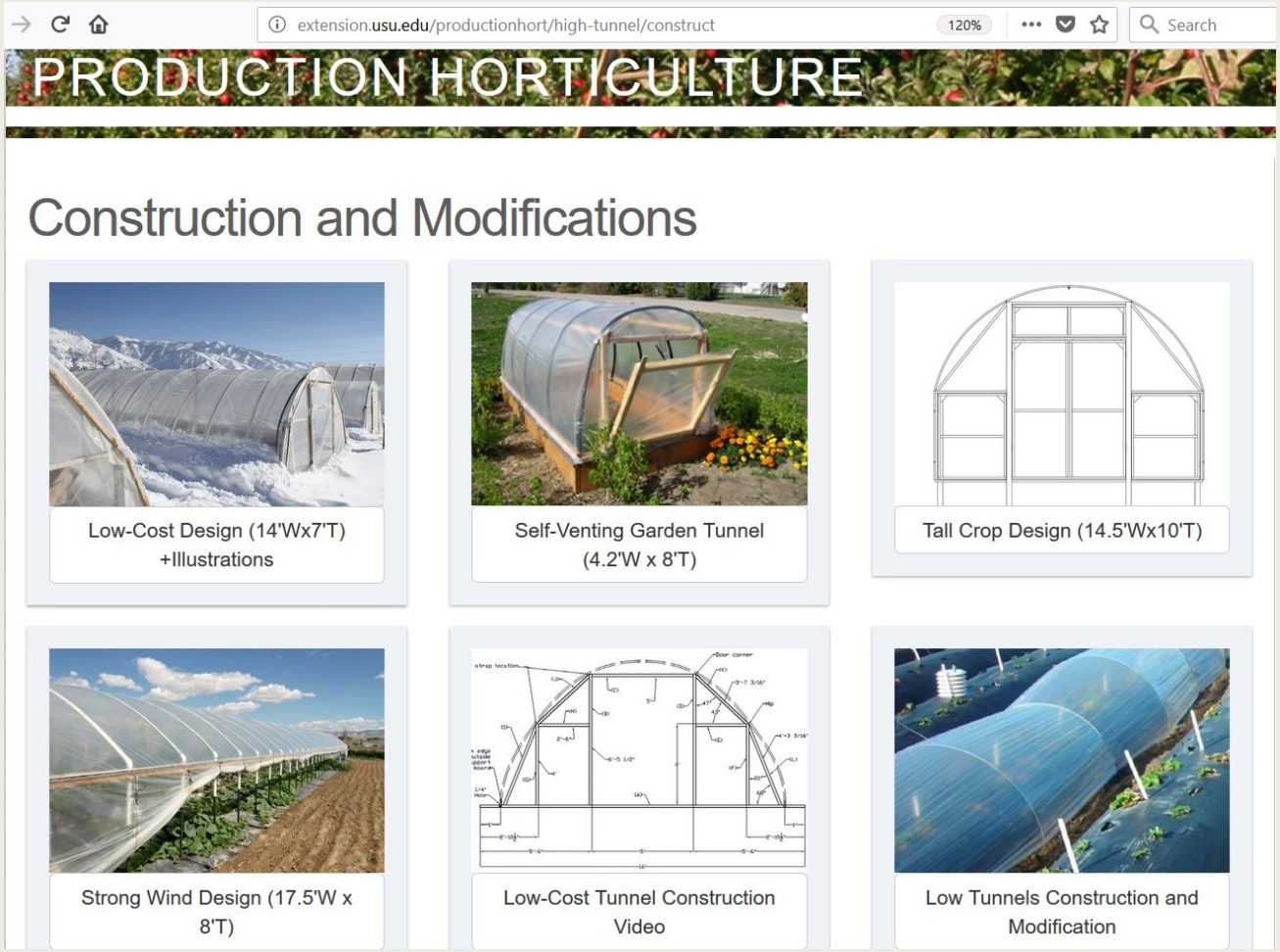
DIY USU Designs: tunnel.usu.edu



- Low-Cost (14’Wx7’T)
- Small garden (4.2’Wx8’T)
- Tall Crop (14.5’Wx10’T)
- Strong Wind (17.5’Wx8’T)
- Low Tunnels

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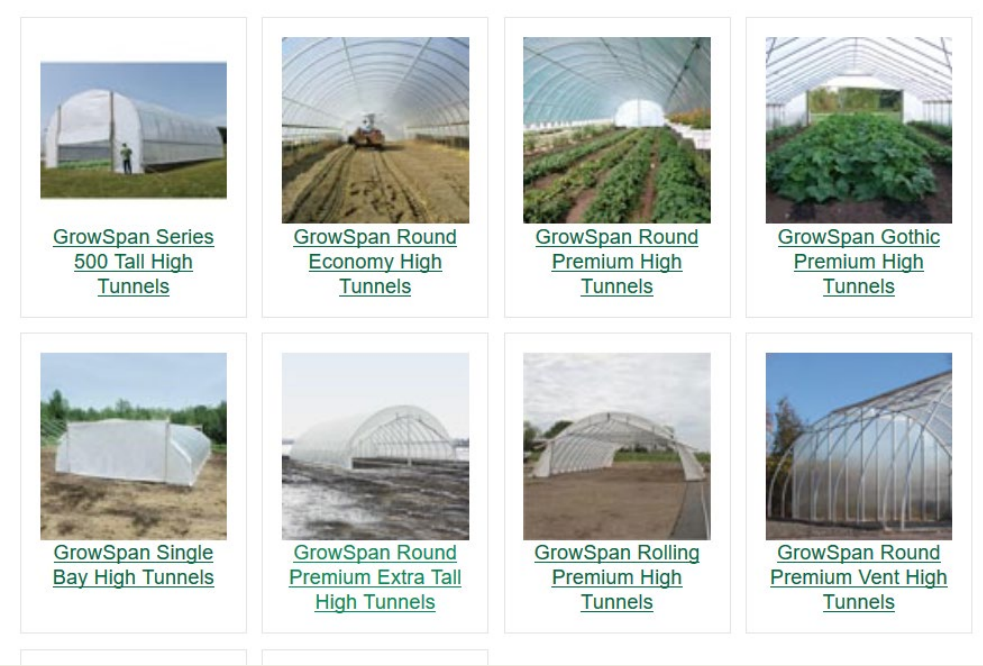
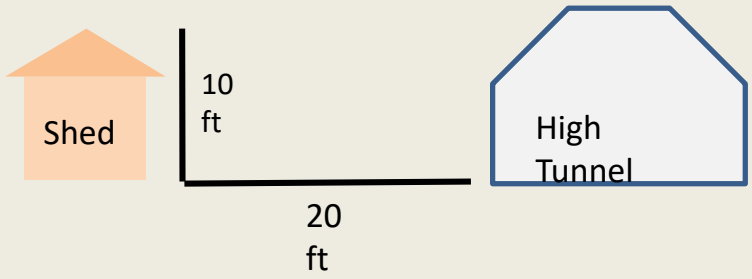
Commercial High Tunnel Kits

- Many options
- $$
- Good places to start looking:
  - FarmTek
  - Haygrove
  - Poly-Tex
  - Rimol



Sunlight: Shade

- Sunlight one of the most important factors
- Other structures
  - Buildings
    - Set HT back 2 to 2.5 times the height of building
  - Trees
- Proximity to other HT
  - N/S High tunnels can be placed closer together than E/W



Access

- High tunnels require daily monitoring
- Proximity to house/main building
- Year-round access
- Equipment access
- Electricity
  - Optional
- Water

Electricity Alternative

- Power source (solar)
- Deep-cycle battery
- Voltage regulator
- 12-volt electric motor

- In this case used to roll up sides

Access: Water

- 3 or 4 season growing
- Culinary
- Filtered Secondary
  - Drip Irrigation

Wind

- Face endwalls toward the prevailing wind
  - Smaller surface area exposed to winds
- Strength

Low Tunnel, High Tunnel & Supplemental Heating

- 6 years of USU strawberry research
- Greenville Research Farm, N. Logan, UT.
- Annual hill system
  - Matted Row?

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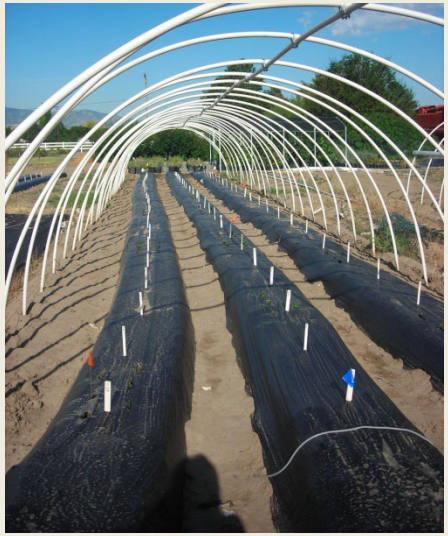
Annual Hill Setup

- Raised beds
- Drip Tape Irrigation
- Black plastic



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Annual Hill Systems

Early Spring Production

- Fall planted
- Dormant or plug plants
- Winter care
  - Runner and flower removal
  - Temperature management
- Earlier spring production

Fall Production

- Spring planted
- Dormant plants
- Summer care
  - Runner removal
  - Temperature management
- Push production into fall

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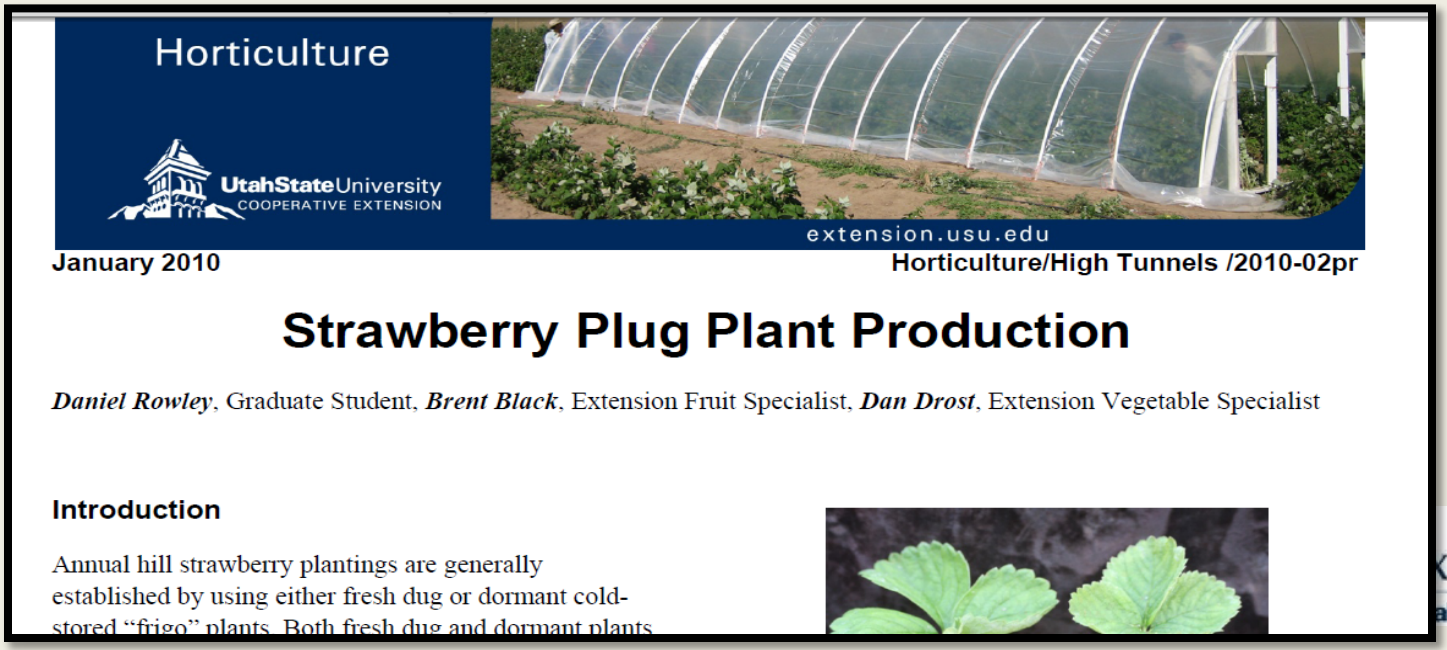
Nursery Plant Type Introduction

- Nursery plant types
  - Plug
  - Dormant
- tunnel.usu.edu



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January 2010

Horticulture/High Tunnels /2010-02pr

Strawberry Plug Plant Production

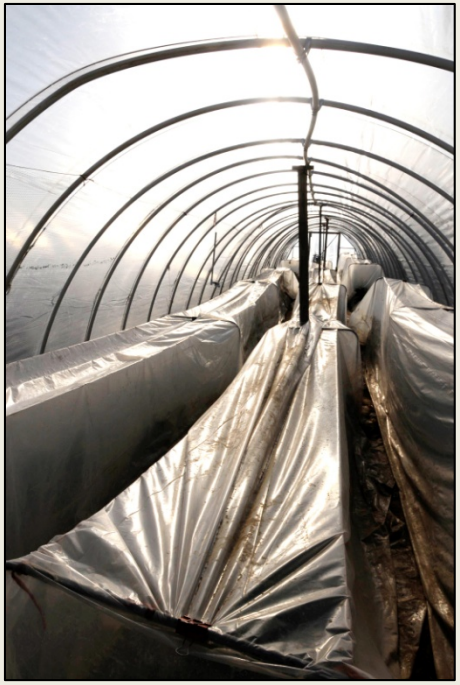
Daniel Rowley, Graduate Student, ***Brent Black***, Extension Fruit Specialist, ***Dan Drost***, Extension Vegetable Specialist

Introduction

Annual hill strawberry plantings are generally established by using either fresh dug or dormant cold-stored "frigo" plants. Both fresh dug and dormant plants

Low Tunnels

- Can be used alone or with a high tunnel
- Different Designs



May 2014 Horticulture/HighTunnels/2014-03

Low Tunnels

A Low-Cost Protected Cultivation Option

Tiffany Maughan, *Brent Black*, and *Dan Drost*

Short growing seasons and early spring frosts can limit some fruit and vegetable production in the

than the outside air temperature (Wien et al., 2006; Maughan, 2013) (Figure 1).

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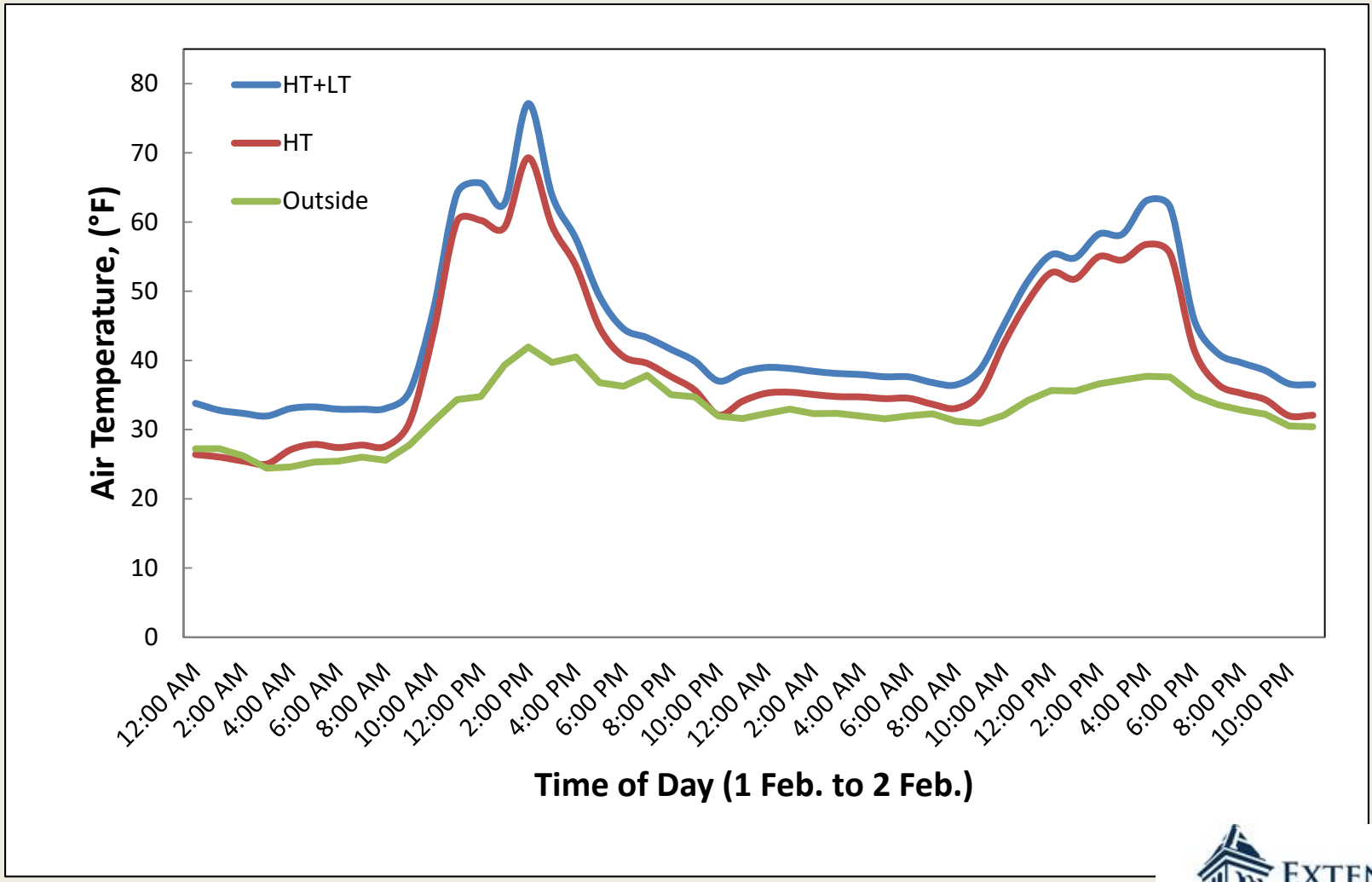
Ventilation Critical For Temperature Management



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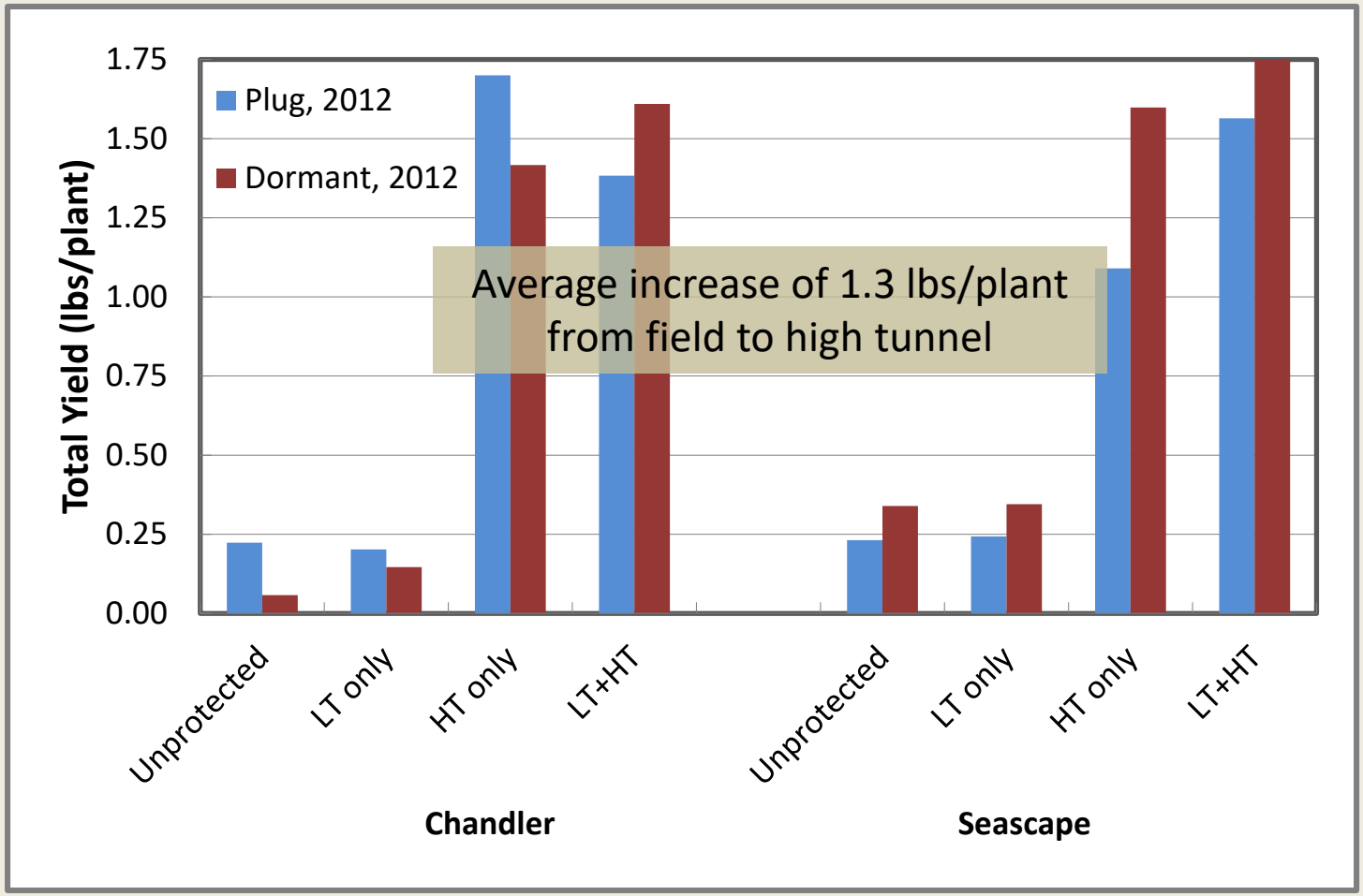
Compare low tunnel to high tunnel protection



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Low Tunnel within High Tunnel Effect

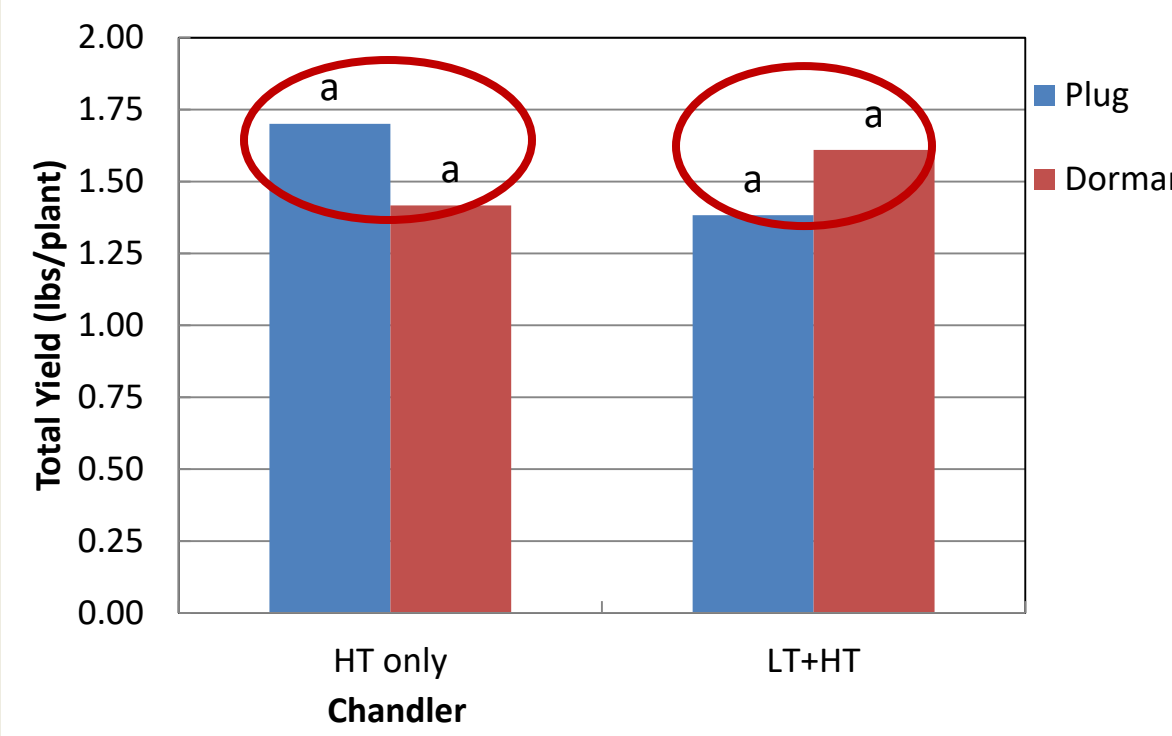
High tunnel only

vs

High tunnel + Low tunnel (HT+LT)

No significant difference between HT and HT+LT total yield

However, LT moved production forward by an average of 14 days.



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Enterprise Budget for High Tunnel Strawberry Production

		1- 96 ft tunnel (27.3 m)		
Revenues	Units	Quantity	Unit Price	Total
Early Out-of Season Strawberries	1 lb clamshells	373	$6.00	$2,238.70
In-Season Strawberries	1 lb clamshells	472	$4.50	$2,122.61
Total Revenues				**$4,361.31**
Operating Expenses				
Total Supplies				$565.06
Labor				
Total Labor				$1,545.00
Total Operating Expenses (supplies and labor)				$2,110.06
Fixed Expenses (Depreciation)				
Total Fixed Expenses				$306.98
Total Expenses				**$2,417.04**
Net Income				**$1,944.27**

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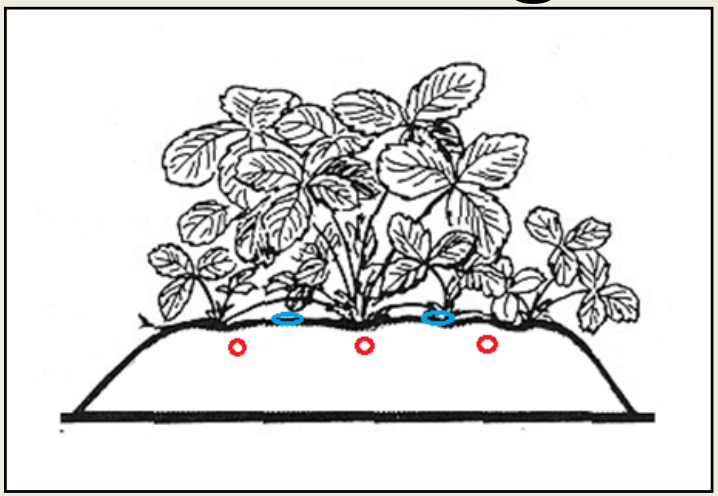
In-ground Supplemental Heating



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Effect of supplemental heating on total yield

		Plug	Dormant
		lbs/plant	lbs/plant
Chandler	HT only	1.70a	1.42b
	HT+LT	1.38b	1.61b
	45F+HT+LT	1.99a	1.90a
	60F+HT+LT	2.04a	2.12a
Seascape	HT only	1.09c	1.60b
	HT+LT	1.57b	2.24a
	45F+HT+LT	1.29b	2.35a
	60F+HT+LT	1.38b	2.07a

Numbers within a column followed by same letter are not significantly different at P=0.05.

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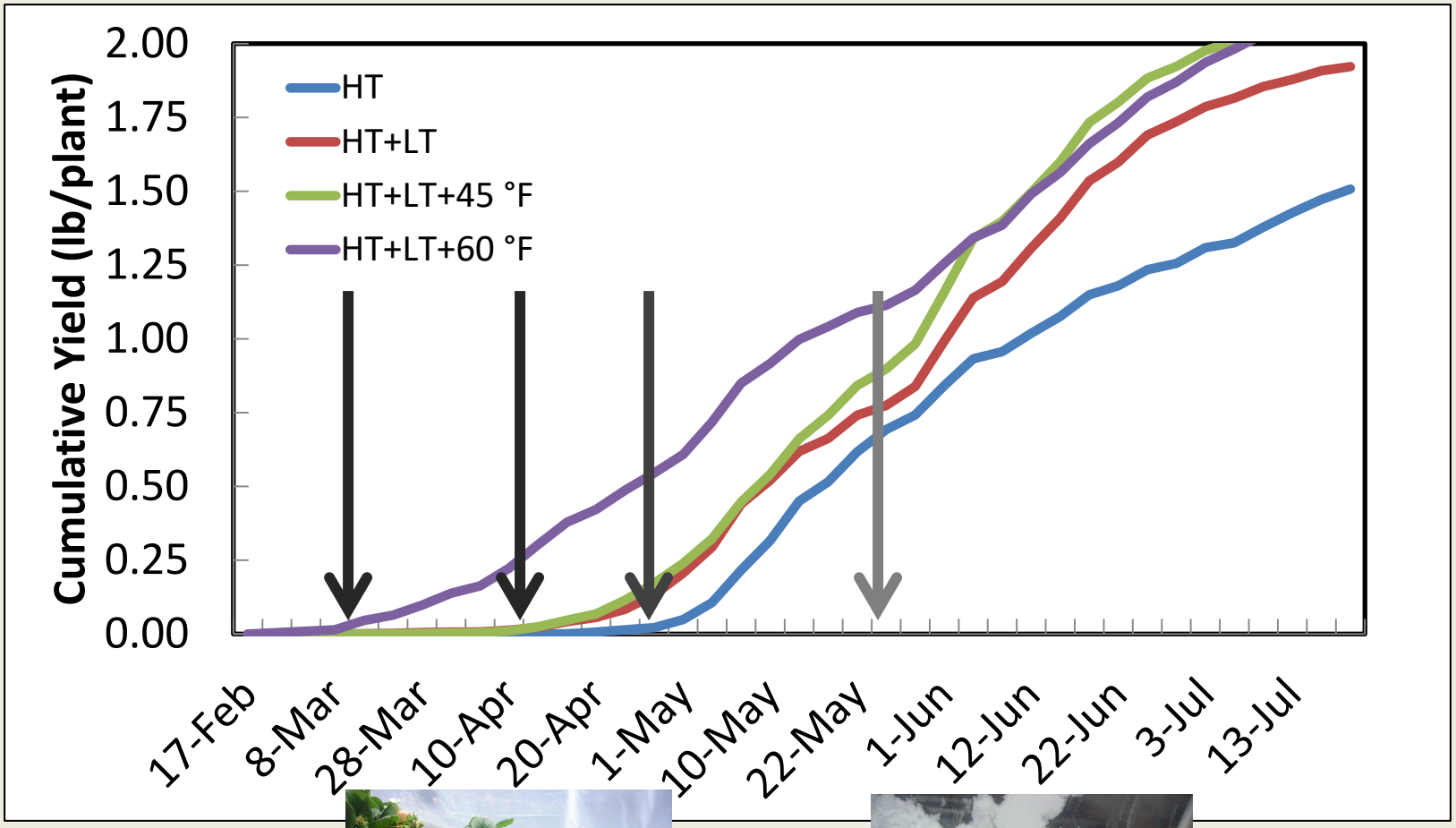
Another Look at Supplemental Heating



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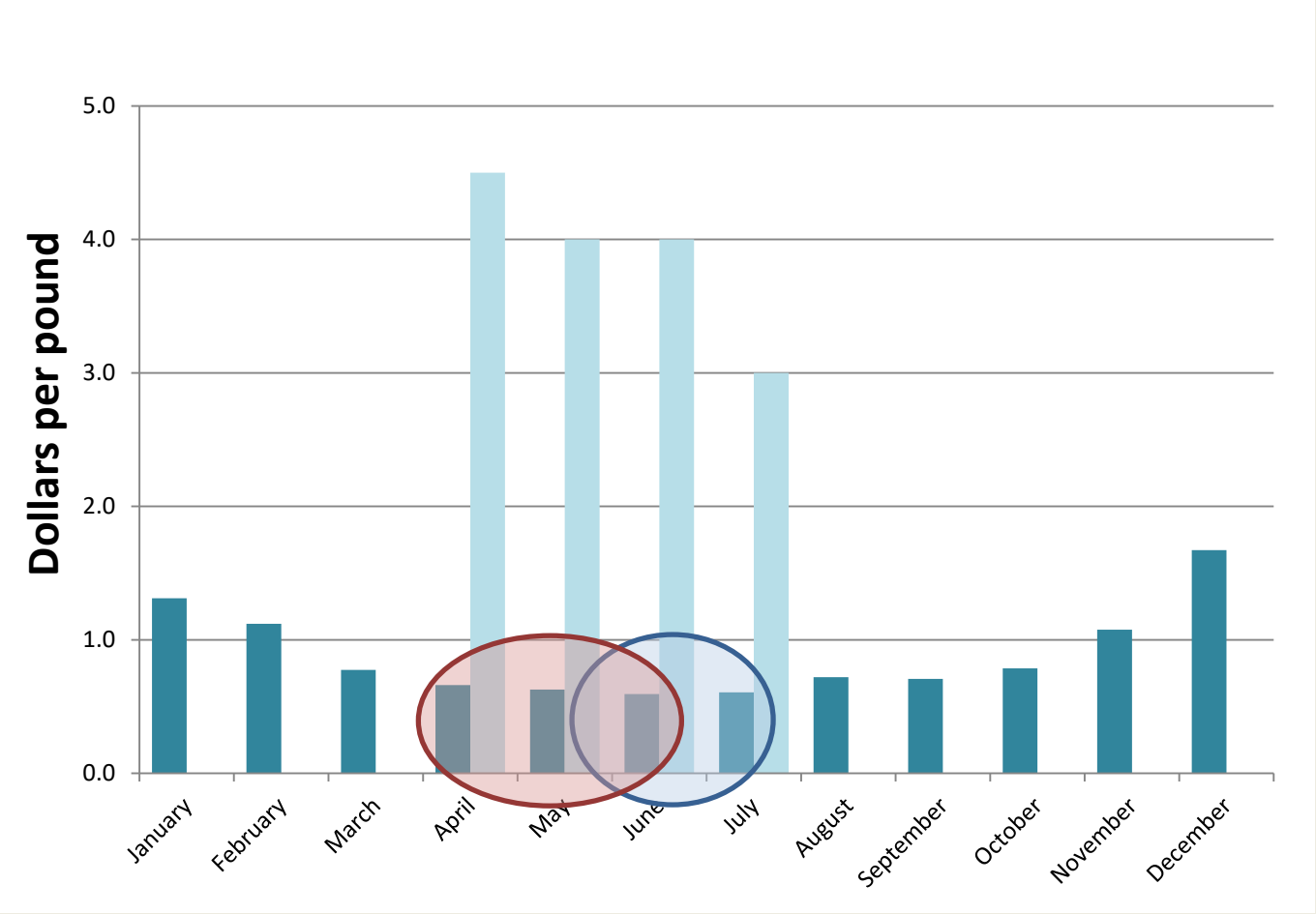
Wholesale vs Local Market Prices



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Market Considerations

- Season extension
  - Early Spring Strawberries

- Do you still have a market?

Utah Agricultural Experiment Station

USDA
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Risk Management Agency

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Raspberry Production 101

General overview of growing and producing raspberries for beginning farmers including variety selection and productivity.

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Sheriden Hansen is an Assistant Professor of Horticulture with USU Extension in Davis County, Utah. Sheriden started as a nurse, receiving a BS in nursing from the University of Utah in 2002. After many years working as an operating room RN, she decided to pursue her passion in horticulture. Sheriden graduated from Utah State University with a BS in Plant Science (Summa Cum Laude) in 2015 and a MS in Plant Science with an emphasis in fruit production in 2017.

RASPBERRY BASICS

Sheriden Hansen

Assistant Professor, Horticulture

Utah State University Extension

RASPBERRY BASICS

How Raspberries Grow

Plant Selection

Site Prep & Planting

Floricane vs. Primocane

Management

Pruning

Harvest

Resources & Questions

HOW RASPBERRIES GROW

- Perennial root system
- Biennial cane growth
  - Canes live 2 years
  - New canes from roots (spread)
  - Second-year canes do not grow taller

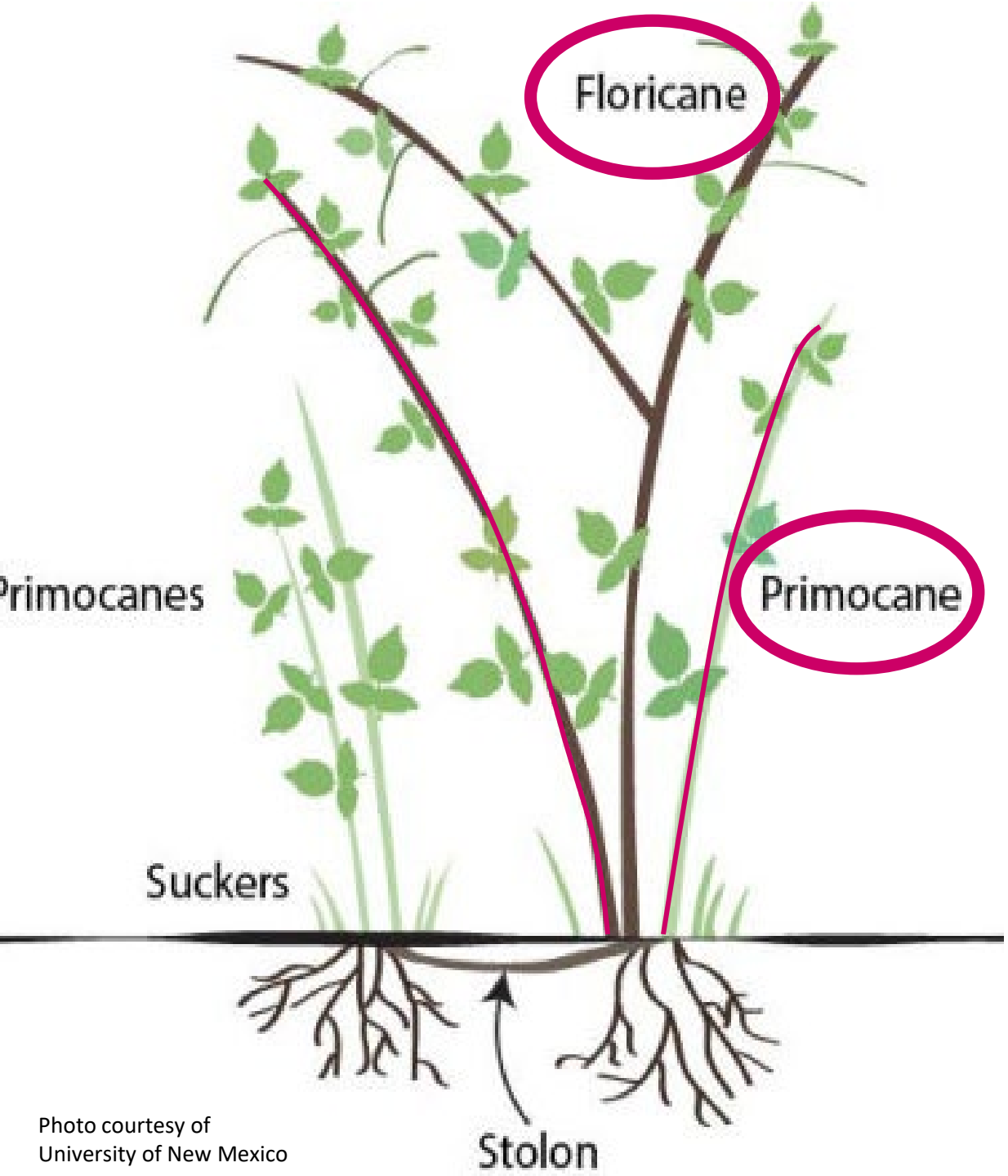


Photo courtesy of
University of New Mexico

PRIMOCANE vs. FLORICANE

- First year cane – **PRIMOCANE**
- Second year cane – **FLORICANE**

- Management for both types is different

- While floricanes are producing fruit, primocanes are growing…

PRIMOCANE TYPES

- Flowers and fruit at the tip of the cane
  - Fruit from top to bottom of cane

- “fall-bearing”, “ever-bearing”, “double cropping”
  - Produce fall crop of berries
  - Top third of the cane
  - Winter dormancy
  - Potential to produce a second crop the following summer on floricanes

FLORICANE TYPES

- Floricane types fruit in early summer

- “summer-bearing” or “June bearing”
  - Single summer crop of berries
  - Only produce on floricanes

PLANT SELECTION

- Bare root plants = excellent spring plantings
  - Larger selection
  - Usually high quality
- Potted plants = good later season plantings
  - More expensive
  - Selection may not be as broad
  - Sometimes quality can vary

PLANT SELECTION

- Certified virus-free stock
- Don’t share plants
- Select varieties that perform well in your area
  - **Primocane** - longer seasons and warm prolonged falls
  - **Floricane** - high elevations, shorter seasons, cooler temperatures

PLANT SELECTION

- Variety traits to consider:
  - Yield
  - Fruit size
  - Harvest dates
  - Consumer preference

KAYSVILLE VARIETY TRIALS

Floricane – FRUIT SIZE

Table 4. Fruit size at peak harvest. (g/fruit)

Cultivar	2008	2009	2010	Mean
Cascade Delight	2.9	2.4	2.4	2.6
Tulameen	2.6	1.7	2.4	2.2
Cowichan	2.1	2.0	2.3	2.2
Royalty	2.4	1.5	2.2	2.0
Titan	1.9	1.9	2.2	2.0
Willamette	2.0	2.2	1.8	2.0
Georgia	2.3	1.8	1.8	2.0
Chemainus	2.2	1.8	1.9	2.0
Cascade Bounty	1.6	1.6	2.2	1.8
Coho	2.4	1.4	1.6	1.8
Cascade Dawn	1.6	1.9	1.8	1.8
Moutere	2.0	1.6	1.7	1.8
Reveille	2.1	1.8	1.4	1.8
Saanich	1.9	1.4	1.8	1.7
Canby	2.0	1.7	1.4	1.7
Lauren	1.7	2.1	1.3	1.7

Table 1. Floricane fruit size at peak harvest. (g/fruit)

	2013	2014	2015	Mean
Octavia	2.68	2.38	3.03	2.70
C. Gold	0.00	3.55	2.98	2.18
Prelude	1.58	2.58	2.13	2.10
Nova	1.85	2.05	2.28	2.06
Chemainus	1.75	2.23	1.75	1.91
ORUS 1142-1	1.53	2.78	1.30	1.87
C. Bounty	1.55	1.80	1.65	1.67

KAYSVILLE VARIETY TRIALS

Floricane - YIELD

Table 2. Yield of summer bearing raspberries, expressed as pounds of fruit per row foot (lbs/ft).

Cultivar	2008	2009	2010	Mean
Royalty	0.97	1.83	1.49	1.43
Cascade Bounty	0.57	1.80	1.38	1.25
Georgia	0.76	1.64	1.22	1.21
Reveille	0.53	1.92	1.16	1.20
Chemainus	0.35	1.92	1.20	1.16
Cowichan	0.47	1.62	1.05	1.04
Canby	0.35	1.55	1.12	1.00
Saanich	0.28	1.50	1.14	0.97
Cascade Delight	0.26	1.49	1.15	0.97
Moutere	0.29	1.44	0.99	0.91
Titan	0.27	1.58	0.70	0.85
Willamette	0.19	1.14	0.84	0.72
Tulameen	0.12	1.21	0.75	0.69
Cascade Dawn	0.07	0.97	0.92	0.65
Coho	0.03	0.79	0.61	0.48
Lauren	0.09	0.51	0.27	0.29

Table 2. Yield of floricane raspberries, expressed as pounds of fruit per row foot (lbs/ft).

	2013	2014	2015	Mean
Prelude	0.36	3.20	1.70	1.75
Nova	0.99	1.86	1.71	1.52
C. Bounty	0.96	1.83	1.22	1.33
Chemainus	0.19	1.03	0.81	0.68
C. Gold	0.00	0.68	0.51	0.60
Octavia	0.26	0.66	0.66	0.53
ORUS 1142-1	0.03	0.39	0.49	0.30

KAYSVILLE VARIETY TRIALS

Floricane – WINTER SURVIVAL

Table 1. Winter survival of summer-bearing raspberry cultivars at the USU Kaysville Research Farm. Values are percent floricane survival.

	2007	2008	2009	2010	2011	Mean
Royalty	100	100	100	100	90	98
Cascade Bounty	93	100	100	96	90	96
Moutere	88	100	100	99	88	95
Reveille	99	100	99	99	73	94
Cowichan	97	100	100	99	74	94
Georgia	100	100	100	96	68	93
Cascade Dawn		100	99	98	68	91
Cascade Delight		100	99	98	64	90
Saanich	82	100	94	98	68	88
Canby	53	100	94	97	75	84
Chemainus	90	100	92	99	22	81
Willamette	64	100	84	78	59	77
Tulameen	88	100	87	82	16	75
Titan	25	100	99	90	40	71
Lauren	49	100	81	42	20	58
Coho	23	100	80	50	30	57

KAYSVILLE VARIETY TRIALS

Floricane – 20% HARVEST DATES

Table 3. Floricane fruiting season, based on the average date at which 20% of the total season's yield was harvested.

	2013	2014	2015	Mean
Prelude	29-Jun	23-Jun	16-Jun	22-Jun
Nova	5-Jul	1-Jul	27-Jun	1-Jul
C. Gold	n/d	3-Jul	5-Jul	4-Jul
C. Bounty	9-Jul	6-Jul	7-Jul	7-Jul
Chemainus	12-Jul	6-Jul	9-Jul	9-Jul
ORUS 1142-1	8-Jul	16-Jul	5-Jul	9-Jul
Octavia	29-Jul	22-Jul	20-Jul	23-Jul

KAYSVILLE VARIETY TRIALS

Primocane – FRUIT SIZE

Table 1. Average fruit size (g/fruit)

	Mean
Anne	2.94
Ruby	2.73
Joan J	2.71
Caroline	2.67
Polka	2.62
Himbo Top	2.55
Jaclyn	2.41
Polana	2.24
Heritage	2.12
Summit	1.51

Table 2. Primocane fruit size at peak harvest. (g/fruit)

	2013	2014	Mean
Joan J	3.53	2.99	3.26
Josephine	3.65	2.63	3.14
Brice	3.35	2.62	2.98
A. Britten	3.03	2.60	2.81
Autumn Bliss	3.05	2.45	2.75
Polana	3.03	2.12	2.57
Dinkum	2.65	2.19	2.42
Autumn Treasure	2.48	2.18	2.33
Vintage (2786-5)	1.93	2.00	1.96

KAYSVILLE VARIETY TRIALS

Primocane – YIELD

Table 5. Yield of primocane raspberries, expressed as pounds of fruit per row foot (lbs/ft).

	2013	2014	Mean
Joan J	2.29	2.80	2.55
Polana	1.47	2.07	1.77
Autumn Bliss	1.23	1.66	1.45
Dinkum	0.82	1.12	0.97
A. Britten	0.67	1.05	0.86
Brice	0.48	1.07	0.78
Josephine	0.33	1.03	0.68
Vintage (2786-5)	0.49	0.82	0.66
Autumn Treasure	0.04	0.48	0.26

KAYSVILLE VARIETY TRIALS

Primocane – 20% HARVEST DATE

Table 6. Primocane fruiting season, based on the average date at which 20% of the total season's yield was harvested.

	2013	2014	Mean
Autumn Bliss	31-Aug	1-Aug	16-Aug
Joan J	3-Sep	3-Aug	18-Aug
A. Britten	4-Sep	4-Aug	19-Aug
Polana	2-Sep	6-Aug	19-Aug
Dinkum	4-Sep	6-Aug	20-Aug
Vintage (2786-5)	7-Sep	14-Aug	26-Aug
Brice	6-Sep	21-Aug	29-Aug
Autumn Treasure	11-Sep	23-Aug	1-Sep
Josephine	12-Sep	3-Sep	7-Sep

KAYSVILLE VARIETY TRIALS

Primocane – CONSUMER PREFERENCE

Table 2. Fruit quality and consumer preferences ratings of 10 fall-bearing raspberries. Varieties are listed according to overall preference by the taste panel.

	Taste panel ratings 2008 (1-5)				Consumer rating 2011 (% of votes)	
Cultivar	Firmness	Appearance	Flavor	Preference	8-Sept.	22-Sept.
Anne	4.0	4.1	4.1	4.4	34.8	21.3
Polka	4.2	4.9	3.9	4.2	22.7	18.4
Heritage	4.1	4.0	3.8	3.4	9.4	11.0
Joan J	3.8	4.3	3.2	3.0	9.4	10.3
Jaclyn	2.9	3.3	3.1	2.9	7.0	7.7
Himbo Top	3.3	3.4	2.6	2.7	4.3	5.5
Polana	3.2	3.7	3.0	2.7	3.9	5.7
Summit	3.2	3.0	2.6	2.6	2.0	5.2
Ruby	3.9	4.0	2.8	2.4	n.a.	7.7
Caroline	3.8	4.6	2.8	2.3	6.6	7.2

SITE SELECTION

- Full sun = 8 hours direct sunlight
- Low wind
  - Winter wind = ⬇ cane survival
- Afternoon shade = prevention of sunburn
  - Shade cloth
  - Applied when fruit start to form

Primocane types: susceptibility to sunburn

Table 3. Susceptibility to common problems

	Sunburn (%)		Horntail injury*
Ruby	14.4	a	0.7
Heritage	13.9	a	0.9
Himbo Top	11.9	ab	0.8
Caroline	11.9	ab	0.6
Anne	11.3	abc	1.0
Polka	9.3	abcd	0.6
Summit	8.3	bcd	0.6
Joan J	6.3	cd	0.7
Polana	6.0	d	0.4
Jaclyn	5.8	d	0.6

SOIL PREPARATION

- Raspberry roots – top 20” soil
- Well draining soil
  - Root rots
  - Soil pathogens
- Heavy soils
  - Hilling beds (10-12”)
  - Raised beds (smaller operations)
  - Addition of OM

Photo from: André Bolay, St. Fédér. de Recherches Agronomiques de Changins, Bugwood.org

WEED CONTROL

- Control before planting
  - Two herbicide applications 30 days apart
  - Weed barrier, mulches
- Weeds can be difficult to control
  - Herbicide use limited for perennial weeds
  - Crop damage
  - Higher risk for pests/diseases

PLANTING

- Raspberries grow by root suckering
  - Rows will fill in
- Plant in manageable rows
- Row spacing to accommodate equipment
  - Usually about 8-feet between rows
  - Tractor
  - Mower

PLANTING

- Soak bare root plants in water 1-2 h.
- Bare root should be planted as soon as soil is workable
- Plant at same level as previously planted
  - Soil line
- Trim broken roots
- Spread roots along the row, cover
- Water immediately

PLANTING

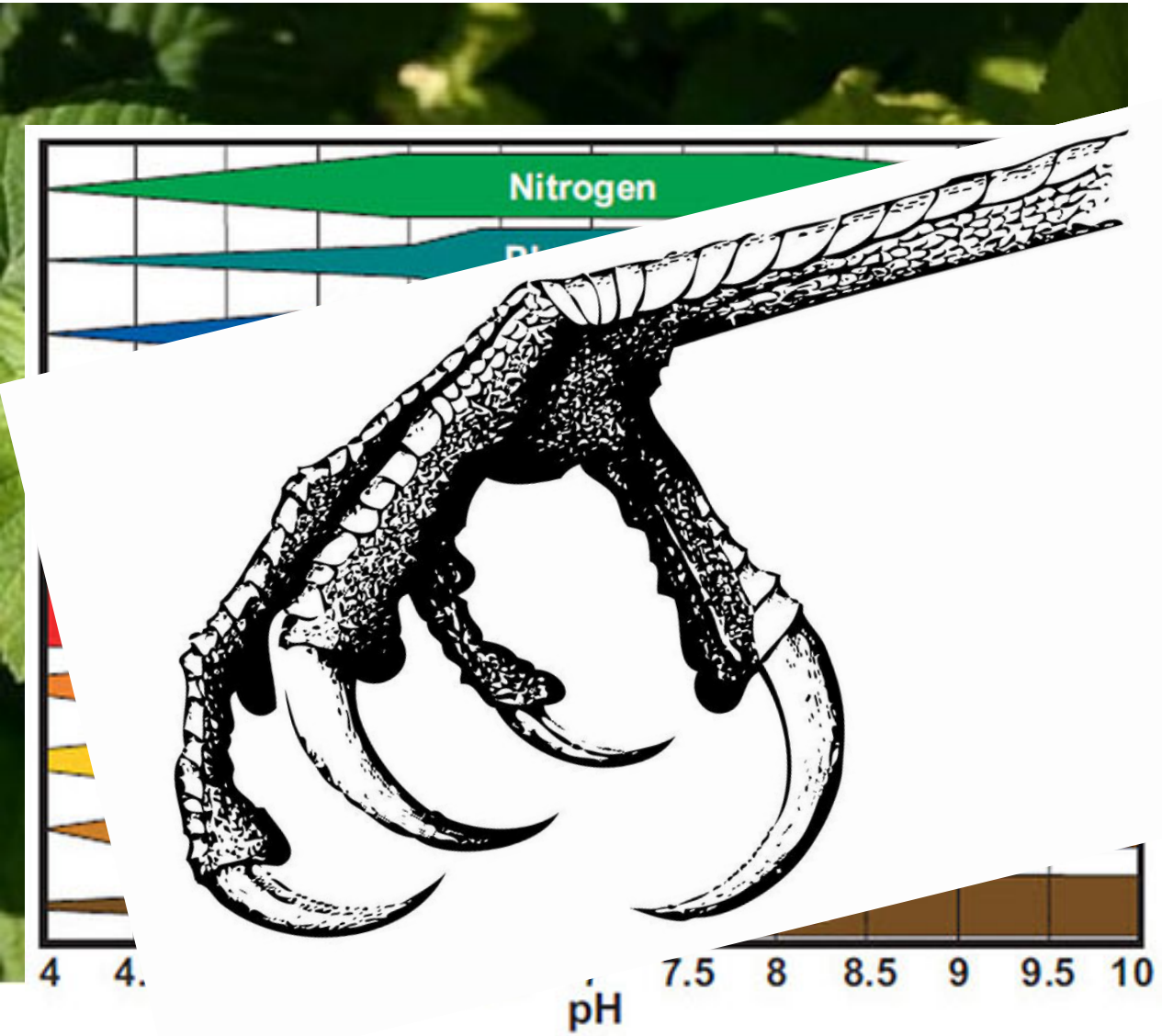
During first 6 weeks:

- Watering is critical
- Weed control
  - Weeds will compete for H_2O & nutrients
  - Slow establishment
  - Grass alleyways & mulches
  - Cultivation can damage developing roots

MANAGEMENT: FERTILIZATION

- Nitrogen (N) – most critical nutrient
- Adequate N – produce long canes
- 3-5 lbs of urea (45-0-0) or ammonium sulfate (21-0-0) per 100 row feet
  - 150-275 pounds of fertilizer/acre
  - Apply early spring
- Soil test for additional nutrients

MANAGEMENT: CHLOROSIS



- Iron Chlorosis
  - Iron deficiency
  - Interveinal yellowing
  - Burning of leaf margins
  - Weakens plants
- Isn't there plenty of iron in Utah soils?
  - High soil pH makes iron unavailable
- Treatment
  - Avoid excessive N & excessive water
  - Add chelated iron supplement spring & fall

MANAGEMENT: IRRIGATION

- Irrigation
  - Wait to irrigate in spring until top foot of soil is dry
  - Wet soils ---> iron chlorosis, root diseases, root death
- Apply 1-2 inches of water per week
  - Increase water during:
    - Fruiting
    - Hot summer months
- Apply mulches late in spring
  - Bark, straw, sawdust, bark chips, compost

MANAGEMENT: TRELLISING

- Reduces cane breakage
- Easier harvests
- Clean fruit
- Several systems for trellising
  - T-trellis
  - I-trellis

PRUNING FLORICANES

- Only produce on 2-year-old canes
- Prune during dormant months
- Four steps to pruning:
  1. Remove spent canes at ground level
  2. Narrow rows by cultivation – tiller or tractor
  3. Thin remaining canes to 4-6 canes per foot of row (remove weak/damaged)
  4. Topping canes = less fruit but larger

PRUNING PRIMOCANES

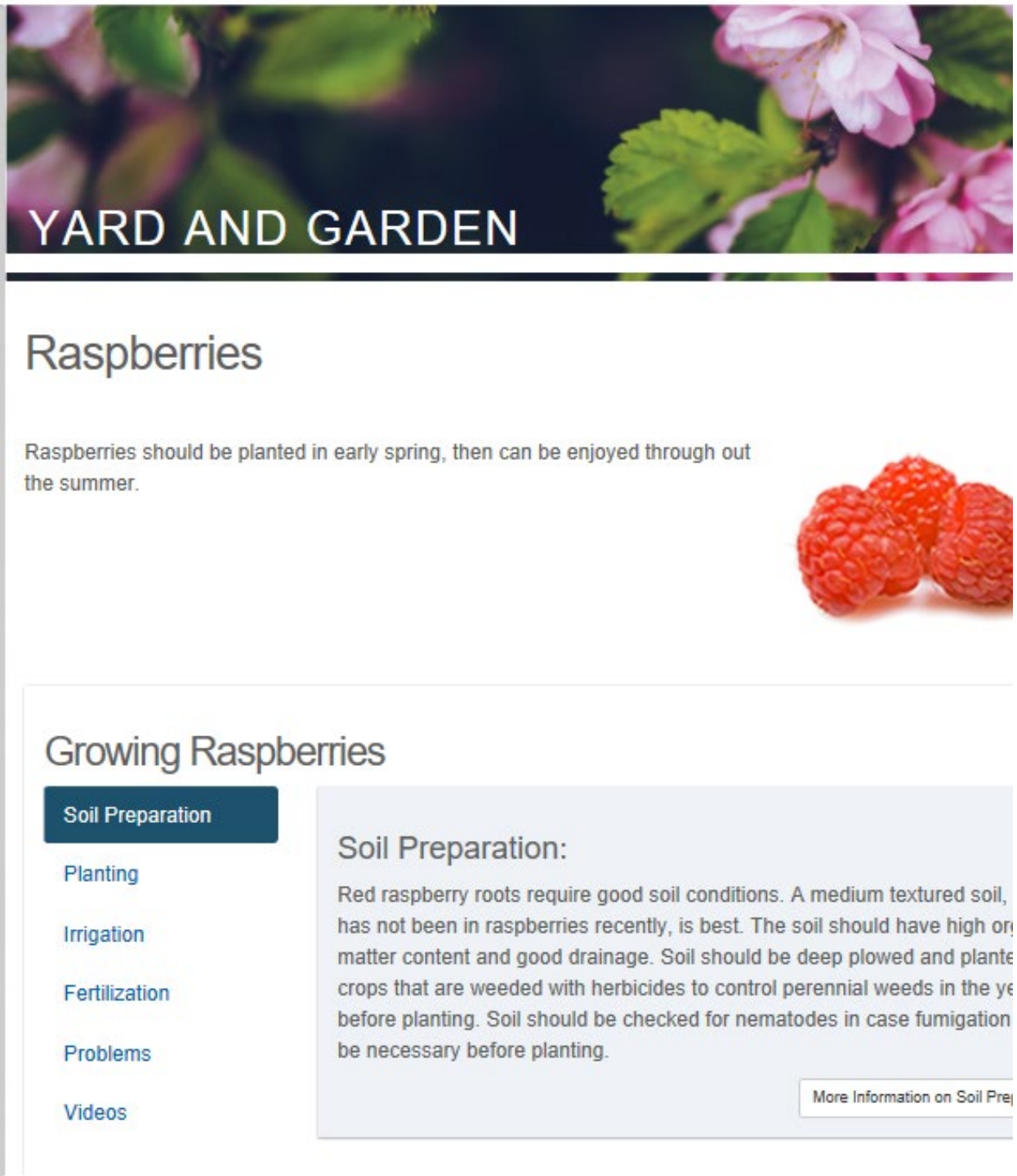
Two ways to prune:

- Single fall crop
  - Prune all canes to the ground after fall harvest
  - Narrow rows by cultivation
- Everbearing – summer and fall crop
  - Results in a smaller fall crop
  - Prune the same as floricanes step 1-4

HARVESTING

Harvested over a 2 to 4 week period

- Berry quality is the biggest issue
  - Berries can degrade quickly
- Pick every 2 days
  - Early morning
  - Directly into clam shells
  - Chill immediately
  - Store up to 5 days



RESOURCES and QUESTIONS

Utah Berry Grower's Association:

- Newsletters
- https://berry.usu.edu (click on UBGA)

USU Raspberry Production

- Garden.usu.edu → Raspberry
- Fact sheets, variety trials

FACT SHEETS

Iron Chlorosis in Berries:

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1710&context=extension_curall

Using Shade for Fruit & Vegetable Production:

https://extension.usu.edu/productionhort/files-ou/UsingShadeforFruitandVegetableProduction.pdf

Raspberry Production in High Tunnels:

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2883&context=extension_curall

How to Prune Raspberries (YouTube):

https://www.youtube.com/watch?v=WBMQri2m-E8

Blackberry Basics

Introduction to blackberry management systems.

Brent Black
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Dr. Brent Black is Professor and Extension Fruit Specialist at Utah State University. Prior to coming to USU in 2005, Dr. Black was a research scientist with the USDA Agriculture Research Service in Beltsville, Maryland, where he worked on production systems of strawberry and blueberry. Prior to USDA, he studied tree nitrogen metabolism at the University of Maryland in College Park. He holds a B.S. degree from Utah State University in Plant and Soil Science, an M.S. degree in Horticulture from Michigan State University, and a Ph.D. in Plant Physiology from Oregon State University. His current research interests are in high density orchard management, precision orchard irrigation, and strategies for extending the production season of berry crops.

Blackberry Basics

Dr. Brent Black
Extension Fruit Specialist
Utah State University

Blackberry Biology

- Growth
  - –Perennial roots and crowns
  - –Biennial canes
- Requirements
  - –More heat tolerant
  - –Tolerant of alkaline soils

Blackberry types

- Growth habit
  - Erect
  - Semi-erect
  - Trailing
- Stems
  - Thorny
  - Thornless

Blackberry biology

- Summer bearing

  Most commercial cultivars

- Fall bearing
  - Prime Jim and Prime Jan
  - Prime-Ark®45 (later than Jim or Jan)
  - Prime-Ark® Freedom (thornless)

Blackberry hardiness

Depends on cultivar

- Some erect and semi-erect types hardy to -20°F
  - Chester, Triple Crown, Illini Hardy
- Some erect types less hardy -10°F
  - Cheyenne, Shawnee, Cherokee, Arapaho
- Trailing types are least hardy (5 to 10°F)

- Time of cold exposure more important than temperature
  - Rapid fall cold snap

Blackberry hardiness

Horticulture

EXTENSION
UtahStateUniversity

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March 2018 Horticulture/Fruit/2018-02pr

Selecting Blackberry Cultivars for Utah

Brent Black, Thor Lindstrom, Britney Hunter, Shawn Olsen, Sheriden Hansen, and *Tiffany Maughan*

Introduction

Historically, Utah has not been a significant blackberry producer. This is likely due to harsh winters and frequent late spring frosts, which result in significant crop loss. Blackberry canes often suffer from some cold injury in Northern Utah, which typically results in loss of floricane buds, or dieback of the entire cane (Figure 1), although Utah winter conditions rarely cause permanent damage to the plant.

blackberries have primocanes that initially grow erect, but then branch and the side branches droop down to the ground. Erect blackberries are mostly self-supporting plants but still benefit from trellising.

For more detailed information on fruiting types and growth habits of blackberries reference our Blackberry Management fact sheet.

www.berry.usu.edu

www.fruit.usu.edu

Blackberry hardiness

. Winter cane survival of blackberry cultivars at the Kaysville Research Farm (% urvival).

cultivar	Year 2007	2008	2009	2010	2011	2012	mean	rank
Illini Hardy	100	90	93	95	93	90	93	1
Chester	73	73	93	95	72	93	83	2
Apache		67	75	98	92		83	3
Navajo	78	65	70	95	88	75	78	4
Arapaho	93	40	73	98	93	73	78	5
Tr. Crown		38	83	95	85		75	6
Hull	55	20	90	75	50	98	65	7
Ouachita	100	15	70	90	85	18	63	8
Doyle's	68	5	73	65	58	90	60	9
→ ORUS 1324		0	78	48	83	80	58	10
→ Loch Ness	35	15	85	60	73	78	58	10
→ Siskyou		17	58	90	50		54	12
→ B. Diamond		0	75	18	8	60	32	13
→ Obsidian	65	5	60	35	5	15	31	14
→ ORUS 1793		0	65	43	5	23	27	15
→ ORUS 1939		0	60	40	33	0	27	16
→ Metolius	0	0	30	38	5	55	21	17
→ Marion	50	15	38	12	0	5	20	18
Kiowa	10	0	45	25	5	13	16	19

Trailing types

Planting systems

Semi-erect blackberries

- Plants generally spaced 5-6’ within row and 10-12’ between rows
- Managed as individual plants
- Trellis
  - Large wooden posts, 25’ apart
  - Two wires at both 2’ and 4’ (can just use one)
  - One upper wire at 5’
- Top primocanes at 6’ during growing season
- In winter, tie canes to upper wire, top canes at 6’, and shorten laterals to 1.5 to 2’

Erect blackberries; floricane fruiting

- Plants generally spaced 2-4’ within row and 10-12’ between rows
- Managed as a hedgerow; root suckers should fill row
- Trellis
  - T-posts
  - Two lower wires, 1.5-2’ high and 1.5-2’ apart (optional)
    - Used to tie first year canes, which are trailing
  - Two upper wires 3.5’ high, and 3’ apart
- Top primocanes at 3-4’ during growing season
- Shorten laterals to 12-14” during dormant season

Erect blackberries; primocane fruiting

- Plants generally spaced 2-4’ within row and 10-12’ between rows
- Managed as a hedgerow; root suckers should fill row
- Trellis
  - T-posts
  - Two wires (or bailing twine) 1.5-2’ high and 1.5-2’ apart
- Tip primocanes when they reach 1.5’; tip laterals when they reach 1.5’
- Still experimenting with pruning and training for different areas

Trailing

Not hardy to Utah

Lay down and cover in winter

- Be careful not to pick immature fruit (black but sour)
  - Color development is complete before flavor development is finished

- Ripe fruit will separate from pedicel with gentle lift and twist

Blackberry yields

5’x12’ = 726 plants/acre

3 lbs/plant = 2,180 lbs/acre

Trailing types
Primocane fruiting

Blackberry yields (pounds per plant)

	2008	2009	2010	average	grade
Triple Crown	3.22	8.51	8.39	6.71	A+
Doyle's	2.94	8.96	5.07	5.66	A+
Hull	1.04	10.41	1.92	4.46	A-
Chester	0.90	6.99	3.07	3.65	B+
Illini Hardy	1.47	7.64	1.49	3.53	B+
Loch Ness	0.40	7.13	1.21	2.91	B
Ouachita		3.36	2.24	2.80	B
Arapaho	0.69	4.03	2.82	2.51	B-
Kiowa	0.71	4.30	0.95	1.99	C+
Navajo	2.09	2.58	0.78	1.82	C+
Apache	0.53	2.17	1.79	1.50	C+
1324	0.00	2.68	0.56	1.08	C
Prime Jim	0.60	1.37	1.05	1.01	C
Siskyou	0.01	1.84	0.80	0.88	C
Obsidian	0.00	1.93	0.60	0.84	C
Black Diamond	0.00	2.35	0.00	0.78	C
1793	0.00	1.58	0.66	0.75	C
Prime Jan	0.17	0.94	0.67	0.59	C-
1939	0.00	1.46	0.13	0.53	C-
Marion	0.02	0.89	0.00	0.30	D+
Metolius	0.01	0.35	0.41	0.25	D+

Blackberry fruit quality

Taste panel preferences among blackberry cultivars

	21-Jul-09	13-Jul-09	04-Aug-10	27-Aug-10	10-Sep-10	Average
1324	4.60	4.33	3.63	.	.	4.19
Triple Crown	.	3.57	4.11	4.17	3.80	3.91
Apache	.	4.40	.	3.6	3.57	3.86
Obsidian	3.82	.	.	.	.	3.82
Ouachita	3.50	4.20	4.14	3.33	.	3.79
Chester	.	4.00	.	3.5	3.06	3.52
1939	3.44	3.40	.	.	.	3.42
Hull	.	3.20	.	3.6	.	3.40
Black Diamond	3.91	2.75	.	.	.	3.33
1793	3.30	3.50	2.88	.	.	3.23
Navajo	.	3.60	.	2.75	.	3.18
Siskyou	3.00	3.75	2.67	.	.	3.14
Arapaho	3.00	3.40	3.33	2.6	.	3.08
Loch Ness	3.00	3.57	.	2.5	.	3.02
Marion	3.78	2.25	.	.	.	3.01
Kiowa	.	3.25	.	2.25	.	2.75
Doyle's	.	2.25	.	3.2	2.73	2.73
Illini Hardy	2.38	3.25	2.78	2		2.60
Metolius	.	.	.	2.4	.	2.40

Sunscald

Shading

Other Blackberry Relatives

- Dewberry: wild *Rubus* native to North America

Hybrids

- Loganberry (blackberry x raspberry)
  - Thorny
  - Growth habit **(and hardiness)** similar to trailing blackberry
- Tayberry (loganberry x raspberry)
- Boysenberry (loganberry x dewberry)
- Youngberry (blackberry x dewberry)
- Olallieberry (loganberry x youngberry)

Planting costs

- Establishment
  - Planted 3-5’ apart
  - Rows 10-12’ apart
  - 725 - 1450 plants/acre
  - $2,200 per 1000
- Trellis (2011 cost est.)
  - $3,400 materials
  - $800 labor

Should I grow them?

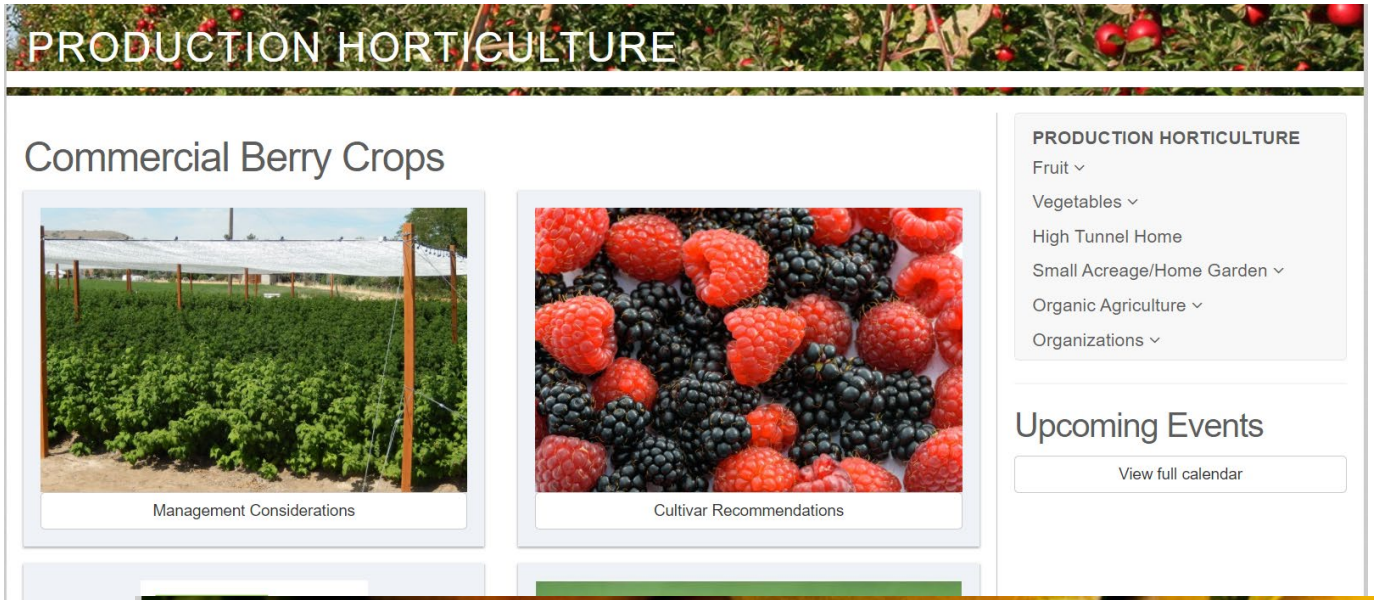
- Advantages
  - Gross income potential
    - 2,000 lbs/acre (2,700 pints)
    - $3.00 per pint PYO
    - $8,100
  - Few equipment costs
    - Small tractor?
    - Cultivator/Rototiller
    - Sprayer?
  - Consumer demand
  - Alkaline soil tolerant

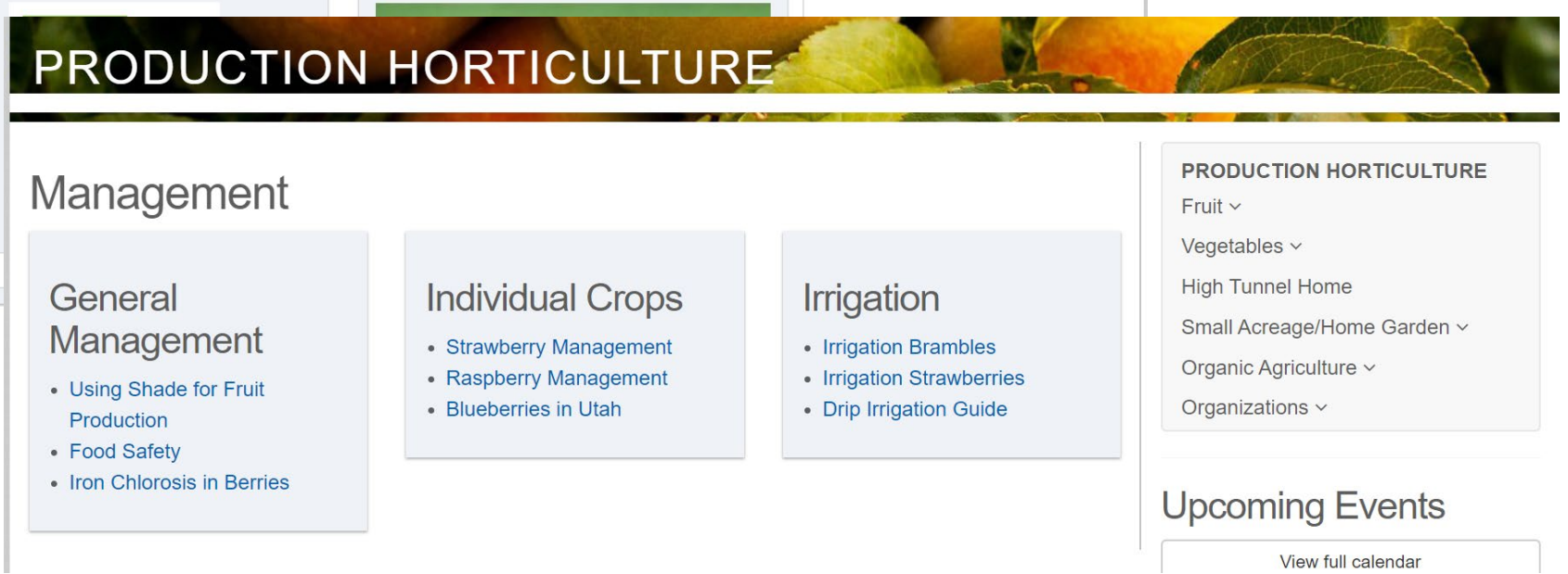
Should I grow them?

- Disadvantages
  - Labor requirements
    - Hand harvesting
  - Intense season
    - Short harvest season
    - Short shelf life
  - Specific site selection
    - Cold injury

More information

www.berry.usu.edu
www.fruit.usu.edu





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Insect Basics

An overview of the primary insect pests of berries in Utah, including integrated pest management recommendations, such as crop management practices, biological control, and insecticides. My presentation will include critical information on berry insect pest biology and ecology.

Diane Alston
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My responsibilities are in research and extension horticultural entomology (fruit and vegetable insect pests) and integrated pest management. I am a member of the Utah Pests Team at Utah State University. We develop educational programs and outreach materials on effective pest management practices for Utah's producers and home gardeners.

Raspberry Insect Pest Basics

Diane Alston, Entomologist, Utah State University

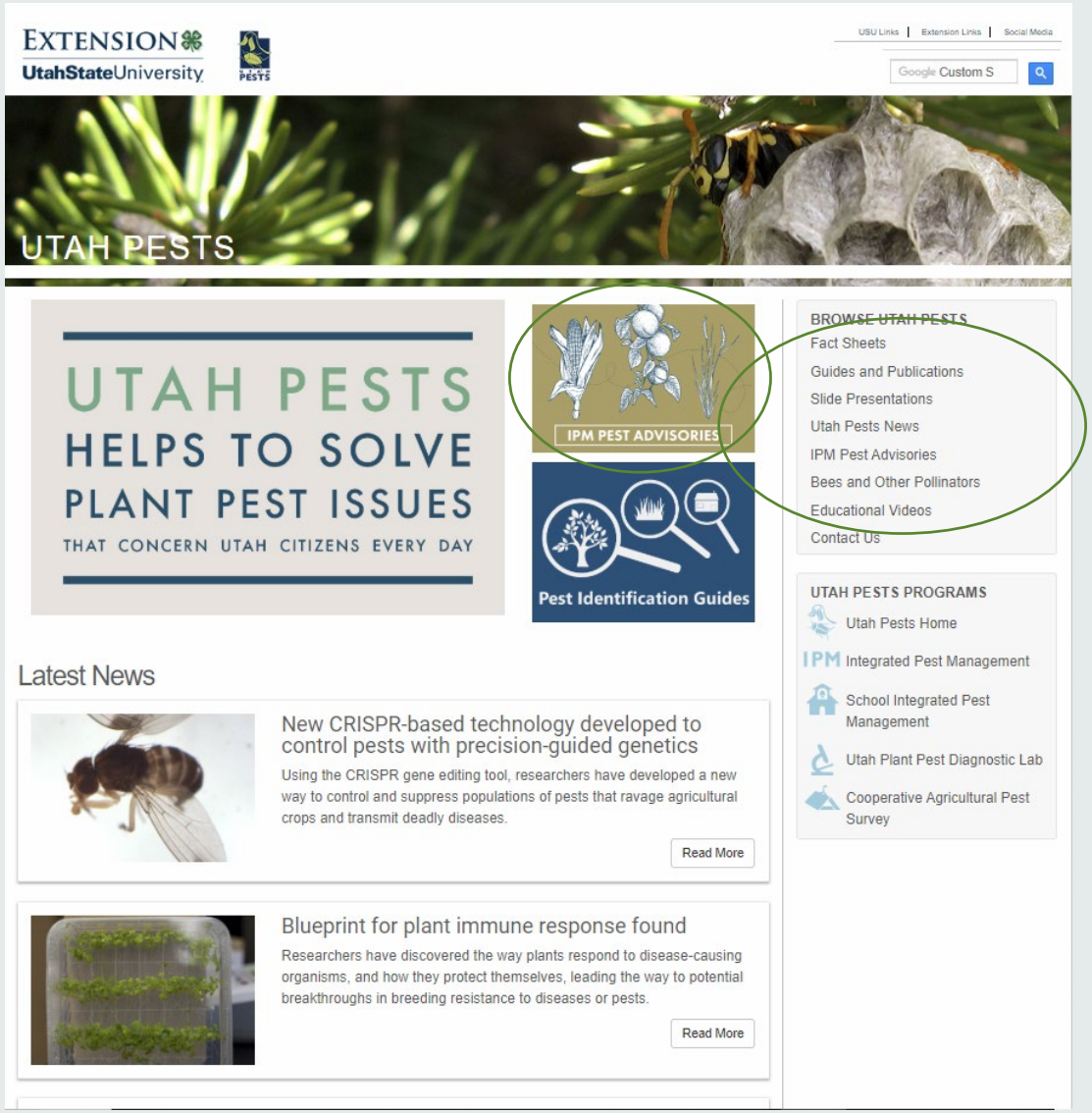
Utah State University

Urban & Small Farms Conference
February 20, 2019
West Valley City, UT

Raspberry Topics

- Cane Borers
  - Raspberry Horntail
  - Raspberry Crown Borer
  - Rose Stem Girdler
- Spider Mites

Utah Pests Online Resources



www.utahpests.usu.edu

Raspberry Horntail

UTAH PESTS fact sheet

UtahState University COOPERATIVE EXTENSION

Published by Utah State University Extension and Utah Plant Pest Diagnostic Laboratory ENT-132-09 September 2009

Raspberry Horntail
(*Hartigia cressonii*)

Diane Alston, Entomologist • Brent Black, Fruit Specialist • Marion Murray, IPM Project Leader

Do You Know?

- The raspberry horntail is a caneboring wasp that can cause crop loss to raspberries in northern Utah.
- Apply insecticides in the spring targeting adults, to prevent egg-laying in the new canes.
- Infested canes often become evident during summer when tips wilt and die back.
- Frequent pruning of infested cane tips during summer can lower horntail populations in a field.
- Several species of parasitic wasps attack horntail larvae within canes and can provide biological control.

Fig. 1. The raspberry horntail larva bears a spine on the tail end[1]

Fig. 2. Raspberry horntail adult[2]

The most injurious insects to caneberries are those that bore within the canes resulting in cane dieback, reduced fruit yields, and even cane death. The most common of the borers attacking caneberries in northern Utah is the raspberry horntail [*Hartigia cressonii* (Kirby)], a type of wasp (Hymenoptera: Cephidae). It was first documented in Utah in the 1980s, and is known to occur in other western states. Horntails spend the winter as mature larvae in the previous year's canes, pupate in the early spring, and emerge as adults to mate and lay eggs in primocanes (first year canes) just after cane growth begins. Early-season egg-laying and protection of the eggs and larvae within canes create challenges for horntail management and potential for high infestation levels in raspberry fields. Recent research to evaluate the susceptibility of raspberry varieties and observations of high parasitism levels of horntail larvae in some fields, provide new insights into raspberry horntail management.

HOST PLANTS

raspberry, other brambles, rose

LIFE HISTORY

There appears to be only one generation per year in northern Utah. Egg-laying extends from early spring to early summer, so larvae of all sizes can be found in canes during the summer.

Mature Larva – Overwintering Stage

- **Size, shape, and color**: cylindrical, white body about 1 inch (25 mm) long; hardened, brown head; short spine on the tail end (Fig. 1).
- **When and where:** spends the winter in a silk-lined cavity in the lower cane.

Pupa

- **Size and color**: tan and about ¾ inch (18 mm) long.
- **When and where:** pupation occurs within the cane in the early spring.

Horticulture

UtahStateUniversity COOPERATIVE EXTENSION

extension.usu.edu

February 2013 Horticulture/Fruit/2013-01pr

A Comparison of 10 Fall Bearing Raspberry Cultivars for Northern Utah

Rick Heflebower, Britney Hunter, Shawn Olsen, Brent Black, Diane Alston, and *Thor Lindstrom*
Utah State University Extension

Introduction

Raspberry plants have a perennial root system with biennial canes. In other words the root system may live for many years, while the individual shoots live for only 2 years. During the first year of growth the canes (primocanes) are typically vegetative, while in the second year, the same canes (now floricanes) flower and bear fruit. Even though the individual canes live for only 2 years, the crown is sending up new canes each year, hence the plant itself is perennial.

Some raspberries have the ability to bear on canes during the first year of growth. These are known as "primocane bearers" or may also be referred to as "fall bearing varieties." The "fall bearing" name is used because by the time the primocane fruiting varieties grow, flower, and set fruit it is usually later into the fall season. This bulletin deals only with fall bearing varieties. If you would like to learn more about general raspberry culture please refer to the fact sheet "Growing Raspberries in Utah."

With fall bearing cultivars, the new canes emerge from the roots in late spring, begin flowering in July and set fruit in August. For this reason, fall bearing cultivars may be better able to withstand extreme cold winters, but are best suited to areas that experience longer growing seasons. Summer bearing varieties set their crop earlier in the summer (usually by July) but require the survival of overwintering canes. Since winter damage is not a major concern with the fall cropping system, the important characteristics to consider in selecting a fall-bearing cultivar are earliness, yield, fruit quality, and resistance to common insects and diseases. In response to increasing local interest in berry production, a research project to evaluate fall-bearing cultivars was carried out at the USU Kaysville Farm.

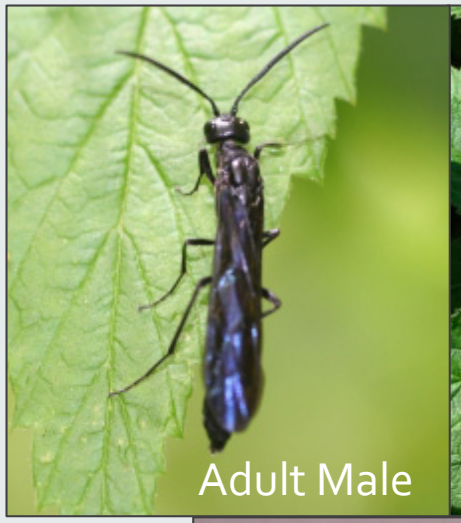
Kaysville Cultivar Trial

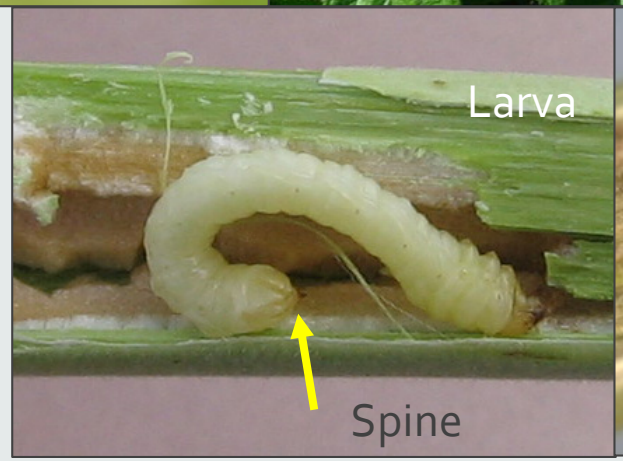
Ten fall-bearing raspberry cultivars were planted in 2006. Each cultivar was grown in a plot measuring 12 feet long with 10 feet between rows, and 8 feet between plots within the row. Each plot was planted with six nursery-produced plants spaced 2 feet apart within the row, and alleyways were planted to grass. Irrigation was provided using both drip and overhead. Plant nutrient needs were supplied by applying 120 lbs of 16-16-16 (NPK) per acre in mid April and again in early June (banded in the row). Only the primocanes were cropped, as all the canes in each plot were pruned to ground level at the end of each season. Canes were supported with a temporary trellis system consisting of a single twine on each side of the row, supported by T-shaped rebar posts (Figure 1).

Figure 1. Trellis system for fall raspberries, consisting of baling twine and a t-post made of rebar.

Raspberry Horntail, *Hartigia cressonii*

- Major cane-boring pest in Utah
- Wasp (Hymenoptera)
  - Stem sawfly (Cephidae)
  - Attacks first-year primocanes
  - Intermountain West & CA
- Infested canes
  - Lower yield
  - Lower vigor
  - Lower winter survival





Natural parasitoid wasps kill RHT larvae

Raspberry Horntail Biology

- One generation per year (late May – early Sep)
- Overwinter in canes within a silk-lined chamber
  - Mature larva
- Pupate within the chamber in the spring
- Adults chew a hole, emerge
  - Temperature dependent
- Eggs inserted under epidermis of young primocanes
- Young larva (winding) tunnels upwards in cambium just under epidermis
  - At cane tip, consumes pith – tip wilting
  - One larva per cane tip
  - U-turn and tunnels down in pith
- Mature larva forms overwintering chamber 1 – 1.5 ft above cane base

Adult Emergence

Study sites (3 years):
Laketown, Richmond, Paradise, Wellsville, Kaysville, & Alpine

Emergence:
Base 50°F since Jan 1
500 to 1800 DD
Average dates:
June 12 to August 3

Degree-Day Model to predict timing of egg-laying

Predict emergence of RHT adults from overwintering chambers in canes

Natural Enemies (Biological Control)

- 3 species of parasitic wasps attacking horntail larvae
- Parasitism occurred near cane tip (smaller diameter, horntail larva consumes pith, softer cane tissue facilitates insertion of the parasitoid's ovipositor, space for parasitoid to develop)
- Some cane injury already occurs before parasitism

Parasitism of RHT Larvae

Percentage of horntail larvae parasitized, Kaysville, UT (Davis Co.), 2009 & 2010

Date	Summer Cultivars		Fall Cultivars	
	2009	2010	2009	2010
June 24	0	-	9.1	-
July 1	-	0	-	25.6
Jul 15	35.1	25.8	41.7	20.0
Jul 22	-	73.1	-	47.1
Jul 29	98.4	59.1	100	33.3
Aug 5	61.5	80.0	25.0	0
Aug 13	70.0	-	40.0	-

Parasitoid I

- Ichnuemonidae
- Long ovipositor
- Ectoparasite
- Solitary

Parasitoid II

- Pteromalidae
- Ectoparasite
- Gregarious
- ~3-20 larvae/horntail

Parasitoid III

- Less common
- Eurytomidae
- *Tenuipetiolus* sp.
- This genus known to parasitize gall midges & gall wasps

Summer (Floricane-Fruiting) Raspberry Cultivar Resistance Trials

USU Research Farm, Kaysville, UT (Davis Co.)

2009-2011
Mean no. RHT per row-ft

Cultivar	RHT	Cultivar	RHT
Royalty	0.25 a	Reveille	2.85 abc
Moutere	0. 80 a	Chemainus	2.95 abc
Cascade Dawn	1.25 ab	Canby	3.25 bc
Cowichan	1.55 abc	Georgia	3.65 c
Coho	1.60 abc	Cascade Bounty	3.75 cd
Cascade Delight	1.75 abc	Titan	4.10 cd
Lauren	1.85 abc	Willamette	5.10 cd
Tulameen	2.20 abc	Saanich	5.95 d

2013-2014
Mean no. RHT per row-ft

Cultivar	RHT	Cultivar	RHT
Octavia	0.01 a	Prelude	0.26 ab
Cascade Gold	0.05 a	Cascade Bounty	0.68 ab
1142-1	0.12 a	Nova	1.07 b
Chemainus	0.18 a		

Horntail population pressure declined in 2013-2014 as compared to 2009-2011: successive years of cane removal as part of the sampling process. Suggests that frequent pruning is an effective management tactic.

In general, cultivars with greater winter hardiness, cane vigor, & yields were more resistant to horntail.

Fall (Primocane-Fruiting) Raspberry Cultivar Resistance Trials

USU Research Farm, Kaysville, UT (Davis Co.)

2009-2011
Mean no. RHT per row-ft

Cultivar	RHT	Cultivar	RHT
Polana	0.4	Joan J	0.7
Caroline	0.6	Ruby	0.7
Polka	0.6	Himbo Top	0.8
Summit	0.6	Heritage	0.9
Jaclyn	0.6	Anne	1.0

2013-2014
Mean no. RHT per row-ft

Cultivar	RHT	Cultivar	RHT
Autumn Treasure	0.03	Polana	0.23
Josephine	0.06	Autumn Bliss	0.30
Brice	0.08	Joan J	0.34
Vintage	0.14	Dinkum	0.50
Autumn Britten	0.18		

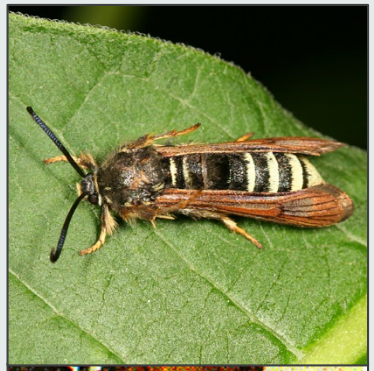
For fall-bearing cultivars, horntail infestation $\leq$ 1 larva per row-ft, and there were no statistical differences among cultivars.

Horntail infestation was substantially lower in fall- than summer-bearing cultivars:
- fall-bearing canes were removed at ground level in the spring before overwintered horntail adults emerged
- horntails seem to avoid thin canes which are more common in fall-bearing cultivars

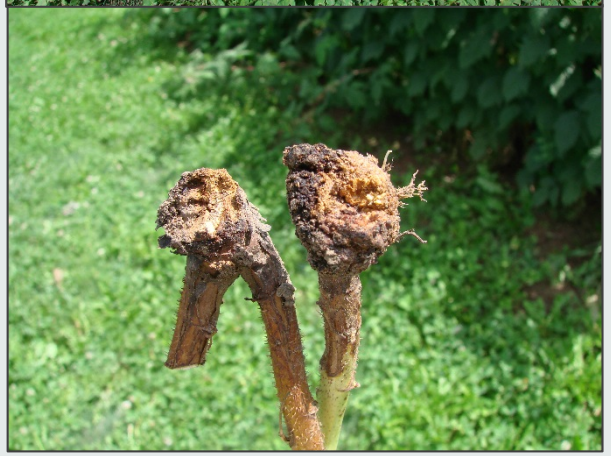
Raspberry Horntail IPM

- Select cultivars with more resistance
  - Fall-bearing are less susceptible than summer-bearing cultivars
- Prune out infested canes before adults emerge (by May)
  - Remove fall-bearing canes at ground level
  - Remove floricane-fruiting canes with a horntail tunnel in pith
- If warranted, apply insecticide beginning at 500 DD to prevent egg-laying; repeat based on protection interval of product (emergence ends by 1800 DD)
  - Carbamate: carbaryl (Sevin)
  - Pyrethroids: bifenthrin (Brigade, Capture), esfenvalerate (Asana), fenpropathrin (Danitol), zeta-cypermethrin (Mustang Max), pyrethrin
  - Organophosphates: diazinon (Diazinon, RUP), malathion (Malathion)
  - Don't spray when bees are active! Follow all product label protections for pollinators
- Frequent pruning of infested cane tips during summer can lower the horntail population in a field
- Conserve parasitoid wasps by avoiding unnecessary insecticide applications

Raspberry Crown Borer

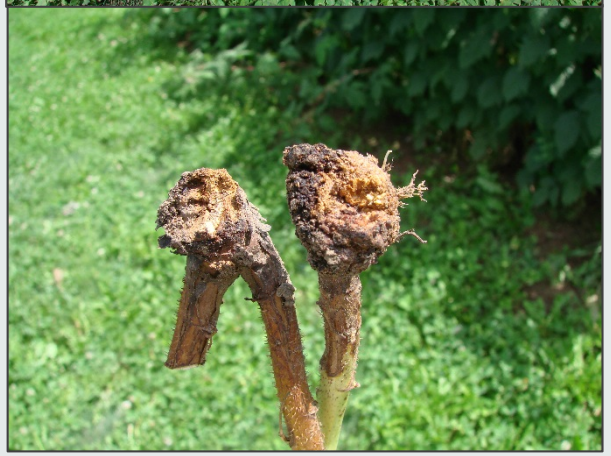


- Day-flying clearwing moth (resembles yellow jacket) (Lepidoptera: Sesiidae)
- Two-year life cycle
- Year 1:
  - In late summer, adult moth emerges from cane, lays eggs on lower leaves
  - Larva overwinters by tunneling into base of cane
- Year 2:
  - Larva tunnels into crown/upper root during summer, spends 2nd winter in roots; overlapping generations
- Infestation symptoms (2nd year):
  - Canes become spindly and wilt during summer
  - Canes break-off easily at the crown
  - Holes in the crown/upper roots with sawdust-like frass

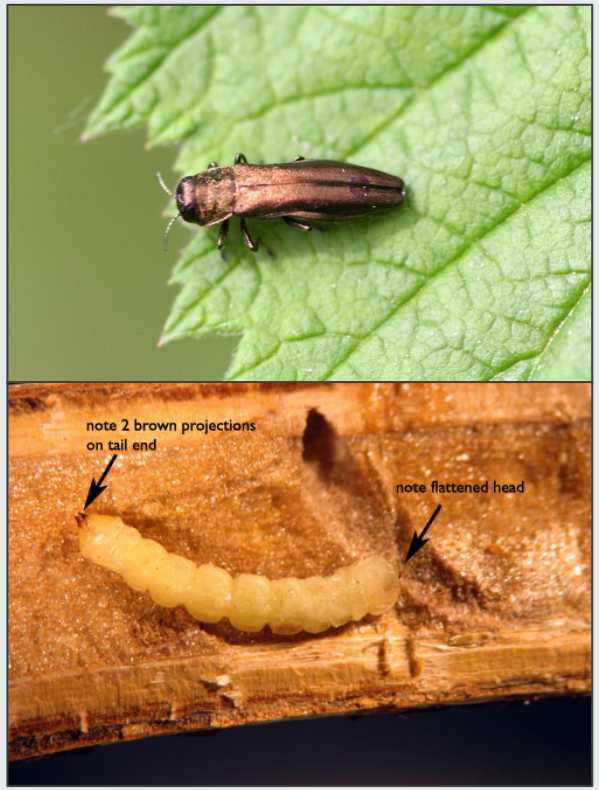


Raspbery Crown Borer Management

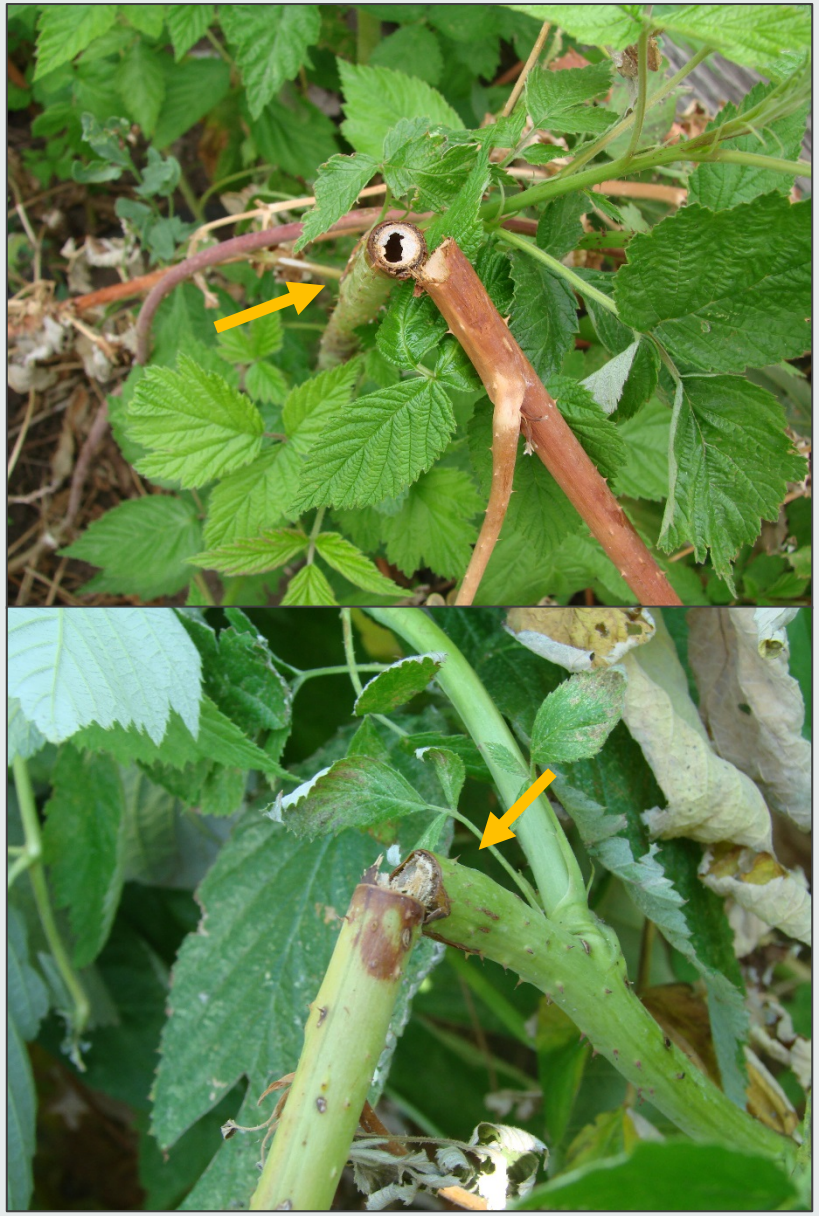
- Only use clean planting stock
- Don't transplant canes between fields
- If infestation is localized in a field, dig and destroy infested crowns/roots
- Monitor by observation of brittle/wilted canes and enlarged crowns
  - Tested sex pheromone lure (British Columbia, Canada) – too volatile, short-lasting
- Insecticides – apply as heavy drench/soak to base/crown/roots for ≥ 2 consecutive years
  - Mid-October to target first year larvae
  - In spring before bud break, to target overwintered larvae before they tunnel deeply into the crown/roots
    - Bifenthrin (Brigade 2 EC) (PHI 3 days; only 1 pre-bloom application allowed per year)
    - Pyrethrin (organic option; short residual)
    - Chlorantraniliprole (Altacor) (PHI 3 days)
    - Diazinon 50W (PHI 7 days; restricted use; only 1 application allowed per year)



Rose Stem Girdler



- Metallic, flatheaded beetle
  (Coleoptera: Buprestidae)
  - Adults emerge from canes in May-June
- Larva is white, flattened head, two short spines on tail end
- Larva tunnels 2-5 spiral grooves in the cambium (just under the bark)
  - Gall-like swelling
- Cane girdling leads to wilt, breakage, and loss
- First-year canes most susceptible to attack



Rose Stem Girdler Management

- Remove nearby roses (wild and climbing) – excellent alternate host
- Prune out and destroy infested canes in spring and summer to remove larvae
- Apply insecticides just after bud break to kill adults and prevent egg-laying
  - Control timing may overlap with first horntail emergence
  - Full cover spray to canes
  - Don’t spray when bees are active
  - Same insecticide recommendations as for raspberry horntail

Spider Mites: How Do They Make a Living?

Twospotted Spider Mite, *Tetranychus urticae*

- Prefer undersides of leaves
- Form colonies, webbing: eggs, nymphs & adults
- Very small (0.02 inch length)
- Overwinter as dormant females (orange color) at base of canes & on weeds
- 10-14 day life cycle in summer
- Suck plant sap: fine, gray stippling on leaves

Spider Mites: Caneberry Symptoms

"Mite Burn"

- Hot, dry conditions promote mites
- "Mite burn": yellow, brown bronzing, begins on lower leaves first
- Mites move up from (broadleaf) weeds on the ground
- Raspberry leaves are sensitive to mite feeding
- Fruiting canes: reduces vigor & berry yield
- Primocanes: weakens, predisposes to winter injury

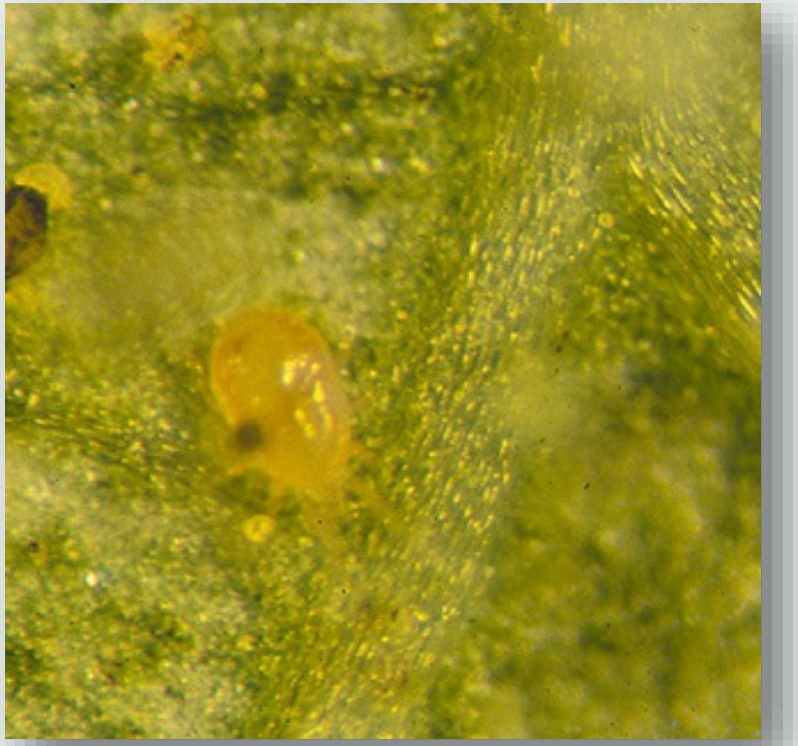
Spider Mite Management: Cultural Control

- Plant vegetation in alleyways (grass)
  - Minimize broadleaf weeds
    - field bindweed, common mallow
- Overhead sprinklers (cool & wet)
- Avoid disturbing ground cover (avoid dust)
- Avoid plant stress – water!
- Macro-tunnels:
  - Good venting, temperature mgmt.
  - Avoid hot, dry conditions
- Cultivar resistance:
  - Heavily pubescent leaves reduce mites

Spider mite-induced defoliation

Spider Mite Management: Biological Control

- Predatory mite
  - *Galendromus* (*Typhlodromus*) *occidentalis*
  - western predatory mite
- Other predators:
  - thrips, pirate & big-eyed bugs, ladybeetles, lacewings
- Naturally occurring
  - Supplemental releases – predatory mite
- Avoid insecticides & miticides toxic to beneficial insects & mites



Western predatory mite, note tear-drop-shaped body

Spider Mite Management: Chemical Control

Least Disruptive & Organic Miticides

- insecticidal soap (M-Pede, others) – physical
- horticultural oil (JMS Stylet Oil, others) - physical
- azadirachtin / neem oil (Trilogy, others) – Unkn*
- cottonseed+clove+garlic oil (GC-Mite) – physical
- sulfur (do not use above 90°F)

*IRAC MoA groups

Commercial Miticides

- acequinocyl (Kanemite) – 20B*
  - adults, eggs, nymphs; 1 day PHI
- bifenazate (Acramite 50WS) – Unkn*
  - adults, eggs, nymphs; 1 day PHI
- etoxazole (Zeal) – 10B*
  - eggs, early nymphs; 1 day PHI
- hexythiazox (Savey) – 10A*
  - eggs, nymphs; 3 day PHI
- fenbutatin-oxide (Vendex 50WP) – 12B*
  - adults, nymphs; 3 day PHI (raspberry only)

Berry Spider Mite IPM

Scout leaves on lower canes for mite injury when temperatures rise

Avoid plant stress

Water!

Good plant nutrition

Scout for early signs of mite feeding

Intervene early:

1. irrigate & cooling, prevent mite dispersal & dust
2. apply less disruptive miticide early in mite population increase
3. Apply stronger miticide, if needed

Observe Pre-Harvest Intervals

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The Basics of Berry Diseases

Plant diseases of small fruits are not common, but if a disease occurs, it is important to recognize it and quickly address it. Learn about diagnosis and management options of diseases such as root rots, crown gall, viruses, and more.

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