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Crop Estimation in Vineyards

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Viticulture is becoming a successful alternative cropping system in Kentucky due to the increased demand for locally grown grapes and their profitability. However, the sustainability of the industry is hindered by insufficient experience on estimating crop size of hybrid and vinifera cultivars in a region that is subject to frequent damaging winter and spring temperatures.

The effects of crop size (number of clusters per vine or hectare) on vine size, yield, and fruit composition are not always the same for different grape varieties, training systems, and growing regions. Growers in Kentucky often overcrop grapevines, leading to decreased fruit quality in the current season and, more important, decreased primary bud cold-hardiness and vine size in the following season.

Grape growers need to estimate the crop size in the current season for the following reasons:

- to know how much crop to expect.
- to ensure that fruit composition target values are met.
- to maintain the vine size for a future crop.

However, there are some problems associated with crop estimation in the vineyards; after all, it is a prediction. The variation in crop size from year to year means that growers must keep accurate records. Winter injury, effect of crop size during the previous season, fruitfulness of buds, fruit set, and berry development all affect crop size in the current season.

Crop estimation is done several times during the season. The various steps in canopy management—such as retaining bud numbers according to a balanced pruning formula, shoot thinning to achieve optimum shoot density, and cluster thinning based on shoot length—are in fact crop estimation.

There are two methods growers can use to estimate crop size: the traditional method and the lag-phase method. However, both methods only provide a prediction of yield that should not be considered final.

Method 1: Traditional Method

The traditional method utilizes the mean cluster weight at harvest during the previous season (or mean of many seasons) to predict the yield in the current season. The following formula is used to predict yield:

$$PY = \frac{ANV \times NC \times CW}{2000}$$

PY: *Predicted yield (tons/ac)*
ANV: *Actual number of producing vines/ac*
NC: *Number of clusters/vine*
CW: *Cluster weight (lb)*

To utilize the traditional method, the grower needs to collect three pieces of information each year. These are:

1. The actual number of producing vines per acre:

The number of vines per acre is determined by row and vine spacing. For example, a vineyard spaced 8 x 9 feet (vine x row) will have 605 vines per acre. However, the actual number of producing vines per acre is lower due to replanting, disease, or winter injury. Because of this reason, an inventory of actual number of producing vines per acre needs to be collected every year. For example, if 7% of the 605 vines per acre (about 42 vines) are missing from a Chambourcin vineyard, the number of actual bearing vines per acre is 563.

2. Number of clusters per vine:

This number varies with the level of canopy management each year. For example, increasing the severity of pruning, shoot thinning, or cluster thinning would decrease the number of clusters per vine. The number of clusters can be counted as soon as bloom or as late as pre-veraison. The advantage of counting clusters at bloom is that they are easily visible because they are not obstructed by canopy cover.

Depending on the size of the vineyard, growers need to count the number of clusters per vine on about 5% of the total vines if the vineyard size is between 1 to 3 acres and pruned uniformly. For larger operations, a greater sample size is needed. However, irrespective of vineyard size, sampling of clusters should be done methodically. For example, sampling from every tenth vine in every other row every year would ensure a representative sample from the vineyard.

3. Cluster weight:

Cluster weight varies from year to year. Environmental conditions and level of canopy management are the two factors that affect cluster weight in any given year. Wet weather during bloom, insecticide application during pollination, and dry summers cause poor berry set and may reduce berry size, respectively, thus leading to reduced yield. Increasing the severity of dormant pruning, shoot thinning at berry-touch, or cluster thinning at fruit set may lead to increased cluster weights. Other factors that may affect cluster weight are irrigation, fertilization, fungal diseases, insect feeding damage, and bird depredation.

Mean cluster weights must be obtained from the same vines where cluster numbers were counted. The accepted practice is to sample at least 100 clusters throughout the vineyard per cultivar. Growers must keep in mind that obtaining cluster weights at harvest is *not* to predict yield in the current season but to provide a record to yield prediction in subsequent years. Growers who do not have these data must refer to Table 1.

Example: Crop estimation of Chambourcin

Spacing ..... 8 x 9 feet, 605 vines/ac
Missing vines..... 7%, or 42 vines/ac
ANV.....605 - 42 = 563 vines/ac
NC.....44 clusters/vine
CW *(from Table 1)* ..... 0.41 lb/cluster

Predicted yield:

$$PY = \frac{ANV \times NC \times CW}{2000}$$

$$PY = \frac{563 \times 44 \times 0.41}{2000}$$

PY = 5.07 tons per acre

Table 1. Mean cluster weight (in pounds) of economically important grape cultivars in Kentucky from 2004 to 2006.[a]

Cultivars	Weight (lb)
Small (<0.2 lb)	
Cabernet franc	0.22
Chardonnay	0.23
Riesling	0.19
Traminette	0.24
Vignoles	0.19
Norton	0.21
Medium (0.3-0.4 lb)	
Concord	0.29
Chardonel	0.36
Niagara	0.33
Vidal blanc	0.33
Viognier	0.30
Large (> 0.4 lb)	
Chambourcin	0.41
Marquis	0.51
Neptune	0.54
Reliance	0.40
Seyval blanc	0.43

[a] Data are means of 200 clusters per cultivar collected from commercial and research vineyards in central and western Kentucky from the 2004 to 2006 growing seasons.

Method 2:
Lag-Phase Method

The lag-phase method is based on collecting cluster weights during the lag-phase of the grape berry growth curve. During the lag-phase, berry growth slows down temporarily, and there is little appreciable gain in the weight of the clusters. The lag-phase occurs at 1200 Growing Degree Days (GDD, 50°F base), and at this stage the clusters have attained 50% of their final size. For crop estimation, mean cluster weight at the lag-phase can be multiplied by 2 to predict cluster weight harvest. The multiplier will vary among cultivars and seasons; therefore, the grower will have to determine his/her own multiplier for each cultivar grown. Mean cluster weights and multipliers at harvest are presented in Table 2 for selected cultivars in Kentucky. Growers need to follow these steps to utilize the lag-phase method:

1. Number of bearing vines per acre:

Same as in the traditional method.

2. Number of clusters per vine:

Same as in the traditional method.

3. Cluster weight at lag-phase:

200 representative clusters per acre or block are measured at lag-phase.

4. Determination of 1200 GDD:

Although growers can measure GDD in their vineyards using weather stations, this information is available for free from the University of Kentucky Agricultural Weather Center at: http://wwwagwx.ca.uky.edu/cgi-bin/generic_dd_www.pl

The following formula is used to estimate crop size using the lag-phase method:

$$PY = \frac{ANV \times NC \times Lag\ CW \times HM}{2000}$$

PY: *Predicted yield (tons/ac)*
ANV: *Actual number of producing vines/ac*
NC: *Number of clusters/vine*
Lag CW: *Cluster weight at lag-phase (lb)*
HM: *Harvest multiplier (from Table 2)*

Table 2. Mean cluster weight of selected cultivars at lag-phase (1200 Growing Degree Days) in Kentucky and harvest multipliers from 2004 to 2006.[b]

Cultivar	Lag-Phase Cluster Weight (lb)	Harvest Multiplier	Harvest Cluster Weight (lb)
Cabernet franc	0.105	2.09	0.22
Chardonnay	0.121	1.90	0.23
Riesling	0.101	1.88	0.19
Traminette	0.121	1.98	0.24
Vignoles	0.106	1.79	0.19
Norton	0.080	2.63	0.21
Concord	0.145	2.00	0.29
Chardonel	0.180	2.00	0.36
Niagara	0.160	2.06	0.33
Vidal blanc	0.161	2.05	0.33
Viognier	0.117	2.56	0.30
Chambourcin	0.205	2.00	0.41
Marquis	0.242	2.11	0.51
Neptune	0.251	2.15	0.54
Reliance	0.200	2.00	0.40
Seyval blanc	0.210	2.05	0.43

[b] Data are means of 200 clusters per cultivar collected from commercial and research vineyards in central and western Kentucky from the 2004 to 2006 growing seasons at 1200 Growing Degree Days.

Crop Estimation Recommendations

- Crop estimation is an absolute MUST if quality grape and wine production is desired.
- Generally, 64% of the variation in yield comes from year-to-year variation in the number of clusters per vine and 27% from year-to-year variation in mean cluster weights.
- An estimate is considered good if it is within 15% of actual yield. More experience and more data would increase the accuracy of estimates in upcoming seasons.
- Perennial record keeping for cluster weights from year to year improves crop estimation.

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