Viticulture Relating to Sparkling Wine

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Introduction
In this paper I will try to explain why Champagne is a unique area producing a unique wine.

The specificity of the region
Climate
The Champagne area is the northernmost part of France used for viticulture (latitude 48°).

The 1992 monthly rainfall is compared to the long term monthly average rainfall for the period 1930 to 1991 in Figure 1. The 1992 total annual rainfall of 698.2 mm is considered to be normal for the region. By comparison, Table 1 gives the annual total hours of bright sunshine recorded for the years 1989 to 1992, and compares these values to the average for the period 1930 to 1990. It is evident that the annual total hours of bright sunshine for the years 1989 to 1992 are higher than the calculated average for the period 1930 to 1990. In 1991, a peak of 2,100 hours was recorded. The annual distribution of hours of sunshine is given in Figure 2, where the 1992 monthly averages are compared to the long term average for the period 1954 to 1991.

The average air temperature, at a height of 2 metres, was 14°C in 1992, 1° more than the average since 1930. The maxima and minima average monthly temperatures are given in Figure 3, where both the 1992 values and the average for the period 1930 to 1991 are shown. In winter time, the temperature can reach -15°C and in summer +30°C.

So we have a continental climate, which will determine the way we manage our vineyard.

Terroir
The Champagne Appellation Area encompasses 28,520 hectares producing 2.1 million hectolitres per year.

The deep soil is essentially pure white chalk from the Upper Campanian geological stage, the remains of an ancient sea (Figure 4).

The chalk acts as a water reservoir. Water rises through the soil capillaries, regulating the water supply to the vine.

The soil is a rendzina type, from 0.3 to 2.0 m deep.

Rootstocks and vine varieties
The permitted varieties for Champagne (Figures 5–8) are restricted to Chardonnay, Pinot Noir, Pinot Meunier, and rarely, Petit Meslier and Arbanne.

For shallow soils where the chalk layer protrudes Chardonnay is preferred as it tolerates limestone better than Pinot Noir or Pinot Meunier.

Pinot Meunier is preferred at the bottom of hills because with...
Figure 4. Typical soil section in the Champagne area, showing the depth of the white chalk.

Figures 5 to 8 show plantings of the permitted varieties, Chardonnay, Pinot Noir and Pinot Meunier.

Figures 9 to 11 show rootstocks used in Champagne, including 41 B, 90 4 and 3309 C.
its later budburst it can better tolerate spring frosts. Today the clonal selection process, which began 20 years ago, permits replanting with homogeneous, virus-free vines, with proven yield and taste characteristics.

For Chardonnay the clones available are Numbers 75, 76, 95, 96, 121, and others; for Pinot Noir, Numbers 386, 521, 870, 779, and others. We still await clones for Pinot Meunier.

For chalky soil the preferred rootstocks are:

- 41B (Chasselas × Berlandieri): 76%
- SO4 (Berlandieri × Riparia) for heavy soil: 11%
- 3309C (Riparia × Rupestris) and 161–49 (Berlandieri × Riparia): 12%. (Figures 9–11)

The Champagne region does not have Phylloxera problems like California, but grape fan leaf virus is a major problem (Figure 12). The first resistant vines will be tested next year in Roederer’s vineyards.

Quality viticulture in Champagne—how it is achieved

1. By moderate fertilization
   In the past, because of the heterogeneous grapevine population, poor selection and weak vines we needed to use high levels of nitrogen, phosphorus and potassium. As a result of the soils of Champagne being very calcareous, magnesium and iron deficiencies were common (Figures 13, 14).

2. By a vine density and a pruning system adapted to our climate and varieties
   These two aspects have been tightly legislated and controlled in Champagne by the INAO (National Institute of Appellation of Origin) since 1938.

   For example the sum of the distance between rows and vines must be less than 2.5 metres. This is because, as previously explained, it rains a lot in Champagne and this water, available all through the year, can be prejudicial to maturity. So we need high planting density to stimulate root competition for water and other nutrients.

   The height of buds should not be more than 0.6 m to limit the canopy to around 1.3 m so as not to shade the other vines.

   In Champagne the weather conditions before and during harvest are not conducive to good maturity. So the high density (8,333 vines/hectare) and the pruning system should provide the vine with a shape helping fruit set and maturity by moderating the water influx.

   The water availability influences vigour and fruit yield (provided there are no deficiencies). Too much water will result in high vigour and growth, thus directing the carbohydrates from photosynthesis to vegetative growth, to the detriment of fruit maturity.

   Furthermore, leaf growth is higher if the shoot is vertical. So to moderate growth and to help maturity the shoot should be horizontal.

   In pruning vines there is a need to adapt grape production according to the vigour and amount of old wood on each vine. Pruning must not be too early because budburst will be early, increasing sensitivity to spring frost, nor too late because the vine will be weakened (lost starch reserve). Therefore a weak vine will be pruned first and strong vines last. Very young vines will be pruned early to limit loss in sap.

   3. Pruning systems allowed in Champagne

   The Chablis system (Figure 15)
   This system produces long canes and long shoots. It is used for vigourous varieties like Chardonnay and Pinot Noir but it is not as suitable for Pinot Meunier.

   If you have a rich soil, you can leave more old wood and if you have a poor soil you leave less. By this pruning you can adjust the yield to the vine vigour and to the type of soil.

   The Royat system (Figure 16)
   The advantages of this system are good ventilation of bunches, less wood is attached to the wire and it is easier to prune. This pruning system is used for Pinot Noir and Pinot Meunier and, to a much lesser extent, Chardonnay.

   The Guyot system (Figure 17)
   This keeps less old wood, so less starch reserve and therefore lower quality grapes.
Figure 15. Chablis training system.

Figure 16. Cordon de Royat training system.

Figure 17. Guyot training system; left, Guyot simple and right Guyot double.

Figure 18. Vallée de la Marne training system.
Figure 19. The lyre trellis training system
THE ‘VALLÉE DE LA MARNE’ SYSTEM (Figure 18)

This is a good system in frosty areas but it produces a dense canopy.

Summarizing the above, only the Chablis and Royat systems are allowed for Champagne’s ‘Grands Crus’.

To give an indication of labour input, 432 hours/hectare/year is required for the Chablis pruning system and 380 hours for Royat, harvest excepted.

Yield can be limited by adjusting the number of buds at pruning.

From our own trials we conclude that the consequences of limiting the number of buds is that yield and sugar are parameters of some sensitivity in the first two years but thereafter you have a regulated vine with less differences.

Another solution is the lyre canopy system (Figure 19).

This gives three times less vines per hectare (2,525 instead of 8,333) and according to the pruning system used (Cordon or Guyot) there will be between 25 and 40 buds per vine, that is 63,000 or 101,000 buds per hectare instead of 150,000 buds in the Chablis system.

The advantages are that by opening the canopy the leaf-to-fruit ratio will be increased, so you can expect better maturity, and grapes have good exposure for spraying and picking. Even pruning is faster, and of course there is a reduction on planting costs. However, very well-trained workers are needed to manage the lyre.

So far no differences have been noticed for sparkling wine.

4. Shoot removal

Shoot removal, carried out on shoots which have 3 to 4 leaves, is undertaken to improve ventilation, to limit loss in sap, and to assist with pruning the year after.

5. Sanitary protection

It is very important that the grapes’ potential at the beginning of the season be realized at harvest. As a consequence of our climate we have to contend with many pests and diseases. For example the more common diseases and pests are downy mildew, powdery mildew, Brenner, black rot, botrytis, aetapoa and esca (measles), blister mite, red and yellow spider mite, vine caterpillar, tortrix and grape berry moth.

The disease botrytis is of major concern in Champagne as the effectiveness of the treatments (aromatic amides and cyclic imides) has decreased due to increased resistance by botrytis. No specific treatment was recommended in 1993. As a consequence, this chemical resistance should decrease and treatment efficiency increase in the future.

A recently employed treatment for spider mite is the use of the natural predator, Typhlodromus. This predatory mite (also sensitive to the same pesticides) can be distinguished from the spider mite by its pear-shaped body and faster movement.

Typhlodromus is collected from old wood of healthy vines at pruning. The predators are then introduced to the base of spider mite-infested vines. Management practices require adjustment to avoid the use of harmful chemicals on the predators.

I used this treatment during the 1992 winter and it was effective. It takes time, of course, but it is worth it as chemical treatments are avoided.

For caterpillars (e.g. tortrix moth) we use Bacillus thuringiensis.

6. Control of the canopy

To control the height of the canopy, we trim 3 times per season at 1.3 metres. If you leave too few leaves you will compromise opening and if you leave too many leaves the shading effects on the nearby row will be prejudicial.

7. Yield control

In Champagne the yield is fixed each year by the profession and the government. So if nature is more generous than the administration you will have to remove some fruit during the season. The best time is around veraison. If you remove less than 30% of the fruit you will have an increase less than 0.5% in potential alcohol. If you remove between 30 and 50% the increase will be between 0.5 and 1.5% potential alcohol.

For the last decade we have been able to estimate exactly the amount of the harvest by counting the vine pollen in the air at flowering, with a maximum error of 8%.
To avoid the cost of manually thinning grapes (100 hours per hectare), we are testing the use of ethylene to kill flowers. We have concluded that yield is correlated more to the bunch weight than to the number of grapes (Figure 20).

Another solution to limit yield is to limit the vigour by low fertilization, or by planting grass between each row; this reduces botrytis and prevents erosion.

8. Optimum date of harvest
Harvest is decided for each village by the profession and the administration. Each year we follow the maturity (sugar and acidity) in each village (Figures 21, 22). At the beginning of the harvest we expect 9% potential alcohol (v/v), 12 g/L tartaric acid of acidity and pH 2.9. Of course these figures vary from year to year (Figures 23–25).

9. Harvest and crushing
It is mandatory to harvest by hand in Champagne and only in small bins with holes. Grapes are carefully selected to avoid damage and exclude rotten berries.

We need 160 kg of grapes to produce 100 litres of clear juice. From 4,000 kg we obtain 20.5 hL of cuvée (premium juice) and 5.5 hL of taille (second pressings).

During pressing, the first juice comes from the intermediate zone of the berry (rich in sugar and tartaric acid), followed by juice from the central zone (rich in malic acid) and finally from the peripheral zone (rich in potassium).

In conclusion, the viticulture employed combines tradition and innovation, to keep the quality of Champagne at the top.