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Temperature variation linked to trellis height: an opportunity for adaptation to climate change?

Laure de Rességuier[1], Philippe Pieri[1], Théo Petitjean[1], Séverine Mary[2], Cornelis van Leeuwen[1]

1 EGFV, Univ. Bordeaux, Bordeaux Sciences Agro, INRAE, ISVV, F-33882 Villenave d'Ornon, France
2 VITINNOV, Bordeaux Sciences Agro, ISVV, F-33175 Gradignan cedex, France

Temperature is a key factor in vine growth and grape composition[1]. Climate change is already having an impact on these parameters in many wine regions, and it is becoming necessary to adapt in order to continue producing quality wines, without strongly altering their typical character[2]. One way to adapt could be to modify the vine's training system. A study of temperature at different heights was carried out in the Bordeaux region to assess whether increasing trunk height could modify the microclimate in the bunch zone[3].

Microclimate study device

The study facility was set up in early 2016 on two adjacent vineyard parcels of Merlot planted on sandy-clay soil. The parcels are trained with Single Guyot pruning (bunches at a height of 45 cm) with a planting density of 6,000 vines/ha. The parcels have different vineyard soil management: one is fully tilled, while the other is naturally grassed over between the rows and tilled under the row.
To study the vertical temperature gradient as a function of soil management, temperature sensors were installed on vine posts inside the two parcels, at 4 different heights above ground level: 30 cm, 60 cm, 90 cm and 120 cm. Three replicates of this system were positioned on each parcel, giving a total of 12 temperature sensors per parcel.

Vertical temperature gradient as a function of soil management and impact on theoretical maturity

The Winkler bioclimatic index[4], which represents the sum of mean daily temperatures above 10°C over the growing season, was calculated for each temperature sensor from 2016 to 2020. This index, expressed in degree-days, is strongly correlated with the mean temperature. The results show that whatever the soil management techniques (tillage or cover crop), the Winkler index is higher close to the ground than at height. However, these temperature differences are small, with only 69 °C-days difference between 120 cm and 30 cm. The impact on ripening was assessed by using the grapevine sugar ripeness (GSR) model[5] to calculate the day on which the Merlot reached a sugar concentration of 200 g/L. The results show that between heights of 120 cm and 30 cm there is only a 3-day difference in ripening on the cover-cropped parcel, and 2 days on the tilled parcel. Hence, a vertical temperature gradient does exist, but it is insufficient to significantly delay theoretical ripening under the assumptions of this study.

Impact of the gradient at extreme temperatures

An analysis of frost nights and very hot days was carried out to measure the effect of height and soil management under these sensitive conditions for yield, vine growth and grape composition.

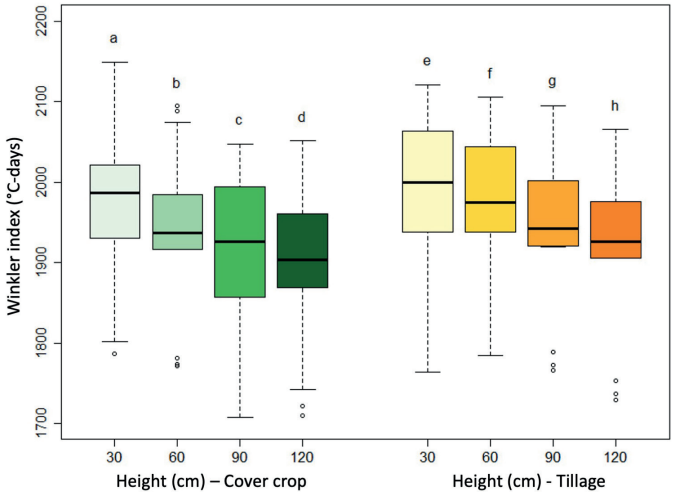


FIGURE 1. Boxplot of the Winkler index from 2016 to 2020 as a function of height for each vineyard soil management (n = 5 years * 3 replicates = 15 individuals / boxplot). The letters indicate significant differences between heights (P <0.05). Different models were built for each soil management

Analysis of the frost night of 27 April 2017 (Figure 2A) shows that whatever the soil management, temperatures close to the ground are lower than at height. The cover-cropped parcel shows a greater temperature difference between the highest and lowest sensors (1.7 °C) than the tilled parcel (0.9 °C), and temperatures in the bunch zone (45 cm) are colder for the cover-cropped parcel (-0.5 °C), mainly because the grass forms an insulating layer that limits heat rising from the soil during the night.
An analysis of all frost nights between 2016 and 2020 with minimum temperatures (Tn) below -2.5 °C at 30 cm was performed. There were 67 such nights for the cover-cropped parcel compared with 50 for the tilled parcel. Of these 67 nights, 66 were colder on the cover-cropped parcel than on the tilled parcel. The frost risk is thus greater on the cover-cropped parcel.
Increasing the trunk height, combined with tillage, could limit the risk of frost damage. However, special care should be taken to avoid tillage just before a frost. This would create an insulating layer, limiting the night-time return of heat from the soil and thus increasing the risk of frost damage[6].

The translation of this article into English was offered to you by Moët Hennessy.

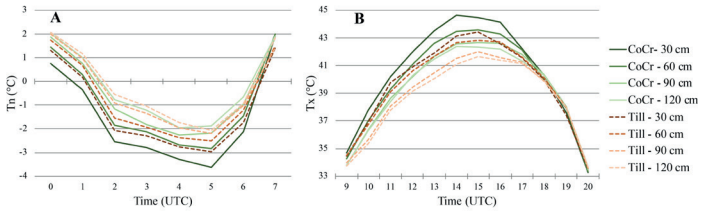


FIGURE 2. Hourly temperature distribution on the frost night of 27 April 2017 (Minimum temperature, A) and the heatwave of 23 July 2019 (Maximum temperature, B) by height and soil management (CoCr: cover crop; Till: tillage).

For very hot days, on 23 July 2019 and whatever the soil upkeep regime, the maximum temperatures (Tx) were highest close to the ground (Figure 2). Temperatures were also higher on the cover-cropped parcel than on the tilled parcel, with a difference of 0.8 °C at 45 cm in the bunch zone.

Analysis of all days of extreme heat (Tx >38 °C at 30 cm) shows that the highest temperatures were always near the ground, but soil upkeep had no consistent effect. For the cover-cropped parcel, 56 days were recorded with Tx >38 °C compared with 47 for the tilled parcel. Also, 45 of these 56 days were hotter on the cover-cropped parcel than on the tilled parcel. These results could be explained in part by drying out of the grass or drainage of the topsoil.

Increasing the trunk height could reduce the risks resulting from very high temperatures, such as sunburn and impairment of the aromatic profile[7].

Mitigate extreme temperatures by increasing the trunk height

To quantify the effects of increasing trunk height on temperatures in the bunch zone during frost nights or on days of extreme heat, the temperature gaps between the different heights were calculated for each parcel and are illustrated in Figure 3.

It can be seen that increasing the trunk height reduces the air temperature in the bunch zone on days of extreme heat and increases the temperature during frost nights. These variations are more pronounced on the cover-cropped parcel which, as seen earlier, is more exposed to extreme temperatures, particularly minimum temperatures. On tilled soils, increasing the trunk height only reduces the risk of frost damage very slightly, but may help reduce the impact of excessively high temperatures.

In the current context of changing vineyard practices, cover-cropped parcels are becoming increasingly common. Increasing the trunk height is a good way of limiting the impact of extreme temperatures on such parcellots.

It might be worthwhile for wine estates to increase the trunk height, for example from 45 cm to 90 cm on this estate. This would certainly make it possible to reduce the maximum temperature during heatwaves, and increase the minimum temperature during frost nights, though the impact on air circulation induced by the change in trunk height has not been measured. The potential reduction in canopy height could be offset by increasing the trimming height by 40 cm (from 160 cm to 200 cm) without changing the leaf area-to-fruit weight ratio, provided the vineyard machinery allows this. Reducing the canopy area could also be considered to further limit the impact of climate change on grape composition, with a decrease in sugar content without significantly increasing the total acidity[8]. ■

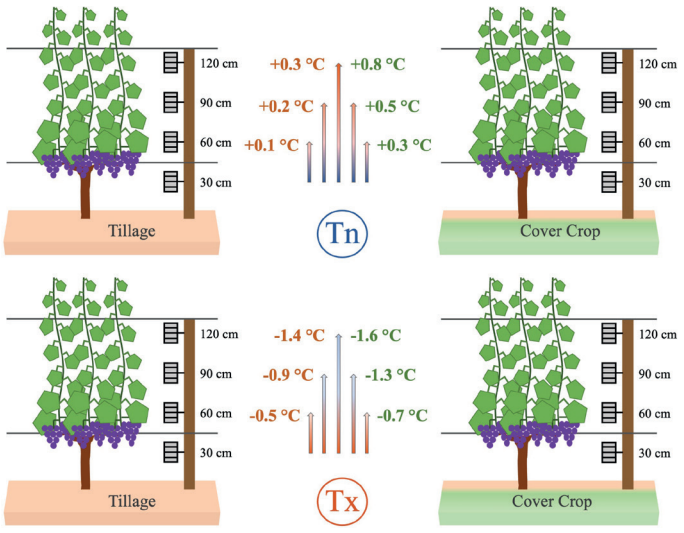


FIGURE 3. Average of daily temperature difference between the various heights and 30 cm (2016 to 2020) on Tn and Tx as a function of soil management on days with extreme temperatures (Tn <-2.5 °C (n = 67) and Tx >38 °C (n = 56)).

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Sources : *Sourced from the research article: "Characterisation of the vertical temperature gradient in the canopy reveals increased trunk height to be a potential adaptation to climate change." (OENO One, 2023).*

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