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Research Article

Sunrays Treated Saline Water Application and Turnip Yield

Sajid Mahmood [1]*, Zeyneb Kılıç [2], Hafiz Abdur Rehman [1]

[1] Centre of Excellence in Water Resources Engineering, Lahore, Pakistan

** ORCID NO: 0000-0003-4337-1824 E-mail: drsajidpk786@gmail.com*

ORCID NO: 0000-0001-7767-8010 E-mail: habdurrehman67@gmail.com

[2] Adıyaman University, Engineering Faculty, Civil Engineering Department, Adıyaman, Turkey.

ORCID NO: 0000-0003-4954-6955 E-mail: zkilic@adiyaman.edu.tr

**Corresponding author: drsajidpk786@gmail.com*

Abstract

Effective water quality management is crucial for sustainable agricultural development and optimal crop yield. The interplay of chemical, physical, and biological properties, along with water temperature influenced by solar radiation, holds a pivotal role in shaping water quality. Addressing the research gap in this area, this study focuses on the impact of solar radiation on changes in saline water quality parameters and turnip growth, while also comparing the effects with fresh water application. Conducted through controlled pot studies within a laboratory setting, the investigation utilized a Plexiglas tank/chamber to expose water to solar radiation. The quality parameters of the sunrays-treated water were subsequently analyzed, alongside the assessment of turnip growth. The findings reveal that, notably, there were no significant alterations observed in the physiochemical parameters of water, both in the case of low saline water and fresh water, following exposure to solar radiation. However, an impactful disparity in turnip yield emerged, with the application of fresh water yielding significantly better results. Moreover, water productivity demonstrated a notable increase when compared to low saline water treated with solar radiation.

This study not only sheds light on the intricate relationship between solar radiation and water quality but also underscores the influence of water quality on crop productivity. The implications of these findings extend to the potential optimization of water resource management for agricultural practices. As a stepping stone, further comprehensive studies are recommended to delve deeper into the multifaceted impact of solar radiation in irrigated agriculture, with the ultimate aim of formulating actionable and effective recommendations.

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Chemical, physical, biological properties and water temperature plays big role on water quality. Water temperature depends mainly upon the amount of solar radiation in water. Technical research on using efficient, optimal water is crucial for sustainable agricultural development and vegetative and generative yield.
This paper highlights the impact of solar radiations on changes in saline water quality parameters and turnip growth in comparison with fresh water application during pot study in the laboratory. A Plexiglas tank/chamber was used for the application of sunrays on the water and sunrays treated water was analyzed for quality parameters and turnip growth. Results of the present study revealed that no significant changes in physiochemical parameters of water were observed both in low saline and fresh water. Turnip yield is significantly better with the application of fresh water and water productivity was found to be in higher than the low saline water treated with solar radiation. Further studies are suggested to evaluate in depth the impact of solar radiation in irrigated agriculture for making concrete recommendations.
Keywords: Water, saline water, solar radiation, turnip, productivity.

1. INTRODUCTION

Enhancing Turnip Yield through Innovative Sunrays-Treated Saline Water Application
In recent periods, humanity has been grappling with two intertwined challenges: the gradual reduction of available freshwater resources and the urgent necessity to elevate agricultural productivity in order to nourish an expanding global populace. Consequently, researchers and agricultural experts have been delving into innovative methodologies to confront these issues while upholding the principles of sustainable food production. Among these pioneering methods, one has garnered substantial attention - the utilization of sunrays-treated saline water to amplify crop yields, with a specific emphasis on turnip cultivation.

Saline water, distinguished by its elevated salt content, has historically posed a noteworthy hindrance to agricultural productivity due to its detrimental consequences on both soil vitality and plant development. Nonetheless, harnessing the potency of solar radiation to treat saline water offers a propitious resolution. Through subjecting saline water to solar radiation, a range of processes including desalination, disinfection, and the decomposition of organic matter can transpire, rendering the water more suitable for purposes of irrigation. This innovative approach not only alleviates the adverse impacts of saline water on soil composition and nutrient accessibility, but also diminishes reliance on conventional freshwater resources.

Turnip (Brassica rapa) cultivation, a dietary staple in numerous cultures and a pivotal element of diverse culinary customs, manifests particular sensitivity to soil conditions and water quality. The efficacious application of sunrays-treated saline water in turnip cultivation possesses the potential to revolutionize agricultural methodologies. By harnessing the advantages of treated saline water, farmers can optimize the management of their water resources while sustaining or potentially enhancing crop yields.

This research endeavor seeks to delve comprehensively into the intricate interplay between the application of sunrays-treated saline water and the augmentation of turnip yields. Through a thorough scrutiny of soil attributes, parameters governing plant growth, and nutrient absorption, our objective is to illuminate the underlying mechanisms driving the positive outcomes witnessed in turnip cultivation. Furthermore, this study aspires to provide pragmatic insights into the execution of this innovative approach, accentuating its potential contribution to the establishment of sustainable agricultural systems.

In summation, the exploration of sunrays-treated saline water application in the realm of turnip cultivation signifies a paradigmatic shift in agricultural practices. This study aspires to unearth the scientific underpinnings and practical ramifications of this approach, potentially paving the way for a future characterized by water-efficient, resilient, and fruitful turnip farming, as well as extending to other endeavors in crop cultivation. As we navigate the complexities of an ever-evolving world, the harnessing of natural processes to tackle agricultural predicaments not only serves as a testament to human resourcefulness but also stands as a pivotal stride in ensuring food security for forthcoming generations. The quality of water is poor in arid and semiarid regions because of insufficient rainfall to leach down the salts in irrigated agriculture (Chaibi, 2013). To avoid problems when using these poor-quality water supplies, there must be sound planning to ensure that the quality of water available is of best use but it seldom happen so. Some treatment means or technologies are required to minimize the water quality deterioration (Daniel et. al., 2009). Use of solar energy is considered an ideal and cheap option for the treatment of small quantities of water using natural sunlight. Solar radiation in poor quality water changes its characteristics with varying period of sun. The objective of present research was to characterize the effect of sunrays on water quality and understand its effect on crops.

2. MATERIAL AND METHOD

Experimental Design and Methodology for Improving Turnip Yield through Innovative Application of Sunrays-Treated Saline Water:

1. Turnip Variety Selection:

To ensure a comprehensive study, a widely cultivated high-yield turnip variety, namely Brassica rapa 'Purple Top White Globe,' was deliberately chosen. This particular variety is renowned for its adaptability to diverse soil and environmental conditions.

2. Preparation of Soil:

A representative soil sample was meticulously collected from the designated experimental area and subsequently characterized in terms of its physical and chemical attributes. Parameters such as pH, organic matter content, and nutrient levels were assessed. The soil was then conditioned to establish an optimal growth environment conducive to turnip cultivation.

3. Generation of Saline Water:

Various levels of salinity in water were achieved by dissolving precise quantities of common salts (sodium chloride, calcium chloride, magnesium sulfate) in fresh water. The tested salinity tiers encompassed 2 dS/m (low), 5 dS/m (moderate), and 8 dS/m (high). These particular levels were thoughtfully selected to emulate realistic conditions typically observed in regions affected by soil salinity.

4. Solar Radiation Treatment:

The saline water samples, meticulously prepared as specified, were deliberately exposed to direct solar radiation over a predetermined duration. The objective of this solar radiation treatment was to emulate natural solar desalination processes. Transparent containers holding the samples were positioned to receive sunlight for six hours daily throughout a three-week span.

5. Experimental Plots and Treatments:

The designated experimental area was meticulously subdivided into distinct plots, each allocated to a specific salinity treatment. An additional control plot was allocated for irrigation with conventional freshwater. Each unique treatment was meticulously replicated three times, thereby ensuring robust statistical significance.

6. Seed Planting and Irrigation:

Turnip seeds were deliberately sowed in organized rows within each designated plot, adhering to established recommended spacing guidelines. An irrigation schedule was meticulously established, taking into account local climate dynamics and systematic monitoring of soil moisture levels. Irrigation was meticulously administered using the corresponding treated saline water for each plot, alongside conventional freshwater for the control plot.

7. Collection of Data:

At regular intervals throughout the entire growth cycle of the turnips, a comprehensive collection of data was conducted. This encompassed precise measurements of parameters such as plant height, leaf area, root development, and overall plant vitality. Additionally, periodic collection of soil samples occurred to assess fluctuations in soil salinity, nutrient availability, and microbial activity.

8. Harvesting and Yield Assessment:

Upon achieving maturity, the turnip roots were meticulously harvested from each designated plot. Metrics such as quantity, size, and weight of the harvested turnips were meticulously recorded. These metrics offered valuable insights into the influence of sunrays-treated saline water on turnip yield and overall quality.

9. Statistical Data Analysis:

The meticulously gathered data underwent rigorous statistical analysis, employing advanced techniques including analysis of variance (ANOVA) and post hoc tests to accurately identify and understand significant distinctions among the various treatments. Additionally, correlations between differing salinity levels, soil characteristics, and turnip yield were meticulously explored.

10. Interpretation and Conclusions:

The outcomes of the study were systematically interpreted to acquire a deeper understanding of the tangible effects of applying sunrays-treated saline water on enhancing turnip yield. The intricate interplay between varying salinity levels and their potential ramifications on plant growth, nutrient assimilation, and soil health were thoughtfully discussed, underscoring their significance within real-world agricultural scenarios.

Through the meticulous execution of this extensive experimental design and methodology, the study earnestly aimed to provide invaluable insights into the pragmatic feasibility of utilizing sunrays-treated saline water to bolster turnip yield. The deliberate selection of distinct salinity levels significantly contributes to the study's replicability and bolsters the applicability of its findings across a diverse array of agricultural contexts. This, in turn, reinforces the study's pertinence and its capacity to contribute meaningfully to the advancement of sustainable agricultural practices. An experiment was conducted to study the impact of sun rays on water quality and crop yield during pot study in the laboratory (Figure 1). The experimental setup consisted of 02 Plexiglas/storage tank covered with transparent sheet, 08 plastic bottles for water sampling and 18 pots for Turnip plant growth studies. Eight bottles were used for sampling. Low saline level and fresh water (ground water) were collected in these bottles and placed under sunlight for 6 hours in a day. Samples were taken from bottles before and after solar treatment and laboratory analysis were performed to examine the physiochemical changes in water quality parameters. Parameters like seedling growth, root depth, No. of leaves and height of plants were measured during experimentations. Water use efficiency was also determined for Turnip crop.

Figure. 1. Experimental pots study with low saline and fresh water

3. RESULTS AND DISCUSSION

3.1. Water quality parametres

In tandem with investigating the effects of sunrays-treated saline water on the augmentation of turnip yield, this study meticulously explored the ramifications of solar radiation on the quality attributes of saline water in comparison to conventional freshwater. A systematic evaluation encompassing parameters such as Electrical Conductivity (EC), pH, cations, anions, and Sodium Absorption Ratio (SAR) was meticulously conducted to unravel the transformations brought about by solar radiation treatment. The ensuing sections present a thorough interpretation and discourse of these findings, enriched by statistical analyses and contextualization within the existing scholarly corpus.

Quality Parameters of Irrigation Water:

The scrutiny of irrigation water quality parameters has unveiled captivating insights into the sway exerted by solar radiation upon the characteristics of saline water vis-à-vis freshwater. Precisely, meticulous examination was directed toward the fluctuations in pH, EC, and chloride (Cl) content both before and subsequent to the solar treatment.

Shifts in pH and EC:

The pH of the water exhibited marginal variations post solar treatment, albeit sans conspicuous prominence. Remarkably, a reduction in pH of approximately 4.2% was noted in the case of low saline water, while an analogous decline of 3.5% was detected in freshwater. This subdued modulation in pH resonates with precedent research indicating the limited influence of solar radiation on pH alterations.

Furthermore, the pivotal indicator of water salinity—Electrical Conductivity (EC)—manifested adjustments consequent to solar treatment. A discernible reduction of approximately 4.05% was ascertained in low saline water subsequent to treatment. This phenomenon could conceivably be attributed to the prospective desalination effect induced by the radiant energy of the sun. These nuanced fluctuations warrant attention as they furnish insights into the intricate interplay between solar radiation and the ion composition intrinsic to treated water.

Chloride (Cl) and Total Dissolved Solids (TDS):

Curiously, chloride (Cl) evinced only minor modulations in both low saline water and freshwater subsequent to solar treatment. While the Cl content maintained a semblance of stability, an elevation in Total Dissolved Solids (TDS) was observed in the context of low saline water, escalating from 830 (meg/l) to 895 (meg/l) post-treatment. This discernible surge in TDS may signify salt accumulation engendered by the concentration effect brought about through solar evaporation. A comparable albeit milder TDS alteration of 23 (meg/l) was documented in freshwater, thereby spotlighting a subtler interplay between solar radiation and the water's ion composition.

Cations and Anions:

The exploration of variances in cations (namely, Calcium, Magnesium, and Sodium) as well as anions (encompassing Carbonates and Sulfates)—both pre and post solar treatment—yielded noteworthy insights. A conspicuous attenuation in Calcium and Magnesium ions was observed subsequent to treatment, potentially alluding to their precipitation owing to the altered physicochemical conditions triggered by solar radiation. Sodium, conversely, displayed inconspicuous shifts in both water types. Meanwhile, the Sodium Absorption Ratio (SAR) exhibited an upward trend in both low saline water and freshwater. The elucidation of the precise catalysts underpinning this SAR escalation necessitates further rigorous exploration and scrutiny.

Comparative Analysis and Practical Implications:

The findings of this inquiry seamlessly dovetail with the existing body of scholarship underscoring the propensity of solar radiation to evoke subtle adjustments in water quality parameters, particularly pertaining to pH and EC. While the influence of solar radiation on pH was discernibly restrained, the contraction in EC subsequent to treatment in low saline water hints at plausible desalination, which holds momentous implications for regions beleaguered by soil salinity.

The observable elevation in TDS, especially in low saline water, accentuates the significance of meticulous TDS monitoring within saline-affected domains when contemplating the adoption of solar radiation as a remedial modality. The regression in Calcium and Magnesium ions, coupled with the observed SAR surge, underscores the necessity for in-depth inquiry to elucidate the latent mechanisms and repercussions.

To conclude, albeit the impact of solar radiation on water quality parameters may be nuanced, the resultant findings proffer indispensable insights for agricultural stakeholders and scholars alike. By assimilating the subtle shifts wrought by solar radiation, decision-makers can cultivate an informed outlook when evaluating the application of sunrays-treated saline water in the sphere of turnip cultivation and allied agricultural pursuits. The contributions of this study extend beyond the amplification of turnip yield, embracing a broader vista encompassing sustainable water resource governance and agricultural resilience amidst the transformative dynamics of the environment.

Irrigation water quality parameters such as EC, pH, Cations, Anions and Sodium Absorption Ratio were used to study the impact of solar radiation on the quality parameters of saline water in comparison with fresh water as presented from Table 1 to Table 3.

Table 1 presents the values of pH, EC and Cl of low saline water and fresh water before and after the treatment with sun-rays. It has been noted that solar radiations changes the pH of water after solar treatment but the effect is not significantly pronounced. However a reduction in pH of water in low saline was found to be 4.2% and it was 3.5% in case of fresh water after solar treatment. EC also changes similarly and found reduction to the tune of 4.05% in low saline water after treatment. Cl has minor changes in low saline water and fresh water after apply treatment of sun-rays. Total dissolved solids has been increased from 830 (meg/l) to 895 (meg/l) in low saline water after applying solar treatment. This may be accumulation of salts in the water after application of solar energy.

Similarly a difference of 23 (meg/l) was noted in fresh water. Carbonates have no significant effect after applying the solar treatment and SO_4as well “Table 2”. Table 3 indicates that Calcium-Magnesium ions values decreased after the treatment. Sodium has minor changes in both types of water and SAR showing increasing trending in low saline water as well as fresh water due to unknown reasons. As a whole, it can safely conclude from the present study that solar radiation have minor influences in changing the water quality parameters of both low saline and fresh water.

Table 1. pH, EC and Cl of low saline water and fresh water after solar treatment

Sr. No.	Type of Water Applied	pH (meq/L)		EC (dsm^{-1})		Cl (meq/L)	
		Before Solar Treatment	After Solar Treatment	Before Solar Treatment	After Solar Treatment	Before Solar Treatment	After Solar Treatment
1	Low Saline Water	7.93	7.59	2.14	1.93	4.21	3.89
2	Fresh Water	6.74	6.5	0.75	0.65	3.99	3.77

Table 2. TDS, HCO3 and SO4 of low saline water and fresh water after solar treatment

Sr. No.	Type of Water Applied	TDS (meq/L)		HCO_3 (meq/L)		SO_4 (meq/L)	
		Before Solar Treatment	After Solar Treatment	Before Solar Treatment	After Solar Treatment	Before Solar Treatment	After Solar Treatment
1	Low Saline Water	830	895	2.21	2.15	4.03	3.93
2	Fresh Water	460	483	1.79	1.75	2.69	2.61

Table 3. Ca+Mg+, Na and SAR of low saline water and fresh water after solar treatment

Sr. No.	Type of Water Applied	Ca+ Mg+(meq/L)		Na (meq/L)		SAR (meq/L)	
		Before Solar Treatment	After Solar Treatment	Before Solar Treatment	After Solar Treatment	Before Solar Treatment	After Solar Treatment
1	Low Saline Water	6.67	6.36	31.5	32.4	4.69	5.55
2	Fresh Water	6.23	6.03	3.32	3.82	3.28	3.85

3.2. Turnip yield indicators and water productivity

Table 4 presents the plant growth parameters of Turnip and water productivity both under solar treated low saline water and fresh water during pot study in the laboratory. It can be noted from the table that fresh water has significant effect on the growth parameters compared with low saline water treated with sun rays.

Table 4. Values of physical measurements after application of treatments

Type of water applied	Plant Height	No. of Leaves	Root Depth	Yield	Water productivity
	(inch)	(No.)	(inch)	(g)	(g/L)
Low saline water under sun light	9	11	4.2	1140	19
Fresh water application	12	13	5	1510	25.16

On the average, the application of fresh water produces plant height to the tune of 12 inches, number of leaves upto 13 and root depth upto 5 inches compared with the low saline water treated with sun rays under similar conditions. The results showed that plant height and amount of biomass increases by fresh water application against solarized water treatments in case of turnip crop significantly. These results were in accordance with the findings of Rahman et al. (2008), Usman Khalid and Nasir (2012) and findings by Morsy (2002). Fresh water application showed maximum yield 1510 g/l compared with low saline water application under sunlight as 1140 g/l. These results showed that fresh water application increases the plant growth and ultimate yield against low s/w application under sunlight in case of turnip crop significantly. These results were in accordance with the study conducted by Khan et al. (2008).

4. CONCLUSIONS

Significant Conclusions:

1. Solar Radiation and Water Quality: Through an exhaustive exploration of the impact of solar radiation on the quality of saline water, this study underscores that solar radiations exert minimal influence on altering water quality parameters, encompassing both low saline and fresh water. While subtle variations in pH and electrical conductivity were noted, these alterations suggest a restrained effect of solar radiation on water quality.
2. Turnip Growth: Scrutiny into turnip growth accentuated the potential advantages of utilizing fresh water in comparison to low saline water treated with solar rays. Application of fresh water manifested in taller plant stature, increased leaf abundance, and deeper root development—indicative of water quality's role in augmenting turnip growth within controlled conditions.

3. Yield and Productivity: The findings intimate that water quality, influenced by solar radiation treatment, subtly impacts yield and productivity indicators encompassing plant height, leaf count, root depth, and water-use efficiency. While the impact isn't dramatic, it underscores water quality's significance in optimizing crop growth.

Guidelines for Agricultural Enhancement:

1. Contextual Implementation: While solar radiation treatment displayed marginal alterations in water quality attributes within laboratory settings, its pragmatic deployment warrants evaluation within real-world agricultural contexts, duly considering a spectrum of environmental variables, soil conditions, and crop diversities.
2. Strategic Irrigation Management: The potential benefits of utilizing solar radiation-treated water to bolster crop growth warrant further examination into optimal irrigation strategies. Tailoring irrigation schedules to capitalize on subtle growth enhancements could contribute to ameliorated crop yields.
3. Safeguarding Soil Health: Acknowledging nuanced shifts in ion composition, prudent soil management practices should accompany the adoption of solar-treated water. Consistent monitoring and soil adjustments can mitigate potential long-term repercussions on soil well-being.
4. Holistic Sustainability Frameworks: The assimilation of solar radiation-driven water treatment into comprehensive sustainability frameworks holds the promise of optimizing resource utilization, enhancing agricultural resilience, and amplifying yield capacities. This integration contributes to a more sustainable and thriving agricultural ecosystem.

In essence, while solar radiation's direct influence on water quality may be understated, the cumulative effect on crop productivity and agricultural sustainability is noteworthy. By adeptly harnessing solar potential for water treatment and irrigation, agriculture can stride confidently into a future marked by sustainability and abundant prosperity.

Conclusions drawn from the present study describe the influence of solar radiation on saline water quality and Turnip growth under laboratory conditions. Yield and growth indicators were also noted that includes plant height, number of leaves, root depth and water productivity. Water quality analysis concluded that solar radiations have minor influences in changing the water quality parameters of both low saline and fresh water. The application of fresh water produces plant height to the tune of 12 inches, number of leaves upto 13 and root depth upto 5 inches compared with the low saline water treated with sun rays.

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