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Shoot density and Canopy Management for Hybrids

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One of the basic principles of viticulture is that vines function best and deliver optimal fruit quality - and quantity - when the grapevine canopy is in balance with the amount of fruit the vine is carrying. This applies whether or not the crop is Concord juice grapes or high-end Cabernet franc. A grower managing a vineyard wants to have the proper ratio of leaf area to fruit to be able to support a reasonable (or large) crop and be able to ripen it.

Too much vegetative growth (under cropping) leads to shoot crowding, excessive shading, numerous leaf layers, and less fruitful buds the following year. Too little leaf area for the amount of fruit present and the fruit won't ripen (overcropping).

Highly vigorous vines with dense canopies can get caught in a vicious vegetative cycle - where excessive growth leads to less fruitful buds, which leads to more growth and even lower bud fruitfulness. Moreover, in dense canopies, quality of the fruit that is there is compromised.

For example, the Traminette vines in Figure 1 had received excessive nitrogen, and produced an extremely dense canopy. The grower found his fruit delayed in ripening, despite a moderate crop, and fruit maturity varied from overripe (exposed clusters) to under-ripe (shaded clusters). Harvest was delayed by 2 weeks compared to other traminette vineyards in the area.

More importantly, many of the compounds that impart Traminette's unique flavors are directly influenced by exposure to sunlight. Wines produced from this particular vineyard undoubtedly had less of the 'gewurztraminer-like' flavors than other blocks with more balanced canopies.



Figure 1. Excess vigor in this Traminette vineyard delayed ripening and harvest, and led to wide variation in fruit maturity. Sun-exposed clusters (top) were over-ripe, while shaded clusters (bottom) lagged in maturity.

The importance of open canopies. Exposure to light directly influences fruit composition. It can improve brix levels, phenolics, and monoterpenes, while reducing acidity. In red varieties, light exposure reduces levels of methoxypyrazines - the compounds responsible for 'green bell pepper' flavors - at harvest. Open canopies also improve light interception by leaves, promote air flow and rapid drying, and thereby reduce disease incidence. Not incidentally, open canopies also make it a lot easier to get good spray deposition and disease control.

So how do you get there?

Managing canopy density and cropping level can be a multi-faceted process, starting with dormant pruning, continuing with shoot thinning, cluster thinning, canopy zone leaf removal, and shoot tipping or summer hedging.

If you are lucky, and have a moderate vigor site, dormant pruning alone will result in moderate growth conducive to optimal crop levels and an open canopy. Leave the right number of buds and the rest will follow. More often, you may need to use additional canopy management techniques to improve light interception and produce a quality crop.

Targets. Ranges of optimal shoot density, shoot length, and crop level to leaf area ratios have been defined for *vinifera* by previous research. They indicate how close the vine is to having a balance of vegetative growth and fruit. Appropriate values for hybrid canopies may be higher.

<i>Item measured</i>	<i>Indicator</i>	<i>Range</i>
Cane length/diameter	Grams cane weight	25-40
Vine growth	Pruning weight	0.3 lb/ft of row or canopy
Shoot density	Shoots per foot	4-6
Crop load (pruning wt /fruit)	Lb fruit/lb pruning wt per vine	5-12
Yield per unit of canopy	Crop per foot of canopy	3-5 lb/ft

From a grower standpoint, the most practical measurements to judge vine balance are yield (lb/vine) and pruning weight (lb/vine). While it's impractical to routinely collect and weigh vine prunings, it may be useful to do so on a

few vines to get a feel for how a '1 lb vine' or a '2 lb vine' looks. Yield per vine (T per acre x 2000 lb/ton /vine count = lb/vine) can then be divided by average pruning weight to determine 'crop load' ratios. As the table above indicates, a range of 5-12 for this ratio is the ballpark you want to be in for *vinifera*, although crop loads for hybrids may be higher.

Appropriate pruning weights vary, but the target for a vine with 6 ft in-row spacing trained to a single canopy would be $0.3\text{lb/row} \times 6\text{ ft} = 1.8\text{ lb}$ pruning weight.

***Vinifera* and VSP.** Most growers are familiar with basics of vertical shoot positioning (VSP) as a training and canopy management system for high-end *Vinifera* grapes. Canes or cordons are tied to a low fruiting wire, and moveable catch wires are used to force shoots to grow upright. Shoots may be thinned early in the season, and clusters removed. When shoot growth extends beyond the top of the trellis, shoot tips are removed in one or more passes to prevent shoots from shading the lower canopy, and basal leaves in the fruiting zone are stripped mechanically or by hand to expose the clusters. Green harvest at veraison of lagging fruit clusters can improve overall uniformity of ripening. (Figure 2)



Figure 2: VSP and canopy management in a Riesling vineyard near Geneva, NY.\

Each one of these practices involves an additional pass through the vineyard, and a substantial amount of labor. High-value *V. vinifera* - at \$1500 to \$2500 a ton - may support this intense labor input. But what about lower-value, more disease resistant hybrids? What canopy management practices will 'pay off' for hybrid grape producers?

A New York Farm Viability Institute - supported project by Dr. Justine Vanden Heuvel and Enologist Gavin Sacks is examining this issue in several hybrid varieties, notably older 'French hybrid' Marechal Foch and newer Cornell releases Noiret and Corot Noir. Their question: Will canopy management to produce light exposure to fruit result in enough improvement in wine quality to support use of these practices by growers? Will wineries be able to capture higher bottle prices for hybrid-based wines as a result?

Hybrid growth habits and canopy management. Many hybrids are ill-suited for low training and VSP, because they have downward growth habits. They are better suited for high training systems, such as the Hudson River Umbrella or 'high cordon' system (Figure 3) - or Umbrella kniffen. Grown on VSP, shoots are hard to train upward,

because they want to grow downward. Moreover, many tend to be highly vigorous when growing 'up', and are devigorated (growth slows) when they grow down. Finally, some hybrids (e.g. Seyval blanc and Dechaunac) have fruitful basal or non-count buds, so it's harder to control their crop through pruning alone.



Figure 3. Top Wire Cordon training system - DeChaunac vineyard.

So what practices are suited for vines trained high?

Catch wires are out, unless the cultivar is extremely low in vigor. When vigorous hybrids are trained to VSP, shoots can grow downwards over the top of the catch wires and shade the fruiting zone (*Figure 4*).



Figure 4. Vigorous Noiret trained to VSP. Note that shoots have grown over the catch wires and back down towards the ground, shading the fruiting zone.

The main opportunities for modifying canopy density and shading in hybrids are shoot thinning and basal leaf removal - supplemented by early fruit thinning in large-clustered varieties such as Seyval blanc and Chambourcin. Shoot tipping (hedging), while possible, is much harder to do on varieties trained high.

Shoot thinning. Shoot thinning accomplishes two things: It reduces canopy density and at the same time reduces the number of clusters per vine. Since it is done early, clusters may compensate by increasing fruit set or berry size - although this doesn't eliminate the difference in crop weight.

In the first year of Justine's hybrid canopy management study, shoot thinning of Marechal Foch reduced cluster number from about 80 per vine to 60, and crop weight per vine from about 14 to 12 lb. Cluster weight increased slightly (0.14 to 0.15 lb/cluster). In Vignoles, there was a similar decrease in cluster number (about 70 to 50), but a larger increase in cluster weight, from about 0.11 lb to 0.13 lb per cluster. Yield was about 1.5 lb/vine lower on the thinned vines (x807 vines per acre = 0.6 T/acre).

In the Vignoles, shoot thinning measurably changed canopy architecture. Average number of leaf layers was reduced from 2.5 to 2.0 (optimum being about 2), and the % of interior (shaded) clusters dropped from 80% to around 50%. Wines made from this experiment showed discernable sensory differences. In the Foch, Justine measured total flavonols (compounds associated with flavor and mouthfeel), and total anthocyanins (compounds that impart the red color to wines). Shoot thinning increased both.

At our spring seminar on canopy management, growers from Lake Erie, Finger Lakes, and the Hudson Valley tasted the Vignoles and some wines made from shaded or exposed NY76.0844.24 (Numbered selection from Cornell's breeding program) fruit. Growers and winemakers were able to correctly identify the 'shaded' vs 'exposed' wines, and rated the 'exposed' wines more highly. There was a difference of opinion on how dramatic the differences were, with the Finger Lakes and Lake Erie growers discerning a larger difference than the Hudson Valley attendees.

Cost and Timing of Shoot thinning. Shoot thinning is best done early in the season, at around 5-10 inch shoot growth. At that time, it is easy to remove shoots rapidly by hand. The more this is delayed, the more shoots will be lignified and hard to remove without pruning shears. Aim for 4-6 shoots per foot of canopy, and concentrate on removing any secondaries (double shoots) when possible.

Figure 5 illustrates what this looked like in a Umbrella Kniffen-trained block of Marechal Foch this spring. Note that with overlapping canes, what counts is to have the appropriate number of shoots (possibly on several canes) in each foot of row.



Figure 5. Marechal Foch on umbrella kniffen before (left) and after (right) shoot thinning.

In a Cabernet Franc vineyard in the Finger Lakes (Figure 6), we thinned several 60-vine rows and timed how long it took to do so. By maintaining a slow walking speed and focusing on picking off shoots in the most dense parts of the vines, we were able to average between 7 and 9 seconds per vine to complete this task. On a per-acre basis (807 vines per acre) that works out to about 1.6 hours per acre. This is a very small amount of time compared to other hand-labor tasks such as pruning, cluster thinning, and suckering vines.



Figure 6: Shoot thinning in a Cabernet Franc vineyard in the Finger Lakes (left)

Basal leaf removal. Removing leaves around the cluster zone is a common method to increase fruit exposure. The difference between high-trained hybrids and VSP trained *vinifera* is that the leaf removal is done at the top, and shoot positioning is not as precise. This may rule out mechanical leaf removal, as one will inevitably cut off horizontally-oriented shoots along with basal leaves, leaving more or less short shoots. Later timing of leaf removal (so that developing clusters weigh down shoots and they don't 'sprawl' out to the side) may reduce this problem.

At any rate, extreme leaf removal in the cluster zone should be avoided. Removing too many leaves will reduce photosynthetic capacity too much. Shoot for about 50% cluster exposure.

Shoot positioning. Shoots can be manually positioned downwards - basically by manually 'combing' the ones that are growing laterally to a downward position. This may devitalize fast-growing shoots, and provide more light in the renewal zone.

Hedging. If vines are not on VSP, then the canopy can be mechanically hedged along the sides to control vine size and provide more light exposure, although studies have demonstrated mixed results with this technique —likely due to the variable shoot length that results. This may be a useful tool if vines are so vigorous that shoots grow too far into the row middles to allow the tractor to pass, but it may not improve fruit and wine quality.

Cluster thinning. Some hybrids will benefit from cluster thinning. One thinks of varieties with large clusters and fruitful buds, like Seyval blanc and Chambourcin. Cluster thinning, in general, takes more time than shoot thinning. Timing can be an issue. The earlier you get in there (for example at fruit-set rather than veraison), the faster you can accomplish this task. Early cluster thinning will likely result in some compensation (larger berries, redirection of photosynthate to remaining clusters). Post-veraison cluster thinning (also known as 'green harvest') will not change fruit chemistry much, but will improve the

consistency of fruit maturity at harvest. Essentially, after veraison, one removes clusters that lag behind in development, so that they don't impart unripe flavors to the wine.

Summary. Hybrids often have different growth habits than *V. vinifera*, and may not be suited to vertical shoot positioning (VSP) - and the canopy management manipulations that are possible with it. Canopies of vines trained to high-cordon or umbrella kniffen, however, can be modified - with improved fruit and wine quality being the payoff.

The most cost-effective way to do this may be shoot thinning. If done at the appropriate time (5-10 inch shoot growth) it can be done rapidly. Aim for 4-7 shoots per linear foot of canopy (if canopy is vertically or horizontally divided, that's 4-7 shoots for each portion of a divided canopy), and remove secondary buds where both primaries and secondaries have pushed. The result will be a more open canopy, less leaf layers, better fruit exposure - and hopefully more intense flavors and fewer 'unripe' flavors in your wines. Try it out in a portion of your vineyard, vinify it separately, and taste the results.