PHYSIOLOGICAL AND YIELD RESPONSES OF GRAPEVINES TO KAOLIN UNDER SUMMER STRESS

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Introduction

Winegrape production in Mediterranean regions, especially in the Douro Demarcated Region (DDR, Northeast Portugal), is subject to warm and dry summer climate conditions, that may irreversibly impair some physiological processes, leading to poor grape yields and quality. Previous work by our team in the region clearly showed that grapevines growing under severe summer stress experienced significant decline in yield due to stomatal and mesophyll limitations to photosynthesis. Frequently, some of these leaves, particularly those lower on the canes and more directly exposed to sunlight, displayed irreversible photoinhibition and chlorosis followed by necrosis, unprotected the cluster zone and leading to a decrease in grapevine water use efficiency. Consequently, in low vigour vines, yield, berry weight and sugar concentration are significantly reduced. Furthermore, other berry characteristics, such as colour, flavour and aroma components are suppressed by excessive solar exposure of grapes and low water availability. Related with adaptation and mitigation practices, we wish to reinforce the knowledge of the effect of film application practices, i.e. spraying canopies with a aqueous suspension of kaolin. Hence, the aim of the present study is to investigate the main effects of a foliar application with a kaolin particle film in the physiological behaviour of the “Touriga Nacional” variety.

Material and methods

Experimental trial: The experiment was undertaken in 2012 and 2013 in the commercial vineyard “Quinta do Vallado”, located at Peso da Régua in the DDR, northern Portugal.

Plant material: Vitis vinifera L. “Touriga Nacional”, grafted onto 110 R. Three vineyard lines, located on a steep hill, with N-S orientated rows and with 20 plants each one, were pulverized soon after veraison, with 5% (w/v) kaolin (Surround WP; Engelhard Corp. Iselin, NJ). Three additional vineyard lines, with 20 plants each one, were maintained as control, i.e. without kaolin application.

Physiological and agronomical measurements: Leaf gas exchange rates were measured with an infrared gas analyser (LCA-3, ADC, England). Chlorophyll a fluorescence features were measured in situ with a pulse-amplitude-modulated fluorimeter (FMS 2, Hansatech Instruments, Norfolk, England). Total chlorophylls and total carotenoids were determined according to Lichtenhainer (1987). Chlorophyll concentration per area was also estimated non-destructively using a SPAD-502 meter (Minolta, Japan). Leaf temperature was measured with an infrared thermometer (InfraTrace KM800S, England) with a 15° field view. Leaf reflectance was measured from 200 to 1100 nm, using a leaf clip with a bifurcated fiber-optic cable attached to both HR2000 Spectrometer (Ocean Optics, Inc., Dunedin, USA) and to an Ocean Optics LS-1 tungsten halogen light source. At harvest, yield per vine was determined in 60 vines per treatment. Values were compared by a one-way ANOVA test. All means were compared at the 0.05 (*), 0.01 (**) and 0.001 (***) levels of significance.

Results

Discussion and conclusions

The application of 5% kaolin resulted in the formation of a whitish dry residue on the exposed leaves which increased the reflector capacity (Fig. 1). One of the direct effects of this application was a significant reduction of leaf temperature (Table 1). Consequently, during the summer period, the degradation of photosynthetic pigments was not as evident as in control vines (Table 2). Measurements of gas exchange indicate significantly higher A in kaolin leaves (Fig. 2). Particularly at ripeness stage, the increase in A was more evident than the slight increase in g, during warmer periods of the day, leading to higher A/g, and lower C/Ci. The increase of the photosynthetic rate in kaolin treated vines was associated to an improvement of the PSII photochemical efficiency. At harvest, mainly in 2012, the kaolin effect had a clearly positive impact on the productivity performance of the vines (Table 4). In conclusion, the results of this study, carried out with grapevines of the same variety and under similar field-grown conditions, emphasized the beneficial role of kaolin as a short-term measure for growing grapevines under high irradiance levels and heat/water stress conditions, such as in Douro region. Particularly during the ripening stage, the photosynthetic capacity depression was associated with important photochemical and biochemical changes that can negatively compromise the grape production, particularly emphasized in low yield years.

References

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See Proceedings of Xth International Terroir Congress for more details.