


Improving Uptake of Nitrogen, Phosphorus, and Potassium and Growth of *Opuntia* Cactus by Integrated Application of Humic Acid, Mycorrhiza, and Seaweed Extract

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Received: December 21, 2024

Revised: March 15, 2025

Accepted: April 15, 2025

Published: March 21, 2025

Extended Abstract

Background and Objectives

In the warm and dry regions of Iran, where water resources are scarce, cultivating drought-resistant species with high nutritional value, economic and environmental benefits is very important. This issue will be more essential in the next years because of the effects of global warming and water deficit all around the world, especially in arid and semi-arid areas. The cactus plant can resist in hot and arid regions. There are many species of cactus and one of them is *Opuntia*. The cultivation of *Opuntia* cactus (*Opuntia* spp.) in the arid and low-water regions of Iran for fruit production and forage application is increasing. However, there is not enough information about the effectiveness of growth stimulants on the growth and quality of *Opuntia* cactus while that is necessary to know all aspects of these plants for having an efficient growth in the large scale. Because of that, the aim of this study was to investigate the effects of humic acid, seaweed extract, and mycorrhizae on cactus growth and some quality properties of its cladodes.

Materials and Methods

A pot experiment was conducted in the research greenhouse of University of Zanjan using a completely randomized design with 8 treatments and 3 replications. In this experiment, the treatments were as follows: T1-Control, T2-Mycorrhiza (My), T3-Humic acid (HA), T4-Seaweed extract (SW), T5-Mycorrhiza + seaweed extract, T6-Mycorrhiza + humic acid, T7-Humic acid + seaweed extract, T8-Mycorrhiza + seaweed extract + humic acid. After 220 days growth period of the plants, cactus cladodes were sampled, and their growth characteristics were measured. All measurements were carried out in the Laboratory of Soil and Water, University of Zanjan, Zanjan, Iran. The software of SPSS was used for statistical analysis of the data.

Results

The highest fresh and dry weights of the shoot, with averages of 77.87 and 12.54 g, respectively, were observed in the treatment of simultaneous application of humic acid and seaweed extract (T7), which had significant differences with other treatments. Also, the average of fresh root weight was increased from 1.21 g in the control (T1) to 3.48 g by simultaneously using the mycorrhiza and humic acid (T6). The treatment with

seaweed extract produced the newest cladodes, while the least new cladodes belonged to the mycorrhiza + humic acid treatment (T6). The seaweed extract-containing treatments (T4) had shown the best results related to the number of cladodes and the leaf surface. In this way, the average number of cladodes was increased to 4.6. The average leaf surface in the control treatment (T1) was 200.0 and was increased to 462.2 cm² by application of the seaweed extract (T4) and this treatment had the most effect on the leaf surface. On the other hand, there were no significant relationships between various treatments and height of cactus and thickness of cladodes. The average of N, K, and P concentrations in the cactuses were strongly increased by simultaneously using mentioned three studied stimuli. The concentrations of N, K, and P in the control (T1) were 0.50, 0.90, and 0.09 percent, respectively, while their concentrations were increased to 1.90, 3.20, and 0.39 percent, respectively, in the integrated treatment of mycorrhiza + seaweed extract + humic acid (T8).

Conclusion

The results of this study indicated that the integrated application of seaweed extract, humic acid, and mycorrhiza had significant effects on the growth and biomass of the cactus compared to other growth stimulants, and this treatment was recommended to be included in cactus nutrition programs. On the other hand, the amount of nutrition and the quality of produced cactus were promoted without using chemical fertilizers. It could be interested for cactus market, especially when this plant is used as food and primary material in medicine and cosmetic materials. Also, it is important that to test the efficiency of these materials in various conditions, especially at the field which many factors may affect the efficiency.

Keywords: Cactus cladode, Fungi inoculation, Growth stimulant, Humic substances, Integrated plant nutrition management.

Author Contributions

Conceptualization, M.S. and A.H.; methodology, M.S. and S.A.; software, M.N.H.; validation, M.N.H.; formal analysis, M.S. and S.A.; investigation, M.S., S.A., M.N.H., and A.H.; resources, M.N.H. and A.H.; data curation, M.S. and S.A.; writing—original draft preparation, M.N.H. and A.H.; writing—review and editing, M.N.H. and A.H.; visualization, M.N.H.; supervision, A.H.; project administration, A.H.; funding acquisition, A.H. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

Data is available on reasonable request from the authors.

Acknowledgements

This paper is published as a part of a Master's thesis supported by the Vice Chancellor for Research and Technology of the University of Zanjan, Zanjan, Iran. The authors are thankful to the University of Zanjan for financial supports.

Conflict of interest

The authors declare no conflict of interest.

Ethical considerations

The authors avoided data fabrication, falsification, plagiarism, and misconduct.

Cite this article: Shafie, M., Hassani, A., Amanifar, S., & Nourzadeh Hadad, M. (2025). Improving uptake of nitrogen, phosphorus, and potassium and growth of opuntia cactus by integrated application of humic acid, mycorrhiza, and seaweed extract. *Journal of Soil and Plant Science*, 35(1), 1–13.

<https://doi.org/10.22034/sps.2025.66187.1002>

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