agriculture

MDPI

Brief Report

Anti-Hail Nets in Viticulture: Do They Affect White Grape Quality in the Mediterranean Region?

Corrado Domanda [1,2], Ileana Blanco [1,*], Riccardo Buccolieri [1] and Laura Rustioni [1]

[1] Department of Biological and Environmental Sciences and Technologies, University of Salento, Via Provinciale Monteroni, 73100 Lecce, Italy; corrado.domanda@unisalento.it (C.D.); riccardo.buccolieri@unisalento.it (R.B.); laura.rustioni@unisalento.it (L.R.)
[2] Department of Agricultural Sciences, University of Sassari, Viale Italia 39, 07100 Sassari, Italy
* Correspondence: ileana.blanco@unisalento.it

Abstract: Anti-hail nets have been employed in viticulture to reduce the damage caused by hailstorms, but whether this strategy may have detrimental effects on grape quality in the Mediterranean region is still unknown. This study was carried out in the Salento region during the 2023 harvest to evaluate the grape microclimate and fruit quality attributes of 'Fiano' white grapes grown uncovered or covered with either crystal or black nets. The nets had a small but significant effect on the air temperature (about 0.3 °C and 0.1 °C higher with black and crystal nets, respectively) and relative humidity (about 1% lower with both black and crystal nets) in the grape zone. However, no significant variation was recorded for grape colouration (except for the chromaticity coordinate a*) nor for the main skin photosynthetic pigments (chlorophyll *a*, chlorophyll *b*, carotenoids), the total polyphenolic content, and the total soluble solids. Our preliminary results suggest that anti-hail nets can be effective to protect the grapevines against hailstorms and other adverse weather conditions, without having negative impacts on the colour development and bioactive compounds of white grapes in the Mediterranean region.

Keywords: antioxidants; abiotic stress management; microenvironment conditions; secondary metabolite; CIELab colour space; photosynthetic pigments

Citation: Domanda, C.; Blanco, I.; Buccolieri, R.; Rustioni, L. Anti-Hail Nets in Viticulture: Do They Affect White Grape Quality in the Mediterranean Region? *Agriculture* **2024**, *14*, 1438. https://doi.org/10.3390/agriculture14091438

Received: 9 July 2024
Revised: 14 August 2024
Accepted: 21 August 2024
Published: 23 August 2024

1. Introduction

The Mediterranean region has frequently been struck by extreme meteorological events, such as disruptive storms and heavy rain events [1,2]. In the Salento peninsula, located in south-eastern Italy, tornadoes and hailstorms have been reported over the last decade [3,4]. Hailstorms in the Salento peninsula can occur particularly from the end of the summer to the beginning of the winter [5], causing economic damages for fruit crops [6–8].

Hail control by nets is one of the adaptation strategies to avoid damage from hailstorms in the production of grapes [9,10]. Before the harvest, particularly after July, farmers wrap their grapes with a plastic cover in order to protect them from hail [11]. Traditionally, anti-hail nets have been manufactured with either black threads or transparent crystal-clear threads [12,13]. Besides acting as a barrier against hailstones, black and crystal anti-hail nets also manipulate the quantity of light reaching the fruits. Black nets reduce light quantity, as they are entirely opaque; transparent nets scatter light [14]. Since light intensity is a crucial factor for fruit colour development [15], anti-hail nets may have a detrimental effect on the quality of the fruits.

In the context of climate change, the use of nets has been increasingly adopted to protect crops from adverse environmental conditions. Shading nets have been applied to grapevines with the primary aim of delaying the ripening process [16]. Still, the consequences of shading on grape quality are not always univocal, as they may change according to the cultivar and the environment. For example, for the cultivar 'Shiraz' grown in south Australia, Ristic et al. [17] did not find any significant difference between covered and uncovered grapes in the total soluble solids (TSSs), while, for cv. 'Grillo' and 'Nero d'Avola' in Sicily, the shading treatment proved to be an effective tool to reduce TSS accumulation [18,19].

Anti-hail net influence on fruit quality has been extensively studied in many orchards (especially apples), but there are few publications regarding grapes, particularly in the Mediterranean basin. Hence, the objectives of the present work were to investigate in the Salento region (1) the possibility of the nets' impact on the grape microclimate, and (2) the effect of black and crystal anti-hail nets on white grape quality including colour and chlorophyll, carotenoid, and phenolic contents in the skin.

2. Materials and Methods

2.1. Experimental Site Characterization

The experiment was carried out in a vineyard belonging to Azienda Vitivinicola Claudio Quarta Vignaiolo (Lizzano, TA, Italy). The vineyard is located in a flat area (latitude 40.35, longitude 17.40, elevation 18 m a.s.l.) and it is north–south oriented. Plants are spaced at intervals of 2.20 m (inter-row) and 0.90 m (in-row), with a resulting density of about 5000 plants ha^{-1}. Vines are trained in a Guyot system; tillage is applied as a soil management technique, and the vineyard is equipped with a drip irrigation system, which consists of a 2 L h^{-1} dripper per vine. During the experimental period, from the beginning of August to mid-September 2023, water was supplied only during the first days of August (about 2000 hL ha^{-1}). The height of the canopy is approximately 1.20 m. The cultivar grown is 'Fiano', an Italian white grape variety.

2.2. Experimental Plan

The experiment involved three treatments: uncovered vines that served as a control, vines that were covered with a crystal anti-hail net (2244KR Iride Uva Bayco; hereafter "crystal net"; technical data from manufacturer: weight 70 g m^{-2}, hole dimension 7.1 mm × 1.9 mm, shading factor 8%), and vines that were covered with a black anti-hail net (2240NE Iride Multi Pro Extra Black; hereafter "black net"; technical data from manufacturer: weight 70 g m^{-2}, hole dimension 7.1 mm × 1.7 mm, shading factor 26%). Both nets are made of 100% ARLENE® HT UV-stabilised high-tenacity polyethylene. The nets used in this study were obtained from a private company (Arrigoni spa, Uggiate Trevano, Como, Italy). The experiment was set up according to a randomized complete block design. Three adjacent rows were selected as blocks in the centre of the vineyard in order to avoid any border effects. Within each row, one experimental unit was assigned to each treatment. Each experimental unit was composed of six consecutive vines. To allow for the comparison of the responses to the same environmental conditions, all of the plants were defoliated by hand in the grape zone before installing the nets. Anti-hail nets were installed on 2 August, and they were removed on 11 September, after the harvest of the grapes. Each net was 1 m wide and was placed vertically along the grape zone over both sides of the canopy.

2.3. Sensors and Micrometeorological Data Analyses

Site climatic parameters, namely air temperature (°C) and relative humidity (as percentage), were continuously recorded using an xSense mini weather station (xFarm Technologies Italia srl, Milan, Italy) that is based on Davis Vantage Vue ISS sensors (Davis Instruments, Davis Instruments, Heyward, CA, USA; ±0.5 °C/±2% Temp/RH accuracy). The weather station was located about 0.2 km from the vineyard and stored 60 min average values. Air temperature and relative humidity measurements in the grape zone were carried out continuously in the period of 2 August–11 September 2023, using waterproof data loggers (Tinytag Plus 2-TGP-4505, Gemini Data Loggers Ltd., Chichester, West Sussex, UK). The data loggers are equipped with air temperature and relative humidity probes with an accuracy of ±0.3 °C and ±3% in air temperature and relative humidity measurements, respectively, at 25 °C. The probes were placed in the grape zone of each treatment within the same row before positioning the nets. The sensors were adequately shielded from solar radiation. The data loggers stored 15 min average values.

2.4. Grape Quality Assessment

2.4.1. Fruit Skin Colour Parameters

Fruit skin colour was measured according to the CIELab system, using 'Spectro 1 PRO' (Variable Inc., Chattanooga, TN, USA), a portable colourimeter functioning with a D65 10° light source [20]. Total colour differences (Delta E, ΔE) were calculated through the subsequent equation:

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \quad (1)$$

ΔE is a standard measurement that quantifies the difference between two colours. It ranges from 0 to 100, where 0 is the absence of colour difference, while 100 indicates complete distortion. ΔE values higher than 3 are detectable by the naked eye [21]. For each sampling date (11 August, 29 August, 11 September), three grapes/treatment were collected. The day after each sampling date, fruit skin colour (according to the CIELab system) was recorded in the laboratory on 15 randomly selected intact berries per treatment (5 berries/grape). Berry colour was recorded in duplicate; thus, 30 measurements per treatment per day were obtained. For each sampling day, the remaining berries were crushed by hand and the TSSs (°Brix) of the juices were determined by using a digital refractometer (RWM-1000, HM Digital Inc., Carson, NV, USA).

2.4.2. Spectrophotometric Indexes

The same berries used for colour measurements were peeled. The resulting skins were weighed and extracted with 15 mL of 85% acetone. The skin extracts were maintained at −20 °C up to the analyses.

Photosynthetic pigments were quantified as described in Domanda et al. [22] using an UV-Vis Spectrophotometer (UV-1900i, Shimadzu Europa, Duisburg, Germany). Chlorophyll *a* and *b* and carotenoids were then calculated through the following formulas:

$$\text{Chlorophyll } a \left(\mu\text{g g}^{-1} \text{ of skin}\right) = \frac{(\text{A662} \times 9.78) - (\text{A644} \times 0.99)}{\text{SW}} \times 15 \quad (2)$$

$$\text{Chlorophyll } b \left(\mu\text{g g}^{-1} \text{ of skin}\right) = \frac{(\text{A644} \times 21.40) - (\text{A662} \times 4.65)}{\text{SW}} \times 15 \quad (3)$$

$$\text{Carotenoids} \left(\mu\text{g g}^{-1} \text{ of skin}\right) = \frac{(\text{A440.5} \times 4.69) - [0.267 \times (\text{Chl } a + \text{Chl } b)]}{\text{SW}} \times 15 \quad (4)$$

where An = absorbance at n wavelength, Chl *a* = chlorophyll *a*, Chl *b* = chlorophyll *b*, and SW = skin weight (g).

Total phenolic content was calculated for each skin extract as described in Domanda et al. [22].

2.5. Statistical Analyses

The data were analysed using SPSS software Version 20 (IBM Corporation, Armonk, NY, USA). One-way analysis of variance (ANOVA) and the Bonferroni post hoc test were performed to identify significant differences between the microclimatic conditions (air temperature and relative humidity) of the grape zone in the three treatments. Significant differences for colour parameters were determined by the unpaired *t*-test at $p \leq 0.05$ (two-tailed). Factorial ANOVA, followed by the Bonferroni post hoc test, was performed to determine significant differences ($p \leq 0.05$) for the spectrophotometric indexes. For this last analysis, the aim was to see the evolution of chlorophylls, phenolics, and carotenoids during the experimental period; thus, in this case, a linear model with the interaction between date and treatment was fitted.

3. Results

3.1. Micrometeorological Data

The daily values of the air temperature and relative humidity recorded on the site during the experiment are shown in Figures 1 and 2 by multiple box plots. The external air temperature varied in the range of 15.9–38.8 °C, while the daily average value varied between 23.5 °C and 31.5 °C, with a mean value of 26.8 °C. The external air relative humidity varied in the range of 25–92%, while the daily average ranged between 46% and 81%, with a mean value of 58%. Air temperature in the grape zone not shielded with any net (control) ranged between a minimum value of 13.9 °C and a maximum value of 39.6 °C, with a mean value of 26.9 °C. The grape zone air temperature behind the nets varied in the range of 14.3–40.1 °C, with a mean value of 27.2 °C, in the black net treatment and in the range of 14.0–39.8 °C, with a mean value of 27.0 °C, in the crystal net one. The air relative humidity in the grape zone of the control ranged between a minimum value of 19% and a maximum value of 100%, with a mean value of 58%. The grape zone relative humidity behind the nets varied in the range of 18–100%, with a mean value of 57%, in the black net treatment and in the range of 18–99%, with a mean value of 57%, in the crystal net one.

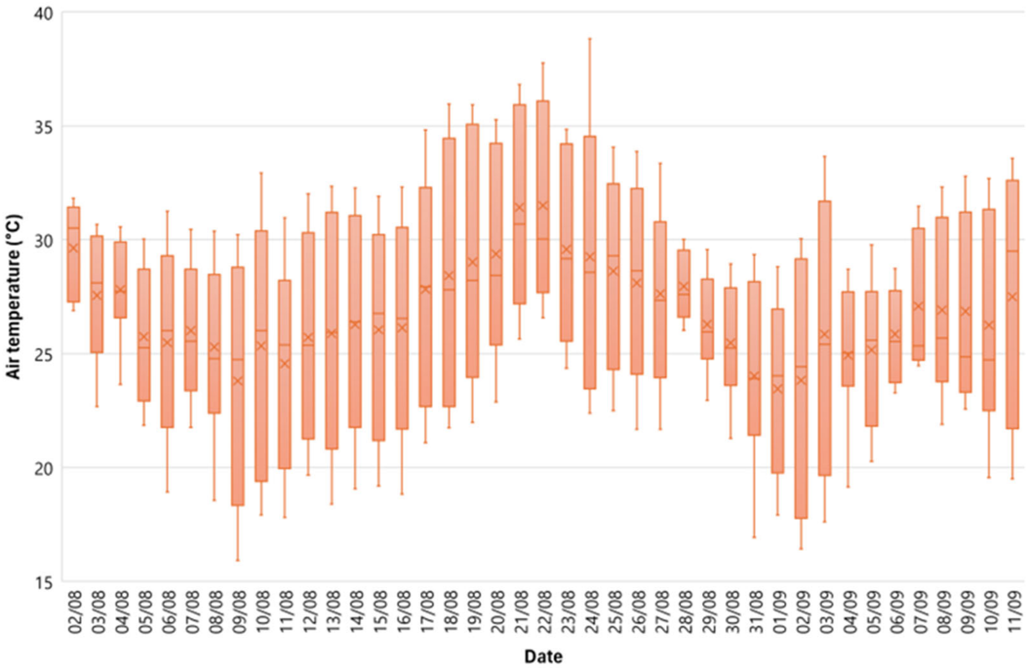


Figure 1. The air temperature during the experimental period (2 August–11 September 2023). The line and the cross inside the box indicate the median and the mean respectively. The date in the figure is reported in the format Day/Month.

The daily microclimatic conditions (air temperature and relative humidity) in the grape zone are shown in Figures 3 and 4. The day with the highest mean air temperature (Figure 3) and the one with the lowest mean air temperature (Figure 4) were chosen. The air temperature and air relative humidity of the grape zone behind the anti-hail nets rose almost in sync with those of the control. In particular, the grape zone of the control was characterised by temperature values quite similar to those regarding the crystal net treatment and, during the warmest hours of the daytime, slightly lower than those regarding the black net treatment (Figures 3 and 4).

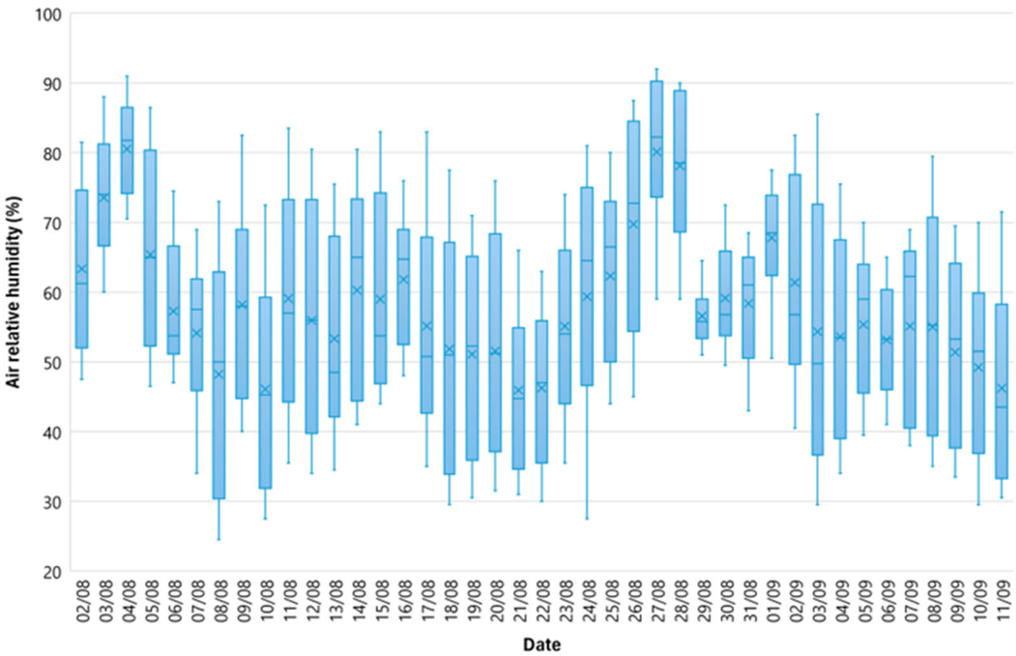


Figure 2. The air relative humidity during the experimental period (2 August–11 September 2023). The line and the cross inside the box indicate the median and the mean respectively. The date in the figure is reported in the format Day/Month.

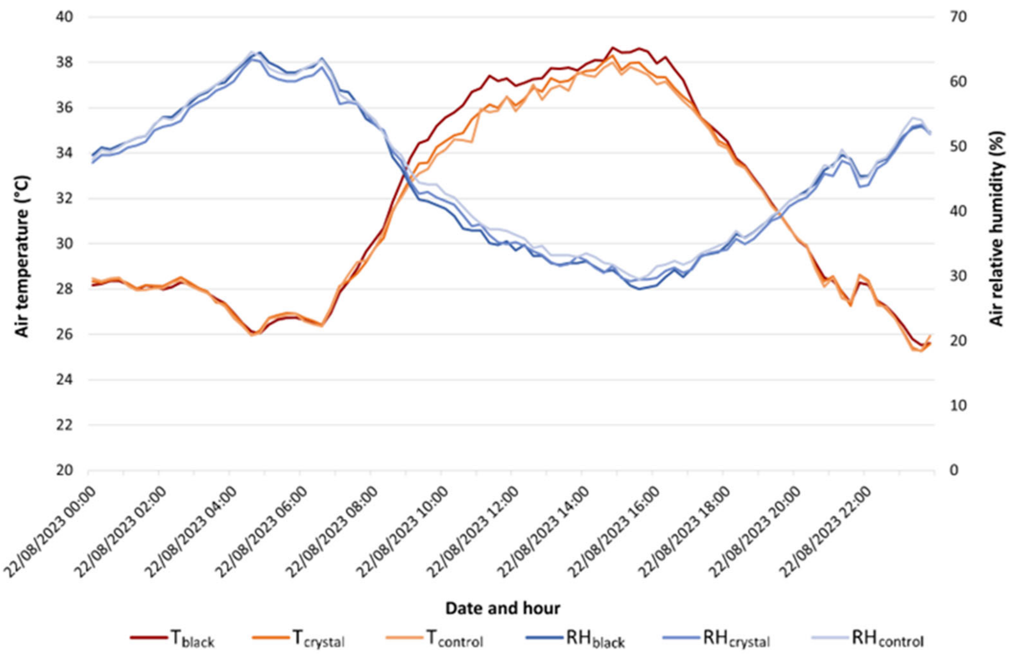


Figure 3. The air temperature (T) and relative humidity (RH) of the grape zone in the three treatments, 22 August 2023. The date in the figure is reported in the format Day/Month/Year.

The ANOVA analyses highlighted that in comparison to the control, the application of the black net in the grape zone caused on average a very slight increase in the air temperature, while the crystal net led to a slight decrease in the air relative humidity (Figure 5).

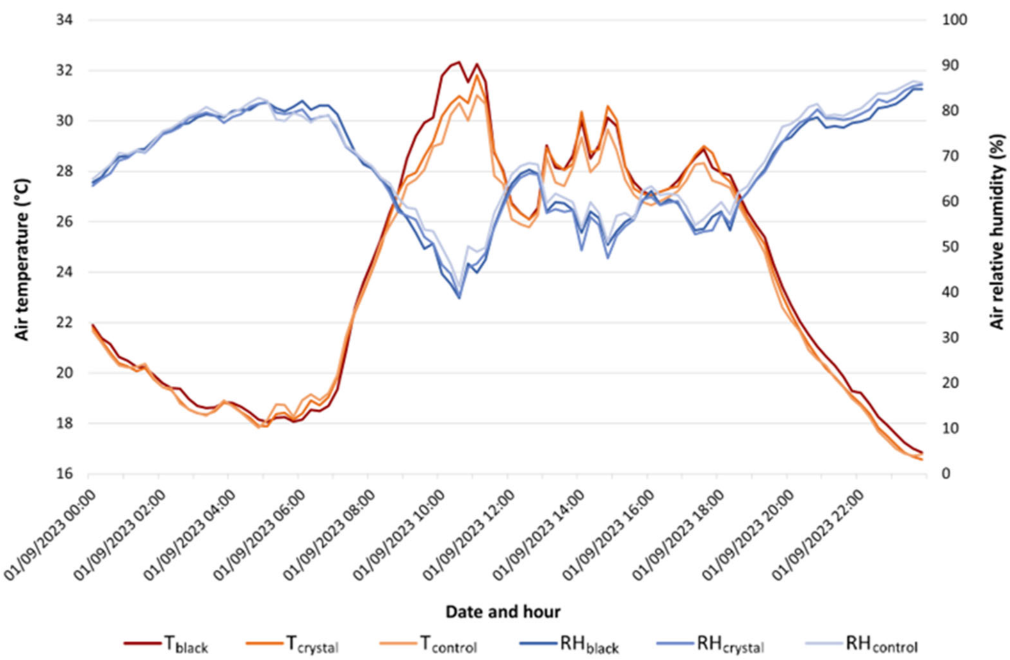


Figure 4. The air temperature (T) and relative humidity (RH) of the grape zone in the three treatments, 1 September 2023. The date in the figure is reported in the format Day/Month/Year.

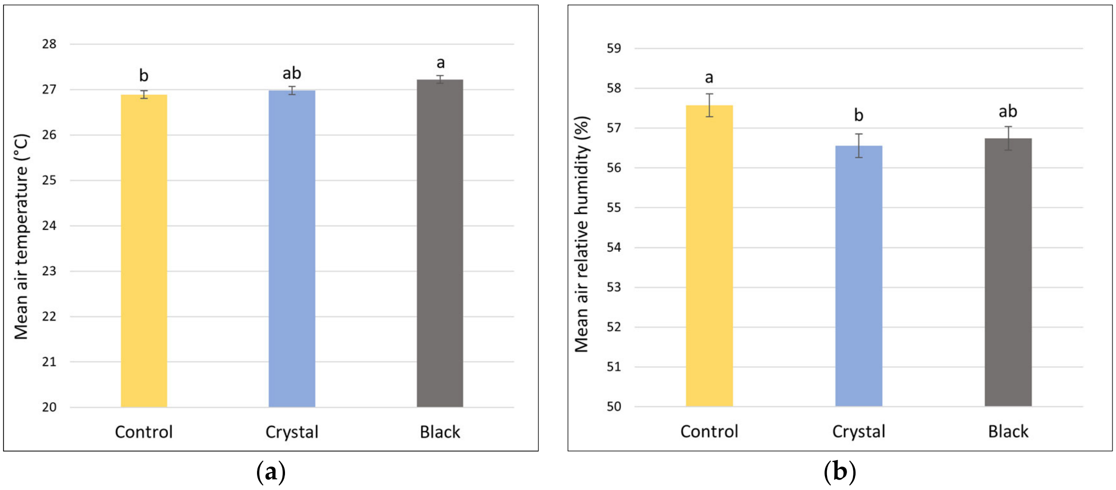


Figure 5. The mean values of the air temperature (**a**) and relative humidity (**b**) in the grape zone in the three treatments (control, crystal anti-hail net, and black anti-hail net) during the experimental period (2 August–11 September 2023). The bars indicate the standard error. Bonferroni's post hoc test results among treatments are indicated alphabetically with significant differences ($p \leq 0.05$) expressed by different lowercase letters (above bars).

3.2. Fruit Quality

Obviously, the berries underwent colour changes during ripening (Table 1 (a)); however, no significant differences in this trend were ascribable to the shading treatments. Considering the average berry colour, treatments had no significant effect on all fruit colour parameters, except for a* coordinate, which was smaller in the grapes grown covered with the anti-hail nets than in those grown uncovered (Table 1 (b)). Net type did not produce any difference in the grape colour parameters. ΔE was lower than 3 regardless of the treatment. No difference among treatments was detected for pigments or for the total polyphenolic content in the grape skins, nor in the grape juices for the TSSs (Figure 6).

Table 1. (a): CIELab colour parameters of 'Fiano' grapes on three different dates (11 August, 29 August, 11 September) during the experimental period (2 August–11 September 2023). The results are averaged over the levels of treatment. Average values ± standard errors are reported. Different letters within the same column represent significantly different means by one-way ANOVA with the post hoc Bonferroni test ($p < 0.05$). (b): CIELab delta colour parameters of 'Fiano' grapes grown uncovered (control) or covered with different anti-hail nets (crystal or black nets). The results are averaged over the levels of dates (11/08, 29/08, 11/09).

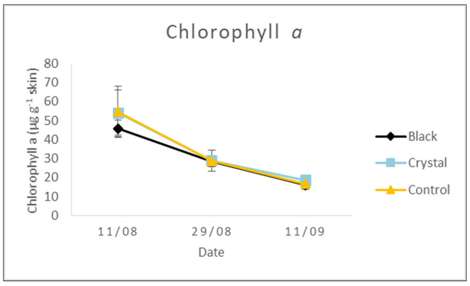
(a)

Date	Colour Attributes		
	L*	**a***	**b***
11 August 2023	38.5 ± 0.5^{a}	-1.6 ± 0.2^{c}	13.8 ± 0.5^{a}
29 August 2023	38.4 ± 0.4^{a}	-0.1 ± 0.2^{b}	13.2 ± 0.4^{ab}
11 September 2023	38.4 ± 0.5^{a}	1.5 ± 0.3^{a}	12 ± 0.4^{b}

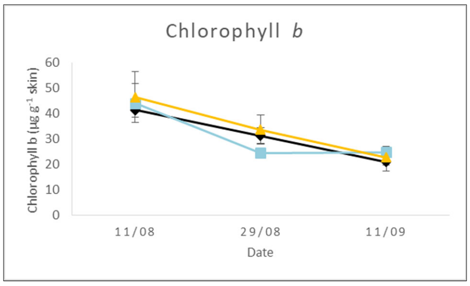
(b)

Treatment	Colour Attributes			
	ΔL*	**Δa***	**Δb***	**ΔE**
Crystal vs. Control	0.7	−1.2 [1]	/	1.4
Black vs. Control	0.1	−1.5 [1]	−0.4	1.6
Crystal vs. Black	0.7	0.3	0.4	0.9

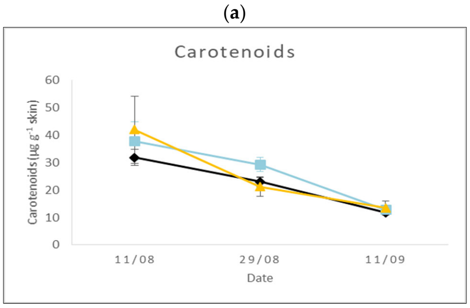
[1] Significant according to unpaired *t*-test at $p \leq 0.05$.



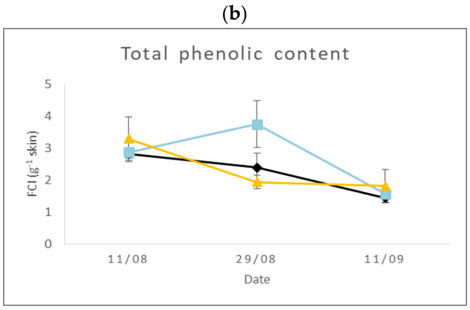
(**a**)



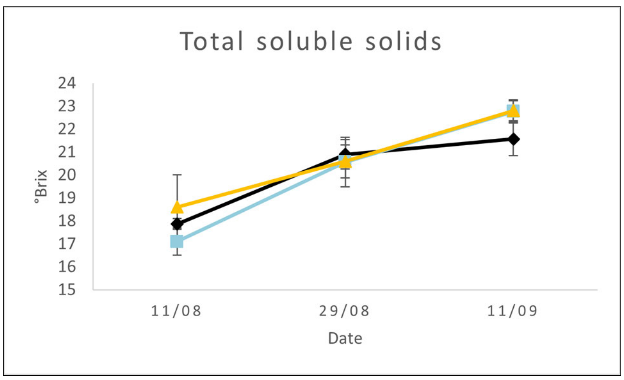
(**b**)



(**c**)



(**d**)



(**e**)

Figure 6. The evolution of chlorophyll *a* (**a**), chlorophyll *b* (**b**), carotenoids (**c**), total phenolic content (**d**), and total soluble solids (**e**) in 'Fiano' grapes grown either without a net (control, yellow line), under a

crystal anti-hail net (light blue line), or under a black anti-hail net (black line) on three different dates (11 August, 29 August, 11 September) during the experimental period (2 August–11 September 2023). The bars indicate the standard error. The factorial ANOVA for the interaction between the treatments and date, followed by the post hoc Bonferroni test, did not highlight significant differences for the treatments nor for the interaction between the treatments and date (significant differences were found only between dates). The date in the figure is reported in the format Day/Month.

4. Discussion

During ripening, the colour of white grape undergoes modifications, mainly due to different catabolic processes, such as chlorophyll and carotenoid degradation and melanin-like pigment accumulation [23]. This is consistent with the modifications in the CIELab colour parameters observed in this study. In particular, the parameter a* indicated a change from greenish to reddish colours.

Our preliminary results suggest that despite the nets having a small but significant effect on the microclimate of the grape zone, it could be easily compensated by other management decisions by winegrowers, such as row orientation [24] or canopy management [25].

In the majority of the studies focusing mainly on blushed apples and apricots, black nets hampered fruit red colouration [13,26]. The crystal net was associated with either intermediate fruit colour values between the black net and the control, or similar values to those of the control at best [27,28]. Anthocyanins are the pigments mainly responsible for the formation of reddish, bluish, or purple tones in fruits and their accumulation is generally stimulated by light [29]. In this case, however, the overall effect of protective nets on the colour development of white grapes, which are unable to biosynthesize anthocyanins [30], was negligible compared to an uncovered control, as was the impact of one net type versus another. The only difference between the treatments was the slightly higher red colour intensity for control grapes, which was probably due to a reduction in non-photochemical quenching when grapes have been fully exposed to an excess-radiation environment [9] or, more likely, to the accumulation of oxidized polymeric pigments induced by the higher light intensity in control berries [31]. However, since ΔE was less than three, no noticeable chromatic changes were observed among the treatments, and thus, the grape colour was not depreciated by the anti-hail nets.

A small ΔE value indicates marginal perceptual colour difference, but other characteristics of fruit quality, such as pigments and phenolics, could also be considered. Consistent with our study, the main findings on apple leaves and apple fruit skins indicate that anti-hail net application does not substantially alter chlorophyll *a* and *b* or carotenoid concentrations [32–34]. Furthermore, a lower light intensity does not mean a lower content of phenolics in fruits [14]. Melgarejo et al. [28] noted that the use of white anti-hail nets did not significantly affect the total polyphenol content in apricots. Working with 'Rose Niagara' grapes, Forte et al. [10] showed that the anti-hail net influenced phenolic compounds in the skin, but this variation was not consistent within two consecutive harvests, concluding that edaphoclimatic conditions have a larger influence on phenolics than the use of anti-hail nets. Of course, different results could be obtained by modifying the experimental plan (e.g., testing different cultivars in different environments or modifying the timing and system of net installation). Thus, further research should be encouraged within this topic.

5. Conclusions

Our preliminary results suggest that anti-hail net application did not alter the colour and the metabolites of 'Fiano' grapes. Despite the nets slightly changing the microclimatic conditions of the grape zone, they did not significantly alter grape quality. Therefore, we suggest that these nets could be used for protection against hail and other storms, without a significant risk of negatively affecting the quality of traditional white wine production in the Mediterranean region. Further studies could be carried out to better understand the impact of anti-hail net application on yield for different vintages.

Author Contributions: Conceptualization, I.B. and L.R.; methodology, I.B., R.B. and L.R.; formal analysis, C.D., I.B. and L.R.; investigation, C.D.; resources, I.B., R.B. and L.R.; data curation, C.D. and I.B.; writing—original draft, C.D. and I.B.; writing—review and editing, I.B., R.B. and L.R.; visualization, C.D., I.B. and L.R.; supervision, I.B. and L.R.; project administration, I.B. and L.R.; funding acquisition, L.R. All authors have read and agreed to the published version of the manuscript.

Funding: This study was funded by RIPARTI project—Regione Puglia. POC PUGLIA FESRT-FSE 2014/2020 Fondo Sociale Europeo approvato con Decisione C(2015)5854 del 13/08/2015 Riparti (assegni di Ricerca per riPARTire con le imprese). TITOLO DEL PROGETTO DI RICERCA: BIODIVERSITÀ INTRASPECIFICA E CAMBIAMENTO CLIMATICO—valorizzazione di una collezione ampelografica per una viticoltura resiliente—Codice Pratica: e7e39722.

Institutional Review Board Statement: Not Applicable.

Data Availability Statement: Data that are not already contained within this article will be available from the corresponding author (I.B.) upon reasonable request.

Acknowledgments: The authors are grateful to Azienda Vitivinicola Claudio Quarta Vignaiolo (Lizzano, TA, Italy) for the access to the vineyard and Gennaro Rispoli for the technical support.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Claud, C.; Alhammoud, B.; Funatsu, B.M.; Chaboureau, J.-P. Mediterranean hurricanes: Large-scale environment and convective and precipitating areas from satellite microwave. *Nat. Hazards Earth Syst. Sci.* **2010**, *10*, 2199–2213. [CrossRef]
2. Laviola, S.; Moscatello, A.; Miglietta, M.M.; Cattani, E.; Levizzani, V. Satellite and numerical model investigation of two heavy rain events over the Central Mediterranean. *J. Hydrometeorol.* **2011**, *12*, 634–649. [CrossRef]
3. Miglietta, M.M.; Rotunno, R. An EF3 multivortex tornado over the Ionian region: Is it time for a dedicated warning system over Italy? *Bull. Am. Meteorol. Soc.* **2016**, *97*, 337–344. [CrossRef]
4. Prodi, F.; Congedo, F.; Pasqualucci, F.; Trivellone, G. Severe weather events over Apulia region observed by newly installed C-band polarimetric Doppler radar of RIVONA Project. In Proceedings of the 37th Conference on Radar Meteorology, Boston, MA, USA, 14–18 September 2015.
5. Congedo, F.; Prodi, F.; Pasqualucci, F.; Trivellone, G. Polarimetric Doppler radar analysis of squall line systems crossing Salento Peninsula. *Meteorol. Appl.* **2017**, *24*, 338–348. [CrossRef]
6. Petoumenou, D.G.; Biniari, K.; Xyrafis, E.; Mavronasios, D.; Daskalakis, I.; Palliotti, A. Effects of natural hail on the growth, physiological characteristics, yield, and quality of *Vitis vinifera* L. Cv. Thompson Seedless under Mediterranean growing conditions. *Agronomy* **2019**, *9*, 197. [CrossRef]
7. Tartachnyk, I.; Blanke, M.M.; Jackson, M.B. Effect of hail on photosynthesis, chlorophyll fluorescence, stomatal closure and evapotranspiration of apple leaves. *Acta Hortic.* **2007**, *732*, 543–547. [CrossRef]
8. Wells, L.D.; McManus, P.S. Effects of simulated hail events and subsequent fungicide applications on cranberry fruit rot incidence and yield. *Plant Dis.* **2013**, *97*, 1207–1211. [CrossRef]
9. De Deus, B.C.; Figueiredo, F.A.; Almeida, L.V.; Ferraz, T.M.; Martins, A.O.; Rodrigues, W.P.; Campostrini, E. Photosynthetic capacity of 'Niagara Rosada' grapes grown under transparent plastic covering. *Cienc. Rural* **2016**, *46*, 950–956. [CrossRef]
10. Forte, F.F.; Susin, E.; Silvestre, W.P.; Corrêa, H.C. Effect of anti-hail net on production and quality of 'Rose Niagara' grapes grown in Serra Gaúcha region, south Brazil. *Cienc. Tec. Vitivinic.* **2022**, *37*, 116–125. [CrossRef]
11. Karaman, B.; Taskin, S.; Simbeye, D.S.; Mkiramweni, M.E.; Kurtoglu, A. Design and development of smart cover system for vineyards. *Smart Agric. Technol.* **2023**, *3*, 100064. [CrossRef]
12. Rana, V.S.; Sharma, S.; Rana, N.; Sharma, U.; Patiyal, V.; Banita; Prasad, H. Management of hailstorms under a changing climate in agriculture: A review. *Environ. Chem. Lett.* **2022**, *20*, 3971–3991. [CrossRef]
13. Solomakhin, A.; Blanke, M.M. Can coloured hailnets improve taste (sugar, sugar: Acid ratio), consumer appeal (colouration) and nutritional value (anthocyanin, vitamin C) of apple fruit? *LWT-Food Sci. Technol.* **2010**, *43*, 1277–1284. [CrossRef]
14. Vuković, M.; Jurić, S.; Maslov Bandić, L.; Levaj, B.; Fu, D.-Q.; Jemrić, T. Sustainable food production: Innovative netting concepts and their mode of action on fruit crops. *Sustainability* **2022**, *14*, 9264. [CrossRef]
15. Zoratti, L.; Karppinen, K.; Escobar, A.L.; Häggman, H.; Jaakola, L. Light-controlled flavonoid biosynthesis in fruits. *Front. Plant. Sci.* **2014**, *5*, 534. [CrossRef]
16. Palliotti, A.; Panara, F.; Silvestroni, O.; Lanari, V.; Sabbatini, P.; Howell, G.; Gatti, M.; Poni, S. Influence of mechanical postveraison leaf removal apical to the cluster zone on delay of fruit ripening in Sangiovese (*Vitis vinifera* L.) grapevines. *Aust. J. Grape Wine Res.* **2013**, *19*, 369–377. [CrossRef]
17. Ristic, R.; Downey, M.O.; Iland, P.G.; Bindon, K.; Francis, I.L.; Herderich, M.; Robinson, S.P. Exclusion of sunlight from Shiraz grapes alters wine colour, tannin and sensory properties. *Aust. J. Grape Wine Res.* **2007**, *13*, 53–65. [CrossRef]

18. Scafidi, P.; Pisciotta, A.; Patti, D.; Tamborra, P.; Di Lorenzo, R.; Barbagallo, M.G. Effect of artificial shading on the tannin accumulation and aromatic composition of the Grillo cultivar (*Vitis vinifera* L.). *BMC Plant Biol.* **2013**, *13*, 175. [CrossRef]
19. Miccichè, D.; de Rosas, M.I.; Ferro, M.V.; Di Lorenzo, R.; Puccio, S.; Pisciotta, A. Effects of artificial canopy shading on vegetative growth and ripening processes of cv. Nero d'Avola (*Vitis vinifera* L.). *Front. Plant Sci.* **2023**, *14*, 1210574. [CrossRef]
20. Domanda, C.; Nuzzo, V.; Montanaro, G.; Failla, O.; Rustioni, L. Trichomes affect grapevine leaf optical properties and thermoregulation. *Theor. Exp. Plant Physiol.* **2023**, *35*, 299–308. [CrossRef]
21. García-Marino, M.; Hernández-Hierro, J.M.; Rivas-Gonzalo, J.C.; Escribano-Bailón, M.T. Colour and pigment composition of red wines obtained from co-maceration of Tempranillo and Graciano varieties. *Anal. Chim. Acta* **2010**, *660*, 134–142. [CrossRef]
22. Domanda, C.; Paradiso, V.M.; Migliaro, D.; Pappaccogli, G.; Failla, O.; Rustioni, L. Epicuticular waxes: A natural packaging to deal with sunburn browning in white grapes. *Sci. Hortic.* **2023**, *328*, 112856. [CrossRef]
23. Rustioni, L.; Rocchi, L.; Failla, O. Effect of anthocyanin absence on white berry grape (*Vitis vinifera* L.). *Vitis* **2015**, *54*, 239–242. [CrossRef]
24. Hunter, J.J.; Volschenk, C.G.; Mania, E.; Castro, A.V.; Booyse, M.; Guidoni, S.; Pisciotta, A.; Di Lorenzo, R.; Novello, V.; Zorer, R. Grapevine row orientation mediated temporal and cumulative microclimatic effects on grape berry temperature and composition. *Agric. For Meteorol.* **2021**, *310*, 108660. [CrossRef]
25. Rustioni, L.; Altomare, A.; Shanshiashvili, G.; Greco, F.; Buccolieri, R.; Blanco, I.; Cola, G.; Fracassetti, D. Microclimate of grape bunch and sunburn of white grape berries: Effect on wine quality. *Foods* **2023**, *12*, 621. [CrossRef] [PubMed]
26. Jakopic, J.; Veberic, R.; Stampar, F. The effect of reflective foil and hail nets on the lighting, color and anthocyanins of 'Fuji' apple. *Sci. Hortic.* **2007**, *115*, 40–46. [CrossRef]
27. Iglesias, I.; Alegre, S. The effect of anti-hail nets on fruit protection, radiation, temperature, quality and profitability of 'Mondial Gala' apples. *J. Appl. Hortic.* **2006**, *8*, 91–100. [CrossRef]
28. Melgarejo, P.; Legua, P.; Martínez-Font, R.; Martínez-Nicolás, J.J.; Soriano, J.S.; Carbonell-Barrachina, A.A.; Hernández, F. Response of apricot fruit quality to protective netting. *Agriculture* **2021**, *11*, 260. [CrossRef]
29. Manja, K.; Aoun, M. The use of nets for tree fruit crops and their impact on the production: A review. *Sci. Hortic.* **2019**, *246*, 110–122. [CrossRef]
30. Kobayashi, S.; Goto-Yamamoto, N.; Hirochika, H. Retrotransposon-induced mutations in grape skin color. *Science* **2004**, *304*, 982. [CrossRef]
31. Rustioni, L. Oxidized polymeric phenolics: Could they be considered photoprotectors? *J. Agric. Food Chem.* **2017**, *65*, 7843–7846. [CrossRef]
32. Jakopic, J.; Stampar, F.; Veberic, R. The influence of exposure to light on the phenolic content of 'Fuji' apple. *Sci. Hortic.* **2009**, *123*, 234–239. [CrossRef]
33. Szabó, A.; Tamás, J.; Nagy, A. The influence of hail net on the water balance and leaf pigment content of apple orchards. *Sci. Hortic.* **2021**, *283*, 110112. [CrossRef]
34. Zhang, Y.; Chu, B.; Zhang, D.; Li, Q.; Li, Q.; Li, X.; Zou, Y. Effects of four photo-selective colored hail nets on an apple in Loess Plateau, China. *Horticulturae* **2023**, *9*, 1061. [CrossRef]