



Chlorosis index, chlorophyll and nutrients content of Thompson grape in response to high bicarbonate application

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Abstract

The present experiment was carried out as a factorial (4 × 2) based on a completely randomized design on grapevine cultivar ‘Thompson Seedless’ hydroponically in greenhouse conditions. The first factor was four levels of dried grape pomace (0, 2.5, 5 and 10 g/kg of culture medium) and the second factor included two bicarbonate concentrations (0 and 10 mM sodium bicarbonate; SB). The highest SPAD and nitrogen, potassium, phosphorus, iron, zinc, and manganese content were observed in the leaves of vines treated with 10 grams of grape pomace without the use of SB. Also, the application of grape pomace powder led to a decrease in the leaf chlorosis index in vines under SB stress. In general, the use of grape pomace powder affected the concentration of nutrients, especially elements effective in chlorophyll structure, such as nitrogen, magnesium, and iron, while stabilizing chlorophyll, reducing chlorosis caused by iron deficiency in Thomson Seedless grape leaves.

Introduction

Bicarbonate ion (HCO₃⁻), which is formed in calcareous soils, is the most important soil factor associated with iron deficiency chlorosis in many plants (Singare, 2022). Various methods have been used to prevent or reduce the occurrence of iron chlorosis-causing agents such as lime and high bicarbonate in fruit trees (Karimi and Salimi, 2021). Pomace is a general term for any solid material, such as skins, pulp, and seeds that remains after the production of vinegar or syrup from grapes. The pomace constitutes about 20 to 30 percent of the original weight of the grape, and the grape skin is also the main component of the grape pomace (GP), which comprises approximately 50 percent of the total weight of the GP. Our hypothesis is that GP powder, due to the presence of organic acids and phenolic compounds, has a significant effect on the absorption and content of elements in grape leaves. Therefore, this study conducted to investigate the effect of different levels of GP on changes in leaf nutrient content, leaf chlorosis and SPAD indices in grape leaves under iron deficiency stress caused by bicarbonate.

Materials and methods

This study was conducted factorially based on a completely randomized design with three replications on grapevines cultivar ‘Thompson Seedless’ under hydroponic conditions. The treatments consisted of two factors: (1) The first factor included four levels of dried GP including 0, 2.5, 5 and 10 g/kg of culture medium (2) The second factor included two bicarbonate concentrations (0 mM and 10 mM sodium bicarbonate; SB). grape were cultured in 6-liter pots containing hydroponic medium consisting of perlite and cocopeat 1/3 (v/v) along with different levels of GP (average pH= 3.48 and average EC =4.97 mS) under semi-controlled conditions in a greenhouse with a temperature of 22±3°C, 55-65% relative humidity, and about 14 hours of light (724μM m⁻² s) per day. The pots were initially divided into two groups and both groups were irrigated with Hoagland nutrient solution for two months. In the first group, SB was not used in the plant nutrient solution (concentration of 0 mM SB per liter, Bic -, control). However, in the second group, 10 mM SB (NaHCO₃) was used as a bicarbonate source (10 mM SB). At the end, iron chlorosis, SPAD index and leaf nutrients were measured.

Results and discussion

The highest SPAD index was related to vines treated with 10 g/kg of GP culture medium without SB treatment, and the lowest of this index was related to plants treated with a concentration of 10 mmol of SB without GP powder treatment. the application of GP powder led to a decrease in the leaf chlorosis index in vines under SB stress.

Table 1- Comparison of the average effect of different concentrations of grape pomace powder on the content of SPAD index, chlorosis index, nitrogen, potassium and phosphorus in the leaves of Thompson Seedless grapes under sodium bicarbonate stress

Treatments	SPAD Index	Chlorosis index	Nitrogen (%)	Potassium (%)	Phosphorus (%)
B ₁ P ₁	3.74a	3.16 ^b	1.66 ^b	0.85f	0.27c
B ₁ P ₂	3.79a	3.65a	1.68b	1.85c	0.27c
B ₁ P ₃	3.80a	3.60a	1.69b	1.78cd	0.34 ^{ab}
B ₁ P ₄	3.91a	3.32ab	1.84a	2.87a	0.36a
B ₂ P ₁	1.46c	1.52e	0.65 ^d	1.84c	0.21d
B ₂ P ₂	2.26b	1.66e	1.01c	1.31e	0.26c
B ₂ P ₃	2.44b	1.98d	1.09c	1.60d	0.32b
B ₂ P ₄	3.77a	2.71c	1.68b	2.47b	0.33 ^{ab}

Means with common letters in each column are not statistically significantly different (5% level). (B₁ = 0 mmol sodium bicarbonate; B₂ = 10 mmol sodium bicarbonate; P₁ = 0 g of pomace powder per kg of soil; P₂ = 2.5 g of pomace powder per kg of soil, P₃ = 5 g of pomace powder per kg of soil; P₄ = 10 g of pomace powder per kg of soil).

The highest amount of nitrogen element was related to vines treated with 10 g/kg of GP without SB treatment, and the lowest amount was related to vines treated with 10 mmol of SB without the use of GP powder in the growth medium.

Table 2 - Comparison of the average effect of different concentrations of grape pomace powder on the content of iron, zinc and manganese elements in Thompson Seedless grape leaf solution under sodium bicarbonate stress

Treatment	Iron (ppm)	Zinc (ppm)	Manganese (ppm)
B ₁ P ₁	94.17e	65.50d	58.73 ^{bc}
B ₁ P ₂	133.3cd	84.80c	67.63c
B ₁ P ₃	148.1bc	109.10 ^b	77.40a
B ₁ P ₄	187.4a	136.23a	80.50 ^a
B ₂ P ₁	51.23f	58.03de	53.00e
B ₂ P ₂	123.57 ^d	56.60e	58.60d
B ₂ P ₃	130.4cd	86.50c	60.06d
B ₂ P ₄	159.1a	110.50b	71.76b

The application of 10 mg/kg of GP powder (B₂P₄) increased leaf iron concentration by 32.2% compared to vines under SB stress without the application of GP (B₂P₁; Table 2). The highest zinc content was found in vines treated with GP 10 g/kg of culture medium without SB treatment and the lowest content of this element was related to vines treated with 10 mmol SB with 2.5 g GP /kg culture medium.

References

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