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THE BIOSTIMULATORY EFFECT OF BROWN ALGAE *ASCOPHYLLUM NODOSUM* ON GRAPEVINE

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ABSTRACT

Currently, the global wine industry is facing numerous challenges related to climate change and the unpredictability of weather conditions. The administration of biostimulants derived from algae to grapevines brings a series of benefits that translate into increased and quality productions.Two biostimulators containing Ascophyllum nodosum were tested in a vineyard on Chasselas Dore grapes. The testing involved three foliar applications at a 0.5% concentration during the vegetative phase. The use of the products with algae led to increases in yield cu 33.3% (AN product) și 38.7% (AN-ME product). The application of the three foliar treatments with an vegetable biostimulant increased by 46.6 – 48.5% the process of photosynthetic assimilation in the vineyard. Also, the nutrient content in the plant (leaves and clusters) has recorded a significant increase.

INTRODUCTION

In the coming years, agriculture must respond to the challenge of producing more food while reducing its impact on human health and the environment, and the use of biostimulants can be one of the means to achieve these goals. (Baltazar et al. 2021, Del Buono 2021, du Jardin et al. 2020, Yakhin et al. 2017; Calvo et al. 2014).

One of the key factors that can aid in addressing these challenges is the development and implementation of innovative and sustainable viticultural strategies. In this context, seaweed-based biostimulants have garnered the attention of farmers as a potential solution to enhance yields, biotic and abiotic stress tolerance, and consequently, the quality of the crops and wine. A series of recent studies have provided substantial evidence that the direct use or incorporation of compounds derived from various sources of plant biomass in fertilizer formulation has led to significant improvements in nutrient absorption by plants, biomass accumulation, resistance to environmental stressors (such as freezing, drought, and salinity), resistance to pathogens (like fungi, bacteria, and viruses), as well as a notable increase in the quality and yield of agricultural production. (Del Buono 2021, Garcia-Gonzalez et al. 2016, Shekhar Sharma et al. 2014).

Marine algae, especially species such as *Ascophyllum nodosum*, have been recognized for their rich content in beneficial substances, such as cytokinins, auxins, and other bioactive compounds, which can stimulate plant growth and development. These marine algae-based biostimulants have been successfully used in various

agricultural fields to increase yields and to make crops more resistant to environmental stresses (Goñi et al. 2016, Craigie 2011).

A substantial number of biostimulants have been derived from algal biomass (microalgae or macroalgae). A significant number of marine algae have been reported to exhibit beneficial activity on plant growth and, therefore, can be utilized in agriculture and horticulture as fertilizers, particularly organic ones. Generally speaking, even at a low concentration, algae extracts are able to induce a series of physical-vegetal and physiological responses, such as: promoting plant growth, increasing production yields, enhancing product quality, and augmenting the nutritional content of edible products (Consentino et al.,2021, Goñi et al. 2018, Shukla et al. 2018, Du Jardin 2015, Sharma et al. 2014, Khan et al. 2009).

In the viticulture industry, utilizing biostimulants based on seaweed can be viewed as a promising strategy to address issues related to climate change and the unpredictability of weather conditions. These biostimulants can aid in enhancing the development of grapevines, reducing the stress caused by extreme temperatures or water scarcity, and increasing tolerance to diseases and pests. Furthermore, they can positively influence the quality of the grapes, contributing to the production of wines that are superior in terms of organoleptic characteristics and have a better aging potential. Moreover, a series of positive outcomes have been reported through the application of various extracts to enhance the plants' tolerance to a wide range of abiotic stresses, namely: salinity, drought, and extreme temperatures (Baltazar et al. 2021, Hashem et al. 2019). Studies on the chemical composition of various extracts, primarily derived from a diversity of marine algae, have highlighted that the nutrient content in the extracts is not sufficient to determine the physiological responses they induce in plants. Consequently, it has been suggested that the physiological effect of the algae extracts is largely attributed to growth-promoting substances, specifically phyto-regulators (Ronga et al. 2019).

One of the main advantages of utilizing Ascophyllum nodosum in agriculture is its high content of essential macro and microelements. This encompasses minerals such as nitrogen, phosphorus, potassium, calcium, magnesium, copper, zinc, and molybdenum, among others. Beyond its rich mineral content, Ascophyllum nodosum also contains bioactive compounds that can positively impact plant growth. These bioactive substances comprise cytokinins, gibberellins, abscisic acid, and other plant hormones, as well as amino acids, vitamins, and antioxidants. These seaweed extracts boast phyto-stimulating properties and phytoelicitor activity, as their components facilitate plant defense responses, enhancing resistance to various pests, diseases, and abiotic stress, including drought, salinity, and cold (Ali et al., 2021,Shukla et al. 2018, Esserti et al. 2017, Delaunois et al. 2014, Khan et al. 2009).

Among all the sources of biostimulants based on seaweed, those manufactured from A. nodosum are probably the most thoroughly researched (Baltazar et al. 2021). *Ascophyllum nodosum* is abundantly found on the north-west coast of Europe and the north-east coast of North America (Hill 2008).

Water scarcity is harming grapevine yields and quality in the Mediterranean due to the crop's high water needs. Biostimulants that reduce vine transpiration are being used to mitigate this (Del Buono 2021).

Although marine algae-based biostimulants present a promising perspective in viticulture, it is pivotal to conduct detailed research and field studies to assess their efficacy in various vineyard regions and cultivation conditions. Nevertheless, the prospects offered by these innovative and sustainable tools in developing more

environmentally friendly and climate change resilient viticulture practices are promising and can contribute to the sustainable future of the wine industry.

MATERIAL AND METHODS

Two variants of plant biostimulants, containing *Ascophyllum nodosum*, were physically-chemically characterized and tested agrochemically, respectively:

- AN variant with: organic nitrogen 3-3.5%, potassium 7.5-8%, organic phosphorus 0.3-0.5%, and organic matter 45-50% from Ascophyllum nodosum seaweed extract;
- AN-ME variant contains: organic nitrogen 3-3.6%, potassium 7.6-8.4%, organic phosphorus 0.3-0.5%, copper 0.07-0.08%, zinc 0.01-0.02%, iron 0.03-0.05%, manganese 0.01-0.02%, boron 0.02-0.03%, and organic matter 45-50% derived from *Ascophyllum nodosum* seaweed extract.

The determination of the agrochemical efficiency of the two biostimulants was carried out by applying them (0.5% solution) to vineyard (Chasselas Dore variety), in the intensive vineyard. The experiment consisted of three foliar treatments carried out with solution by fine atomization on the entire leaf surface, as follows: the first treatment - after the flowering phenophase; the second treatment – during the grain growth phase, the third after 10 days after the second. Tests were performed in comparison to an unfertilized control.

The main physical, chemical and biological properties of Anthrosol were: a fine clay soil texture (42% clay); pH – weakly acidic (6.2 pH units); humus 3.2%; total nitrogen 0.14%; mobile phosphorus 41 ppm; mobile potassium 210 ppm.

RESULTS AND DISCUSSIONS

The two products containing *Ascophyllum nodosum* were characterized and tested to establish their agrochemical efficacy in the vineyard (Chasselas Dore) within an intensive non-irrigated farm.

The agrochemical trials assessed the evolution of production and the production yields, the process of photosynthetic assimilation, and the macronutrient content (N, P, K) present in vineyard leaves after fertilization, as well as the quality of the grapes (Figures 1 to 6).

The forthcoming figures illustrate the progression of yields, photosynthetic activity, and leaf nutrient content.

The application of the AN and AN-ME products resulted in significantly higher production increases compared to the control to which only water was applied, reaching up to 38.7% for the AN-ME product. (Figure 1).

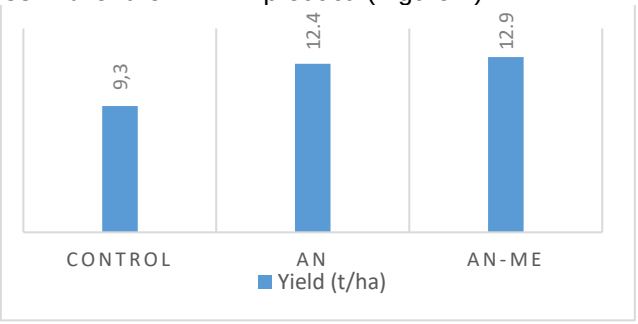

Figure 1. The crop yield obtained through the foliar application of AN and AN-ME products in a Chasselas Dore variety grapes

Research indicates that organic substances, including extracts from algae, play a critical role as plant biostimulants, initiating physiological and molecular reactions that enhance growth and productivity (Baltazar et al. 2021, Del Buono 2021, Taskos et al. 2019)

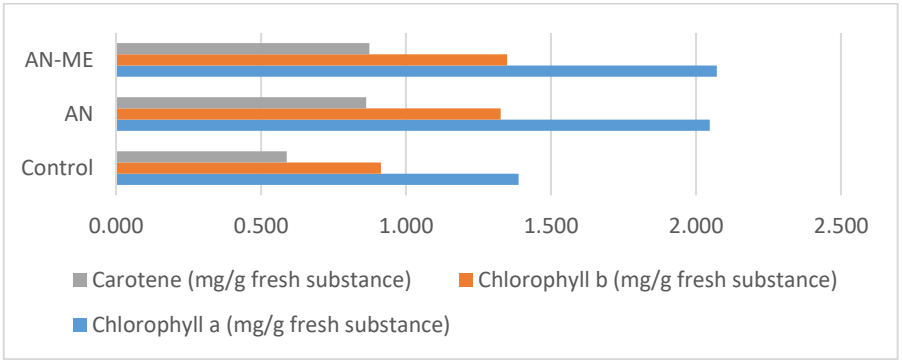

Figure 2. The Influence of foliar application utilizing AN and AN-ME products on photosynthesis in Chasselas Dore variety grapes

The obtained results (Figure 2) show a statistically very significant yield compared to the control, for each assimilatory pigment after the three foliar treatments.

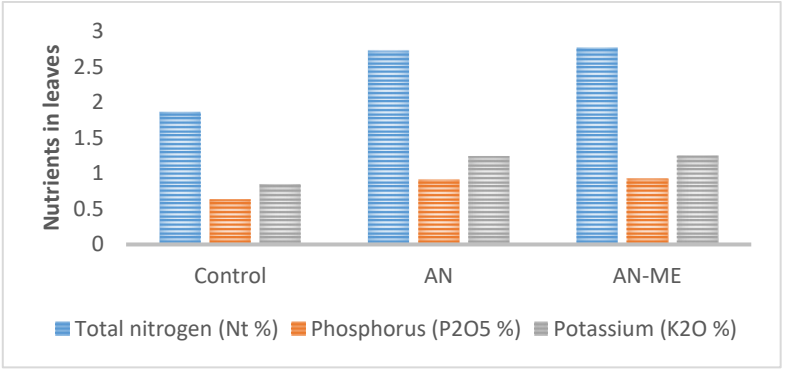

Figure 3. The Impact of foliar application utilizing of AN and AN-ME products on the mineral nutrition of grapevine leaves in the Chasselas Dore variety grapes

It can be observed (see Figure 3) that applying three foliar treatments with biostimulants during critical and high-demand periods for plant nutrition in the vineyard positively affects the content of macronutrients in the leaf metabolism. Specifically, there is an increase in the levels of nitrogen (N), phosphorus (P), and potassium (K), resulting in significant increases compared to the control for An and AN-ME, with respective increases of 44.6% and 46.6% for phosphorus, 46.1% and 48.5% for nitrogen, and 45.9% and 47.1% for potassium.

Additionally, the main characteristics of the grapes were improved through the application of the two products compared to the control variant (figures 4 and 5).

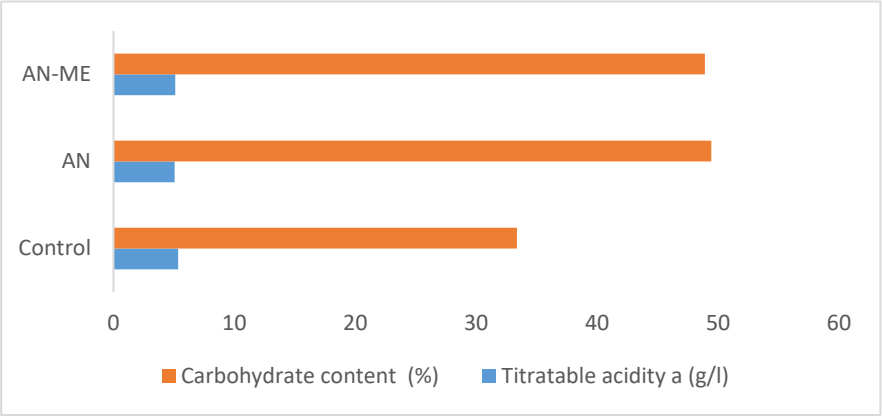

Figure 4. The effect of foliar application utilizing of AN and AN-ME products on the total carbohydrate content (%) and titratable acidity (g/l) of Chasselas Dore variety grapes

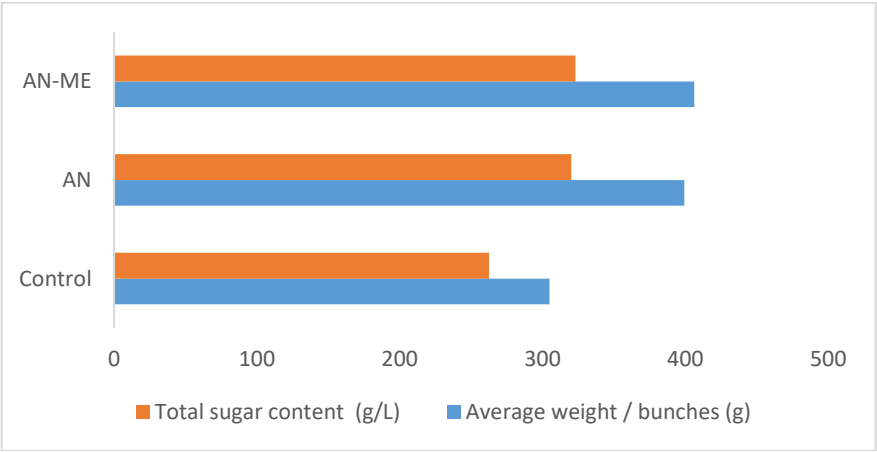

Figure 5. The effect of foliar application utilizing of AN and AN-ME products on the bunches weight (g) and total sugar content (g/l) of Chasselas Dore variety grapes

The enhancements achieved through the application of the biostimulant, relative to the control, can be attributed to adequate soil nourishment, coupled with the biostimulant formulations facilitating the plant's assimilation of requisite nutrients (figures 6 and 7).

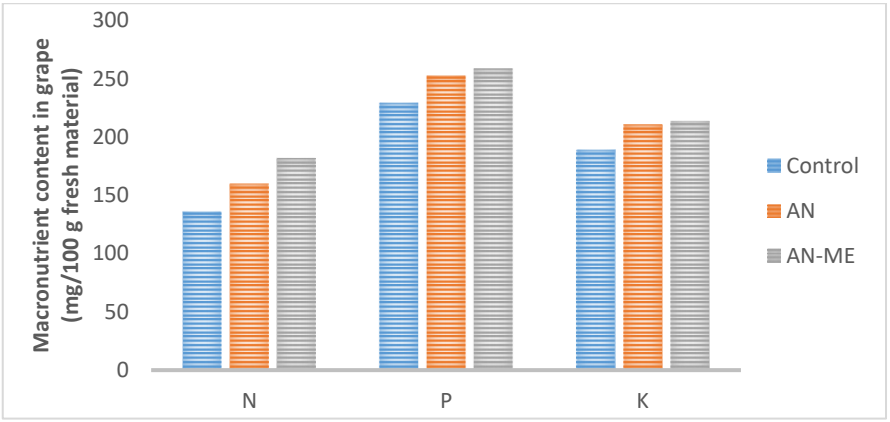

Figure 6. Effect of foliar application using AN and AN-ME products on macronutrient (N, P, K in mg/100 g fresh material) content of Chasselas Dore variety grapes

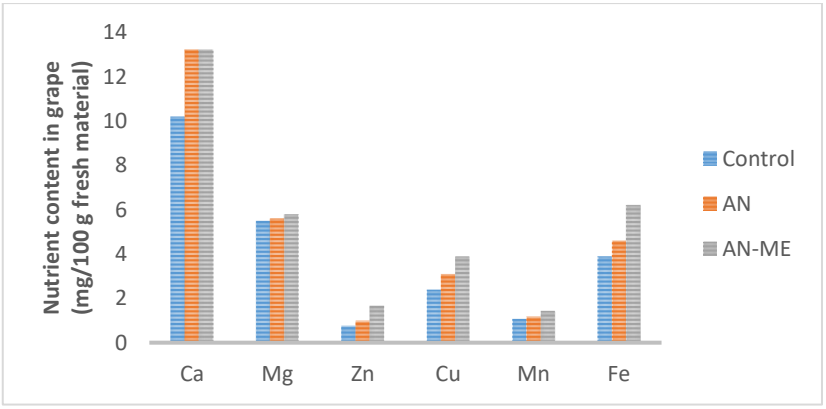

Figure 7. Effect of foliar application using AN and AN-ME products on nutrient (Ca, Cu, Fe, Mg, Mn, Zn in mg/100 g fresh material) content of Chasselas Dore variety grapes

The application of the two biostimulants improved the quality and the ripening rate of the grapes, a phenomenon observed in other studies as well. (Frioni et al., 2018; Sabir et al., 2014; Norrie et al., 2002)

CONCLUSIONS

The foliar application of the two biostimulants containing *Ascophyllum nodosum* resulted in production yield increases of 33.3% for the AN product, and 38.7% for the AN-ME product, and improved grape quality, compared to the control. The three foliar treatments led to statistically very significant increases compared to the control for the chlorophyll pigment content, with values of 46.6% (AN) and 48.5% (AN-ME). The addition of trace elements (copper, zinc, iron, manganese, boron) to the *Ascophyllum nodosum* matrix (AN product) ensured an additional production increase of approximately 4% in favor of the AN-ME product. Also, the accumulation of nutrients in the plant (leaves and bunches) registered a significant increase.

Foliar fertilization had a positive influence on productivity and quality indicators, as well as on photosynthesis activity. Foliar fertilization also stimulated the biosynthesis of assimilatory pigments, by decreasing the extent of organogenesis stages.

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