Untangling the concepts of vine size, capacity, crop level, vigor, and vine balance

Grapes 101

Grapes 101 is a series of brief articles highlighting the fundamentals of cool climate grape and wine production.

By Alan Lakso

Grapevines use nutrients and water from the soil and sunlight to convert carbon dioxide into leaves, fruit, canes, trunks, and roots. Producing optimal yields of quality fruit is a site-specific task, requiring management of canopy and crop based on an understanding of how vines grow and a firm grasp of the many terms used to describe vine growth and its relationship to the crop. Vine size, vine capacity, cropping level, vine vigor, and vine balance are all related concepts that describe vine productivity. They are commonly—but not always consistently—used.

This vineyard has sparse canopy fill and therefore limited vine capacity.
**Vine size is the total vegetative growth of the vine over the growing season.**

Vine size includes leaves, shoots (prunings), trunks, and roots, however it often is expressed as *winter pruning weight* since the pruning weight is generally well correlated with the other components of vine size. Note that pruning weight is NOT a useful measure of vine size for minimally-pruned vines (i.e., mechanically pruned with a hedger) as the relation of pruning weight to total weight is very different and very little is pruned off.

Take, for example, mature vertical shoot positioned (VSP) vines of moderate vigor with shoots three to five feet long (about 30 to 50 grams pruning weight/shoot) and four to five shoots per foot of trellis. They will produce about 0.3 to 0.4 lbs pruning weight per foot of trellis, and a six-foot vine would have a vine size of 2 to 2.4 lb, commonly referred to as a "two-pound" vine.

*Example of a vineyard that has full trellis fill and relatively high vineyard capacity.*

**Vine capacity is the total dry weight of both the crop and the vegetative growth.**

Vine capacity is a measure that reflects the energy gained by sunlight interception. It can be expressed as crop weight plus pruning weight, although since the crop contains more water (about 75%) than dormant canes (about 50%), it more accurate to adjust them to dry weight as follows:

\[
\text{dry weight} = \frac{\text{crop}}{4} + \frac{\text{pruning weight}}{2}
\]

For our six-foot vine as above, cropping at 10 lbs/vine (four tons/acre if spaced 6 x 9 feet), the vine capacity would be calculated as follows:

\[
10/4 + 2/2 = 3.5 \text{ lbs dry weight.}
\]

**Vigor refers to the rate of shoot growth or final shoot length.**
The term "vigor" is often misused to mean vine size, but it is not vine size or capacity and is not always directly related to either. If you prune two identical vines to leave 100 shoots on one and only two on the other, the vine with two shoots will have tremendous shoot vigor but much less vine size or capacity than the one with 100 shoots. Because vine size and capacity have clear metrics and vigor is a vague, subjective term, it is better to be more specific and use, for example, average shoot length or winter cane weight.

Horizontally-divided canopies such as the Lyre intercept more sunlight than single canopies and therefore have greater vineyard capacity. In addition, Lyre systems allow much higher shoot numbers that can be used to reduce shoot growth in high-vigor sites.

**Crop load is the relative balance of vine capacity to crop demand.**

Each vineyard has the capacity to ripen a specific amount of fruit, and both supply and demand must be considered.

The target crop load—the maximum crop that can be ripened without losing quality—is affected by many factors. Generally, the more sunlight a healthy vineyard can intercept, the greater the crop it can ripen. Sunny, long-season climates and larger, divided canopies (e.g., GDC, Lyre, tall Scott Henry) will be able to ripen more fruit. Temperature can affect these relationships in complex ways. Pruning severity and bud fruitfulness will limit the potential crop, while thinning can regulate actual crop demand. Vine maturity also affects the target crop load. For example, a crop of 6 lbs. per vine would produce an excessive crop load on a first year vine (overcropping), but it would be a light crop load on a large, mature vine (undercropping).
Crop load is often expressed as pounds of crop/pounds of pruning weight, using pruning weight as the estimate of vine capacity. Because crop and pruning weights are both easy to measure by growers, this is a useful tool. This assumes that the shoots are well-positioned for good sunlight interception. Values of 5 to 8 lbs crop/lb pruning weight seem to be optimal, although the optimum may be a bit lower in climates with shorter seasons. So our 6 x 9 foot vine with 2 lbs of pruning weight should be able to ripen about 10 to 16 lbs of fruit per vine, or about 4 to 6.5 tons per acre, if healthy and well-managed. Diseased leaves or poorly trained canopies will reduce the optimal crop load.

**What is vine balance?**

Vine balance (i.e., the balance of supply and demand) as a concept can mean the same as crop load. But generally we mean the *correct balance* of vine capacity and crop load to give the desired fruit quality and vine sustainability. In other words, vine balance is achieved when adequate, but not excessive, growth is combined with an optimal crop load as described above. A target shoot size is about four feet, plus or minus as that length shoot will provide enough leaf area to ripen about 200 grams of fruit.

The optimal crop load or balance for specific wine grape varieties appear to differ when varietal flavors and aromas are considered. Recent research suggests that for Cabernet family varieties, a very low crop load with excess vigor tends to be as detrimental to quality as over-cropping, so there is probably a moderate crop that is optimal. Chardonnay appears to be much less responsive to crop load than many varieties, while Pinot Noir may have a lower optimal crop than most. This aspect needs much more objective research to provide better guidance.

**What if your vines are too weak or too strong?**

Soils, water and nutrient availability and climate affect the inherent potential for vine growth in given vineyard. This can make reaching vine balance difficult. A large part of a growers' job is to manage vines to maximize good light interception and to use management practices (e.g., pruning, thinning, shoot positioning) to achieve the appropriate crop load and shoot vigor. Vines that intercept more light (GDC, Lyre or tall Scott Henry) can ripen more crop, and growers should aim to fill the trellis as uniformly as possible to maximize light interception and vine capacity.

If poor soil leads to excessively weak shoot growth and low vine capacity with normal shoot numbers, there are several approaches to consider. The low capacity can be accepted and a low crop grown though it can be difficult to judge just how much to thin on each shoot to get proper balance. Alternatively, leaving fewer shoots per vine will increase shoot growth in the remaining shoots. If shoots reach three to four feet, then thinning can likely be simplified to one cluster/shoot.
Another option is to increase shoot growth by irrigation or increased fertilization to raise vine capacity to sufficiently ripen a normal crop.

Excess growth, on the other hand, can be difficult to handle. Excessive shoot growth can be reduced by leaving more shoots per vine to reduce growth per shoot. But to maintain good canopy exposure with more shoots may require wider spacing between vines or divided canopies such as with Scott Henry or Lyres. The advantage is that the divided canopies will increase vine capacity and thus crop ripening. The alternative is to reign in shoot growth by reducing water or nutrients or increasing competition from cover crops or weeds for water and nutrients. This can be successful, but it can be difficult in deep, fertile soils and in wet seasons or climates where rainfall is abundant.

Can heavier crops reduce shoot growth? In trials with vigorous Cabernet Franc/101-14 on a deep silt soil, we found no effect on shoot growth of thinning at set to crop levels from six tons per acre down to 1.5 tons per acre. Over many years of observation, it appears that crop level reduces vine growth primarily in combination with another stress, such as drought stress or nutrient deficiency. That may be why in high vigor conditions crop tends to have relatively little effect on reducing growth.

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