

Physiology of Minimal versus Normal Pruning of Concord Grapes

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With the economic pressures for high yields and production efficiency, there has been increasing use of the method of minimal or mechanical pruning due to its reduced inputs and higher yields. Yet, many times the yields on minimally-pruned vines may be too high for the juice Brix and quality required by the industry. Since this production method changes many of the basic relationships we have developed over decades for conventionally pruned vines, we need to understand the bases of these differences in a systematic way in order to optimize management.

In the 1930's Professor Albert Winkler at UC Davis conducted early trials on grapevine growth and productivity and concluded that unpruned vines had the greatest inherent productivity and would be an optimal production system if the vines could be thinned efficiently. Due to limitations in technology for thinning, minimal pruning was not pursued commercially until the last decade or so when mechanization technology has been developed for efficient thinning. With new adaptations in mechanical thinning, Winkler's concept is proving feasible. Initial results with minimal pruning in good sites are encouraging, but the level of understanding and management skill required is higher because of the increased risks seen in cases of overcropping, inadequate Brix, reduced juice quality, and alternate bearing.

The very early canopy development of minimal pruned vines due to the high shoot numbers holds potential for higher seasonal light interception and thus higher yields. Yet, this potential productivity is not always seen, possibly due to reduced late season photosynthesis of the minimal pruned vines. Over the past several years we have examined the reasons for the differences in vine growth and performance between conventional and minimal pruning. Below is a summary of our findings in several studies at Fredonia (near Lake Erie) and in Geneva on good sites.

Leaf and Canopy Development

The most obvious visual effects of minimal pruning is the great number of short shoots and rapid canopy fill before bloom. We have examined the canopy development in several studies. In comparisons of minimal versus normal pruning, the greatest effects of minimal pruning were found to be:

- Much greater numbers of buds and shoots (generally 300-400 shoots/vine vs 60-90 shoots/vine normally).
- Much shorter shoots with minimal pruning giving shoots about 30-40% as long.

- ⌋ Earlier canopy development resulting from so many shoots.
- ⌋ Earlier termination of canopy development around bloom while normally pruned vines grow for several weeks past bloom.
- ⌋ Similar total leaf areas per vine by late season.

Vine Root Growth

If minimally-pruned vines carry larger crops we were concerned that the root systems may be debilitated over time, leading to weaker vines. So, a cooperative study with Dr. Dave Eissenstat at Penn State University on the dynamics of root growth and lifespan in minimal and normally pruned Concord grapevines was started in 1997 in the 8th year of a trial. We placed clear 2 inch diameter plastic tubes under vines in the field and at 2-week intervals observed the roots with a remote video camera that was positioned down the tubes to observe roots through the clear tubes. Although we have data completed from only one year (1997) so far, there were interesting preliminary observations (note that 1997 was very cool, wet and late bloom):

- ⌋ The beginning of root growth in the summer started around bloom and continued only for about 6 weeks or so. No Spring or Fall root flushes were found as reported from warm climate studies. A very warm spring of 1998 allowed some early root growth before bloom, but we still need to confirm how important this was.
- ⌋ There were somewhat more new roots produced under the minimally-pruned vines than under the normally-pruned vines.
- ⌋ Most of the young white roots only lived about 4-10 weeks and were gone by harvest. Of course a few thickened and survived until the next year. The roots of minimally-pruned vines seemed to live slightly longer although the difference was not very great.

In general then the minimally-pruned vines had at least as many roots as normally-pruned vines. The major difference due to minimal pruning seemed to be the earlier root flush that may reflect the earlier slowing of shoot growth as discussed above. These observations raise questions about the relationship between new root growth and nutrient uptake, and if the timing of our fertilizers is optimum. Much more work is needed on root behavior.

Vine Productivity

In our several studies we have made many detailed physiological measurements and yield/juice quality measurements. In 1995 we made measurements throughout the year of sunlight capture, leaf photosynthesis, whole canopy photosynthesis and dry matter accumulation in the tops of the vines. The strongest effects of minimal pruning (compared to normal pruning) on vine productivity were found to be:

- Greater early season sunlight capture but few differences after bloom. Overall the seasonal sunlight capture is about 15% higher.

- The photosynthesis of mature, exposed leaves was essentially the same for minimally- and normally-pruned leaves.
- The photosynthesis of the whole canopy, however, was similar to the sunlight capture in being up to 3 times higher before bloom, but similar after bloom. The canopy function did not drop off faster late in the season even though the average leaf was older for the minimally-pruned vines.
- Yields average about 20% higher than normally-pruned vines due to 3-4 times more clusters and berries although cluster weights were 60% lower and berry weights were 25% smaller. The yield differences were sustained at that level for over 9 years in one trial with minimally-pruned vines averaging almost 11 tons/acre (Fig. 1).
- Juice brix averaged about 1.5 degrees lower for minimally-pruned vines due to the heavier crops (Fig.2). The relationship of brix to yield, however, was the same for both types of pruning.
- Total dry matter accumulated in the fruit, young shoots and leaves indicated that (a) the total was higher for minimally-pruned vines, (b) leaf weight was similar, but (c) shoot stem weight was much lower in minimally-pruned vines. This suggests a shift of energy from producing cane weight to the fruit.
- The higher sunlight capture, and dry matter production early in the season seems to manifest itself in higher sustained yields rather than in higher brix at the same yield.

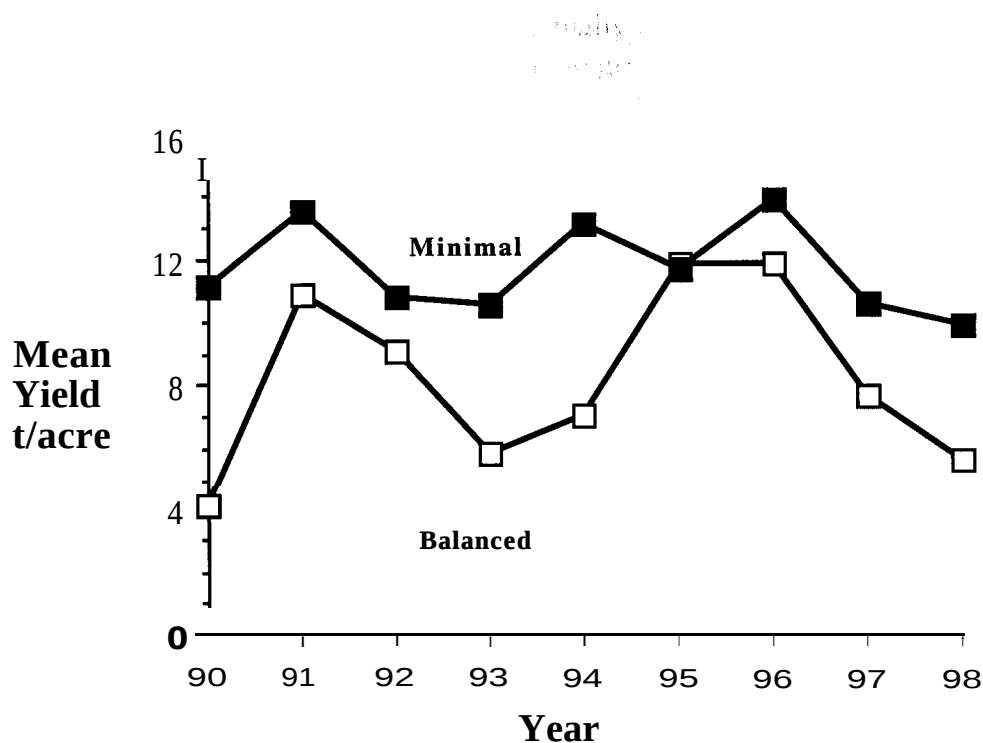


Figure 1. Yearly mean yields of mature, own-rooted Concord vines with minimal or balance pruning over 9 years at a very good site in Fredonia, NY.

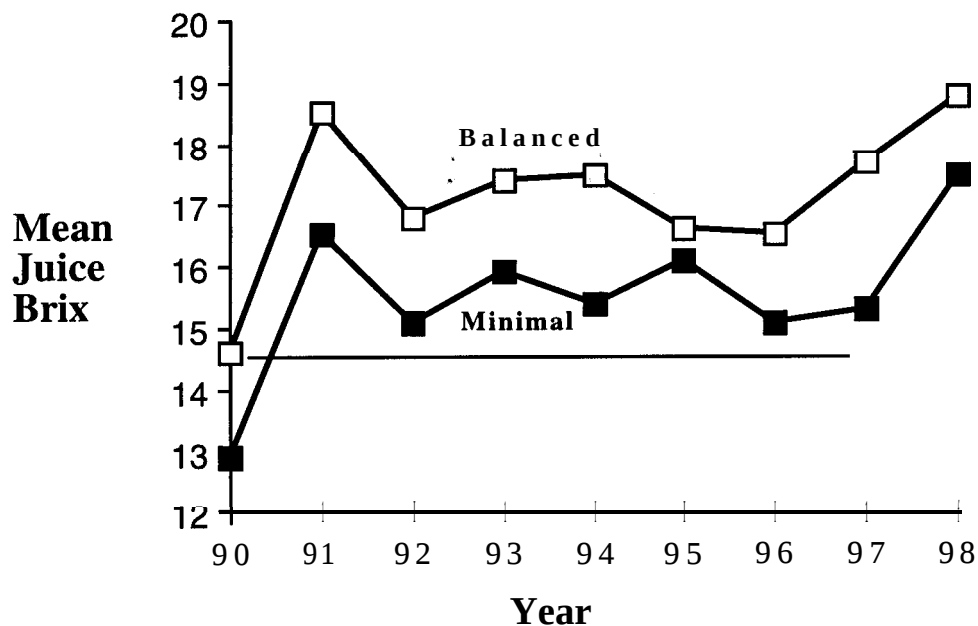


Figure 2. Yearly mean juice brix of mature, own-rooted Concord vines with minimal or balance pruning over 9 years at a very good site in Fredonia, NY.

Conclusions

The results indicate that the minimally-pruned vines have a greater potential yields due to the greater light interception and less energy investment in canes. In our good site with good timely management by our station staff, this potential paid off in consistently high yields of non-crop-adjusted vines although the lower juice brix increased the economic risk.

It should be noted, however, that the same components that lead to higher potential productivity in the good sites may also lead to more problems in limiting sites. For example the higher sunlight capture also leads to higher water requirements and thus greater drought stress responses in drier sites. There have been several problems with minimally-pruned vines in sites that have some limitations. Therefore, *it appears that the cost of higher yield potential is the requirement of a good site and the extra management required to be sure there are no major limitations to vine productivity.*

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