Mechanisms involved in the heating of the environment by the aerodynamic action of a wind machine to protect a vineyard against spring frost
Clara Le Cap, Johan Carlier, Dominique Heitz, Hervé Quénol, Emmanuel Buisson

To cite this version:
Clara Le Cap, Johan Carlier, Dominique Heitz, Hervé Quénol, Emmanuel Buisson. Mechanisms involved in the heating of the environment by the aerodynamic action of a wind machine to protect a vineyard against spring frost. TERCLIM2022 - XIVth International Terroir Congress | 2nd ClimWine Symposium, Jul 2022, Bordeaux, France. hal-03864547

HAL Id: hal-03864547
https://hal.inrae.fr/hal-03864547
Submitted on 21 Nov 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
MECHANISMS INVOLVED IN THE HEATING OF THE ENVIRONMENT BY THE AERODYNAMIC ACTION OF A WIND MACHINE TO PROTECT A VINEYARD AGAINST SPRING FROST

Clara LE CAP1,2,3, Johan CARLIER1, Dominique HEITZ1, Hervé QUENOL2, Emmanuel BUSSON3
(1) INRAE UR OPAALE, (2) UMR 6554 LETG, (3) Weather Measures

CONTEXT
Spring frosts are devastating for the buds and by a continuous air mixing, the wind machine (WM) allows to avoid this both biological and economical disaster (Le Cap et al., 2021). Today, the wind machine is often associated with a fixed heating system at its base, the efficiency of which is today not well known, leaving the winemakers uncertain in their decision making.

High frequency measurements were made on a plot during a typical radiative frost night to assess the performance of the wind machine, with and without the help of a supplementary heater. The experiment consisted in measuring the temperature in the vicinity of the WM during the night. The aim was to measure the establishment of the thermal inversion and the WM effect on it by using the machine for 2 hours just before the sunrise and supplemented by alternating periods of 30 min with and without heating.

MATERIAL AND METHODS
Three types of device with high frequency probes:
- 16 local measurements stations (4 Hz):
  - placed around the WM at different radii, staggered from one radius to the other.
  - Vine-height and ground thermocouple
  - 1 LCJ® ultrasonic anemometer.
- A 10m mast (4 Hz):
  - placed at 40 m from the WM
  - 11 thermocouples distributed from the ground to 10.50 m high.
- A Campbell® METSENS500 weather station (1 Hz):
  - placed on the nearby plot
  - monitoring of the temperature in a WM-free zone.

THERMAL INVERSION
- The thermal inversion increases progressively until 2:00 am then fades during the night.
- A 3:00 am a large standard deviation for all temperature sensors appears as the temperature decreases between 2:00 am and 4:00 am
- Thermal inversion reaches its minimum at 6:00 am, when the wind machine has been operated continuously.
- The significant temperature deviation is due to the natural restratification of the atmosphere after each rotation of the tower.
- At 7:00 am, the temperature cools down and the inversion is enhanced due to the shutdown of the tower at 7:15 am.
- Finally, at 8:00 am the inversion becomes chaotic with a strong dispersion of temperatures.

TEMPERATURE DESCRIPTION
The analysis focuses on the red curve representing the temperature at 1.5 m height, 40 m away from the wind machine. During the whole experiment, it is surrounded by two darker curves, the upper one representing the temperature at 10.50 m height and the lower one the temperature on the nearby plot, out of the wind machine’s reach.

On the nearby plot, the temperature decreases progressively throughout the night and warms up shortly after sunrise.

The temperature at 10.50 m height feels the effect of the machine gust since a peak is recorded for each rotation.

Before and at the beginning of the experiment, the temperature at 1.5 m height is close to the one out of the WM reach.

During the WM operation, it remains higher than the unprotected thermocouple. After the switch-off of the WM the two temperatures get closer again and increase with the sunrise.

During the using of the heater 1.5 m temperature peaks reach those at 10.50 m. However, the average temperature remains lower than the one at the top of the 10 m mast

The burner, placed at the suction of the tower, seems to increase the peaks of temperature but also their magnitude of decrease.

CONCLUSION
- Only a few of the results are presented in this poster:
  - With a smaller thermal inversion than recommended in literature.
  - The wind machine, with or without heating, maintained a local atmosphere favorable to the protection of the bud.

Next steps:
- Quantify the protective surface with and without heating thanks to simultaneous high frequency acquisitions at different radii;
- Estimate the amount of heat transferred to the bud with a smaller time step than the rotation period of the wind machine.

REFERENCES