biology and life sciences forum

MDPI

Proceeding Paper

Wheat Growth Parameters in Response to Irrigation Salinity in Wheat—*Triticum aestivum* L. †

Brajesh Kumar [1,*], Naresh Kumar Arora [1], Raman Kumar [2,*], Sonu Sharma [2] and Monu Sharma [2]

1 ICAR—Central Soil Salinity Research Institute, Karnal 132001, Haryana, India
2 Department of Biotechnology, Maharishi Markandeshwar (Deemed to be University), Mullana 133207, Haryana, India
* Correspondence: brajesh.saxena@icar.gov.in (B.K.); ramankumar4@gmail.com (R.K.)
† Presented at the 3rd International Electronic Conference on Agronomy, 15–30 October 2023; Available online: https://iecag2023.sciforum.net/.

Abstract: Crops grown on salt-affected soils may experience physiological drought stress, ion toxicity, and mineral shortage, resulting in lower growth and output. Salinity is the most important abiotic factor limiting crop development and output globally. Improving agri-food production in salt-prone locations is critical for meeting rising food demands in the near future. A pot experiment was conducted to study the impact of saline irrigation water on the chemical properties of sandy loam soil and their influence on growth, yield, and other biometric parameters of wheat (*Triticum aestivum* L.), *Cv KRL 213* in the farmer's field at Karnal. Three irrigation water treatments, i.e., Tube well water (TW), saline water (SW1, EC_{iw} 10.0 dS m^{-1}, SAR 5.0 $mmol^{1/2}$ $L^{-1/2}$), and concentrated saline water (SW2, EC_{iw} 10.0 dS m^{-1}, SAR 5.0 $mmol^{1/2}L^{-1/2}$), were applied in reclaimed normal soil (pHs 7.5 and ECe 1.0 dS m^{-1}). The results showed that, when low-quality water was applied to normal soil, salt increased, increasing the likelihood of normal soil deterioration. Continuous irrigation with concentrated salt water (SW2) raised the ECe of the root zone soil, which had a negative impact on wheat crop mortality (approximately 70%). In post-wheat samples, soil organic carbon, calcium carbonate, and cation exchange capacity (CEC) remained constant across all water treatments. Concentrated salty water (SW2) is not advised on its own, but it can be used in conjunction with other management practices (by mixing with rain, pond, or canal water) to reduce the negative impacts on soil chemical characteristics and crop development.

Keywords: salinity; irrigation; soils; sandy loam; wheat

Citation: Kumar, B.; Arora, N.K.; Kumar, R.; Sharma, S.; Sharma, M. Wheat Growth Parameters in Response to Irrigation Salinity in Wheat—*Triticum aestivum* L. *Biol. Life Sci. Forum* **2023**, *27*, 57. https://doi.org/10.3390/IECAG2023-16319

Academic Editor: Yang Gao

Published: 21 November 2023

1. Introduction

Wheat (*Triticum aestivum* L.) is a cereal crop that is widely farmed in many parts of the world [1,2]. It belongs to the Poaceae family. It is usually cultivated between 30° N and 60° N latitudes, and between 27° S and 40° S latitudes, at elevations of up to 3000 m [3]. It can also endure a wide variety of temperatures and humidity levels, with an annual precipitation of 250–2000 mm [3]. Wheat provides around 20% of the calories and 55% of the carbohydrates globally. Salinity has a deleterious impact on wheat growth and production [4]. Wheat bread contains a lot of vitamins B, thiamine, and B2-riboflavin [5]. Wheat flour is used to make leavened bread, pasta, flat and steamed breads, cakes, pastries, noodles, and couscous. In 2020–2021, the world wheat production capacity was 768.9 million metric tonnes [6]. Wheat (*Triticum aestivum* L.) is the dominant cropping system in arid and semi-arid countries. This crop requires a lot of water to grow and yield well. The suitability of water for agricultural production is determined by its impact on soil productivity. Irrigation with low-quality salty water degrades soil qualities and generates conditions unfavorable for crop economic growth under regular agricultural conditions. The amount and kind of salts in irrigation water influence the type of crop growth impediment. One of the most important criteria to evaluate the quality of water used for irrigation and other criteria in which irrigation purposes creates alkalinity and sodicity in the soil, depending on the relative number of particular cations and anions present in the water, is the overall quantity of soluble salts. When soils receive irrigation with bicarbonate-type water that is dominated by Na+ ions, an excessive quantity of sodium accumulates on the exchange complex. The number of CO32- and HCO3- ions in irrigation water also influences soil salinity. Thus, water is a crucial component for sustainable agriculture and irrigation water quality is essential in agricultural output.

Saline groundwater underpins large portions in various Indian states. Irrigation with these fluids may exacerbate soil salt issues and make crop growth and development harder. This needs to involve the creation of effective management practices for using poor-quality water individually or in partnership with good-quality water from canals in order to minimize the salt effects on soil resources. In alluvial soils of Haryana, Uttar Pradesh, Punjab, and Rajasthan, the diverse techniques and interacting impacts of water quality on physical [7,8] and chemical attributes [9,10] are examined. This needs a study of various saline waters and their effects on soil chemical characteristics and wheat crop development metrics [11]. In light of this, a research project with the following aims was launched. (1) To investigate the impact of water quality on soil chemical characteristics. (2) To investigate the impact of water quality on wheat growth and production.

2. Materials and Methods

A pot experiment was carried out to investigate the effect of varied saline water conditions on soil chemical characteristics and their effects on growth, yield, and other biometric heat parameters. Tube well water (TW), saline water 1 (SW1, ECiw 5.0 dS m^{-1} and SAR 5.0 $mmol^{1/2}$ $L^{-1/2}$), and saline water 2 (SW2, ECiw 10.0 dS m^{-1}, SAR 5.0 $mmol^{1/2}$ $L^{-1/2}$) were used as irrigation water treatments. This study employed sandy loam soils, namely normal soil (pHs 7.5 and ECe 1.0 dS m^{-1}). The current investigation was carried out at the farmer's field in Karnal, which is located at latitude 29° 43′ N and longitude 76° 58′ E. For this experiment, normal soil and reclaimed soil were employed. The test area's soil was sandy in texture with a low clay percentage.

2.1. Treatments and Experimental Details

The experiment, which included three treatments and three water levels, was set up in a Randomised block design with three replications. The therapies and their symbolism are described in depth.

2.2. Water Preparation of Various Qualities

Two different grade waters were created using bicarbonate: chloride and sulphate of calcium and magnesium and sodium, as reported in Table 1. The irrigation water utilised in the study was tube well water (TW), Saline Water 1 of EC 5.0 dS m^{-1} (SW1), and Saline Water 2 of EC 10.0 dS m^{-1} (SW2). Every crop was watered with newly manufactured water quality. The ionic composition of the water was calculated using the techniques listed below. The ionic consumption of each water quality was calculated as follows:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}} \quad (1)$$

[SAR = $Na^{+}/[(Ca^{2+} + Mg^{2+})/2]^{1/2}$ in $mmol^{1/2}$ $L^{-1/2}$; RSC = $(CO_3^{2-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+})$ in me L^{-1} (all ions expressed in me L^{-1}); ratio of Ca^{2+} and Mg^{2+} or Cl^{-} and SO_4^{2-} were maintained at 2:1].

Table 1. Chemical composition of prepared saline water.

Total Electrolyte Conc (me L^{-1})	Ca^{2+}/Mg^{2+} and Cl^{-}/SO_4^{2-} Ratio of 2:1	Ionic Composition at SAR 5.0 $mmol^{1/2}$ $L^{-1/2}$		
		Cl^{-}	SO_4^{2-}	Total
Saline Water 1 (50 me L^{-1})	Na^{+}	13.01	6.506	19.519
	Ca^{2+}	20.32	--	20.32
	Mg^{2+}	--	10.16	10.16
	Total	33.33	16.67	50.00
Saline Water 2 (100 me L^{-1})	Na^{+}	19.77	9.88	29.65
	Ca^{2+}	46.90	--	46.90
	Mg^{2+}	--	23.45	23.45
	Total	66.67	33.33	100.00

2.3. Test Crop

Wheat (*Triticum aestivum* L.) cv. KRL 213 was cultivated as a test crop to investigate its performance under poor water quality irrigation. At each of the five crucial growth phases, the wheat crop was watered with 6 cm of water. Table 2 shows the various N, P, and K nutrient dosages used during wheat production in kg ha^{-1} and their determined weight per pot.

Table 2. Nutrient management in wheat cultivation.

Recommended Fertilizer Dose for Wheat (kg ha^{-1})				
Nutrients	**N**	P_2O_5	K_2O	Zn^{2+}
Total dose	150	60	40	25
Basal	75	60	40	25
Top dressing	75 + 75	--	--	--
Required Fertilizer Amount for Each Pot (g)				
Total dose	2.12	0.92	0.47	0.54
Basal	1.06	0.92	0.47	0.54
Top dressing	0.53 + 0.53	--	--	--

2.4. Soil Sample Collection

Prior to filling the pots, first, soil samples were gathered in order to determine the chemical qualities of regular soil. After harvesting the wheat crop, soil samples were taken at two depths: 0–15 and 15–30 cm. Soil samples were collected, dried, sieved through a 2 mm sieve, and kept for different analytical purposes. Tables 3–5 show the ionic composition, physicochemical characteristics, and composition of exchangeable cations of the initial soils.

Table 3. Ionic composition (cations and anions, me L^{-1}) of saturation extract of initial soils.

Soil Type	Na^{+}	K^{+}	Ca^{2+}	Mg^{2+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
Normal soil	4.6	0.17	3.7	1.8	0.0	1.0	4.0	3.2

Table 4. Physico-chemical properties of initial soils.

Soil Type	Ph	ECe (dS m^{-1})	CEC [c mol (p^{+}) kg^{-1}]	ESP%	OC%	$CaCO_3$%
Normal soil	7.5	1.01	13.2	4.2	0.50	0.3

Table 5. Composition of exchangeable cations in initial soils.

Soil Type	Na^+	K^+	Ca^{2+}	Mg^{2+}
	c mol (p^+) kg^{-1}			
Normal soil	0.64	0.36	8.36	3.14

2.5. Determination of Soil Chemical Properties

2.5.1. Extraction of Soluble Salts in Saturation Paste Extract

A 300 g soil sample was placed in a plastic container. To saturate the soil sample, a measured amount of distilled water was added while mixing. The sample was let to stand for at least two hours. The soil paste was poured into a Buckner funnel lined with double filter paper. The extract was obtained using a hoover. The soil extract was kept at 4 °C until it was analysed.

2.5.2. Determination of Carbonate and Bicarbonate

Titrating the soil extract against standard acid using phenolphthalein and methyl red as indicators, the carbonate and bicarbonate in the soil extract were determined. When the colour of phenolphthalein was emitted, it signified that half of the carbonate had been neutralised. This reading was assigned the letter y. The titration was then resumed with the addition of methyl red indicator. The full neutralisation of bicarbonate was reached when the colour changed from yellow to rose red. This reading was given the letter z.

$$CO_3^{2-}\left(me\ L^{-1}\right) = \frac{2x\ Vol\ of\ H_2SO_4\ used \times Normality\ of\ H_2SO_4 \times 1000}{mL\ of\ Aliquot\ \ Taken} \quad (2)$$

$$CO_3^{-}\left(me\ L^{-1}\right) = \frac{(Z-2Y) \times Normality\ of\ H_2SO_4 \times 1000}{mL\ of\ Aliquot\ \ Taken} \quad (3)$$

2.5.3. Determination of Chloride

The chloride content of the soil extract was evaluated by titrating it against a standard AgNO3 solution using potassium chromate as an indicator. At the end point, a sparingly soluble brick red silver chromate precipitate formed.

$$Cl^{-}\left(me\ L^{-1}\right) = \frac{Vol\ of AgNO_3\ used \times Normality\ of\ AgNO_3 \times 1000}{mL\ of\ Aliquot\ \ Taken} \quad (4)$$

2.5.4. Determination of Sulphate by Turbidity Method

In the soil extract, sulphur was estimated using a turbidimetric technique. The amount of turbidity caused by fine suspensions of barium sulphate generated in solution by reacting sulphate ions with barium chloride was measured using a UV-Vis Spectrophotometer. To create the standard curve, a 100 ppm standard solution of sodium sulphate was produced.

$$SO_4^{2-}\left(me\ L^{-1}\right) = \frac{R\ (PPM) \times Dilution}{48} \quad (5)$$

2.5.5. Determination of Calcium by Versenate Method

Titration of the soil extract with standard versenate 0.01 N solution using mureoxide (ammonium purpurate) indicator in the presence of NaOH solution was used to measure calcium in the soil extract. When the whole calcium complex formed a compound with EDTA, the colour changed from orange red to purple.

$$Ca^{2+}\left(me\ L^{-1}\right) = \frac{Normality\ of\ EDTA \times Vol.\ of\ EDTA \times 1000}{mL\ of\ Aliquot\ taken} \quad (6)$$

2.5.6. Determination of Magnesium by Versenate Method

The magnesium in the soil extract was evaluated by titrating the soil extract with 0.01N EDTA in the presence of ammonium chloride and ammonium hydroxide buffers. The colour shifted from wine red to blue or green at the final point. This titration will estimate calcium and magnesium levels. Magnesium concentration was calculated by subtracting calcium concentration.

$$Mg^{2+}\left(me\ L^{-1}\right) = \frac{Normality\ of\ EDTA \times Vol.\ of\ EDTA \times 1000}{mL\ of\ Aliquot\ taken} \quad (7)$$

2.5.7. Determination of Sodium and Potassium

A flame photometer was used to measure sodium and potassium. The sodium and potassium standard curves were created by creating 10, 20, 40, 50, and 100 ppm solutions from oven-dried sodium chloride and potassium chloride salt, respectively.

$$Na^{+}(ppm) = Na^{+}(ppm) \times Dilution\ Factor \quad (8)$$

$$Na^{+}\left(me\ L^{-1}\right) = \frac{Na^{+}(ppm) \times Dilution}{Equivalent\ weight\ of\ Na^{+}\ (23)} \quad (9)$$

$$K^{+}\ (ppm) = K^{+}\ (ppm) \times Dilution\ Factor \quad (10)$$

$$K^{+}\left(me\ L^{-1}\right) = \frac{K^{+}(ppm) \times Dilution}{Equivalent\ weight\ of\ K^{+}\ (39)} \quad (11)$$

Residual sodium carbonate (RSC): This is a crucial characteristic for determining the appropriateness of irrigation water in light of the potential sodium threat. It is determined using the analytical results for carbonates, bicarbonates, calcium, and magnesium.

$$RSC\left(me\ L^{-1}\right) = \left[\left(CO_3^{2-} + HCO_3^{-}\right) - \left(Ca^{2+} + Mg^{2+}\right)\right] \quad (12)$$

All parameters expressed in me L^{-1}.

Sodium adsorption ratio (SAR): The SAR, an index of the sodicity or relative sodium status of soil solution/aqueous extracts of water in equilibrium with soil, is calculated as

$$SAR = \frac{Na^{+}}{\frac{\sqrt{Ca^{2+}+Mg^{2+}}}{2}} \quad (13)$$

Where concentrations are in me L^{-1}.

Soil with SAR values greater than 13 are usually considered to be sodic (Soil Science Society of America, 1984).

2.5.8. Cation Exchange Capacity (CEC)

Soil samples (5 gm) were first saturated in the centrifuge with sodium acetate, then surplus salts were washed with 60% alcohol, and the sodium of the soil was swapped with the help of ammonium acetate by collecting 100 mL leachate in the centrifuge. CEC was calculated by estimating the sodium content in the leachate using a flame photometer. It is measured in centimoles of positive charge per kilogramme of soil (C mol(p) kg^{-1}), which is equivalent to me/100 g.

$$CEC\ \left[c\ mol_{(p+)}\ kg^{-1}\right] = \frac{Na^{+}\left(me\ L^{-1}\right) \times 10}{weight\ of\ soil\ sample\ (g)} \quad (14)$$

2.5.9. Exchangeable Sodium Percentage (ESP)

Soil ammonium acetate extracts were tested for exchangeable sodium. Soil samples (5 grammes) were washed with 60% alcohol before the sodium of the soil was replaced with ammonium acetate by collecting 100 mL leachate using a centrifuge. To calculate the ESP, the sodium content in the leachate was determined using a flame photometer.

$$Exchangeable\ Sodium\ \left[c\ mol_{(p+)}\ kg^{-1}\right] = \frac{Na^{+}\left(me\ L^{-1}\right) \times 10}{weight\ of\ soil\ sample\ (g)} \quad (15)$$

$$Exchangeable\ Sodium\ Percentage = \frac{Ex.Na^{+}\left(me\ L^{-1}\right) \times 10}{CEC} \quad (16)$$

2.5.10. Estimation of Organic Carbon

Using the heat of the dilution of sulfuric acid, chromic acid (potassium dichromate + concentrated sulfuric acid) oxidises the organic matter (humus) in the soil. Back titration with ferrous ammonium sulphate (redox titration) was used to determine the unreacted dichromate.

$$Organic\ Carbon\ (\%) = \frac{10(B - T\ ) \times 0.003 \times 100}{B \times Wt\ of\ soil\ (g)} \quad (17)$$

$$= \frac{(B - T\ ) \times 3}{B} \quad (18)$$

where B = blank and T = volume of ammonium ferrous sulphate used

3. Results and Discussion

3.1. Soil Chemical Properties

3.1.1. Electrical Conductivity

The findings provided (Table 6) demonstrated that substantial increases in soil salinity were found after adding saline water relative to the original soil. In post-wheat samples, the application of tube well water (TW) had no discernible effect on soil salt concentrations. ECe remained somewhat higher or about the same in surfacdsee samples but was found to be slightly lower in lower soil layers than in surface samples in normal soil. A total of 5 irrigations of saline water 1 and saline water 2 (SW1 and SW2; 0–15 cm soil layer) enhanced electrical conductivity (ECe) in wheat samples by roughly 8 and 12 times, respectively, compared to initial soil, perhaps owing to salt deposition around the root zone. Cations and anions in water used for irrigation can cause a rise in EC2 [12,13]. When irrigation with salty water was applied to normal soil, lower depths had somewhat lower ECe values than surface samples.

Table 6. Effect of water quality on electrical conductivity of saturation extract of soil.

Depth (cm)	Initial Soil	TW	SW1	SW2
0–15	1.0	1.2	7.8	11.5
15–30		1.1	6.6	9.7
$LSD_{0.05}$ 0.5 and 0.4 for 0–15, 15–30 cm soil depths, respectively				

3.1.2. Soil pH

Because it impacts the availability of vital plant nutrients, soil pH is an important chemical characteristic. In wheat samples, the soil pH was raised by 0.3 units after five cycles of TW due to some RSC (0.7 me L^{-1}) of normal water, whereas the application of SW1 and SW2 slightly reduced the soil pH due to the presence of neutral salts of Na^{+}, Cl^{-}, and SO42- which neutralize the soil and prevent the hydrolysis of sodium carbonates and bicarbonates, resulting in a decrease in pH. When the concentration of these salts rose in SW2, the soil pH decreased somewhat when compared to SW1 (Table 7).

Table 7. Effect of water quality on pH of soil under varying soil depths.

Depth (cm)	Initial Soil	TW	SW1	SW2
0–15	7.5	7.8	7.3	7.2
15–30		7.9	7.5	7.4
$LSD_{0.05}$ 0.1 and 0.1 for 0–15, 15–30 cm soil depths, respectively				

3.1.3. Exchangeable Sodium Percentage

Table 8 shows the exchangeable sodium percentage (ESP) for each saline water irrigation after five irrigation cycles. When irrigation with TW, SW1, and SW2 was applied to normal soil, ESP increased by double when compared to the initial soil (4.2). The results showed that applying saline water to soils that had not received any chemical/organic amendments resulted in a significant increase in soil ESP [13,14]. A similar type of increase in ESP from 10.1 to 19.8 was found in a column-leaching experiment with calcareous sandy loam soil (pH2 7.5, EC2 2.3 dS m^{-1}).

Table 8. Effect of water quality on exchangeable sodium percentage of three soils under varying soil depths (post-wheat).

Depth (cm)	Initial Soil	TW	SW1	SW2
0–15	4.2	8.0	9.5	8.6
15–30		7.5	8.2	7.4
$LSD_{0.05}$ 2.4 and 1.2 for 0–15, 15–30 cm soil depths, respectively				

3.1.4. Ionic Composition Analyses

Soil was found to be richer in all cations, such as Na^+, K^+, Ca^{2+}, and Mg^{2+}, as well as anions such as $CO32^-$, $HCO3^-$, Cl^-, and $SO42^-$ (Table 9). In post-wheat soil samples, the Na+ content at the surface layer rose 1.5-fold after irrigation with tube well water (TW) compared to the starting soil (4.6 me L^{-1}). When irrigation was treated with SW1 and SW2, a preferential Na+ in addition to Ca^{2+} and Mg^{2+} holding was seen in normal soil. In the case of normal soil, a 10-fold rise in Na^+ was seen in SW1 and a 12-fold increase in Na^+ in SW2. A significant quantity of Na^+ in irrigation water (ECiw5.0 and 10. dS m^{-1}; SAR 5.0 $mmol^{1/2}$ $L^{-1/2}$) can raise the level of Na^+ in the soil. At the same time, significant amounts of Ca^{2+} and Mg^{2+} were identified in all treatments in normal soil, with greater cation accumulations near the top layers compared to lower depths. In both saline water treatments, the tendency of increasing ionic concentration persisted. TW enhanced Na^+ content by 2.9 times compared to original soil (4.6 me L^{-1}). Under wheat crop on normal soil, it was enhanced 15.5 times in SW1 and 17.9 times in SW2. Similar patterns of manifold rises in Ca^{2++} Mg^{2+} ion concentrations (7 times for SW1 and 13 times for SW2) were seen; however, this was unaffected by the application of tube well water. Surface chlorides and sulphate (Cl^- and $SO42^-$) ion concentrations increased dramatically under wheat (17-fold for SW1 and 27-fold for SW2).

Table 9. Effect of water quality on chemical composition of saturation extract of normal soil under varying soil depths.

Depth (cm)	Initial Soil	TW	SW1	SW2
		Sodium (me L^{-1})		
0–15	4.6	13.3	71.4	82.3
15–30		15.6	61.2	55.5
		$LSD_{0.05}$ 4.4 and 2.9 for 0–15, 15–30 cm soil depths, respectively		
		Potassium (me L^{-1})		
0–15	0.2	0.15	0.31	0.45
15–30		0.13	0.18	0.36
		$LSD_{0.05}$ 0.0 and 0.0 for 0–15, 15–30 cm soil depths, respectively		
		Calcium (me L^{-1})		
0–15	3.7	3.00	26.5	28.0
15–30		3.25	14.5	27.0
		$LSD_{0.05}$ 2.5 and 2.7 for 0–15, 15–30 cm soil depths, respectively		
		Magnesium (me L^{-1})		
0–15	1.8	6.0	34.5	54.0
15–30		6.25	24.5	34.2
		$LSD_{0.05}$ 2.6 and 2.4 for 0–15, 15–30 cm soil depths, respectively		
		Carbonate (me L^{-1})		
0–15	0.0	0.0	0.0	0.0
15–30		0.0	0.0	0.0
		$LSD_{0.05}$ 0.0 and 0.0 for 0–15, 15–30 cm soil depths, respectively		
		Bicarbonate (me L^{-1})		
0–15	1.0	3.75	3.0	2.5
15–30		4.25	3.25	2.25
		$LSD_{0.05}$ 0.3 and 0.4 for 0–15, 15–30 cm soil depths, respectively		
		Chloride (me L^{-1})		
0–15	4.0	7.5	71.0	102.0
15–30		6.0	47.0	63.0
		$LSD_{0.05}$ 6.4 and 7.2 for 0–15, 15–30 cm soil depths, respectively		
		Sulphate (me L^{-1})		
0–15	3.2	10.5	45.5	55.9
15–30		12.2	41.3	40.5
		$LSD_{0.05}$ 6.9 and 5.4 for 0–15, 15–30 cm soil depths, respectively		

3.1.5. Organic Carbon

Normal soil had an initial organic carbon content of 0.50 (Table 10). It was marginally enhanced in all water treatments in normal soil, ranging from 0.55 to 0.60% in the surface layer (0–15 cm). It was found to be between 0.44 and 0.50% in the 15–30 cm layer, but between 0.21 and 0.28% below 30 cm soil depth with all water treatments. The slightly greater value of organic carbon in the surface samples can be explained by the buildup of leaf and root remnants in the pots.

Table 10. Effect of water quality on organic carbon of three soils under varying soil depths.

Depth (cm)	Initial Soil	TW	SW1	SW2
0–15	0.50	0.60	0.55	0.55
15–30		0.45	0.49	0.46
$LSD_{0.05}$ 0.0 and 0.0 for 0–15, 15–30 cm soil depths, respectively				

3.1.6. Cation Exchange Capacity

In post-wheat soil samples, cation exchange capacity reduced insignificantly to roughly 12.5 of the surface soil compared to the baseline value (13.2) due to salty water application (Table 11). At 15–30 cm soil depth, it dropped to roughly 11.0. The CEC remained nearly constant across all water treatments. There was no significant difference between post-wheat samples and initial soil samples. The clay concentration of typical soil was found to be 13.2%. Because there was little variance in clay concentration, no change in CEC values was found across all water treatments.

Table 11. Effect of water quality on cation exchange capacity of three soils under varying soil depths.

Depth (cm)	Initial Soil	TW	SW1	SW2
0–15	13.2	12.5	12.8	11.7
15–30		10.9	12.1	11.2
$LSD_{0.05}$ 0.5 and 0.4 for 0–15, 15–30 cm soil depths, respectively				

3.2. Biometric Observation

Crop Yield of Wheat

In comparison to TW, SW1 yielded 22% less grain on typical soil. Under typical soil conditions, a yield penalty of 70% was found in SW2. TW had the highest 1000 grain weight of 39.2 g, whereas SW2 had the lowest 1000 grain weight of 24.0 g under typical soil conditions. SW1 had a 1000 grain weight of 35.9 g, whereas SW2 had a roughly 40% drop in 1000 grain weight when compared to TW. In normal soil, straw weight was detected in the sequence of TW (119.5 g) > SW1 (113.3 g) > SW2 (36.3 g), as shown in Table 12. Straw weight was found to be the lowest in SW2. It was substantial in SW2 compared to TW in normal soil, but it was decreased to 50% in SW1 compared to TW. SW2 saw an almost total crop loss, with straw weight having decreased by 75 to 95%.

Table 12. Effect of water quality on wheat (*Triticum aestivum* L.) yield parameters in normal soil.

Parameters (Average)	TW	SW1	SW2
Grain weight/pot (g)	61.4	47.6	18.2
Straw weight/pot (g)	119.5	113.3	36.3
1000 Grain weight (g)	39.2	35.9	24.0
$LSD_{0.05}$ 4.6 and 10.6, respectively			

4. Discussion

The study investigated how tap water (TW) and saline water (SW1 and SW2) affected soil and wheat in a pot experiment. SW1 and SW2 had higher salt content than TW. The results showed that SW1 and SW2 increased soil salinity (ECe) by 8 to 11.5 times compared to the initial soil. SW1 and SW2 decreased soil pH slightly, more in SW2 than in SW1. SW1 and SW2 increased soil sodium (ESP) by a factor of two compared to the initial soil. TW, SW1, and SW2 increased the concentration of all cations and anions in the soil, more in SW1 and SW2 than in TW. The study investigated how tap water (TW) and saline water (SW1 and SW2) affected soil organic carbon (OC), calcium carbonates, cation exchange capacity (CEC), and wheat yield in a pot experiment. The results showed that the organic carbon increased slightly in the surface layer and decreased in the lower layers of the soil under all water treatments. Calcium carbonates and CEC remained stable or decreased slightly under all water treatments. Wheat yield decreased significantly under SW1 and SW2 compared to TW, along with other biometric parameters.

Author Contributions: B.K.: Conceptualization, Methodology; N.K.A.: Supervision, Visualization; R.K.: Supervision, Visualization, investigation, data curation; S.S.: writing—review and editing, writing—original draft preparation; M.S.: writing—review and editing, Visualization. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Acknowledgments: The authors are grateful to all research staff that contributed to the data collection required for this research article.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Cuong, D.M.; Kwon, S.-J.; Nguyen, B.V.; Chun, S.W.; Kim, J.K.; Park, S.U. Effect of salinity stress on phenylpropanoid genes expression and related gene expression in wheat sprout. *Agronomy* **2020**, *10*, 390. [CrossRef]
2. Wei, C.; Jiao, Q.; Evgenios, A.; Liu, H.; Li, G.; Zhang, J.; Fahad, S.; Jiang, Y. Hormetic effects of zinc on growth and antioxidant defense system of wheat plants. *Sci. Total Environ.* **2022**, *807*, 150992. [CrossRef]
3. Deng, X.P.; Shan, L.; Inanaga, S.; Inoue, M. Water-saving approaches for improving wheat production. *J. Sci. Food Agric.* **2005**, *85*, 1379–1388. [CrossRef]
4. Arzani, A.; Ashraf, M. Cultivated ancient wheats (*Triticum* spp.): A potential source of health-beneficial food products. *Compr. Rev. Food Sci. Food Saf.* **2017**, *16*, 477–488. [CrossRef] [PubMed]
5. Rakaščan, N.; Dražić, G.; Živanović, L.; Ikanović, J.; Jovović, Z.; Lonèar, M.; Bojović, R.; Popović, V. Effect of genotypes and locations on wheat yield components. *Agric. For.* **2019**, *65*, 233–242. [CrossRef]
6. Lark, T.J.; Schelly, I.H.; Gibbs, H.K. Accuracy, bias, and improvements in mapping crops and cropland across the United States using the USDA cropland data layer. *Remote Sens.* **2021**, *13*, 968. [CrossRef]
7. Abrol, I.P.; Saha, A.K.; Acharya, C.L. Effect of exchangeable sodium on some soil's physical properties. *J. Ind. Soc. Soil Sci.* **1978**, *26*, 98–105.
8. Yadav, J.S.P.; Girdhar, I.K. Effect of varying Mg/Ca ratio and electrolyte concentration in the irrigation water on the soil properties and growth of wheat. *Plant Soil* **1980**, *56*, 413–427. [CrossRef]
9. Poonia, S.R.; Jhorar, L.R.; Nath, J.; Khanna, S.S.; Singh, A. Salt balance in soil profiles as affected by different combinations of canal and saline water irrigation. *J. Res. Hisar* **1984**, *4*, 266–270.
10. Sandhu, B.S.; Khera, K.L.; Prihar, S.S.; Singh, B. Irrigation needs and yield of rice on a sandy-loam soil as affected by continuous and intermittent submergence. *Indian J. Agric. Sci.* **1980**, *50*, 492–496.
11. Van-Schilfgaarde, J. Irrigation—A blessing or a curse. *Agri. Water Manag.* **1994**, *25*, 203–219. [CrossRef]
12. Ould Ahmed, B.A.; Inoue, M.; Moritani, S. Effect of saline water irrigation and manure application on the available water content, soil salinity and growth of wheat. *Agric.Water Manag.* **2010**, *97*, 165–170. [CrossRef]
13. Chaudhari, S.K.; Somawanshi, R.B. Unsaturated flow of different quality irrigation waters through clay, clay loam and silt loam soils and its dependence on soil and solution parameters. *Agric. Water Manag.* **2004**, *64*, 69–90. [CrossRef]
14. Jalali, M.; Ranjbar, F. Aging effects on phosphorus transformation rate and fractionation in some calcareous soils. *Geoderma* **2010**, *155*, 101–106. [CrossRef]