Winegrape Trellis and Training Systems for the San JoaquinValley

Peter Christensen
Extension Viticulturist
University of California, Davis
UC Kearney Agricultural Center
9240 S. Riverbend Avenue, Parlier, CA 93648

Improved winegrape management through vine spacing, training, trellising, and pruning practices is a continuing research effort by the University of California. The long-term goals include improved yields, fruit quality, and mechanization. Fred Jensen, Extension Viticulturist, initiated this work in 1975 comparing three cultivars -- French Colombard, Chenin blanc, and Barbera -- in a row spacing and trellis trial at the Kearney Agricultural Center. Subsequent work, in cooperation with Nick Dokoozlian, Extension Viticulturist, has compared vine training, trellising, pruning, and leaf removal systems. Most of the trials have involved French Colombard, Barbera, and Sauvignon blanc to represent a range of growth characteristics. This discussion summarizes the trial work to date and current recommendations on vineyard systems for San Joaquin Valley conditions.

Spacing

Traditionally, most vineyards in the San Joaquin were planted with 12-foot row spacing. This has been the all-purpose spacing for raisin, wine, and table cultivars, although only raisin vineyards require such wide spacing for the drying process itself. Theoretically, however, narrower spacing should produce higher yields due to greater sunlight interception.

Five years of data comparing 8, 10 and 12-foot row spacing demonstrated yield increases somewhat proportionally to increased row density per acre with single-curtain trellising (no crossarm). Ten and 8-foot row spacing increased yields by 13% and 22%, respectively, over 12-foot spacing. Thus, there was approximately *a 5-6% yield increase for every foot of narrower row spacing*. This response was consistent with all three cultivars -- French Colombard, Chenin blanc, and Barbera -- representing a wide range of vigor.

Vine age also did not affect the results. One might expect that the narrower row spacings would give higher yields in the first producing year, and that as the vines matured, the differences would lessen. This was not the case. In fact, in the eighth year the differences were greater than they had ever been. The 10 and 8-foot row spacings yielded 21% and 29% more, respectively, than 12-foot spacing.

Thus, rows should be close enough to intercept the most sunlight possible, while allowing for equipment accessibility. Eight and nine-foot rows are too close for most conventional equipment and to accommodate the growth of vigorous cultivars such as French Colombard. However, 10-foot row spacing would require only minor adjustments in most cases. It should be the norm for vineyards without crosssarms.

Vine spacing within the row is usually 6 to 8 feet, depending on vine vigor. One only has to be concerned with filling the cordon wires with spur positions. This can easily be accomplished with 7 or 8-foot spacing with vigorous cultivars such as French Colombard, Sauvignon blanc, Grenache, or Syrah (Shiraz), as well as vines grafted onto vigorous rootstocks such as Freedom. Closer spacing should only be considered in low vine vigor situations.

The idea of increasing yields or devigorating vines with close in-row spacing is not valid. Any early-years' yield advantage due to high vine density will probably disappear within 2 to 3 years of cropping. Close spacing ultimately crowds the vine canopy much more than the root

environment. Close vines tend to shade one another and become less productive due to shoot crowding and reduced fruitfulness.

Training and Trellising

A 3-year study (1989-91) compared 8 training-trellising systems suited to mechanization and San Joaquin Valley conditions. It compared cordon height, numbers of vertical foliar support wires, cordon-type (bilateral vs quadrilateral), and distance of quadrilateral cordon separation. Barbera and French Colombard were used to represent moderate to high vigor cultivars. The results are summarized as follows:

Cordon height - An 11-inch increase in cordon height (53" vs 42") increased yield in both cultivars, averaging 6.9%. Additionally, fruit soluble solids were increased by 0.5 °Brix in Barbera. Thus, cordons should be at 52 to 60-inches to be at a good working height, suitable for mechanization, and for yield and fruit maturation potential.

Foliar wires - Adding a single foliar support wire 11 inches above a bilateral cordon increased berry and cluster weights overall and vine yields in some years by as much as 7.1%. Fruit soluble solids was also favored with a single foliar wire over no catch wire in one year. Thus, directing some of the growth vertically, as well as increasing canopy height, tended to improve yields. However, the effect was not as consistent or pronounced as an increase in cordon height.

Adding a second foliar support wire (3-wire vertical system) was not very beneficial. Yields were lower, while soluble solids were higher as compared to a single catch wire (2-wire vertical system). The lower yield with 3 wires was due to lower cluster numbers, presumably from more canopy shading of the spur positions on the cordon. Thus, the cost and inconvenience of using more than 1 vertical foliar support wire is not warranted.

Overhead 'T' trellis - An overhead, 24-inch, 2-wire T trellis with an intermediate catch wire increased yields by 8.5% overall, while increasing fruit soluble solids, as compared to a 2-wire vertical system. Brush weights were also highest with this system due to the invigorating effects of additional foliar support. However, growers must weigh this potential response against the added trellising and pruning costs, as well as lowered convenience in mechanized practices.

Quadrilateral cordons - Using quadrilateral as compared to bilateral cordons gave the most dramatic yield response. Leaf area was spread by 2 to 4 feet and spur positions increased by 75%. Yields were increased by 53% and 69% in Barbera and French Colombard, respectively. The trade-off was lower fruit soluble solids of 1.1 °Brix (Barbera) and 0.5 °Brix (French Colombard).

Widened quadrilateral separation provided marginal benefits. Four-foot quads as compared to 2-foot quads improved yields by 12% in French Colombard and 0% in Barbera and with no improvement in fruit composition. Thus, it appears that there is no economic advantage to going to wider quad separation than 24-30 inches, especially since machine harvesting becomes increasingly difficult.

Pruning Systems

Machine hedge (non-selective) pruning and minimal pruning (bottom trimming only) are gradually increasing in California as we gain experience and confidence in the practices. They are widely practiced in Australia due to their more severe labor constraints. The practices can be expected to increase in California whenever labor is in short supply and economic returns are low.

Machine hedge pruning and minimal pruning were incorporated into our training/pruning trials during 1993-95. Machine pruning was compared to hand pruning on bilateral cordon and quadrilateral (2-foot separation) training systems. Two minimal pruning treatments were also included: No bottom trimming vs Bottom trimming after fruit set for crop adjustment.

Machine pruning was the best system for vigorous French Colombard, especially with bilateral cordons. Hand pruning with bilateral cordons was too restrictive, producing the lowest yields with no improved fruit composition. Quadrilateral cordons showed comparable yields and fruit composition with machine and hand pruning after the first year of treatment. During the first year, machine pruning on quadrilateral cordons delayed fruit maturation one week along with a yield increase. By the second year and thereafter there were only minor differences among bilateral cordon-machine pruned, quadrilateral cordon-hand pruned, and quadrilateral cordon-machine pruned. Thus, French Colombard is very forgiving in terms of pruning method, adjusting well to the higher node numbers of machine pruning, regardless of training method.

Barbera responded dramatically to machine pruning with a 45% overall yield increase over hand pruning. However, this response corresponded with a 1.7 °Brix or about a 2-week delay in fruit maturation. These responses were fairly consistent over the three years of study and were similar with either bilateral or quadrilateral cordon training. Barbera represents the moderately vigorous or highly fruitful cultivars which may continue to show some delayed fruit maturation from the higher node numbers with machine pruning. However, previous studies have shown than most cultivars will adjust to the higher node numbers by the third year, if not sooner.

Overall, as in previous studies, machine pruning can produce economical results with certain cultivars. Highly vigorous, moderately fruitful, or self-thinning, loose-clustered cultivars most often respond favorably to machine pruning. They tend to adjust crop load to vine capacity with lower fruit set and smaller berries when high node numbers are retained. French Colombard and Sauvignon blanc have been notable examples in Kearney trials. Other cultivars such as Carignane, Ruby Cabernet, and Grenache may take one or several years to completely adjust. Chenin blanc continues to show some delayed fruit maturation. Very vigorous vineyards of any cultivar tend to respond favorably to machine pruning. A number of commercial vineyards have been successfully machine-hedge pruned for over 15 years.

Minimal pruning produced higher yields than hand pruning; it was similar to or poorer than machine pruning, yield-wise. However, fruit ripening was delayed by 1 to 3 weeks as compared to hand or machine pruning. It also contributed to lower titratable acidity, higher pH, and lower skin anthocyanin content in Barbera.

Adjusting crop by trimming the bottom half of the canopy (including clusters) after fruit set was not beneficial. It reduced yield while not improving fruit composition. Apparently, this was due to the fact that shoots and leaves were removed in the same proportion as the clusters. Thus, the leaf/fruit ratio tended to stay the same on the remaining canopy.

Some commercial vineyards have successfully used minimal pruning for over 10 years. Yields have been consistent and with acceptable fruit quality. However, some harvest delay is usually expected. The system is best suited to vigorous vineyards with a high bilateral cordon or retrained to a high cordon. According to our studies, the bottom the canopy can just as well be trimmed in the winter rather than in late spring.

Leaf Removal for Cluster Exposure

Increasing cluster exposure to sunlight by leaf removal is a cool climate winegrape practice to improve fruit composition and reduce fungal infections. It was evaluated in a 1992 trial at Kearney. Three leaf removal treatments -- cluster region by hand, side window by machine

(simulated), and mechanical skirting -- were studied with French Colombard and Barbera. Leaf removal was performed 4 to 5 weeks after fruit set while skirting was done 2 weeks later, just before veraison.

French Colombard was not benefitted, as the vigorous leaf canopy largely recovered early in the ripening period. Hand leaf removal actually reduced yields due to sun exposure on the developing berries. The Barbera canopies remained open longer. The side window increased sunlight in the fruit zone through veraison while hand leaf removal was effective through harvest. All of the treatments, including mechanical skirting reduced bunch rot in Barbera. However, none improved fruit composition, including pH, soluble solids, or anthocyanin content, as has been reported in coastal climate tests. The only treatment effects were smaller berries with lower titratable acidity from the window and hand removal treatments.

Overall, it was again demonstrated that canopy leaf removal can reduce bunch rot. However, fruit composition was not benefitted and was actually worsened (lower acidity) by hand- and window-leafing in Barbera. Also, yields can be reduced by fruit burn and smaller berries due to excessive exposure. The negative effects of leaf removal are probably due to excessive berry temperatures experienced in the San Joaquin Valley. Certainly, the fruit exposure practices used in coastal vineyards cannot be assumed as beneficial to our conditions.

Summary Recommendations

Row spacing

8 to 10 feet for single curtain or vertical systems, depending on equipment.
11 to 12 feet for quadrilateral systems or GDC (Geneva Double Curtain).

Vine spacing

6 to 8 feet, depending on vine vigor and training system. Quadrilateral can be 1-foot closer than bilateral systems with comparable vigor.

Training and Trellising

Bilateral cordon at about 54 inches with a single foliar support wire (10"-12" above) for low to medium vigor or highly fruitful cultivars. Examples are Barbera, Ruby Cabernet, Rubired, Zinfandel, Sangiovese, Viognier, and Chardonnay.

Quadrilateral cordons separated 24 to 30 inches on a T trellis at about 54 inches for high vigor and small, loose-clustered cultivars. No foliar support wires are recommended. Examples are Syrah (Shiraz), Cabernet Sauvignon, French Colombard, and Sauvignon blanc. Most cultivars grafted onto a vigorous rootstock such as Freedom can also be trained in this manner due to the high vigor characteristics.

Pruning

Conventional hand pruning for low to medium vigor or large-clustered cultivars. Spur and node numbers are adjusted to vine capacity. Examples include Zinfandel, Chenin blanc, Sangiovese, Viognier, and Chardonnay.

Machine hedge pruning is best adapted to high vigor and/or small cluster cultivars. Cultivars such as Syrah (Australia experience), Rubired, French Colombard and Sauvignon blanc respond very favorably in the first year. Others, such as Ruby

Cabernet, Carignane, and Grenache may take 1 or 2 years to adjust to the higher node numbers with a balanced crop load (no delay in fruit maturation).

Minimal pruning takes the most courage but is the easiest to endure. Basically, no pruning is involved, only bottom trimming or skirting. It is suited to almost any vigorous cultivar trained to a high bilateral cordon. Yields will increase and maintain a certain level. Ripening is usually delayed by 1 to 3 weeks. Bunch rot is almost eliminated. Machine harvesting is performed by shaking the canopy with in-phase horizontal rods.

We gratefully acknowledge the **American Vineyard Foundation** for its generous support of this research.