


The Importance of Training Systems and Canopy Management in Developing Fruit Quality

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Viticulture Program

PURDUE



Good wine comes from happy vines!
Happy vines CAN GROW in
WISCONSIN!!!

- 
- Proper Variety Selection
 - Training System Selection
 - Adequate Pruning
 - Crop Load Adjustments
 - Shoot Positioning
 - Leaf Removal

Vineyard Establishment and Maintenance

- Establishing the vineyard
- Choosing Training Systems
- Importance of Canopy Management
- Affects on Fruit Quality
- Affects on Wine Quality

Establishing the Vineyard

1. Select Location
 - Hill/slope for frost pocket areas
 - Avoid heavy clay soils or wet areas
2. Prepare soil (1 year prior to planting)
 - Soil Test
 - Tillage
 - Herbicide control of perennial weeds
 - Cover Crop
3. Select Variety
4. Planting and Establishment
5. Maintenance, maintenance, maintenance!!!

Establishing the Vineyard

- Determine Grape Variety
 - Winter hardiness
 - Disease susceptibility
 - Yield
 - Quality –what is it going to be used for???
 - Market trends and winery needs
 - Determine your market!
- Start with a manageable planting
 - First time growers – no more than an acre



Year 1 - Preparation

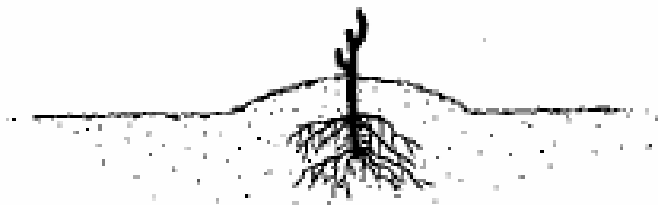
- Soil Test
- Make necessary adjustments to soil
 - pH, nutrients, organic matter
 - Sub-soil tillage to 24 inch depth, making ridge on which to plant vines
 - Tiling for drainage
- Cover crop to reduce weeds and increase organic matter
 - rye

Year 2 – Planting

- Posts and trellising system must be in place BEFORE you plant.
 - Posts should be long enough to have adequate anchor in ground and height for proposed training system.
 - 2 - 3 ft in ground, 5.5 - 6 feet above ground
 - 3 - 4 vines between posts, 7 feet between vines within row
 - 9-12 ft between rows depending on equipment needs
 - High tensile wire needed (12.5 gauge)
 - Rows running N → S

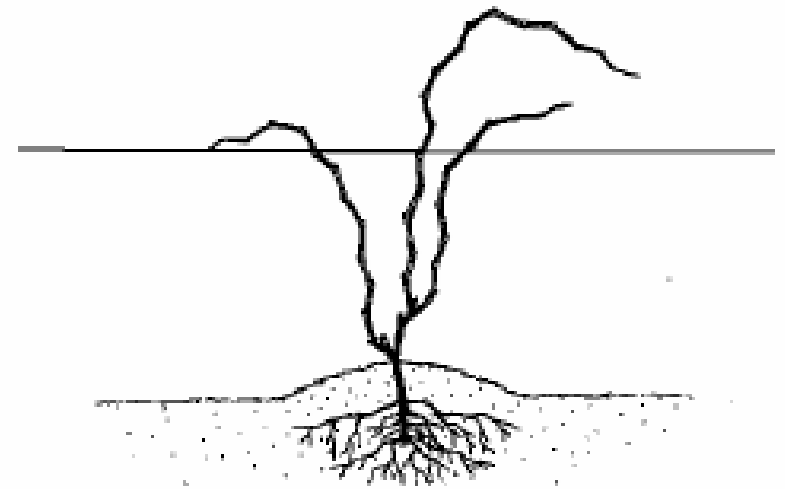
Year 2 - Planting

- Obtain vines from a reputable source that has disease indexed vines that are “true” to type
- One-year old rooted vines
- Unrooted cuttings can be savings, but is risky, need time to establish roots and irrigation is a MUST
- Planting grafted vines → graft union 2-3 inches above soil
- Irrigation installed (drip)
 - Vital for vine water status in establishing new vines.

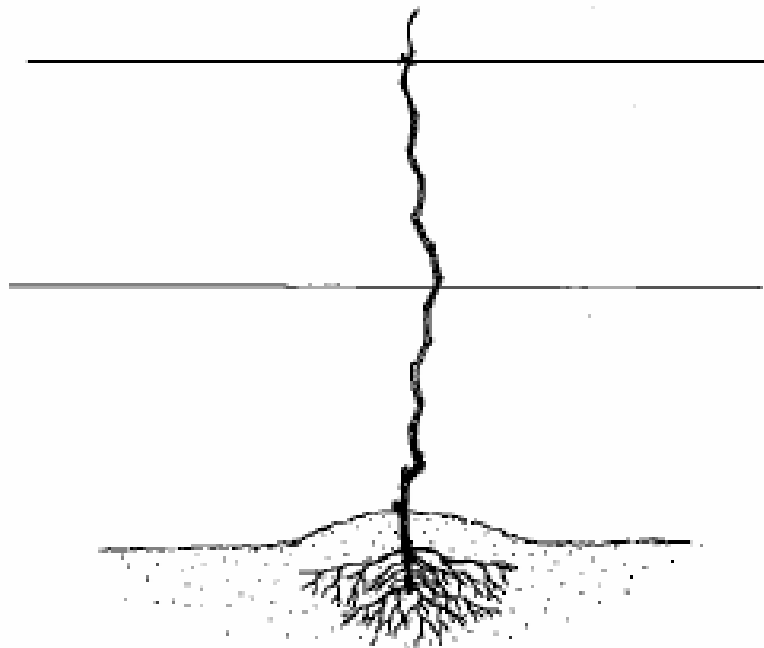


At planting

Year 1

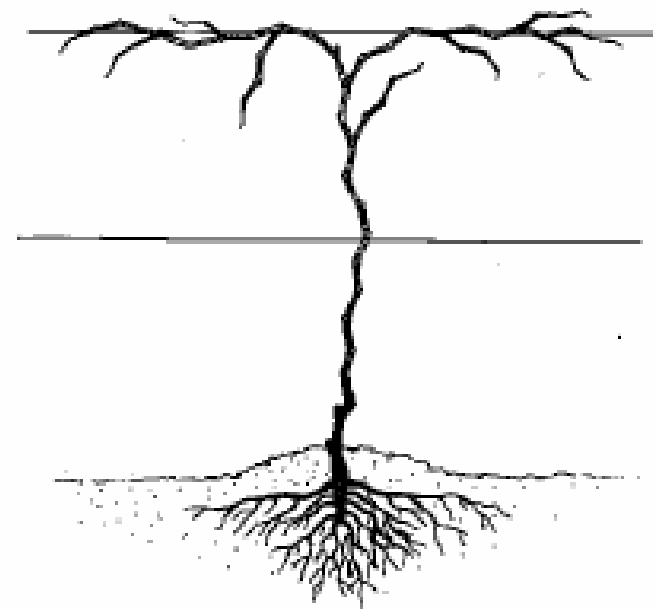


End of 1st year

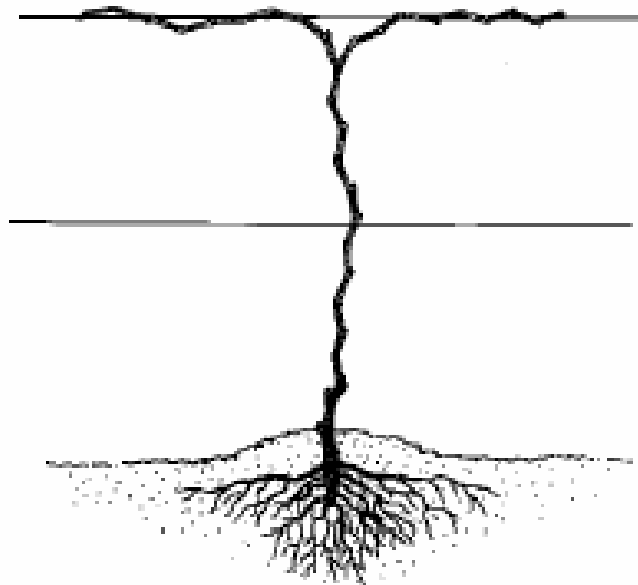


Beginning of 2nd year

Year 2

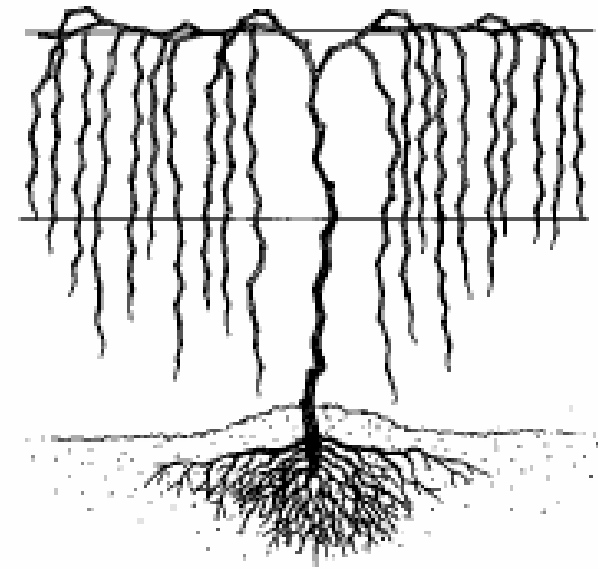


End of 2nd year

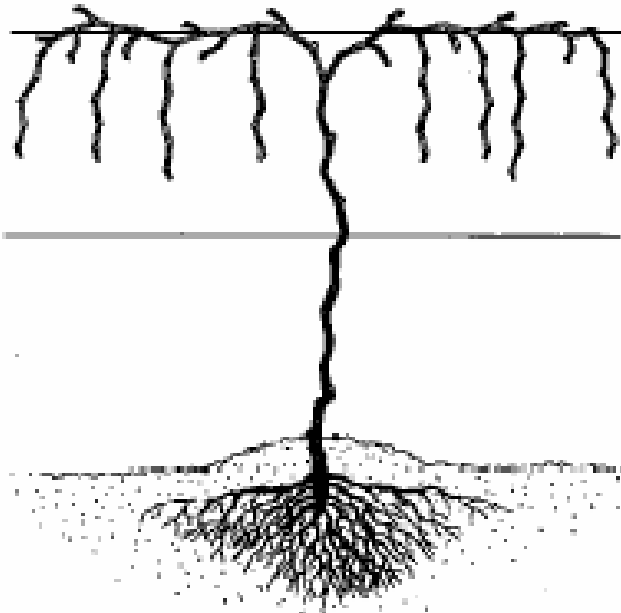


Beginning of 3rd year

Year 3

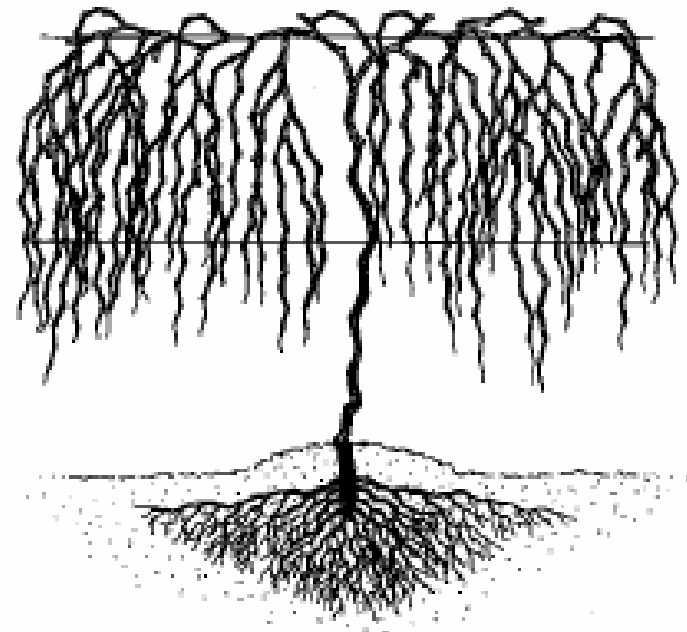


End of 3rd year



Beginning of 4th and subsequent years

Year 4



End of 4th and subsequent years

Wine Quality and Canopy Management

- Quality wine is produced in the **VINEYARD**
- Grape components
 - Aroma and flavor compounds
 - Pigments and tannins
 - sugars and acids
 - influenced by vine status, growing conditions and weather
- Increased light penetration hastens ripening.
- High quality grapes develop with proper canopy balanced achieved through management.

Training Systems

- Control vegetative vigor
- Increase light exposure for fruit/foilage
- Increase air flow to prevent disease infestation
- Facilitate pruning and harvest methods and mechanization
- System used is variety specific



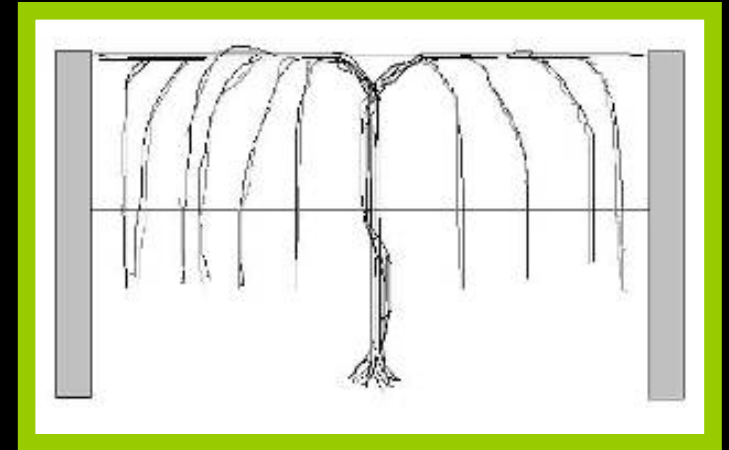
Vines are short in dry regions so the canopy can benefit from the warm soil, avoid wind desiccation, etc.

Moist areas, such as American Midwest and East, canopies are placed high to avoid disease infestation from the soil.

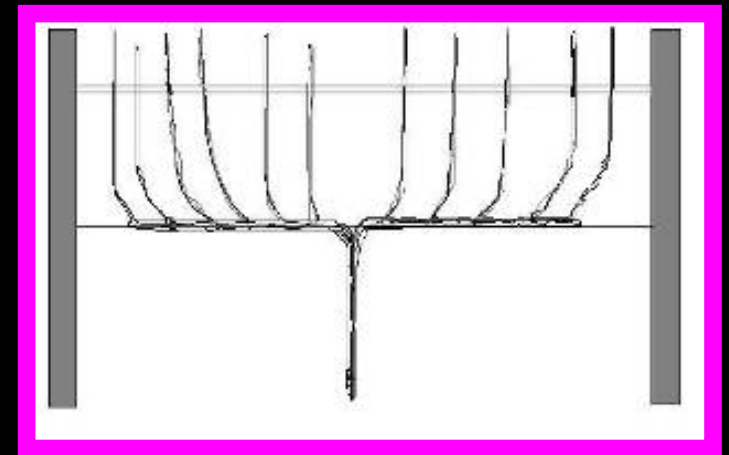


Training Systems

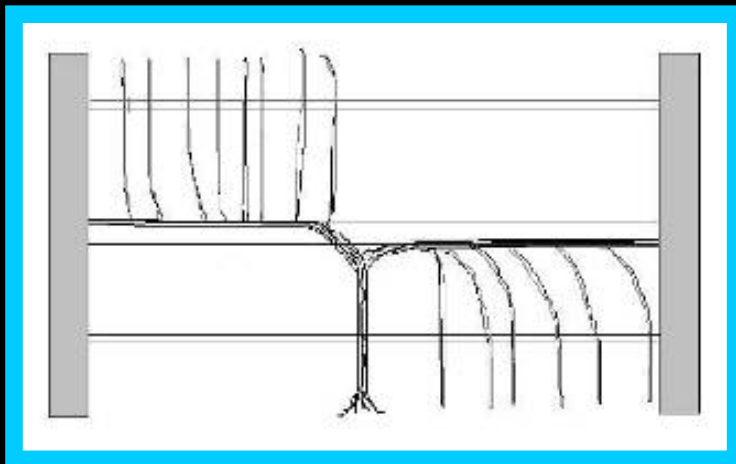
High Cordon - used for procumbent growth; used for American varieties



Mid-Wire Cordon – vertical shoot positioning (VSP); used for vinifera and hybrids



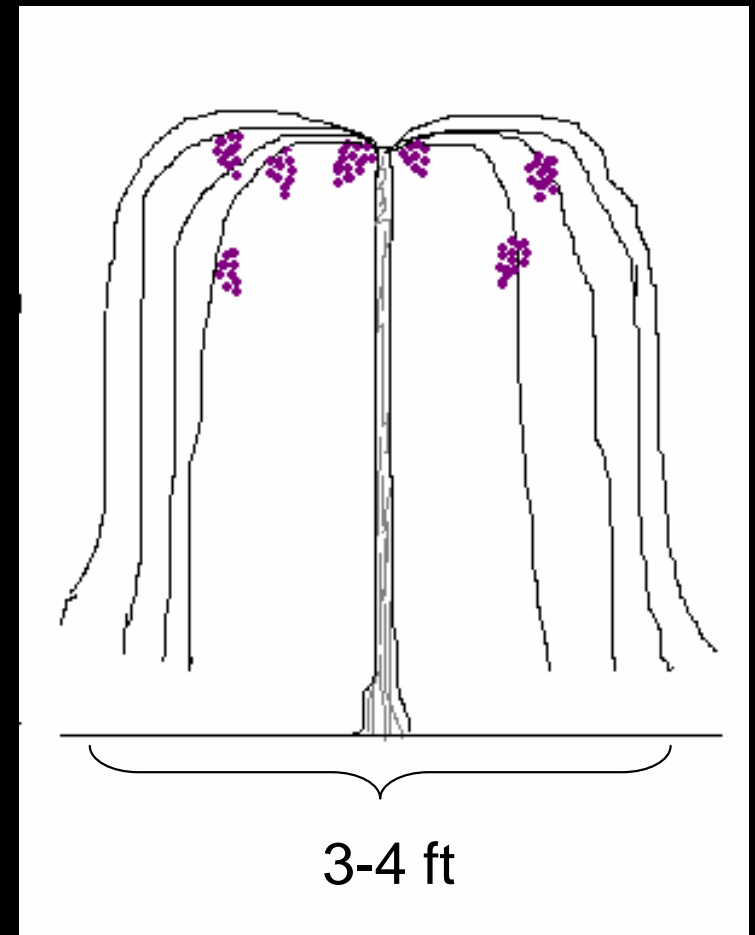
Scott Henry – split canopy



Other suitable systems in Midwest: Smart Dyson, Geneva Double Curtain, etc.

High Cordon

- Bilateral cordon system with cordon placed ~5 ft high
- Shoots positioned downward
- 3-4 leaf layers over cluster zone
- Potential for heavy shade if vigor not controlled
- May require shoot thinning, shoot positioning
- Leaf removal not beneficial because cluster zone placement



High Cordon





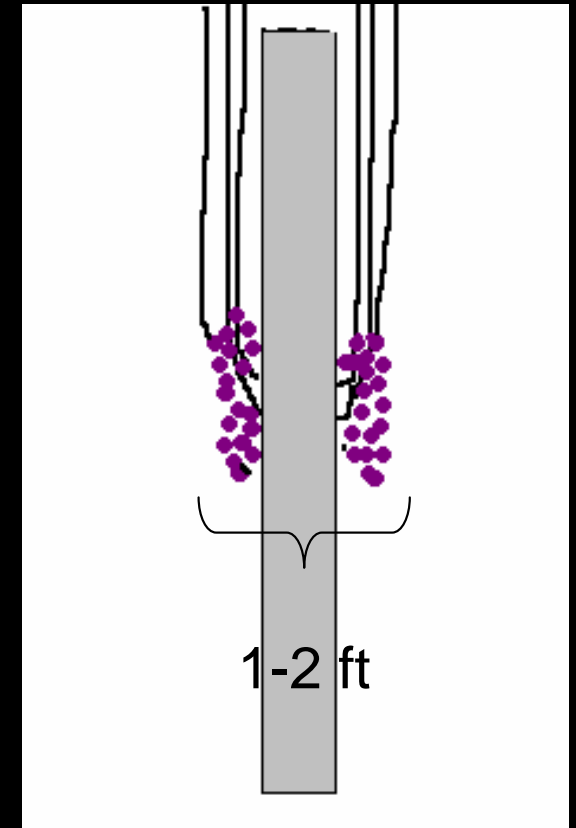
Heavy Vigor

>5 Leaf Layers

Shoot thinning necessary

Mid-Wire Cordon (VSP)

- Bilateral cordon system with cordon placed mid height (~1 m)
- Shoots positioned upwards in catch wires
- Fruiting zone along cordon nicely exposed
- 1-2 leaf layers
- Facilitates basal leaf removal
- May need post extensions or taller posts to facilitate height and weight
- Easy harvest



Mid-Wire Cordon

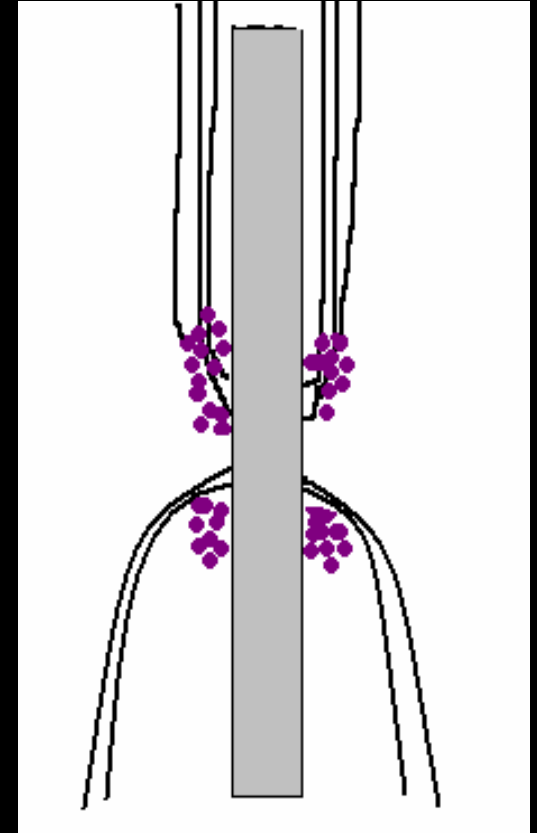


**Mid-Wire Cordon
w/ Basal Leaf Removal**



Scott Henry

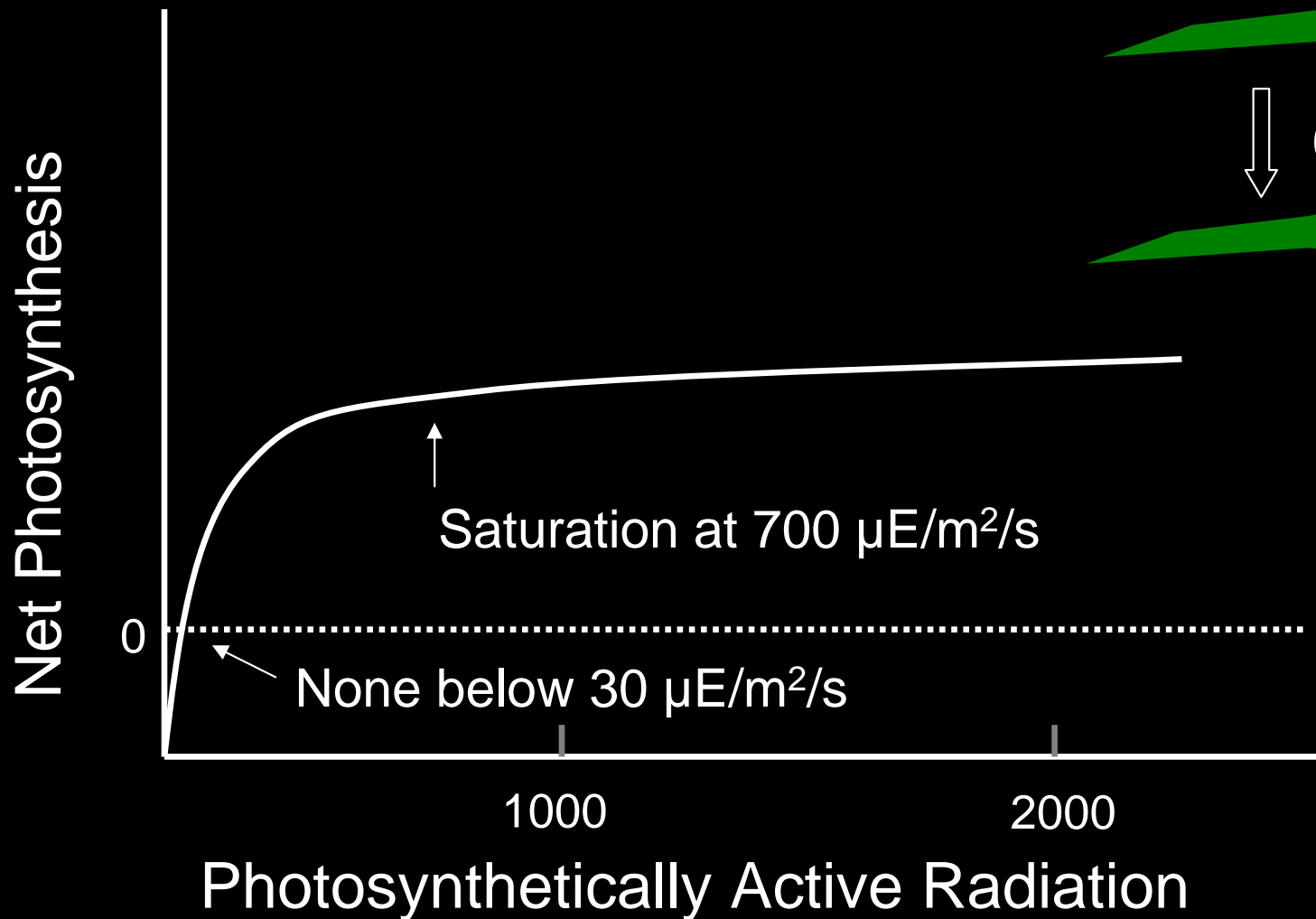
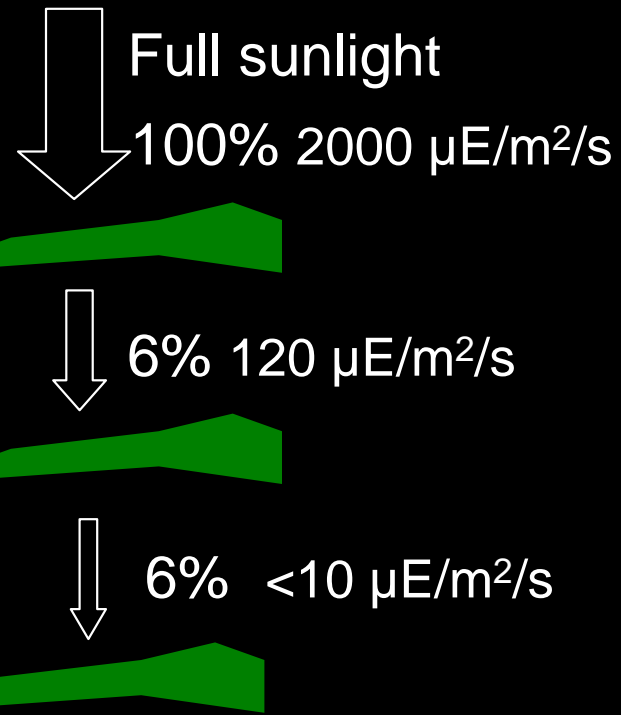
- 2 cordons/vine, divided canopy
- Used on vigorous vines, double the canopy exposure
- Cluster zone along cordon, nicely exposed
- 1-2 leaf layers
- Facilitates basal leaf removal
- May need post extensions
- Easy harvest



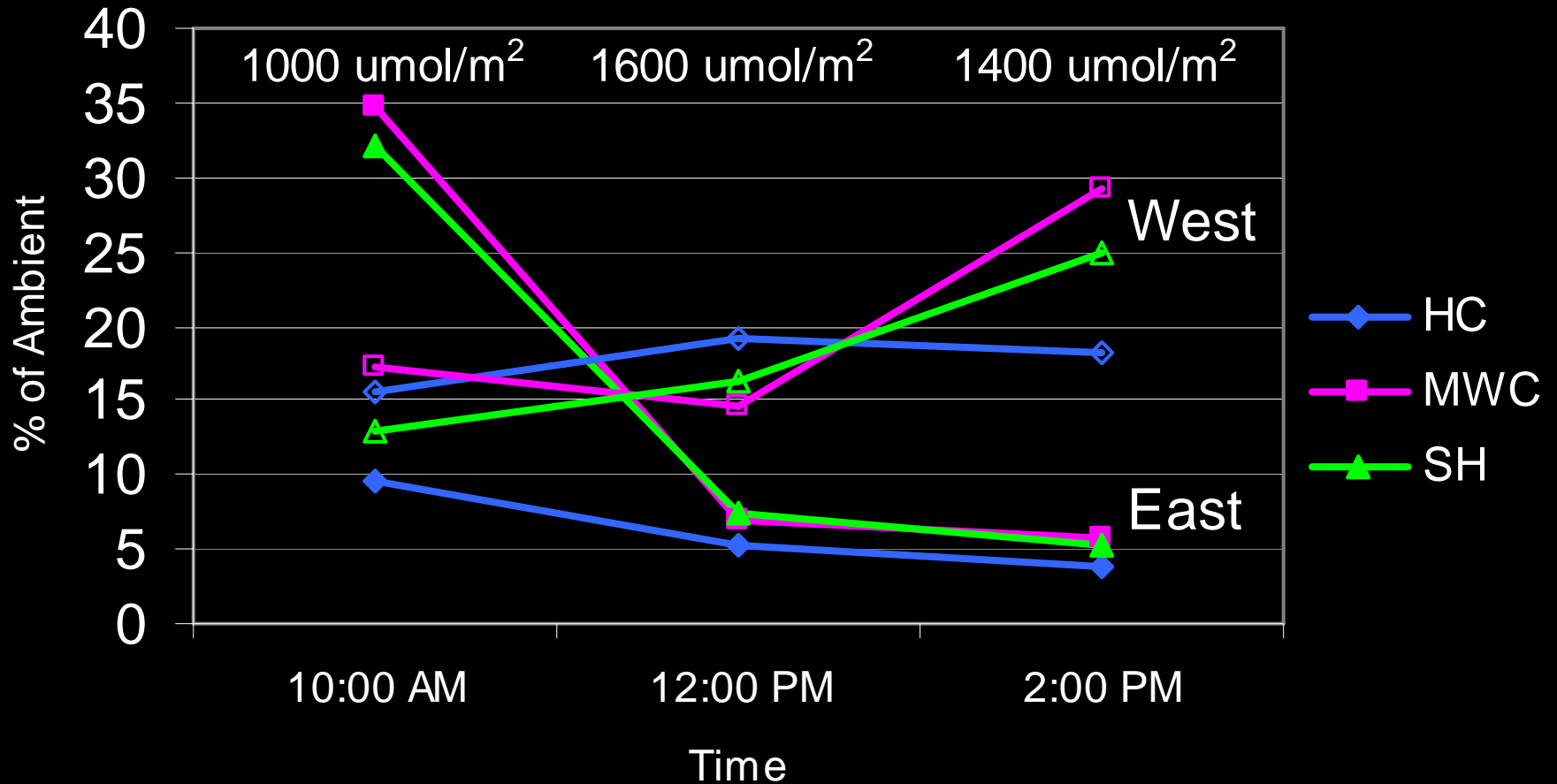
Scott Henry



Leaf Layers, Sunlight Transmission and Photosynthesis



Incident Sunlight of Cluster Zone 2005



All levels of sunlight are $> 30 \mu\text{mol}/\text{m}^2/\text{s}$, photosynthesis still occurring

In this case, increased shading has more of an affect on cluster chemistry than photoassimilation of the vine canopy.

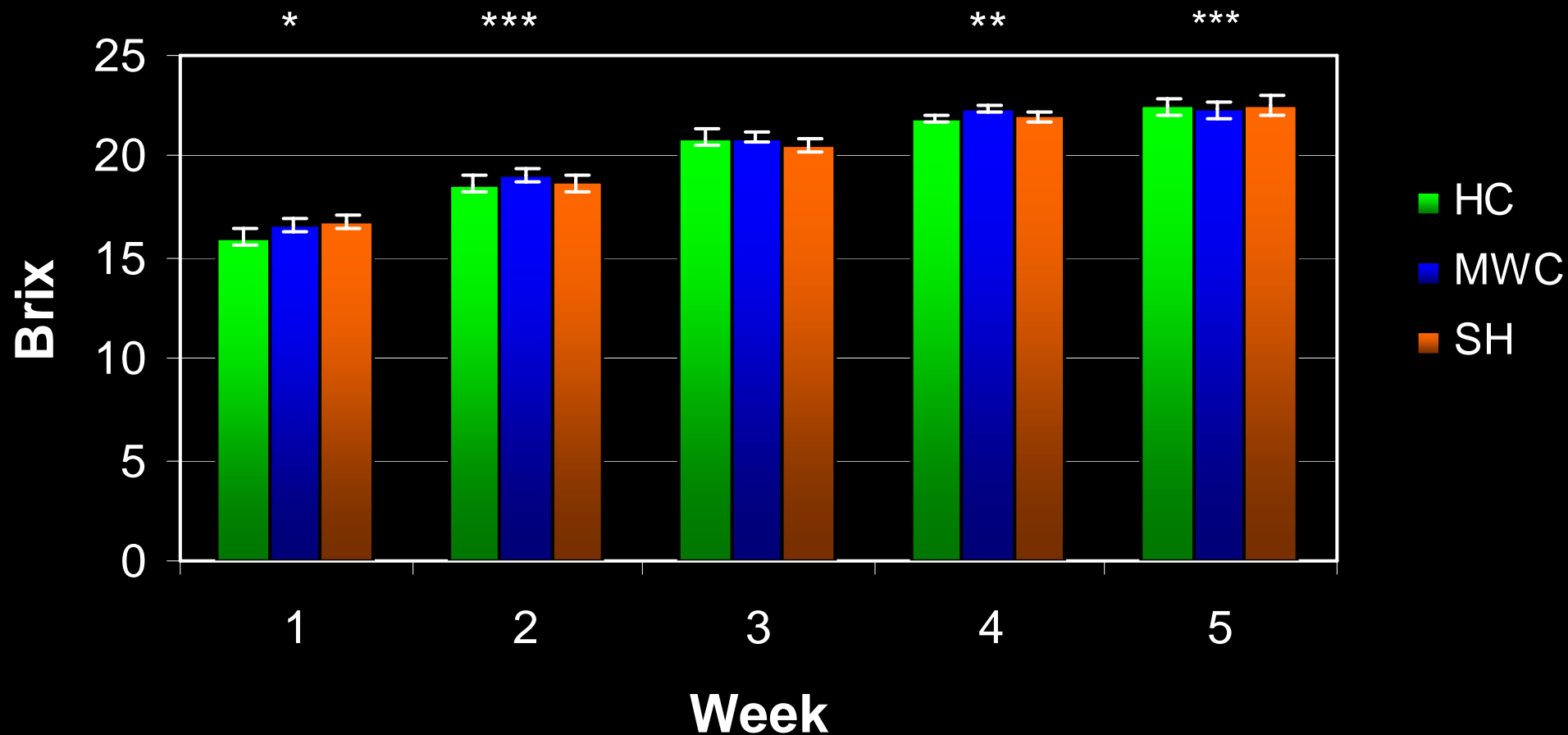
| Year | Training System | % Gaps | # Leaf Layers | Interior leaves (%) | Exterior Clusters (%) | Interior clusters (%) |
|-------|-----------------|--------|---------------|---------------------|-----------------------|-----------------------|
| 2 | HC | 0 b | 4.8 a | 39.7 | 26.7 | 73.3 |
| 0 | MWC | 3.3 b | 2.1 b | 27.1 | 59.6 | 40.4 |
| 0 | SH | 14.3 a | 1.8 b | 27.4 | 39.0 | 61.0 |
| 3 | Significance | * | **** | n.s. | n.s. | n.s. |
| 2 | HC | 3.3 | 3.7 a | 54.8 | 35.7 | 64.3 |
| 0 | MWC | 6.7 | 2.0 bc | 33.6 | 42.6 | 57.4 |
| 0 | SH | 11.3 | 1.8 b | 24.7 | 43.7 | 56.3 |
| 4 | Significance | n.s. | *** | n.s. | n.s. | n.s. |
| 2 | HC | 1.7 | 3.7 a | 66.6 a | 8.8 b | 91.2 a |
| 0 | MWC | 5.3 | 1.9 b | 34.2 b | 34.7 a | 65.3 b |
| 0 | SH | 8 | 1.9 b | 33.8 b | 35.6 a | 64.4 b |
| 5 | Significance | n.s. | *** | *** | * | * |
| | HC | 1.7 c | 4.1 a | 53.7 a | 23.7 b | 76.3 a |
| All | MWC | 5.1 b | 2.0 b | 31.6 b | 45.6 a | 54.4 b |
| Years | SH | 11.2 a | 1.8 b | 28.6 b | 39.4 ab | 60.6 ab |
| | Significance | * | **** | **** | * | * |

Means presented. Significant treatment x year interaction for leaf layer $P=0.0285$.

Treatment x year not significant for other point quadrant measures.

* $P<0.05$, ** $P<0.01$, *** $P<0.001$, **** $P<0.0001$

Soluble Solids of Traminette During Ripening 2002-2005

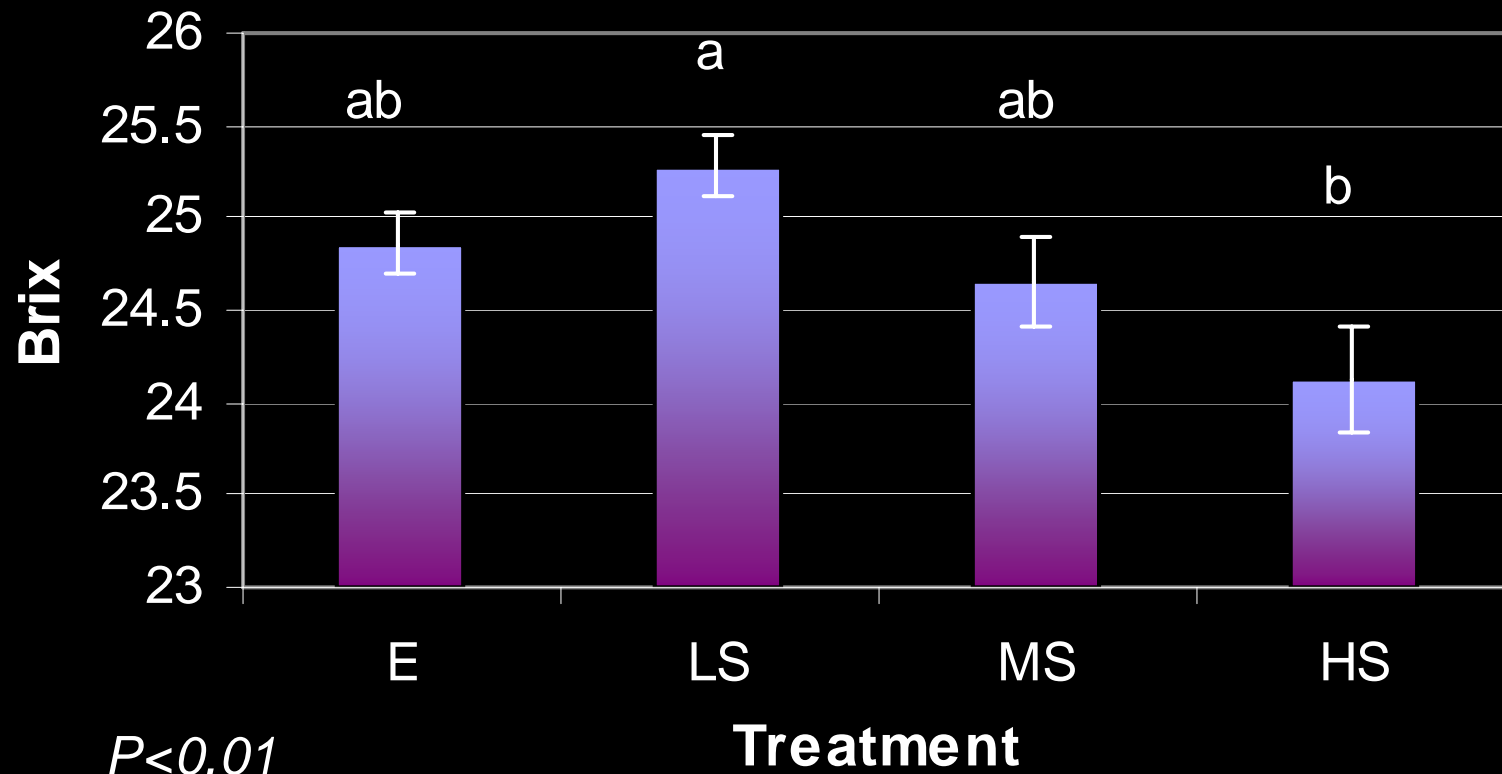


MWC 22.8 SH 22.6 HC 22.1 at harvest

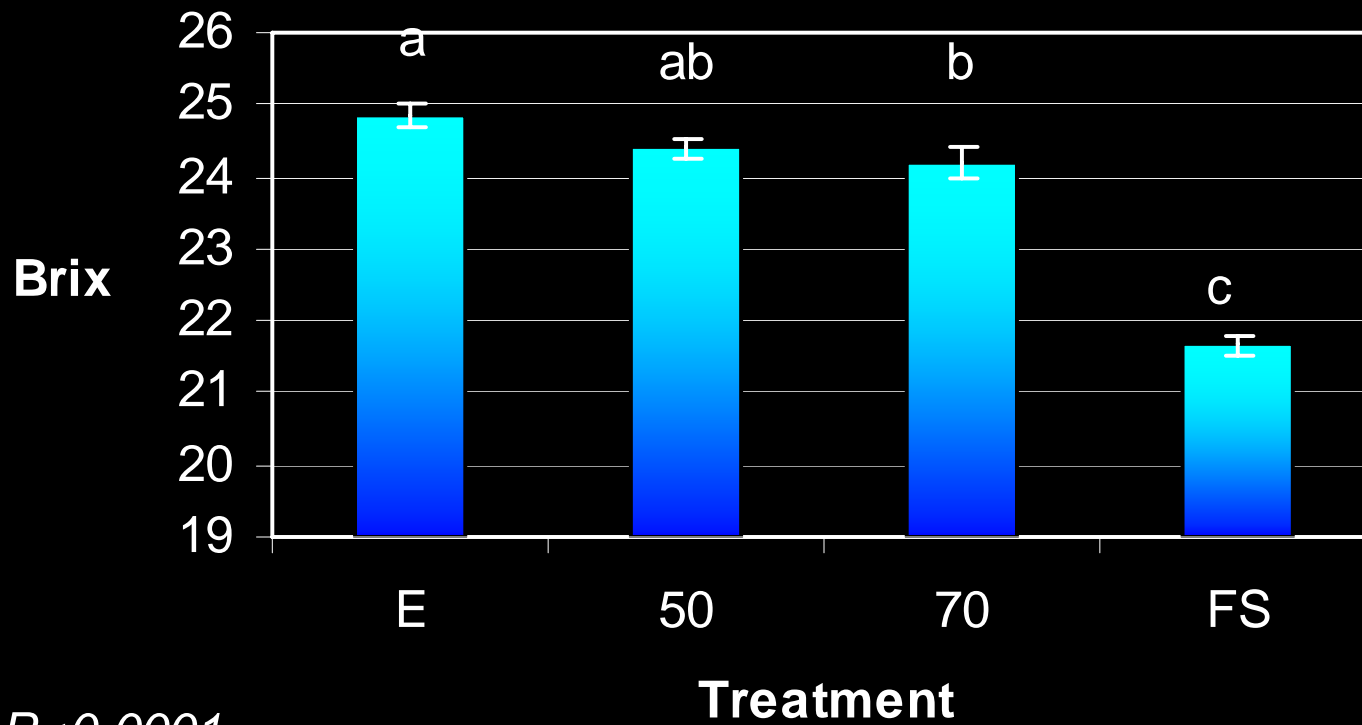
Results of Excessive Canopy Density

- Decreased canopy efficiency
 - Underlying leaves become chlorotic and increase disease potential
 - No increase in photosynthesis and carbohydrate assimilation with excess foliage
 - Shading of underlying canes results in poor bud formation and possibilities for decreased winter hardiness
 - Poor spray penetration of canopy
- Reduced berry quality
 - SS levels reduced, pH lower with higher total acidity
 - Lack of uniformity in ripening

Soluble Solids of Traminette Under Various Leaf Layers of Shading - 2004



Soluble Solids of Traminette Under Various Shade Levels - 2004

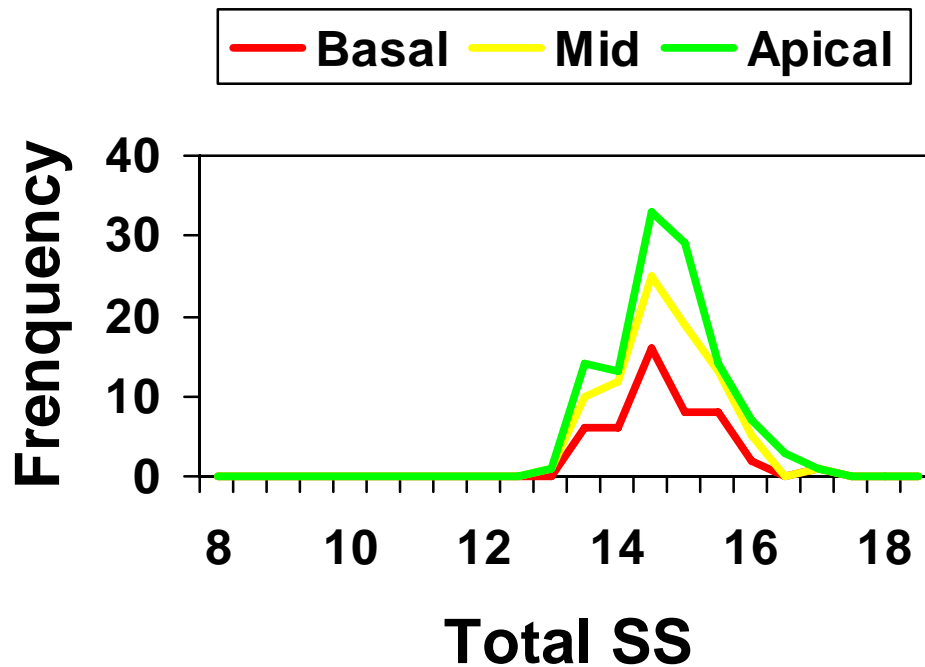


$P < 0.0001$

Asynchronous Berry Development

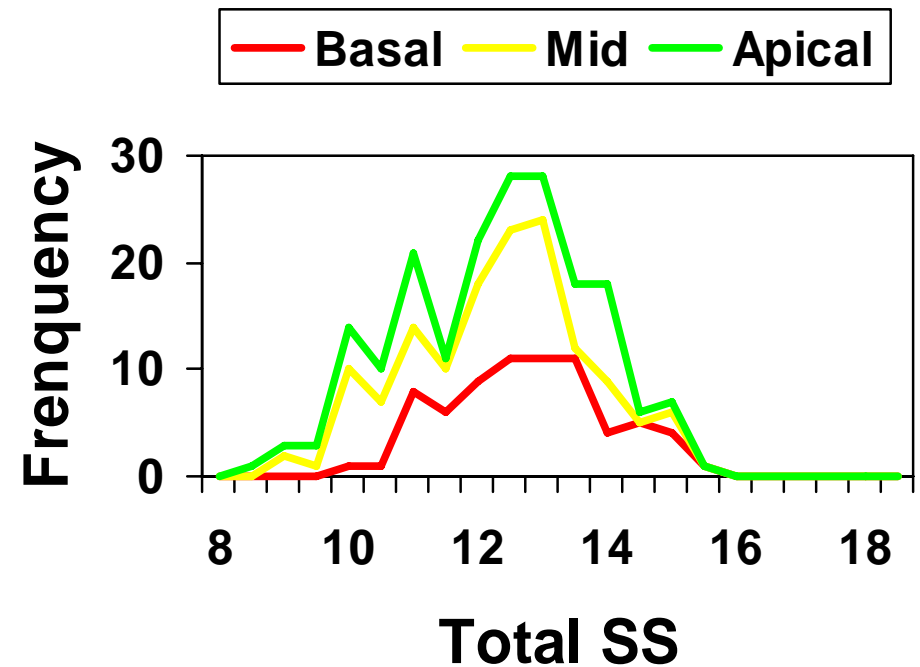
Balanced

40 nodes/vine
6 tons/acre



Overcropped

160 nodes/vine
12 tons/acre



Source: D. Miller, MSU

How do you obtain balance?



Dormant pruning



Shoot thinning (summer)

- Balanced pruning absolutely necessary!!!
- 4-6 shoots per foot of canopy, 12-15 nodes/shoot



Cluster thinning
Flower thinning

Obtain vine balance and open canopy through...

Shoot positioning

Leaf removal

Determining Vine Capacity

- Leaf area to fruit ratio = 7-10 cm²/g → 0.3-0.4 m²/lb
- At 8 ft spacing and 5 ft height → 7.2 m² of canopy
- support ~15-20 lbs of fruit (5-7 tons/a)
- Decrease in leaf area to fruit ratio (higher amount of fruit than leaf area)
 - reduced soluble solids
 - delayed ripening
 - reduced flavor and aroma
- Increase in leaf area to fruit ratio (higher amount of leaf area than fruit)
 - Shading problems
 - Poor fruit quality
 - Increased potential for disease, rots, etc

Crop Load

- Determines balance of leaf area and fruit
- Crop load=yield (lb)/ pruning wt (lb)
- 5-10 for vinifera
- 8-12 for French hybrids and American varieties

$$\frac{(\# \text{ of clusters on vine}) \times (\text{average cluster weight})}{\text{pruning weight}}$$

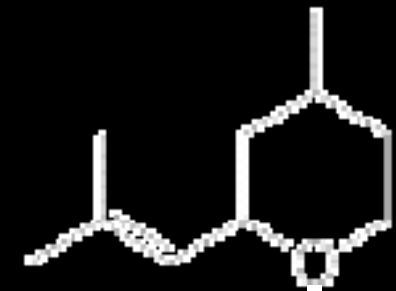
- NEED to keep crop RECORDS !
- Adjust crop load accordingly
 - Flower thinning
 - Cluster thinning
 - Shoot thinning

The influence of training systems and shading on AROMA



Affect of Training Systems on Aroma Monoterpenes (MTs)

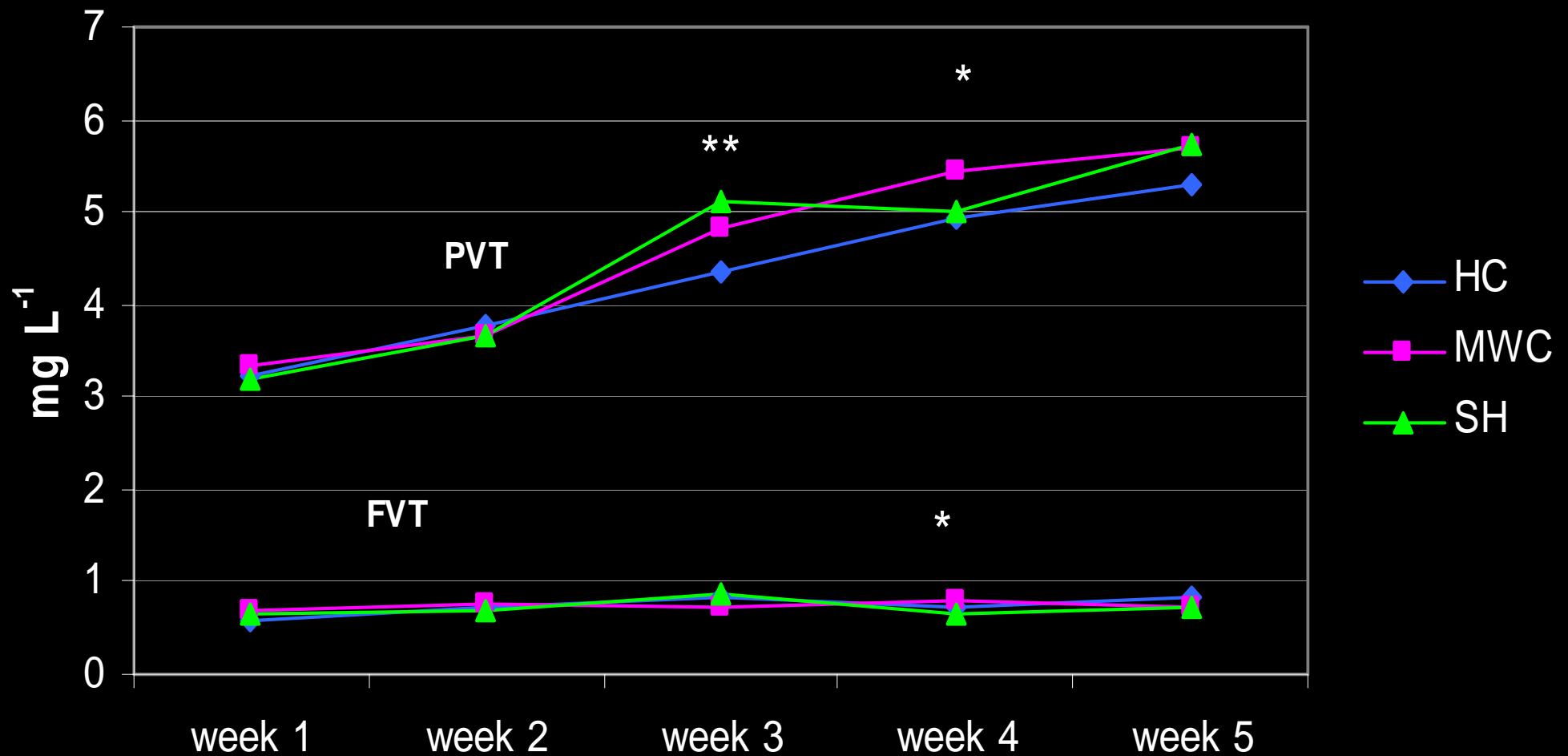
- Organic aroma compounds
- Floral and fruity aromas
- Found in Riesling, Gewürztraminer, Muscat, Traminette
- Greatest concentrations in berry skins
- Free volatile terpene (FVT)
 - 10% total MTs
 - Odor active
- Potentially volatile terpenes (PVT)
 - 90% total MTs
 - Chemically stable, water soluble
 - No odor activity



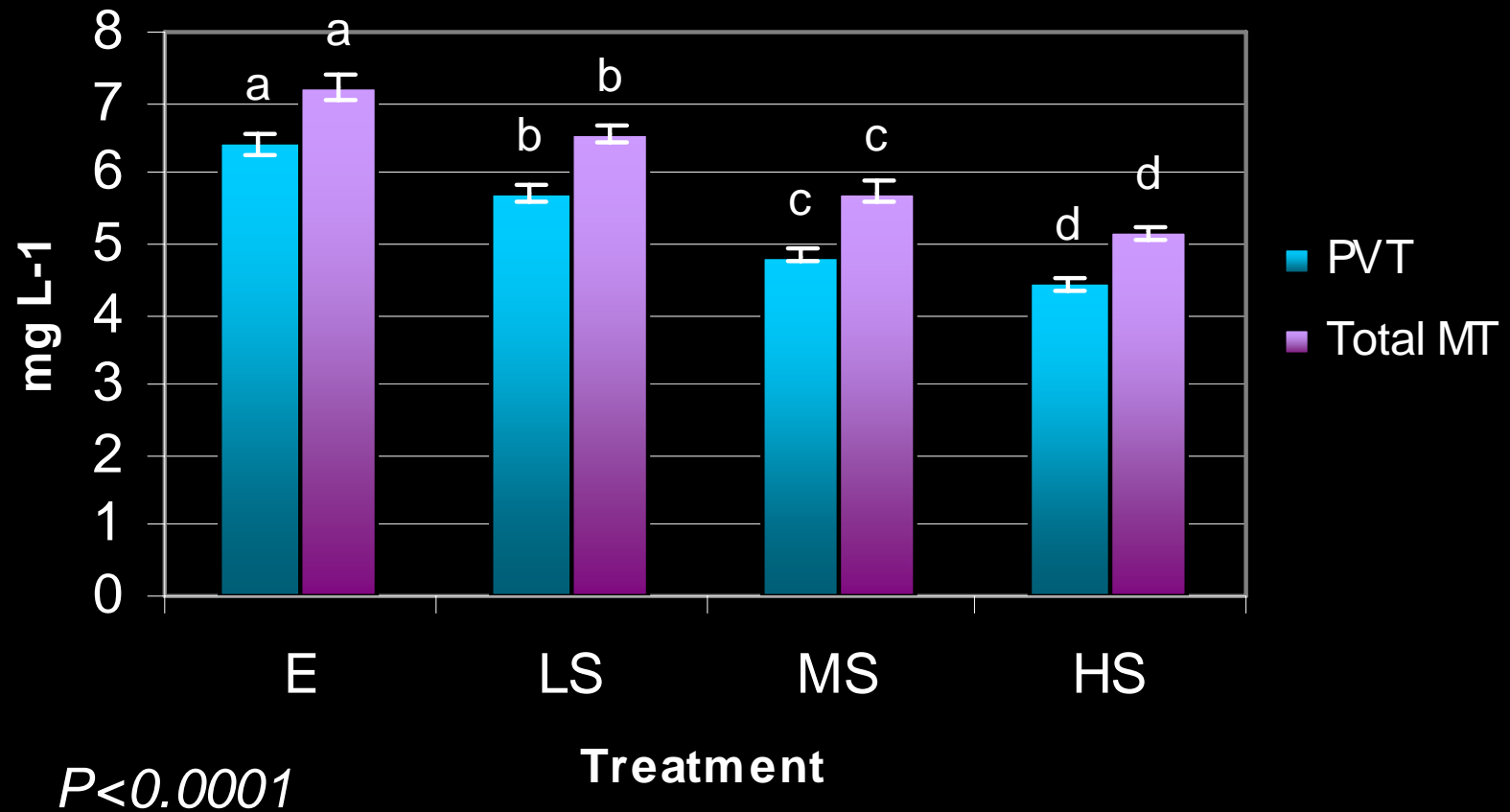
Monoterpenes in Traminette

- Investigated affects of training systems on MT levels
- Determined accumulation rates during ripening
- Wine making from 2002-2005 to determine carry over into wine
- Analytical studies of wine and grape components of aroma – variety specific
- Sensory studies

Trametinone Berry Monoterpene Levels 2002-2005



Monoterpene Levels of Traminette Under Various Shade Levels 2002-2005



Sensory Evaluation

- Analysis of aroma only due to interest in MTs
- 2002 and 2003 vintages analyzed with triangle testing to determine a difference
- 2004 and 2005 vintages analyzed with descriptive analysis to determine qualitative differences in given aromas

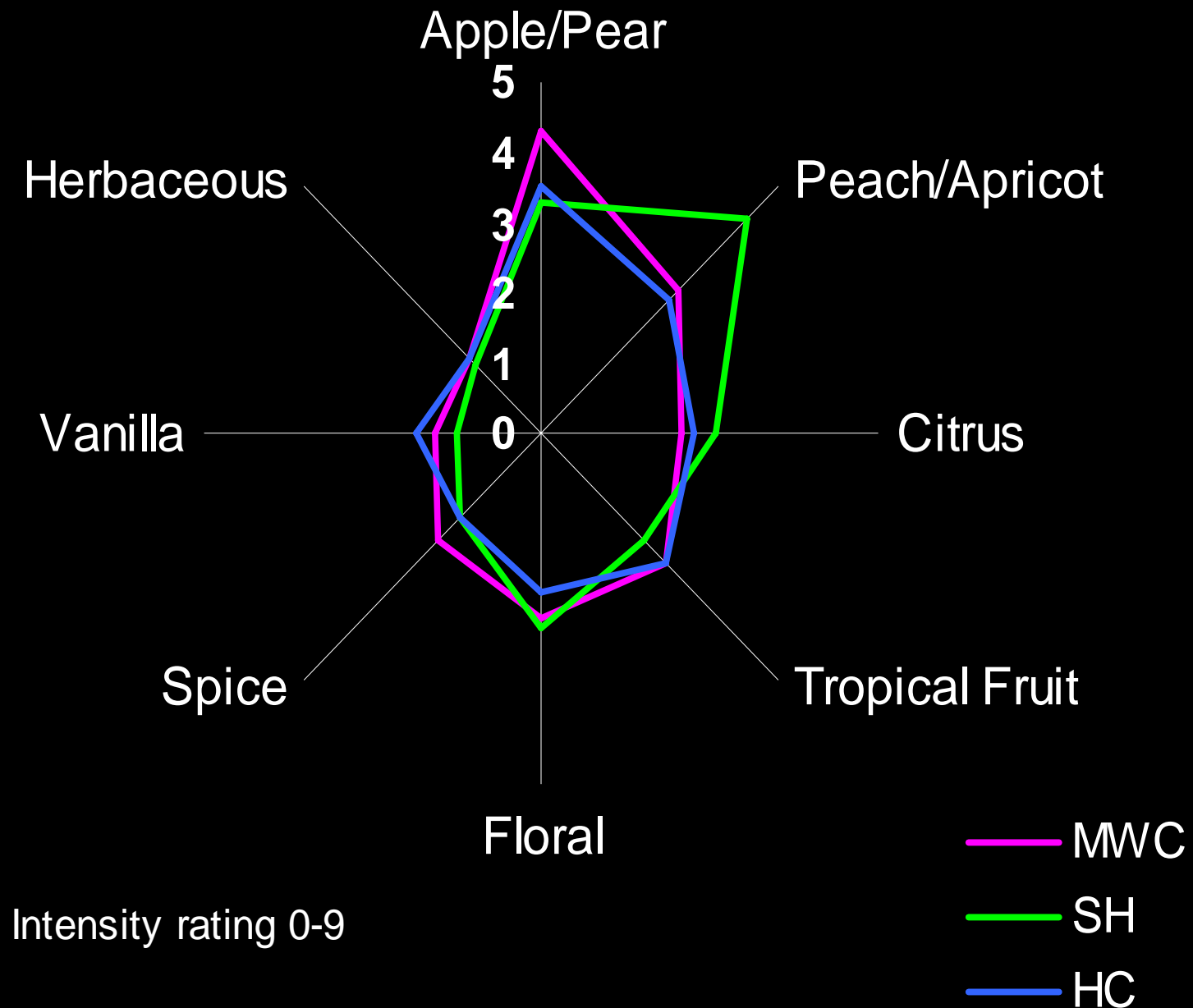


Sensory Results

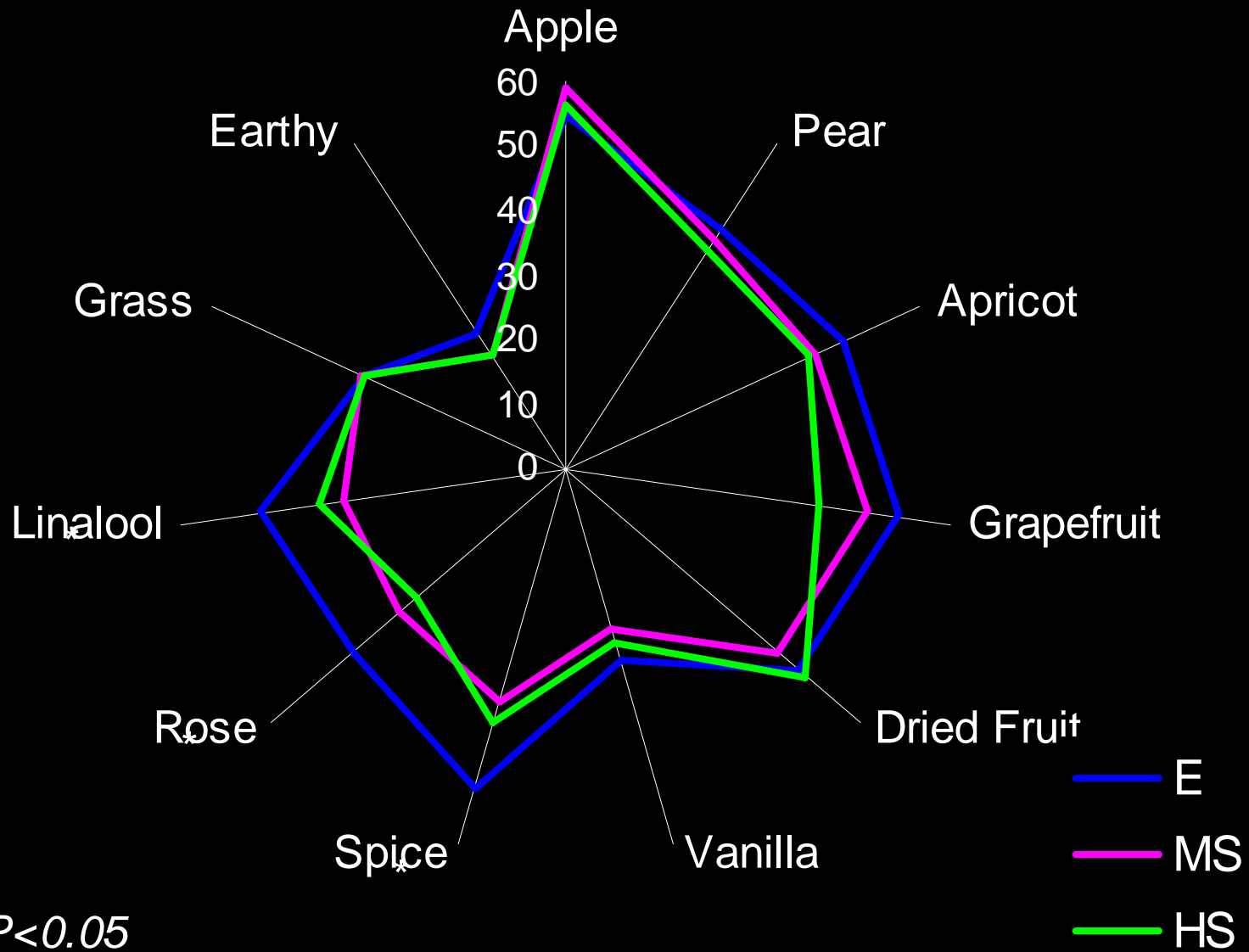
- Triangle test 2002 and 2003 wines:
 - All panelists distinguished difference between HC and MWC.
 - Most panelists unable to determine difference between SH-MWC and SH-HC wines.
 - Differences in aroma likely due to differences in shading of clusters → MT levels



Aroma of Traminette Wines - 2004



Exposure Study Traminette Wines - 2004



Summary

- Wine quality starts in the VINEYARD
- Proper care of vines and fruit is necessary for quality fruit
- Canopy management:
 - Carbohydrate balance
 - Sunlight penetration
 - Synchronize berry development
 - Management of berry chemistry
 - Disease control, spray efficacy
 - Develop strong wood and enhance winter hardiness

Thank You!

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Purdue Wine Grape Task Force:

[http://www.foodsci.purdue.edu/research/labs/
enology/](http://www.foodsci.purdue.edu/research/labs/enology/)