



## Effect of phosphorus application rate on *Mentha spicata* L. grown in deep flow technique (DFT)

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### ABSTRACT

The present study evaluated the impact of phosphorus application rate on plant growth and physiological parameters, antioxidant activity, chemical composition, and essential oil yield and composition of hydroponically grown spearmint plants. Increased P levels resulted in high dry matter content of the aerial part. Antioxidant activity of spearmint leaves was significantly higher at the highest P levels. Although essential oil yield was not affected, essential oil composition varied among the studied P levels, especially carvone content. Total and individual organic acids content was higher when 50 mg/L P were added in the nutrient solution. Rosmarinic acid was the main detected phenolic compound, while the highest total phenolic compounds and rosmarinic acid content was observed at 50 and 70 mg/L of P, respectively. In conclusion, phosphorus application rate may affect spearmint growth and development, as well as chemical composition and essential oil composition.

### 1. Introduction

Phosphorus (P) uptake from plants has been suggested to determine photosynthetic potential, while any deficiencies are associated with reduced carbon fixation in the chloroplasts. Furthermore, high P application rates have been shown to decrease *Matricaria chamomilla* L. essential oil yield (Emongor, Chweya, Keya, & Munavu, 1990), whereas they are associated with increased oil yield of *Salvia officinalis* L. (Nell et al., 2009). Moreover, interactions between minerals have been usually found to be stronger than the action each individual mineral may have. Research on marjoram (*Origanum majorana* L.) has reported that increasing phosphorus application rates up to 3 mM resulted in an increase of total volatile oil yield by 50% (Trivino & Johnson, 2000). Moreover, in the study of Ramezani, Rezaei, and Sotoudehnia (2009) phosphorus was applied on basil plants (*Ocimum basilicum* L.) by foliar spray at two growth stages, resulting in a significant increase of essential oil yield, without however affecting fresh and dry weight of the aerial biomass. Considering that phosphorus is generally applied in soil with basal dressing prior to seeding or planting, the effectiveness of phosphorus fertilization on plant growth and essential oil content for soilless growing systems needs further examination.

At present, an increasing interest has been noted both in industrial

and scientific research for using compounds and extracts of medicinal and aromatic plants as alternatives to synthetic antioxidants, due to their powerful antimicrobial and antioxidant properties. According to Kivilompolo and Hyötyläinen (2007), spearmint leaves are a rich source of rosmarinic, chlorogenic and caffeic acids. Rita, Pereira, Barros, Santos-Buelga, and Ferreira (2016) suggested that antioxidant activity of infusions from apical leaves of spearmint was due to phenolic compounds content and rosmarinic acid in particular, while Gonçalves et al. (2017) also attributed antioxidant potential of spearmint leaves to other phenolic compounds apart from rosmarinic acid, as well to non-phenolic compounds with synergistic effects.

In soilless production systems the nutrient are supplied through the nutrient solutions enabling rapid growth and biomass production while nutrient solution composition is fully controlled and adjusted according to plant requirements (Garlet & Santos, 2008). Float cultivation systems are successfully used for the commercial production of various leafy vegetables such as endive, lettuce, radish, rocket, spinach and so forth. These production systems are also very promising for aromatic plants and herbs and micro-greens production. The aim of the present study was to investigate the effect of five different phosphorus application rates (30–70 mg/L of nutrient solution) on agronomic performance, mineral composition, and antioxidant properties, as well as on essential

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