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Interactions between Zn enrichment of grapes cv. Syrah fertilized with ZnO and photoassimilates mobilization†

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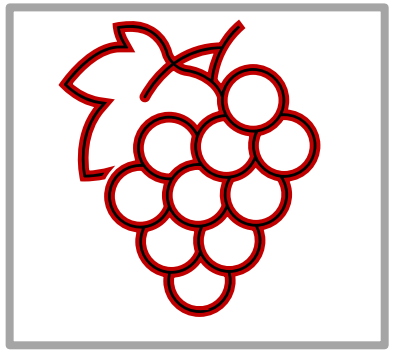
Zn ↓



= Zn ↑

Improves quality and growth

- Increase in Zn → 55 %
- Field → 65 % of superficial drainage capacity
- Positive response→ Pn and iWUE

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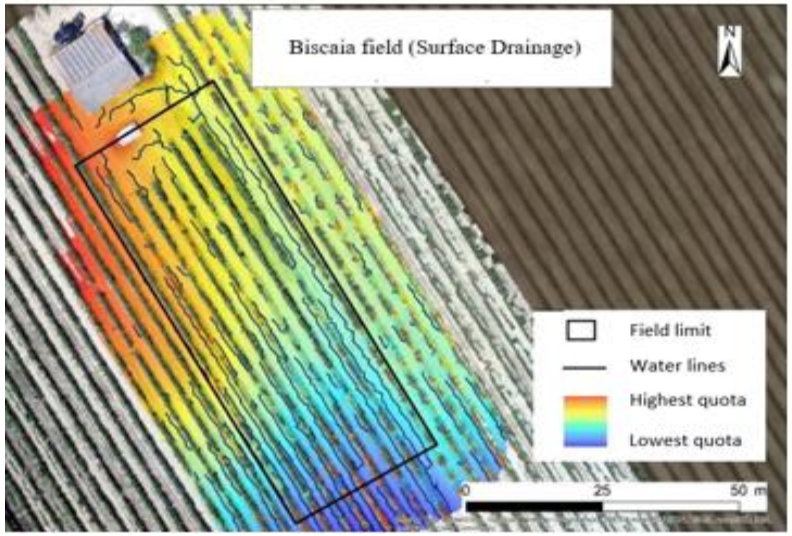
Abstract: Micronutrients have an important role in crops, namely Zn, being responsible for several physiological pathways, improving crops quality and growth. Zn role is related to enzymes activity, carbohydrate metabolism, photosynthesis, protein metabolism and maintenance of the integrity of biological membranes. Considering his importance and the deficiency observed worldwide, an itinerary of foliar spraying with zinc oxide (ZnO) in vines of cv. Syrah during the production cycle, was outlined at Biscaia field in Palmela, Portugal (38º 35'23.629''N; 8º 51' 46.208'' W). The treatment applied have concentrations of 10 % and 30 % (150 and 450 g ha^{-1}). At harvest, Zn concentration in grapes, reached a maximum increase of 55 % with the highest treatment concentration, face to control. Also, leaf gas exchange after foliar spraying, didn't present toxic signs in both concentrations, even being observed a positive impact in Pn and iWUE, thus contributing to biomass levels. Moreover, remote detection through Unmanned Aerial Vehicles (UAV's), allowed to obtain the morphology of the field, being observed a superficial drainage capacity of 65 % with water lines in the direction of NW-SE and SE sense, along the lines of the vines, also contributing to quality of the crops. This strategy of Zn enrichment, demonstrated to have potential benefits for crops, being additionally advantageous for consumption once this micronutrient has several important functions.

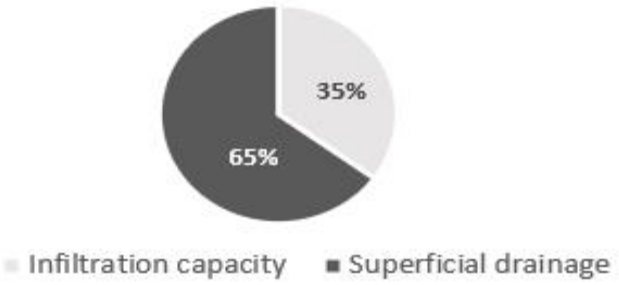
Keywords: Leaf gas exchange; Syrah; Zn; ZnO

Introduction

Grapes are one of the fruits with an important role in the total global production, particularly in Europe (Muhlack et al., 2018), since this continent presents the main wine production and vineyard area in the world (Droulia et al., 2021). Among the advantages of vine cultivation, its composition has shown to have potential benefits for human well-being, related to the antioxidant components, which, in addition to their antioxidant capacity, have cardioprotective, anticancer, anti-inflammatory, anti-aging and antimicrobial characteristics (Seccia et al., 2019). In order to provide a good quality of grapes, Zinc (Zn) is an essential micronutrient involved in crop growth and reproduction, also contributing to human health (Cakmak et al., 2017). Considering the different cultures, grapes are in the group that are more vulnerable to Zn deficits (Noulas et al., 2018). Zinc is related to several physiological functions in crops: membrane structure, photosynthesis and sugar formation, phytohormones activity, lipid and nucleic acid metabolism, gene expression and regulation, protein synthesis and also defense against drought and disease. Moreover, his role is also related to its activity as a cofactor for many hormones (*i.e*, auxin), which will affect plant growth and development (Noulas et al., 2018). Regarding the photosynthesis, Zn's role in case of deficiency can lead to a loss of quality in crops growth, once 90% of biomass results from photosynthesis (Yamori et al., 2020). Therefore, it is important an adequate supply of nutrients, being mineral fertilizers, an option used to potentiate a positive response on food production (Zhang et al., 2020). Additionally, the nutrient content is influenced by water status of the soil, being an important factor to guarantee a proper nutrition of crops (Zhang et al., 2017), and the normal function of photosynthesis (Wang et al., 2012).

Results and Discussion





- Syrah field have only 35 % of the water storage capacity, namely in the SE region, implying less water available in a dry climate
- Being essential to optimize the WUE (water use efficiency)
- Without water, crops cannot adequately absorb nutrients, which poses another important concern once, many vine soils are Zn deficient

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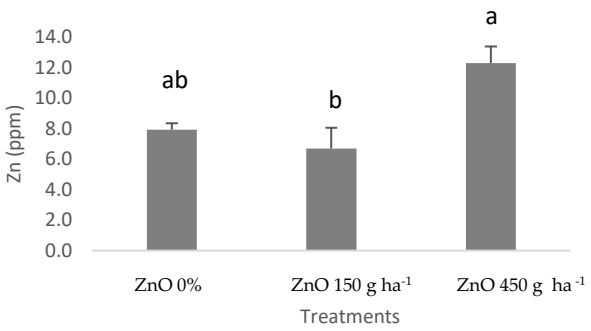

Treatment	Photosynthetic parameters
	Pn (μmol CO_2 m^{-2} s^{-1})
0%	13.6 ± 0.4a
ZnO 30%	13.7 ± 0.1a
	gs (mmol H_2O m^{-2} s^{-1})
0%	201.3 ± 5.8a
ZnO 30%	197.8 ± 4.4a
	E (mmol H_2O m^{-2} s^{-1})
0%	5.4 ± 0.1a
ZnO 30%	4.6 ± 4.4b
	iWUE (mmol CO_2 mol^{-1} H_2O)
0%	2.5 ± 0.1b
ZnO 30%	3.0 ± 4.4a

- Zn content reached an increase of 55 % in the highest concentration of ZnO – 30 %, 450 g ha^{-1}, compared to grapes without fertilization

- With fertilization of Zn, a positive trend was found, since Pn and WUE of those grapes increased

Conclusions

Fertilization with ZnO 30 % (450 g ha^{-1}) was efficient in increasing Zn amount in Syrah grapes, being also observed a positive effect in parameter iWUE. Therefore, this fertilization can decrease Zn deficits in grapes and potentiate a positive response in vineyards growth

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