GRAPE RIPENESS

An Australian winemaker, Peter Cargasacchis, observed that leafroll virus affects the vines in the best vineyards in the Côte de Nuit in November. (Leaf roll virus is discussed below.) It could be, or the vines in the Côte de Nuit are simply showing the processes of natural leaf senescence, which manifest somewhat differently between varieties. Not all grape varieties go yellow or red as they senesce. Shiraz goes golden as does Semillon but Cabernet shows only red tips prior to leaf fall and Grenache is another variety that stays green for a long time. The actual colour of the leaves may not be a very good indication of their state of health or productivity.

It's probable that a dramatic reduction in leaf function that can manifest as leaf senescence in some varieties, at harvest time or before, is associated with the best vineyards. Another Australian, Erl Happ, related that he remembers inspecting 'Petrus' in Pomerol a couple of days after vintage and wondering what had happened to the leaves. There were few left and those that were left were senescent.

Potential wine quality is largely dependent on the so-called secondary plant metabolites, such as aroma/flavor and phenolic compounds and not on the primary metabolites, such as sugar. Grape-derived aroma/flavor compounds are the principle source of wine aroma, flavor, color and taste. The 'ripe' flavors that we appreciate in wine cannot manifest as the dominant flavors in grapes in the presence of functioning green leaves. Green leaves carry green flavors to fruit, entrained with the sugar molecules, including in the case of the Bordeaux varieties the methoxypyrazines. There are over twenty known pyrazines, with 3-isobutyl-2-methoxy-pyrazine (IBMP) being the dominant one. It is probable that pyrazines are synthesized in the berries just like terpenes, esters, etc. It appears they are broken down by strong sunlight. The persistence of green flavors is also associated with excessive shade in the fruit zone which reduces light interception by the berry, is associated with lower berry temperatures and the retention of methoxypyrazines and chlorophyll in the pulp especially in the innermost portions closest to the seeds, insufficient breakdown of cellular tissue in the cell pulp (indicated by retention of material around the seed when it is extracted from the berry) and immaturity of the seeds at harvest. Unfortunately the only green flavor compound that we can currently measure in the fruit is isobutylmethoxypyrazine and that does not appear in all varieties. It must be remembered that few methoxypyrazines have precursors. They can be tasted in the berry. Only 10% of the "good" flavors in grapes have no precursors. So a wine maker, going through a vineyard tasting the grapes for "grape maturity", will taste all the methoxypyrazines and only 10% of the "good" flavors.

This you can verify for yourself by tasting berries at harvest time and noting the association of flavors with the state of the leaves. Methoxypyrazines are just one of the green flavours that may be present in grapes at harvest. I have read about methoxypyrazines in Shiraz wines from New Zealand, and even less in Pinot Noir but there can be flavors equally green and firm in this variety as those associated with the pyrazines that one sees in the Bordeaux varieties. Some methoxypyrazines have been found in Rieslings and other non-Bordeaux cultivars. In the 1970's in California, several wineries planted large acreages of grapes in Monterey and San

Benito counties. Every wine made there had a veggie character; not just Cabernet Sauvignon and Sauvignon blanc, those known to have methoxypyrazines. Andy Reynolds thinks they might have been due to pyrazines as well as C6 compounds produced from breakdown of fatty acids in the skins during ripening. If insufficient light is present to synthesize the "fruity" compounds and sunlight is lacking to breakdown the pyrazines, veggie wines will occur. They changed training and cultural practices to solve that problem.

Research in Bordeaux has shown that the methoxypyrazines in Cabernet Sauvignon, Cabernet Franc and Sauvignon Blanc, and other methoxypyrazines bearing varieties, can be substantially reduced by removing the three or four basal leaves from the vines between fruit set and verasion. Their numbers showed that prior to verasion; almost 80% of the IBMP is in the stems. These basal leaves store most of the methoxypyrazines and deliver them to the grapes up to harvest. Other similar unidentified green characters in other varieties may follow the same pattern.

What is required, and what Erl Happ believes happens in the best vineyards is that the process of leaf senescence is commenced before veraison. This is triggered by a situation of carbohydrate surplus in the vine that makes it impossible for the leaves to unload sugars to the phloem. The level of carbohydrate in the leaf becomes toxic and the processes of leaf senescence are started. This in turn depends upon a strong carbohydrate delivery in relation to demand. In this uniquely favorable but rare situation, healthy vines carry low crops from year to year with a very low ratio of crop to leaf area (probably better than 25 sq cm of leaf area per gram of crop at veraison and better than 15 sq cm of crop per gram of fruit at harvest...although the presence of green leaves at that point is indicative of failure). Secondly, low moisture status in the soil ensures that shoot growth is complete within six weeks of flowering and the vine does not waste its carbohydrate on the generation of unnecessary shoot and leaf. If it does so, continual depletion to support shoot and leaf growth makes it difficult for the vine to generate the carbohydrate necessary to mature the crop prior to veraison.

I've seen calculations based upon the observation of how much dry weight can be produced by a vine between set and veraison, and it is eminently possible for the vine to generate sufficient carbohydrate to satisfy the needs of the current years crop and the needs of the vine between budburst and bloom in the following year and to accomplish all this in the period between the establishment of full leaf and veraison.

We must rid ourselves of the notion that the presence of working leaves after veraison is absolutely necessary in all circumstances to ripen the crop. In some circumstances it is vital but in the very best and most fortunate circumstances it is not. In the latter there is more than enough carbohydrate stored in the leaves themselves, the shoots, the permanent wood and the roots to satisfy all current needs and the needs of the vine for increase in structural growth, root extension and the development of next years crop until bloom, by which time next years leaves can take over. Work with potted vines shows that there is no increase in dry weight of the vine between budburst and bloom. It is simply redistributed from permanent parts to current growth with no net gain in dry weight at all. If it is going to be distributed it has to be there at the start.

Insufficient reserves at budburst results in poor budburst, reduced shoot numbers, slow shoot growth a lousy set and a small crop. Big swings in crop from one year to the next are prima facie evidence of a lack of attention to crop levels and big swings in vine carbohydrate status.

Logically if ones viticultural circumstances are inconsistent with a finish to shoot growth within five or six weeks of set it may be impossible to produce carbohydrate toxicity in leaves prior to veraison and the process of leaf senescence can not begin at that point. Once veraison starts the demand for sugar by the developing berries will remove the tendency towards carbohydrate toxicity in the leaves. However, the hardening off of the shoots results in the progressive addition of sugars from hitherto immobile starch reserves to the stream of soluble carbohydrate in the phloem and this massive addition to soluble carbohydrate, far in excess of the daily capability of the leaves will condition the ability of the leaves to unload carbohydrate. It may be that what is happening to leaves during the ripening process is very much determined by the crop load in relation to leaf area and stored reserves in the vine at this very important time of fruit maturation. This is the time when the balance of flavors in the grapes is being determined. Striking the right flavor balance is impossible while the vine is carrying functioning leaves. However, the leaves will function according to need. If we want to make great wine we must reduce the need.

The circumstances that will make it difficult to have shoot growth complete within six weeks of set include: Summer rainfall, soils that continue to support shoot growth, excessive irrigation and nitrogen fertilization.

The circumstances that will make it difficult for the vine to generate all the carbohydrate it needs prior to veraison include: Continued shoot growth, excessive crop in relation to leaf area, nutrient deficiencies especially potassium and phosphorous, disease or virus that impairs leaf function, insufficient sunlight or warmth to support photosynthesis and poor spatial distribution of the leaves so that they can not function as an efficient solar array.

Of course, if you are growing grapes in very warm conditions and harvesting them in warm conditions flavor of any sort can be a plus, whether green or ripe in character. The above comments relate to places where the vine ripens its fruit in the cool of autumn rather than the heat of summer. They will be irrelevant to the grower intent on maximising yield. They may be of interest to the small band of people intent on creating truly great wine...the sort of wine that creates it's own market.

Leaf roll virus was a widespread disease on *Vitis vinifera* grapes in California. It greatly declined following the introduction of certified stock.

The University of California at Davis has established and maintains a foundation vineyard of indexed vines of the major grape cultivars, managed by the University's Foundation Plant Material Service (FPMS). The California Dept. of Food and Agriculture (CDFA) monitor the nursery stock production and certify that the materials are free from important virus diseases. The CDFA reports[2] the following acres planted with certified wine grape stock:

	Napa County	State of California
1971	14,834 acres	179,854 acres
2003	43,378 acres (294% increase)	472,445 acres (262% increase)

That shows substantial growth in "clean" vineyards in the past three decades. However, presently, not all nursery stock in certified; it's been noted only about half of the sales from grapevine nurseries is certified stock. The rest is non-certified and includes things such as "old vine" zinfandel or similar selections that are often full of leafroll. In addition, some of the new French clones have leafroll. We now know that mealy bugs can spread leafroll. It apparently is happening more now than in the past.

Many symptoms are evident in early June, in non-irrigated vineyards, the leaves began to roll downward and turn red. They don't always stay green. In some varieties, with some virus strains, the whole leaf can go red. The "classic" symptom of leafroll is for the veins to stay green, but this isn't always the case. This red color resulted in a loss of chlorophyll in the leaves. This loss of chlorophyll resulted in:

- Low sugar in the berries
- Low total acid
- High pH
- Lower fruit yield
- Reduced color in the red grapes
- Smaller clusters
- Smaller berries

Since the Napa Valley was essentially a dry farmed growing region, the symptoms showed, especially on over cropped or struggling vines. The present planting of certified vines has substantially eliminated these diseased vineyards. Ripening can easily be delayed four to five weeks with leaf roll virus[1].

Lucy Morton has an interesting "Dying Vine Theory". She writes "...any factor that contributes to increased vine vigor beyond what is necessary to keep the plant alive will result in decreased wine quality." She cites the conditions defining suspect vineyards set down by Professor Jean Branas of the National School of Agriculture of Montpellier

1. flat land
2. clay soils
3. irrigation
4. over-generous nitrogen fertilization
5. wide vine spacing
6. high trellises
7. tall vine trunks

8. leaving more than one cane and one spur per vine at pruning
9. planting of vigorous rootstock
10. non-traditional grape varieties
11. high yielding clonal selections

Some of these things are specific to France. Could it be that our certified vines have gone beyond the pale?

In the years leading up to 1980, it was difficult to make 12% alcohol Cabernet Sauvignons every year. In most years harvest lasted until November. Many wineries had to purchase high proof alcohol after harvest and fortify their wines to raise the alcohol to 12 %. Every year at Charles Krug, from 1971 through 1978, the Krug Cabernet (except the Vintage Select) was fortified to raise the alcohol to 12%. Looking at the records from the 1960's, in Oakville in Napa County, the grapes were around 21 to 22 °Brix in October. To make 12% alcohol wines from Napa Valley Cabernets, the harvest, today, would probably be over sometime in August or September. The long, cool growing season to ripen grapes in the Napa Valley no longer exists.

What has caused these changes in ripening patterns? Andy Reynolds of Brock University in Ontario, Canada suggested, among other thing:

1. Cleaned and certified cultivars and rootstock
2. Global warming
3. Irrigation is better managed.
4. Crop levels might be more tightly controlled.
5. The St. George rootstock was the major one used. More vigorous rootstock, like 110R, 3309, 101-14, etc., have made for smaller vines with more exposed fruit.
6. VSP and Scott Henry and other trellising have allowed for more leaf and fruit exposure than the sprawling head trained spur-pruned vines.

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