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Maximizing medical cannabis growth and quality: An evaluation of the effects of ecological water regeneration in greenhouse cultivation

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Abstract

The use of medical cannabis for therapeutic treatment of various medical conditions has gained popularity due to its pain-relieving, anti-inflammatory, and sleep-improving properties. In greenhouse and closed buildings cultivation, optimizing water and nutrient management is essential for achieving maximum yield and quality. Water quality used for irrigation is critical for cannabis plant growth and yield, as it affects mineral uptake. This study assesses the impact of an ecological water regenerator system, based on physical and electromagnetic principles, on the growth and quality of medical cannabis cultivated in a greenhouse. These techniques restore water quality to its optimal state, promoting optimal hydration and nutrition of medical cannabis plants. The results show that using the ecological water regenerator system significantly enhances mineral uptake and growth stimulation, improving water and nutrient management and enabling the supply of an optimal amount of water and nutrients to the plants. Consequently, this approach promotes vigorous and productive growth, indicating that incorporating an ecological water regenerator is an effective approach for optimizing and enhancing medicinal cannabis cultivation. Compared to bulk water, using regenerated water significantly improves cannabis plant growth, flower biomass, and THC levels while reducing water and fertilizer usage. This innovative system can achieve new standards of quality and performance in the sustainable cultivation of medical cannabis.

Keywords: Medical cannabis cultivation; Greenhouse technology; Water quality management; Nutrient management; Growth optimization

1. Introduction

Medical cannabis has been gaining popularity as an alternative treatment for various medical conditions due to its therapeutic benefits such as pain relief, inflammation reduction, and improved sleep quality (1, 2). This growing interest in the medicinal properties of cannabis has resulted in a significant increase in the industry's demand, with greenhouse and closed buildings cultivation being leading methods for producing (3), allowing for consistent, reliable production of high-quality plants. Both methods offer a controlled environment that can be customized to meet the specific needs of the plants, enabling growers to optimize their yield and quality through precise management of air, humidity, CO2, water, nutrients, temperature, and light (4, 5).

Greenhouse cultivation, however, comes with its own set of challenges, such as the need to optimize water and nutrient management to ensure the best possible plant growth. It's important to note that the quality of water used for irrigation is a critical factor that can have a significant impact on plant growth and development. Thus, paying close attention to the quality of irrigation water is essential to maximize yield and quality, all while promoting sustainability. (6).

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Water quality parameters significantly affect plant growth and. The physical and chemical properties of water, such as surface tension (7), oxygen concentration (8), and the formation of organized water molecule clusters, play significant roles in determining mineral uptake (9-12). The use of water with better physicochemical characteristics, allows better nutrient acquisition at the root level, mainly increasing the efficiency in the use of fertilizers, by mechanisms that improve cation exchange, pH and the concentration of ions in the solution around of the roots (13). The rhizosphere, which surrounds plant roots, plays a crucial role in nutrient and water absorption. Water quality affects the rhizosphere's ability to facilitate root uptake, making it important in assessing cannabis plant health and growth (14). Therefore, water quality has an impact on the rhizosphere's ability to facilitate root uptake of water and nutrients (15). Ecological water regeneration, based on new findings and evidence from water science, involves the use of various methods to restore water quality (16). Some of these techniques are based on physical and electromagnetic principles, such as the use of vortex, resonance, and electromagnetic frequencies of mineral origin to improve water cluster ensemble organization and water quality (17-19). The vortex can induce piezo response of minerals, generating free charges on mineral surfaces. This improves water's ability to dissolve and transport nutrients for plants. (20). Hydromechanical vortex forces have been demonstrated to be effective in enhancing the rate of oxygen transfer from air to water, thereby increasing the concentration of dissolved oxygen in the water. (21). Recent studies suggest that water molecules can be assembled through "semi-harmonic frequency patterns" induced by electromagnetic frequencies, resembling those observed in biological systems, leading to a coherent organization of water molecules. This reorganization effect is further enhanced by water resonance phenomena, in which water vibrates at specific frequencies, amplifying the response to external excitations such as electromagnetic radiation produced by certain minerals. (22, 23).

Ecological water regeneration uses electromagnetic frequencies to enhance water's ability to dissolve and make nutrients available for optimal growth, based on the connection between these frequencies and biological systems.

The hypothesis of this study is that the use of ecological water regenerators integrating vortex, resonance, and mineral electromagnetic frequencies can improve the growth and yield of medical cannabis plants compared to the use of bulk water.

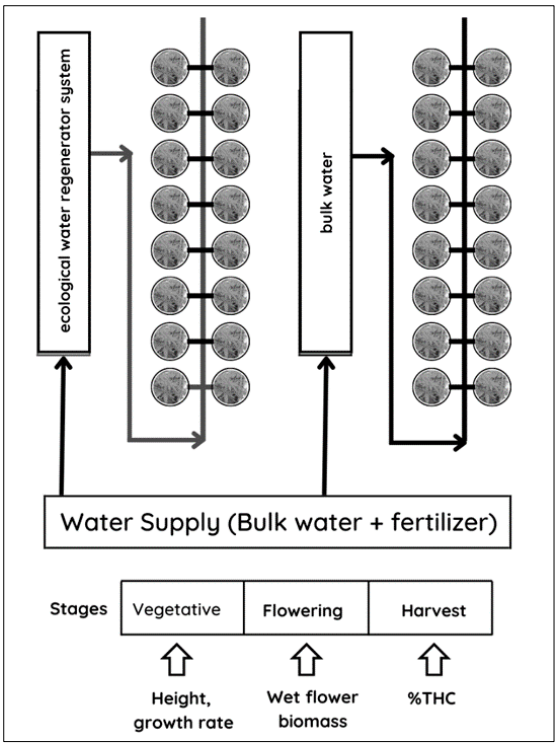
2. Material and methods

2.1. Experimental design

To evaluate the impact of an ecological water regenerator system (RNX NERO POWER ™, Euronix Sistemas, S.L., Valencia, Spain) on the growth of medical cannabis in a greenhouse environment, we conducted a 4-month experiment at a leading Israeli farm in the market (Evergreen Solomon Sgula). The study involved randomly assigning 420 cannabis plants into two groups, the experimental group (n=280) and the control group (n=140). The water utilized in the greenhouse was obtained from the drinking water system, filtered via a carbon filter, mixed with fertilizer, and then distributed into various irrigation lines.

In the experimental group, the water line was treated with the ecological water regenerator system before being utilized to irrigate the plants (n=280), while the water line in the control group was used directly without any treatment with the ecological water regenerator system (Figure 1).

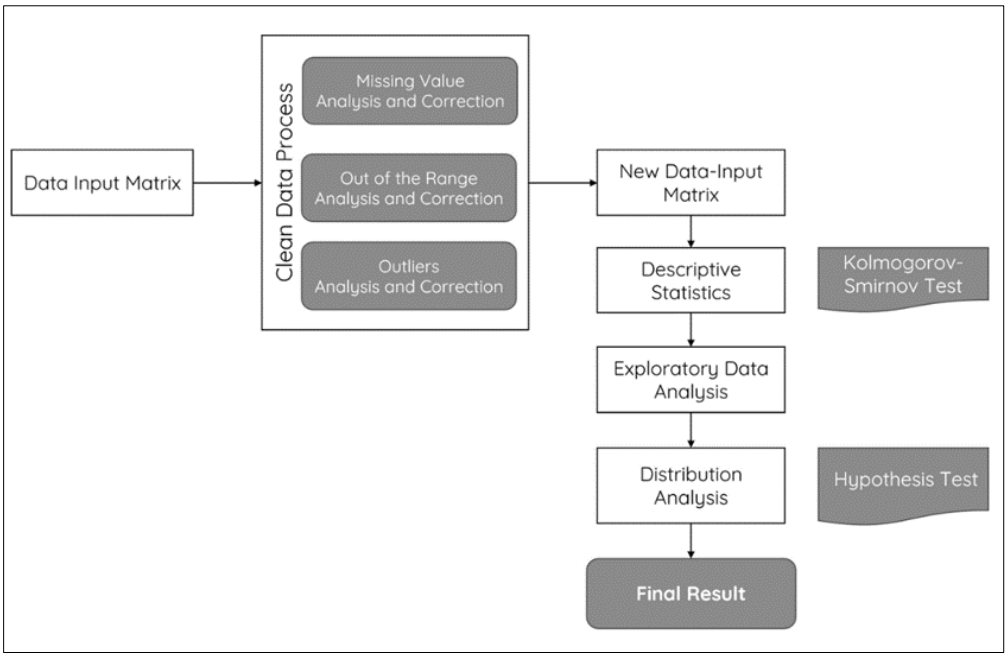
We quantified several variables at different stages of cultivation, including the vegetative stage (up to week 6-7), flowering stage (up to week 16), and harvest stage. At the end of the vegetative stage, we evaluated height (cm), growth rate (cm/day), and height over control (%). At the end of the flowering stage, the flowers were harvested and placed in a drying chamber. Subsequently, we determined the wet root biomass (g). In the post-harvest period, we determined the dry and wet weight (kg) of the flower biomass and the THC level (%). Water and fertilizer saving were calculated based on the reduction of the growth cycle.



In the experimental group (n=280), the water line was previously treated with ecological water regenerator system (RNX NERO POWER ™), In the control group (n=140) the water was utilized directly without treatment.

Figure 1 Experimental design

Statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 26.0. The Kruskal-Wallis test was employed to analyze the data, and the results were considered statistically significant at a p-value < 0.05 (Figure 2).

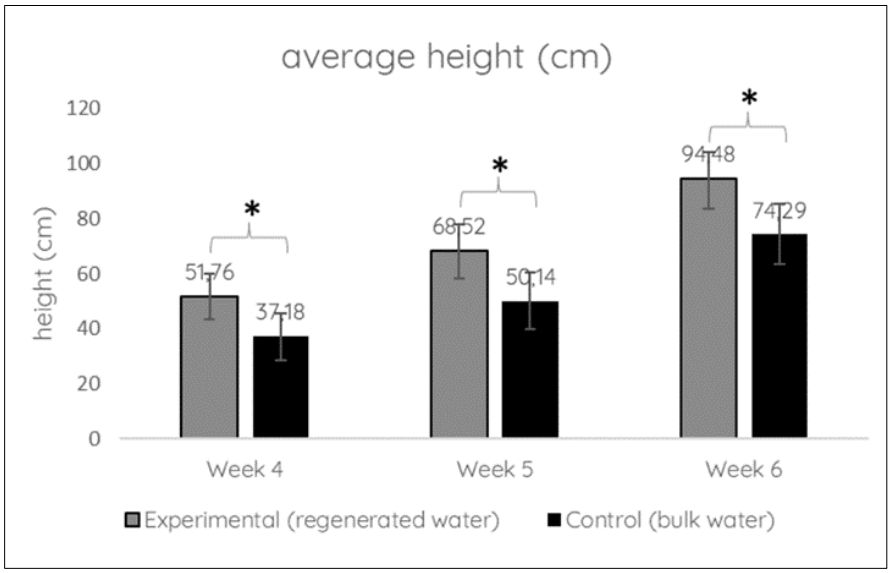


Data cleaning and analysis data process using the statistical package IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp. Results were considered statistically significant at a p-value < 0.05

Figure 2 Statistical analyses

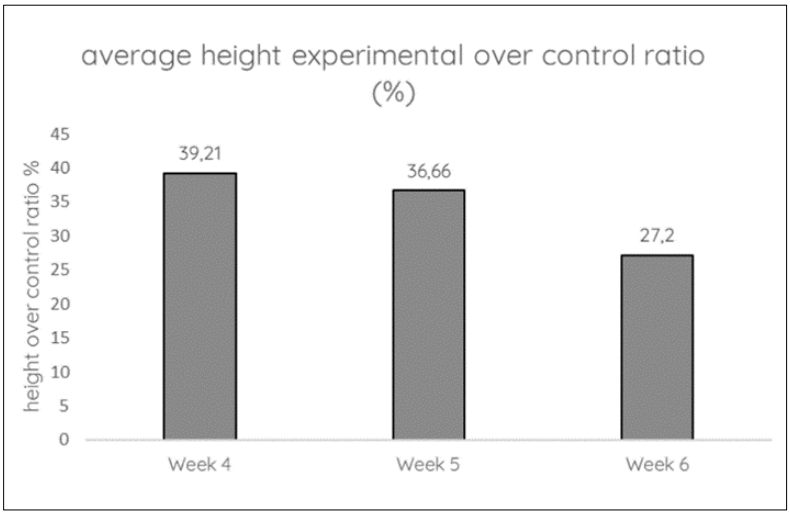
3. Results

The use of the ecological water regenerator system had a significant effect on the cultivation of medical cannabis in a greenhouse setting. At the end of the vegetative stage, after six weeks, the average height of the plants in the experimental group (94.48 ± 0.817 cm) was significantly higher than that of the plants in the control group (74.29 ± 0.92 cm). This represents a 27.2% increase in height for the experimental group compared to the control group (Figures 3 and 4).



*Significative difference concerning the control group. Kruskal Wallis test.

Figure 3 Average Height (cm) of Plants in Vegetative Stage: Ecological Water Regenerator System vs. Bulk Water



*Significative difference concerning the control group. Kruskal Wallis test.

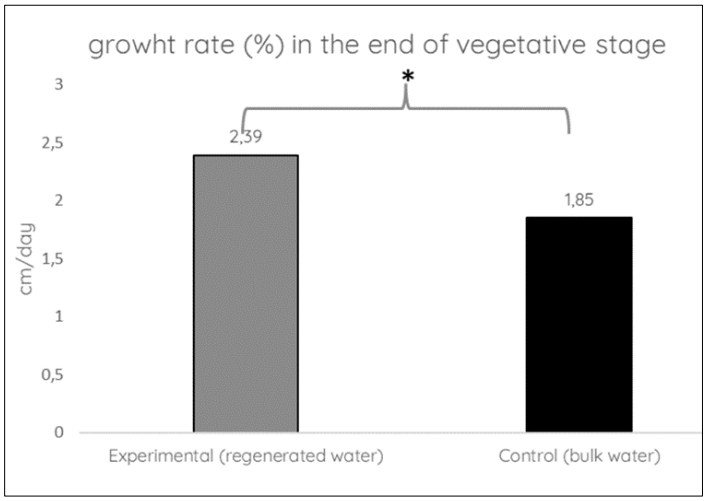
Figure 4 Height-to-Control Ratio of Plants: Ecological Water Regenerator System vs. Bulk Water

The experimental group also showed a significantly higher average growth rate (2.39 cm/day) compared to the control group (1.85 cm/day) (Figure 5). This resulted in a shortened growth cycle of 3-4 weeks, with the target vegetative height being reached in just 3 weeks (compared to the usual 6-7 weeks).

Furthermore, the total biomass of dry flowers was 17% higher in the experimental group compared to the control group (Figure 6). The THC levels in the experimental group were also 8% higher than those in the control group (data not shown).

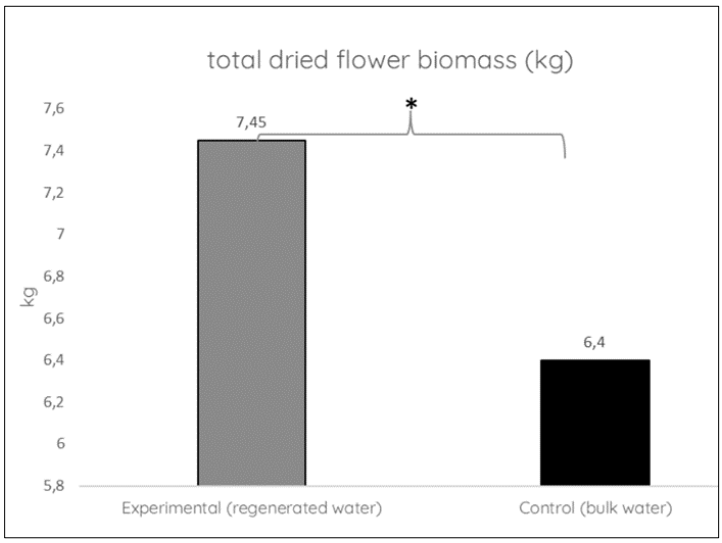
In addition, the total average wet biomass of the root system was significantly higher in the experimental group (50.8 grams) compared to the control group (39.2 grams) (Figure 7).

The experimental group demonstrated a significant reduction in the total usage of water and fertilizer of approximately 8.4-14 liters per plant compared to the control group (data not shown). This reduction was achieved by shortening the growth cycle of the plants, which was made possible by the increased plant growth induced by the ecological water regenerator system treatment. Specifically, the treatment resulted in an earlier entry of the plants into the defined growth stage, resulting in a reduction of growth duration and, consequently, a direct reduction in water and fertilizer usage. The results of this study indicate that the ecological water regenerator system has a positive impact on the cultivation of medical cannabis in a greenhouse. The system increased plant growth, resulting in higher yields, reduced growth cycle duration, and reduced water and fertilizer usage.



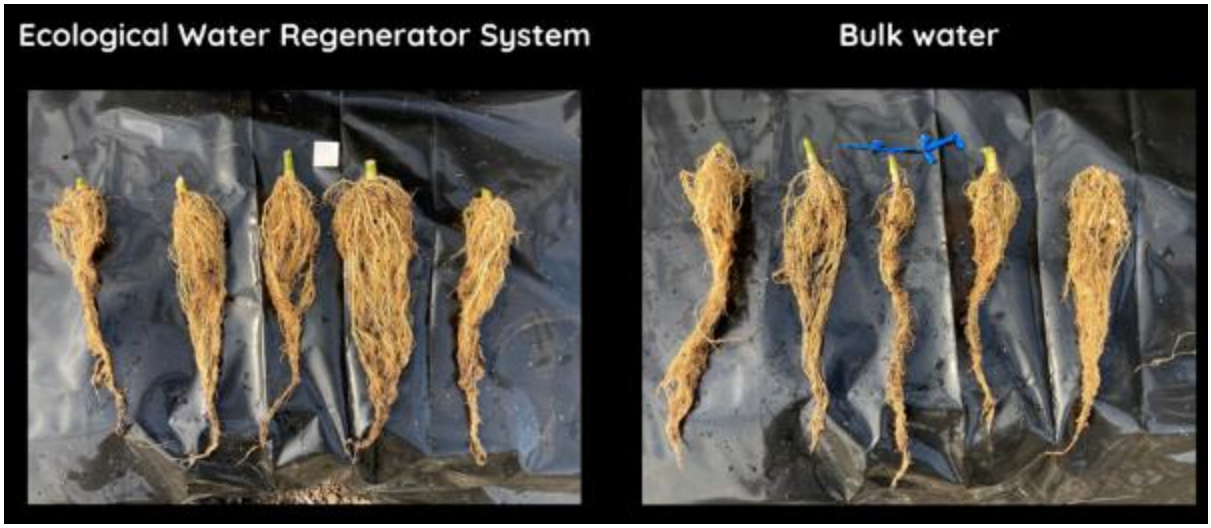
*Significative difference concerning the control group. Kruskal Wallis test.

Figure 5 Higher Average Growth Rate of Plants During Vegetative Stage: Ecological Water Regenerator System vs. Bulk Water



*Significative difference concerning the control group. Kruskal Wallis test.

Figure 6 Total Biomass of Dry Flowers in Ecological Water Regenerator System and Bulk Water Groups



Average Wet Biomass Significantly Higher in Ecological Water Regenerator System (50.8 g) Compared to Bulk Water Groups (39.2 g). Significative difference, Kruskal Wallis test

Figure 7 Randomly Selected Images of Root Systems from Ecological Water Regenerator System and Bulk Water Groups

4. Discussion

This study's findings indicate that using an ecological water regenerator system, integrating vortex, resonance, and mineral electromagnetic frequencies, significantly impacted on the growth and yield of medical cannabis plants in a greenhouse environment. Although this study is not without its limitations, as a randomized block design could not be implemented due to physical limitations of the greenhouse, a controlled experimental design was utilized. Both experimental groups were subjected to the same greenhouse operating conditions. While the lack of a randomized block design may introduce some bias, the controlled experimental design still allows for meaningful comparisons between the experimental and control groups. Overall, despite these limitations, the study provides valuable insights into the potential effects of the treatment being evaluated.

The experimental group, which received water treated with the ecological water regenerator system, showed higher plant height, growth rate, more flower biomass and wet root biomass compared to the control group that received bulk water without any treatment.

Our findings are consistent with previous research highlighting the crucial role of high-quality water in maintaining proper functioning of biological systems (6, 9-15). The physical and chemical properties of water, such as surface tension, oxygen concentration, and the formation of organized water molecule clusters, play a crucial role in determining its quality, which can significantly impact mineral uptake in plants. The use of water with superior physicochemical characteristics can enhance fertilizer efficiency by improving cation exchange, pH, and ion concentration in the solution surrounding the plant roots (13).

The experimental group exhibited an increase in root system thickness, measured as root biomass, compared to the control group., the improved quality of water has resulted in a healthier rhizosphere, leading to this outcome. The rhizosphere, which is responsible for nutrient and water absorption, is a critical component in the growth and health of cannabis plants. As such, water quality is a crucial factor in determining the rhizosphere's ability to facilitate root uptake, making it an essential consideration for assessing cannabis plant health and growth (14). Strengthening the root system is paramount to ensure healthy vegetative growth and better plant immunity, as roots produce cytokinins that play a crucial role in plant immunity. Cytokinins are signaling molecules that help coordinate the plant's response to stress, pathogens, and environmental changes. They act as messengers, transmitting information between different parts of the plant and activating various defense mechanisms. Cytokinins influence various traits of plant growth, development, and physiology such as seed germination, apical dominance, flower and fruit development, leaf senescence and plant-pathogen-interactions A robust root system can produce more cytokinins, leading to better plant health and resilience. Therefore, it is essential to provide plants with adequate water, nutrients and other factors that promote root growth and development to optimize plant growth and health (24).

The ecological water regenerator system used in this study was designed to improve water quality using various techniques, such as vortex, resonance, and electromagnetic frequencies of mineral origin, to improve water cluster ensemble organization and water quality (17-19). The piezoelectric response induced by the vortex effect in minerals generates free charges on mineral surfaces, leading to an enhanced dissolution and transportation of nutrients in water, ultimately benefiting plant growth (20). Additionally, electromagnetic frequencies induce the assembly of water molecules into semi-harmonic frequency patterns, resembling those found in biological systems, which results in a coherent organization of water molecules. Water resonance, the ability to vibrate at specific frequencies, amplifies this effect in response to external excitations such as electromagnetic radiation from minerals (22, 23). By combining the vortex effect, electromagnetic frequencies, and water resonance, we can obtain water with optimal characteristics for plant root development and growth. Overall, the use of these techniques can enhance the quality of water used for medical cannabis plant growth and development.

The findings of this study support the hypothesis that the use of an ecological water regenerative system can improve the growth and yield of medical cannabis plants in a sustainable way, saving water and energy, and reducing the contamination of greenhouse wastewater.

5. Conclusion

This study underscores the vital role of water quality in cannabis cultivation and presents compelling evidence for the potential of ecological water regeneration techniques. Specifically, the use of synergic effect of vortex, resonance, and mineral electromagnetic frequencies was found to significantly enhance plant growth and yield. These findings have important implications for the cannabis industry, as growers strive to improve the quality and productivity of their crops while promoting sustainability.

The results of this study are particularly noteworthy, as they demonstrate the efficacy of the ecological water regenerator in promoting the healthy growth of cannabis plants. The use of the regenerator led to substantial improvements in root development and overall plant health. These results suggest that the ecological water regenerator could be a valuable tool for cannabis growers looking to enhance the quality of their plants and reduce their reliance on fertilizers, water, and energy. Overall, this study provides compelling evidence for the potential of ecological water regeneration techniques in cannabis cultivation and highlights the importance of water quality for the growth and yield of this valuable crop.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare no conflict of interest with respect to the research, authorship, and/or publication of this article.

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Authors short biography

Héctor Núñez Alarcón is a highly accomplished senior researcher and biochemist who specializes in water regeneration. With extensive experience in both basic and clinical research, as well as soil and water bioremediation, he has earned recognition as an expert in his field. Héctor is the author of several internationally indexed publications and has presented at numerous international conferences. He is committed to discovering sustainable solutions for water reclamation and advancing scientific research in his field.