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RESEARCH ON THE EFFICIENCY OF FOLIAR FERTILIZATION IN SUNFLOWER CULTIVATION (HELIANTHUS ANNUUS L.)

Rebeca VARGA[1] , Isidora RADULOV[1] (ORCID: 0000-0001-7113-9163),
Laura CRISTA[1] (ORCID 0009-0003-7940-3258),
Alina LATO[1] (ORCID 0000-0003-0523-8969),
Adina BERBECEA[1] (ORCID 0000-0002-0592-6940),
L. NITA[1] (ORCID 0009-0003-1756-4291),
F. CRISTA[1] (ORCID 0000-0001-5545-9669)
University of Life Science King Mihai I Timisoara Romania

Corresponding author: florin_crista@usvt.ro

Abstract. *Sunflower (Helianthus annuus L.) is one of the most important oilseed crops worldwide, requiring balanced nutrient management to achieve high productivity, superior seed quality, and sustainable agricultural performance. Foliar fertilization has become an increasingly adopted agronomic practice because it complements soil fertilization, improves nutrient availability during critical growth stages, and enhances plant physiological processes associated with growth and yield formation. The present study evaluated the effectiveness of different foliar fertilization strategies applied under field conditions in western Romania. Four treatments, including an untreated control, foliar NPK fertilization, micronutrient application, and a combined NPK plus micronutrient treatment, were compared in terms of seed yield, thousand-seed weight, oil content, and plant height. The combined application of macro- and micronutrients consistently produced the highest values for all evaluated parameters, indicating a synergistic effect on plant growth and productivity. The observed responses highlight the importance of balanced foliar nutrition in supporting photosynthetic activity, nutrient uptake, assimilate translocation, reproductive development, and seed filling. Improvements in vegetative growth were accompanied by increased seed yield, enhanced thousand-seed weight, and higher oil content, demonstrating the beneficial influence of foliar fertilization on both crop productivity and seed quality. These findings confirm that foliar fertilization represents an effective complementary nutrient management strategy capable of improving sunflower performance, increasing nutrient-use efficiency, and supporting the development of more productive and sustainable cropping systems under modern agricultural conditions.*

Keywords: *foliar fertilization; sunflower; micronutrients; NPK; seed yield; oil content*

INTRODUCTION

Sunflower (*Helianthus annuus L.)* is among the world's leading oilseed crops, valued for its high-quality edible oil, protein-rich meal and adaptability to diverse agroecological environments. Increasing climatic variability and the need for sustainable intensification require management practices that improve nutrient-use efficiency while maintaining productivity. Balanced fertilization remains one of the most important agronomic factors influencing crop growth, photosynthetic capacity, yield formation and seed quality.

Although soil fertilization supplies most of the crop nutrient requirements, nutrient availability may become limited during critical phenological stages because of drought, temporary nutrient fixation, soil pH or restricted root activity. Foliar fertilization provides nutrients directly through the leaves, allowing rapid correction of deficiencies and supporting plant metabolism when root uptake is constrained. [1], [2] Numerous studies have shown that

foliar applications can improve chlorophyll content, enzyme activity, flowering, seed filling and oil accumulation, particularly when combined with balanced soil nutrition. [3]

Macronutrients such as nitrogen, phosphorus and potassium regulate vegetative growth, energy transfer, protein synthesis and water relations, whereas micronutrients including boron, zinc and manganese participate in pollen viability, carbohydrate transport, antioxidant defence and enzyme activation. Their combined application is therefore expected to generate synergistic effects on sunflower productivity.[4]

The present study aimed to evaluate the effectiveness of several foliar fertilization strategies under field conditions in western Romania by comparing an unfertilized control with NPK fertilization, micronutrient fertilization and a combined NPK + micronutrient treatment. The effects on plant growth, yield components and oil content were assessed to identify an efficient fertilization strategy suitable for sustainable sunflower production.[5], [6], [7]

MATERIALS AND METHODS

This study was conducted under field conditions to evaluate the effectiveness of foliar fertilization on the growth, productivity and seed quality of sunflower (*Helianthus annuus L.*). The experimental design and treatments were developed according to the information presented in the research poster, with the methodology expanded into a manuscript format suitable for scientific publication.

Field trials were established under the pedoclimatic conditions of western Romania during the growing season. Sunflower was cultivated using conventional agronomic practices recommended for the region. All treatments received identical crop management practices regarding soil preparation, sowing density, weed control and plant protection, the only experimental factor being the foliar fertilization strategy.

The experiment consisted of four fertilization variants: (i) Control (without foliar fertilization), (ii) foliar NPK fertilization, (iii) foliar micronutrient fertilization, and (iv) combined foliar application of NPK and micronutrients. Foliar products were applied according to the manufacturer's recommendations during key phenological stages characterized by an increased nutrient demand. The combined treatment was designed to evaluate the possible synergistic effect between macro- and micronutrients on sunflower growth and yield formation.[8], [9]

The trial was arranged using a randomized block design with replicated plots in order to minimize the influence of field heterogeneity and to ensure statistical reliability. All plots were subjected to the same environmental conditions throughout the vegetation period.

At physiological maturity, representative plants were sampled from each experimental plot. Agronomic observations included plant height (cm), capitulum diameter (cm), thousand-seed weight (g), seed yield (kg ha^{-1}) and seed oil content (%). Plant height was measured from soil surface to the top of the capitulum. Capitulum diameter was determined using a graduated ruler, while thousand-seed weight was established after drying the harvested seeds to a constant moisture content. Seed yield was calculated for each experimental plot and converted to kilograms per hectare. Oil content was determined according to standard analytical procedures commonly used for oilseed crops. [10], [11], [12]

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RESULTS AND DISCUSSIONS

The results demonstrate that foliar fertilization improved all evaluated agronomic traits compared with the untreated control. The combined application of NPK and micronutrients (V4) consistently produced the best performance, indicating a synergistic effect between macro- and micronutrients.

Effect of foliar fertilization on seed yield

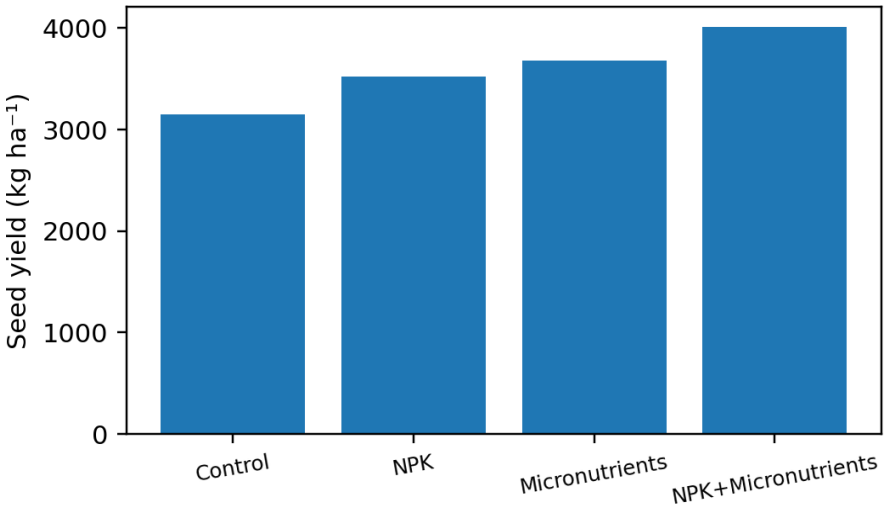

Figure 1. Effect of foliar fertilization on seed yield

The combined treatment increased seed yield from 3150 to 4010 kg ha^{-1} (+27.3%). Balanced foliar fertilization improved nutrient availability during reproductive growth, resulting in greater assimilate accumulation and higher productivity. Similar findings have been reported by Fageria et al. (2011), Fernández & Eichert (2009) and Marschner (2012).

Effect of foliar fertilization on thousand-seed weight

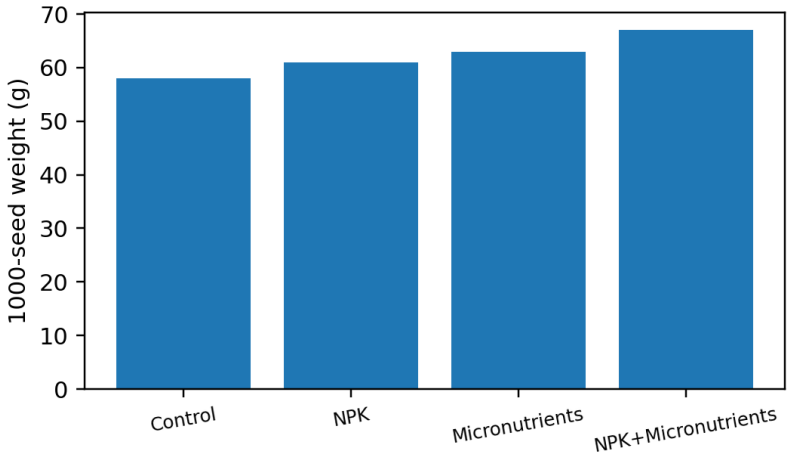

Figure 2. Effect of foliar fertilization on thousand-seed weight

Thousand-seed weight increased progressively from 58 g to 67 g (+15.5%). This response reflects improved grain filling and carbohydrate translocation promoted by balanced nutrition, particularly the combined supply of macro- and micronutrients.

Effect of foliar fertilization on oil content

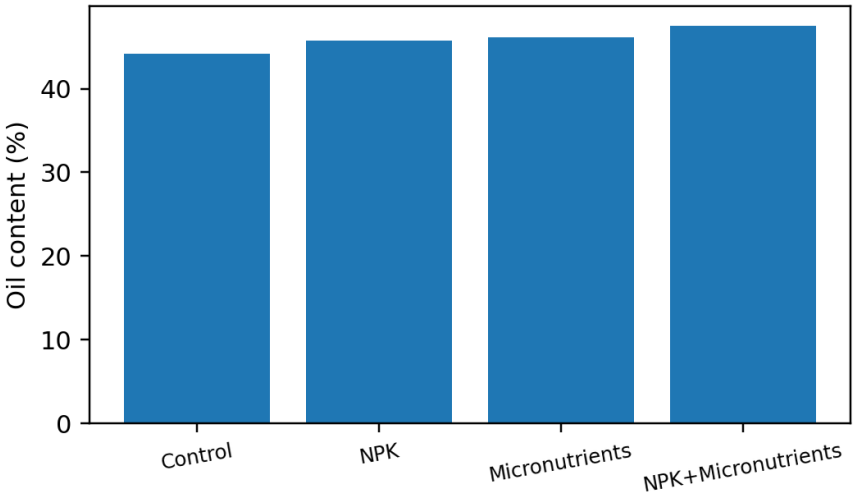

Figure 3. Effect of foliar fertilization on oil content

Oil content increased from 44.2% to 47.5%. The improvement indicates enhanced lipid biosynthesis under balanced nutrition. Potassium, magnesium and boron contribute to photosynthetic efficiency, assimilating transport and reproductive development, leading to better oil accumulation. [13], [14], [15]

Effect of foliar fertilization on plant height

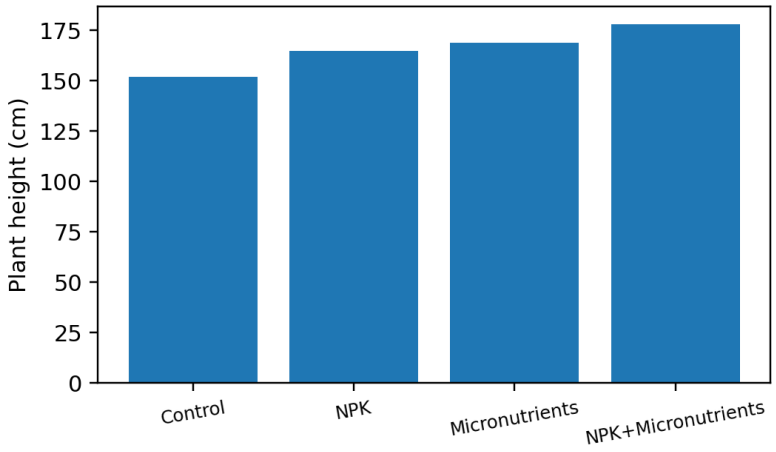

Figure 4. Effect of foliar fertilization on plant height

Plant height increased from 152 cm to 178 cm (+17.1%). Greater vegetative development was associated with the highest seed yield, demonstrating that improved canopy growth supported reproductive performance.

The combined NPK + micronutrient treatment improved seed yield by 27.3%, thousand-seed weight by 15.5%, oil content by 3.3% and plant height by 17.1% compared with the untreated control. The consistent improvement across all evaluated parameters demonstrates the agronomic potential of balanced foliar fertilization for sunflower production.

CONCLUSIONS

The application of foliar fertilizers significantly improved sunflower growth, yield components and seed quality.

The combined application of NPK and micronutrients produced the highest agronomic performance among all treatments.

Foliar fertilization enhanced plant height, capitulum diameter, thousand-seed weight, seed yield and oil content

Balanced foliar nutrition represents an efficient complementary strategy capable of increasing nutrient-use efficiency and crop productivity.

Further multi-year studies under contrasting environmental conditions are recommended to validate these findings and optimize fertilization programs.

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