Vineyard Design

Spacing and Trellis Selection

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Spacing & Trellis Decision Goals

• High quality as defined by your market
• High productivity per acre
• Vineyard that is efficient to farm
Definitions

- **Vine vigor** is a measurement of the rate of vine growth.
- **Vine capacity** is the total annual vegetative and fruit biomass produced.
- **Vine size** is the annual vegetative growth.

Capacity refers to the vine’s ability for total production rather than rate of growth.
Factors Influencing Vigor

- Soil – depth, texture, water-holding capacity, fertility
- Climate
- Rootstock
- Variety
- Spacing
- Farming practices – irrigation, fertilization, site preparation, cover crops
### Characteristics of the Ideal Wine Grape Canopy

<table>
<thead>
<tr>
<th>Canopy Character</th>
<th>Optimal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoot density</td>
<td>~ 5 shoots per foot</td>
</tr>
<tr>
<td>Shoot length,</td>
<td>15 to 20 nodes</td>
</tr>
<tr>
<td>Lateral shoot development</td>
<td>None to very minimal</td>
</tr>
<tr>
<td>Growing shoot tip presence</td>
<td>Ideally none</td>
</tr>
<tr>
<td>Ratio of leaf area to fruit weight</td>
<td>3 to 8 ft²/lb</td>
</tr>
<tr>
<td></td>
<td>(0.6 to 1.5 m²/kg)</td>
</tr>
<tr>
<td>Leaf layer number</td>
<td>1-2</td>
</tr>
<tr>
<td>Percent exterior leaves</td>
<td>80-100%</td>
</tr>
<tr>
<td>Percent exposed clusters</td>
<td>50 to 80%</td>
</tr>
<tr>
<td>Cane weight</td>
<td>0.7 to 1.4 oz</td>
</tr>
<tr>
<td></td>
<td>(20 to 40 g)</td>
</tr>
<tr>
<td>Internode length</td>
<td>2.4 to 3.1 in</td>
</tr>
<tr>
<td></td>
<td>6 to 8 cm</td>
</tr>
<tr>
<td>Pruning weight</td>
<td>0.2 to 0.4 lb/ft</td>
</tr>
<tr>
<td></td>
<td>(0.3 to 0.6 kg/m)</td>
</tr>
<tr>
<td>Ratio of crop weight to pruning weight</td>
<td>5-10</td>
</tr>
</tbody>
</table>

Adapted from Smart and Robinson 1991
SPACING
Vineyard spacing has 2 components:

- Row Spacing
- Vine Spacing
Row Spacing:
• Based on farming equipment
• Light Interception efficiency
• Operational efficiency

Vine Spacing:
• Based on anticipated vine vigor
Row Spacing

• What equipment will be going down the row?
• How wide is it?
12 Foot row width
5-foot row width
5 foot row width
Ten 9-foot rows: 11 passes per tractor operation

Sixteen 6-foot rows: 17 passes per tractor operation

60% more time for tractor work:
mowing, cultivation, spraying, dusting

40-60% more time for hand vine care:
pruning, suckering, leaf removal, thinning...
4 row sprayer
Light Interception efficiency

12 foot

6 foot
a < b
Based on 6-foot in-row spacing

\[ \text{Yield per acre (tons)} \]

\[ \text{Distance between rows (feet)} \]

\(~ 6 \text{ to } 10 \% \text{ per foot}\)

*Taken from Jensen et al, 1988*
In-Row Vine Spacing

- Should be based on anticipated vine vigor.
In-Row Vine Spacing

- Close enough together to produce a continuous fruit zone without gaps.
In-Row Vine Spacing

- Close enough together to produce a continuous fruit zone without gaps
- Far enough apart to provide space for enough buds to be left at pruning in order to balance the vine
Vine Spacing

Too Narrow

Optimum

Too Wide

28 in

48 in

68 in

From: Intrieri and Filipetti American Journal of Enology and Viticulture, 50th Anniversary
8 x 10 spacing, 66 in high cordon
# Planting Density

\[ \text{# vines/acre} = \frac{43,560}{\text{row spacing (ft)}} \times \text{vine spacing (ft)} \]

<table>
<thead>
<tr>
<th>Spacing (ft)</th>
<th>Vines per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 x 12</td>
<td>454</td>
</tr>
<tr>
<td>6 x 12</td>
<td>605</td>
</tr>
<tr>
<td>4 x 12</td>
<td>908</td>
</tr>
<tr>
<td>8 x 8</td>
<td>681</td>
</tr>
<tr>
<td>6 x 8</td>
<td>908</td>
</tr>
<tr>
<td>4 x 8</td>
<td>1361</td>
</tr>
</tbody>
</table>
Vine Density Effects

More vines per acre, less crop per vine

Yield per vine

Plant density
Vine Density Effects

Less crop per vine, but more vines per acre

Yield per acre

Plant density

1000 vines per acre
2000 vines per acre
ROW ORIENTATION
Row Direction Considerations

- Row length: long vs. short
- Hillside slope
- Soil variability
- Prevailing wind
- Sunlight interception
- Sunburn
- Ripening uniformity
FIGURE 14: Light interception by a vertically shoot-positioned canopy in the morning, at midday and afternoon.
## VSP Trellis

<table>
<thead>
<tr>
<th>Row Direction</th>
<th>Balance of light exposure (ratio)</th>
<th>Sunburn risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-W</td>
<td>Maximum uneven (4:1)</td>
<td>High (south side)</td>
</tr>
<tr>
<td>N-S</td>
<td>Even (1:1)</td>
<td>Very high (west side)</td>
</tr>
<tr>
<td>NE-SW</td>
<td>Somewhat uneven (2:1)</td>
<td>Moderate (NW)</td>
</tr>
<tr>
<td>NW-SE</td>
<td>Somewhat uneven (2:1)</td>
<td>Extremely high (SW side)</td>
</tr>
</tbody>
</table>
Goals of Training/Trellis System

1. Support the mechanical load of the grapevine
2. Facilitate the cultural operations
3. Maximize canopy exposure
4. Improve the canopy microclimate
5. Promote balance between the vegetative growth and crop to optimize quality and quantity
Relative differences in climate in a dense canopy

(Smart 1984)
Vine Balance or Capacity

Leaf area or vegetative growth

Fruit yield or reproductive growth

Crop load
## Canopy Characteristics

<table>
<thead>
<tr>
<th>Indices</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruit yield</strong></td>
<td>Production efficiency</td>
</tr>
<tr>
<td>pruning weight</td>
<td></td>
</tr>
<tr>
<td><strong>Exposed leaf area</strong></td>
<td>Canopy efficiency</td>
</tr>
<tr>
<td>Total leaf area</td>
<td>-fruit ripening capacity</td>
</tr>
<tr>
<td><strong>Exposed clusters</strong></td>
<td>Fruit exposure</td>
</tr>
<tr>
<td>Total clusters</td>
<td>-composition and flavor</td>
</tr>
</tbody>
</table>
Measuring “balance”

Yield / Pruning Weight ratios

- Lbs of crop / lbs of prunings per vine
  - <3 Undercropped
  - 4-8 Normal
  - >10 Overcropped

Reds generally lower than whites
Trellis Options
Non-Trellised
Single Curtain Systems
SINGLE CURTAIN SYSTEMS

Two-wire vertical trellis (also called Simple Curtain or California Sprawl)

- foliage support wire
- cordon wire

Vertical-shoot-positioned trellis (VSP)

- movable shoot wires (3 pairs)
- cordon wire

Dimensions:
- Foliage support wire: 12" up
- Cordon wire: 54" up
- Movable shoot wires: 14", 12", 10", 32"
Single wire high cordon

cordon wire
Vertical canopy division or separation
Vertically Divided

✓ Scott – Henry
✓ Smart - Henry

Vertically Separated

✓ Smart - Dyson
SINGLE CURTAIN SYSTEM WITH VERTICALLY DIVIDED FOLIAGE

Smart-Dyson
upward shoot positioning wires (2 pairs)
cordon wire
downward shoot positioning wires (1 pair)

VERTICALLY DIVIDED DOUBLE CURTAIN

Smart-Henry
upward shoot positioning wires (2 pairs)
cordon wires
downward shoot positioning wires (1 pair)

VERTICALLY DIVIDED DOUBLE CURTAIN

Scott Henry
upward shoot positioning wires (2 pairs)
cane wires
downward shoot positioning wires (1 pair)
Horizontally Divided Double Curtain Systems
Trellis Options
<table>
<thead>
<tr>
<th>Shoot Orientation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal/Downward</td>
<td>Moderate to low growth rate</td>
</tr>
<tr>
<td>Vertical</td>
<td>High growth rate</td>
</tr>
</tbody>
</table>
HORIZONTALLY DIVIDED DOUBLE CURTAIN

Double curtain (also called GDC type or Wye trellis)

Lyre trellis
Other Design Considerations

- End assemblies
- Metal or wood trellis materials
- Staging areas
- Turn-around space (20 to 30 ft)
- Ability to mechanize harvest and pruning
Vineyard Design

✓ There is not a “one size fits all” design for all sites.

✓ For a given site there is no “best” design.

✓ All factors need to be considered to match the design to the economic and production goals of the vineyard.
Summary

✓ Vine density and trellis should match vine vigor

✓ Ability to predict the potential vigor of a site is key to the decision making process
Questions ?