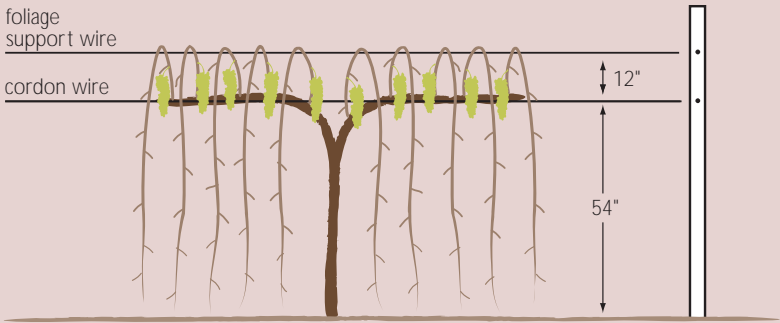
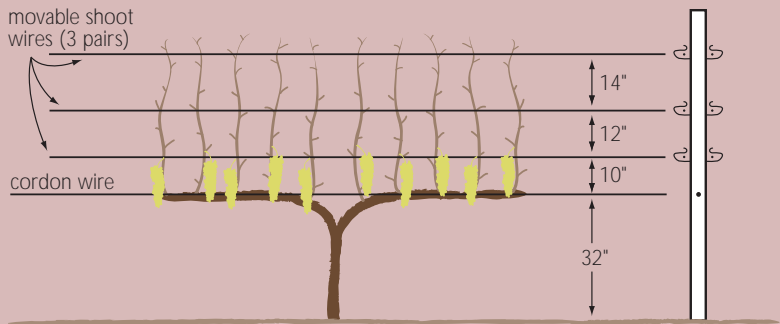


# Trellis Selection and Canopy Management

Over the past two decades, advancements in vineyard design, trellis and training systems, and canopy management practices have dramatically improved wine grape productivity and fruit quality in California. Prior to this period, a standard vineyard design and trellis system was used throughout the state. Little attention was paid to site-specific factors influencing vine vigor such as climate, growing region, soil type, and rootstock. Now significant effort is made to match vineyard design and trellis system to the site-specific factors that influence potential vine growth.

As a result, a wide range of plant densities and training/trellis systems are routinely employed in California wine grape production. The trellises used range from single to divided curtain systems and employ both horizontal and vertical canopy division. Due to both cost and durability, metal has replaced wood as the material of preference for trellis construction.

The major wine grape trellis systems currently used in California are outlined in the following table. A primary consideration when selecting the proper trellis system is anticipated vine vigor or canopy size. Highly

SINGLE CURTAIN SYSTEMS	Region	Application
<p><b>Two-wire vertical trellis (also called Simple Curtain or California Sprawl)</b></p> 	<p>Used in the San Joaquin Valley as well as some areas of the Central Coast</p>	<p>Used when anticipated vine vigor is moderate to high</p>
<p><b>Vertical-shoot-positioned trellis (VSP)</b></p> 	<p>Used in coastal regions and in the northern San Joaquin Valley</p>	<p>Used when anticipated vine vigor is moderate to low</p>

vigorous vines require larger, more expansive trellising systems than low-vigor vines. Before vineyard establishment it is important to accurately estimate anticipated vine vigor or canopy size to select the proper trellis system.

Climate plays a major role in determining vine growth potential, particularly temperature, annual rainfall, sunlight exposure, and wind velocity. Warm summer temperatures and large amounts of sunlight exposure encourage large canopies, while cooler temperatures or constant and high-velocity winds in the spring and summer result in less-vigorous growth. Soil texture and potential vine-rooting depth also influ-

ence vine growth. Deep, fertile soils with large amounts of stored soil moisture support vigorous vine growth, while soils of moderate rooting depth and lower amounts of stored water support less growth. Lastly, pre-plant soil preparation (ripping or slip plowing), cultivar, rootstock selection, and anticipated cultural practices (irrigation, fertilization, and vineyard floor management) also impact vine growth.

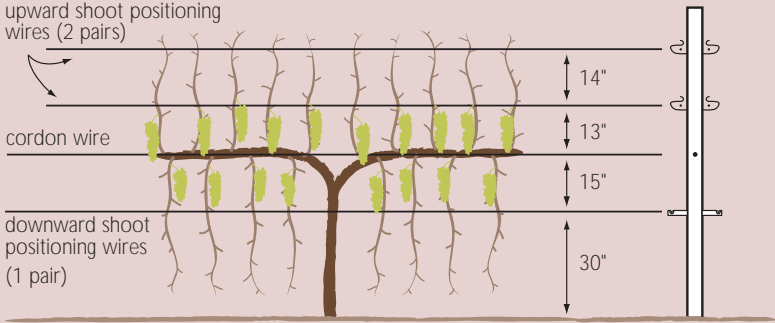
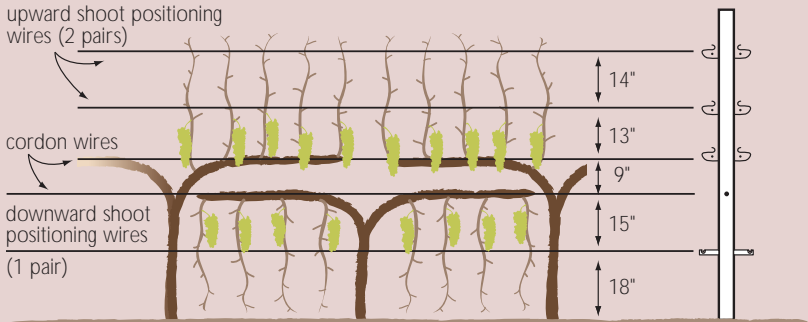
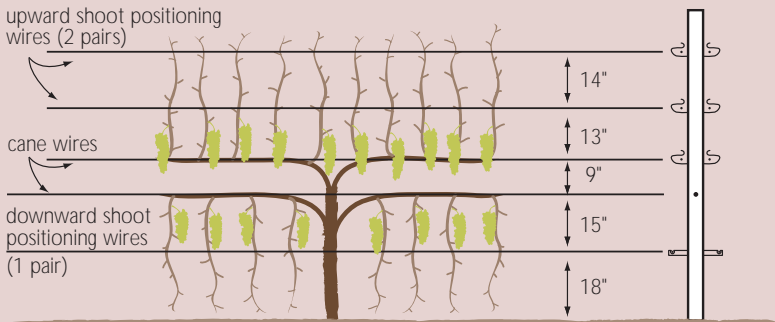
Other factors influencing trellis choice include plant and row spacing, row orientation, establishment costs, equipment requirements, and the desire to mechanize labor-intensive practices such as pruning and harvesting.

Training and pruning systems	Spacing	Mechanization	Approximate cost	Comments
Bilateral cordon training and spur pruning	Spacing between vines is generally 6 to 8 feet. Spacing between rows is 10 to 12 feet.	Harvest; pruning or pre-pruning; leaf removal; hedging	\$1,500 per acre for materials, trellis, and installation	Most common system for wine grape production in San Joaquin Valley due to low establishment cost and ease of pruning and harvest mechanization. Canopy configuration prevents excessive fruit sunlight exposure in warm climates. Interior canopy shading can be a problem if vines are highly vigorous.
Bilateral cordon training and spur pruning most common. Unilateral cordon training and spur pruning used when in-row vine spacing is 5 feet or less. Head training and cane pruning used for some cultivars in cool regions.	Spacing between vines is 3 to 8 feet. Spacing between rows is between 7 and 8 feet.	Harvest; pre-pruning; shoot positioning; leaf removal; hedging	\$2,500 per acre for materials, trellis, and installation	Most common trellis system for wine grape production in coastal regions. Allows reduced between-row spacing and increasing vineyard design efficiency; requires shoot positioning.

In addition to proper trellis selection, canopy management practices such as basal leaf removal, shoot positioning, and hedging are an integral part of high-quality wine grape production. Some form of basal leaf removal is practiced in the majority of coastal wine grape vineyards, as well as in many vineyards in the northern and central San Joaquin Valley. Shoot positioning is per-

formed in all vineyards trellised to the lyre, vertical-shoot-positioned, Scott Henry, Smart-Henry, and Smart-Dyson systems. Some form of hedging or shoot trimming is necessary with most of these systems as well.

Basal leaf removal consists of removing primary leaves and lateral shoots that subtend the four to six basal nodes on each primary shoot. In

SINGLE CURTAIN SYSTEM WITH VERTICALLY DIVIDED FOLIAGE	Region	Application
<p><b>Smart-Dyson</b></p> 	Used in coastal regions and the northern San Joaquin Valley	Used when anticipated vine vigor is moderate to high
VERTICALLY DIVIDED DOUBLE CURTAIN		
<p><b>Smart-Henry</b></p> 	Used in coastal regions	Used when anticipated vine vigor is moderate to high
VERTICALLY DIVIDED DOUBLE CURTAIN		
<p><b>Scott Henry</b></p> 	Used in coastal regions	Used when anticipated vine vigor is moderate to high

most regions leaves are removed on the shaded side of the row only (that is, the north side of east-west-oriented rows or the east side of north-south-oriented rows). Normally leaves are removed shortly after berry set to allow clusters to acclimate to increased sunlight exposure and higher temperatures and to reduce the likelihood of sunburn. Growers should avoid remov-

ing leaves immediately before berry softening, or veraison, as fruit grown in the canopy shade is highly susceptible to sunburn if suddenly exposed at this time.

In many coastal vineyards, shoots are thinned in the early spring to reduce shoot congestion and crop load. Sterile shoots, and in some cases cluster-bearing shoots from non-count nodes, are

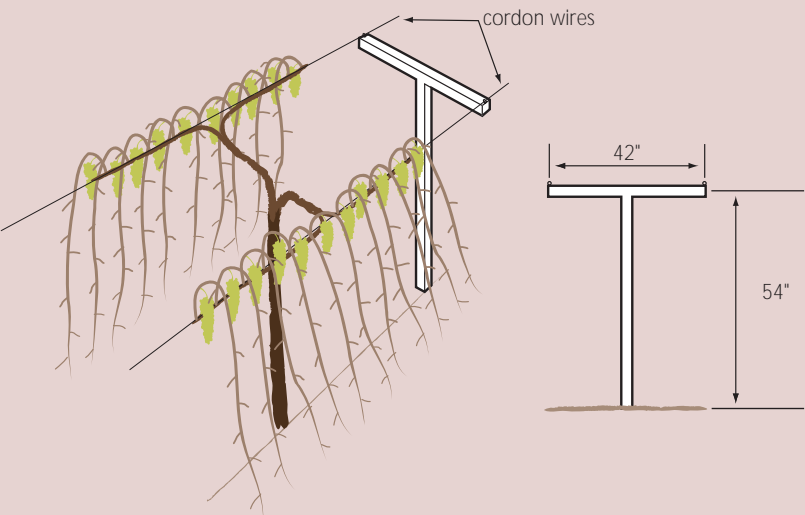
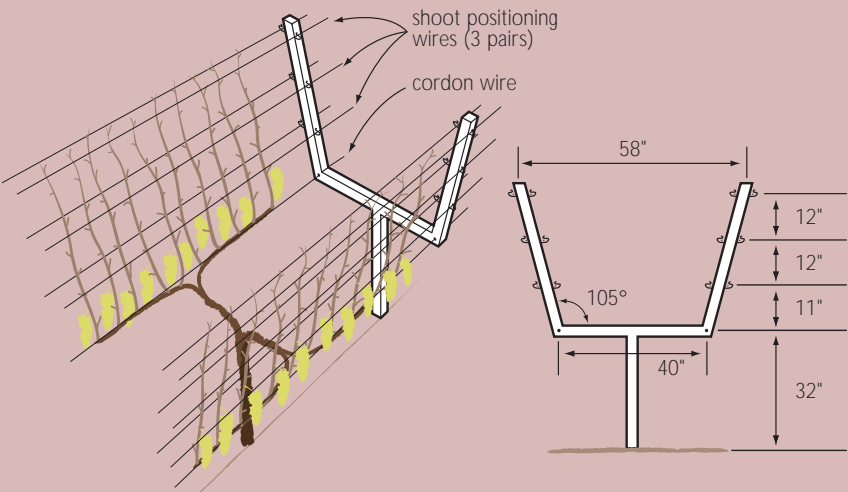
Training and pruning systems	Spacing	Mechanization	Approximate cost	Comments
Bilateral cordon training and spur pruning	Spacing between vines is generally 6 to 8 feet. Spacing between rows is 7 to 8 feet.	Harvest; pre-pruning; leaf removal; hedging	\$2,500 per acre for materials, trellis, and installation.	Used for new vineyards or as a retrofit for existing vineyards trellised to VSP. Generally used in coastal regions when anticipated vine vigor is too high for VSP but narrow-row spacing is desirable. Between-row spacing should not be less than 7 feet in order to prevent shading of lower portion of canopy. Requires both upward and downward shoot positioning. Popularity increasing.
Bilateral cordon training and spur pruning	Spacing between vines is 6 to 8 feet. Spacing between rows is 7 to 8 feet.	Harvest; pre-pruning; leaf removal; hedging	\$2,500 per acre for materials, trellis, and installation.	Used in coastal regions when anticipated vine vigor is too high for VSP but narrow row spacing is desirable. Requires that bilateral cordon-trained vines be alternated at two heights to create upper and lower fruiting zones. Lower fruiting zone often becomes weak over time.
Head training and cane pruning	Spacing between vines is 6 to 8 feet. Spacing between rows is 7 to 8 feet.	Harvest; leaf removal; hedging	\$2,500 per acre for materials, trellis, and installation.	Similar application as Smart-Dyson, except that cane pruning allows easier separation of canopy. Used when cane pruning, VSP canopy configuration, and narrow-row spacing are desired under moderate- to high-vigor conditions.

removed when the average shoot length is 6 to 8 inches. Shoot thinning increases light reaching the basal buds in the canopy interior. However, under moderate- to high-vigor conditions the effects of this practice on canopy microclimate may be temporary due to compensating lateral shoot growth.

In vertical-shoot-positioned (VSP) canopies, shoot positioning maintains canopy form and foliage separation in narrow-row spacings. On horizontally divided canopies (GDC or Wye), shoot positioning maintains canopy separation. It improves light penetration to the canopy interior, particularly in vigorous, horizontally divided

vineyards where the row middle or area between the fruiting zones becomes shaded following fruit set. The vine foliage is separated or positioned using movable wires. On vertically divided systems, shoot positioning is performed several times per year, typically near bloom and following berry set. For horizontally divided systems, shoot positioning is normally performed once per year near bloom.

Hedging or shoot trimming maintains canopy shape, prevents shading, and facilitates cultivation and mechanization. The shoots of VSP canopies are trimmed when the foliage begins to grow over the positioning wires at the top of the

HORIZONTALLY DIVIDED DOUBLE CURTAIN	Region	Application
<p>Double curtain (also called GDC type or Wye trellis)</p> 	<p>Used in coastal regions and the San Joaquin Valley</p>	<p>Used when anticipated vine vigor is moderate to high</p>
<p>Lyre trellis</p> 	<p>Used primarily in the North Coast</p>	<p>Used when anticipated vine vigor is moderate to high</p>

canopy, usually sometime between berry set and veraison. The shoots are typically trimmed 6 to 8 inches above the top canopy wires. If significant lateral shoot growth has occurred, sides of the canopy are also hedged to maintain canopy width of approximately 18 to 20 inches. California Sprawl (two-wire vertical) canopies in the San Joaquin Valley are typically trimmed approximately 24 inches above the vineyard floor sometime near veraison. This facilitates air movement and decreases humidity in the fruiting zone.

—Nick K. Dokoozlian

Training and pruning systems	Spacing	Mechanization	Approximate cost	Comments
<p>Quadrilateral cordon training and spur pruning; divided curtain may also be formed using bilateral cordon trained vines that alternate from side to side (e.g., GDC). Distance between curtains ranges from 2 to 4 feet, depending on desire to mechanize harvest.</p>	<p>Spacing between vines is 6 to 8 feet. Spacing between rows is 11 to 12 feet.</p>	<p>May be mechanically harvested if curtains are no more than 30" apart. Pruning or pre-pruning, hedging may also be mechanized.</p>	<p>\$2,000 per acre for materials, trellis, and installation.</p>	<p>Used to reduce canopy density under high-vigor conditions. Shoot positioning used in some cases to increase sunlight penetration to the center of the canopy. Overcropping may be a problem with highly fruitful or large clustered cultivars.</p>
<p>Quadrilateral training and spur pruning; distance between curtains is 3 to 4 feet.</p>	<p>Spacing between vines is 6 to 8 feet. Spacing between rows is 10 to 12 feet.</p>	<p>Pre-pruning; leaf removal; hedging</p>	<p>\$3,500 per acre for materials, trellis, and installation.</p>	<p>Found primarily in the North Coast in moderate- to high-vigor Cabernet Sauvignon and Merlot vineyards. Not widely used due to high establishment and annual production costs.</p>