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Assessment of Physico-chemical Properties of Soil and Irrigation Water Quality of Phulpur Blocks of Prayagraj District, Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

We aimed to study nutrient status in Phulpur block of Prayagraj District of Uttar Pradesh, India. We collected representative soil samples covering nine villages of Phulpur division at depths like 0-15cm, 15-30cm and 30-45cm before sowing of crops. The soil samples were analyzed for their

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physico-chemical properties. Results show that the soil samples of the areas of the Phulpur division were found to be mildly alkaline and non-saline. There are many reasons leading to soil quality deterioration, including changes in land use types of forest to arable land and the consequences of intensive land use. The colour of soil changes between the three depths at all locations. There were differences in the colour of dry and wet soils was dark brown to dark yellowish brown. The soil bulk density varied from 1.22 to 1.41 Mg m^{-3}, soil particle density varied from 2.291 to 2.452 Mg m^{-3}, pore space from 41.6 to 48.2 %, water holding capacity from 36.60 to 43.30 % respectively. Soil pH varied from 7.26 to 7.84 and EC is 0.24 to 0.38 dS m^{-1}. while soil organic carbon varied from 0.29 to 0.45 % and available nitrogen from low to medium (180 to 275 kg ha^{-1}), available phosphorous from medium to high (10.80 to 22.5 kg ha^{-1}), potassium was found to be medium range (132.00 to 231.00 kg ha^{-1}), exchangeable calcium and magnesium low from (3.48 to 5.50 Meq $100g^{-1}$) and (1.66 to 2.72 Meq $100g^{-1}$) respectively. The water pH of varied from 6.24 to 7.50, the electrical conductivity of water ranged from 0.31 to 0.90 dS m^{-1}, the bicarbonate of water varied from 7 to 18 Meq L^{-1}, the chloride of water varied from 4.5 to 10.4 Meq L^{-1}, the available calcium of water varied from 4.2 to 8 Meq L^{-1}, the available magnesium of water varied from 2.5 to 3.6 Meq L^{-1}, the potassium of water varied from 0.05 to 0.17 Meq L^{-1} and the sodium of water varied from 0.08 to 0.21 Meq L^{-1}. The sodium absorption ratio (SAR) ranged from 0.03 to 0.1 Meq L^{-1}, indicating low to moderate levels of sodium content in the water samples. The soluble sodium percent (SSP) ranged from 1.47 to 3.93 Meq L^{-1}, providing further insight into the sodium content in the water. The residual sodium carbonate (RSC) varied from -2.4 to 7.4 Meq L^{-1}. The permeability Index (PI) ranged from 28 to 56 Meq L^{-1}, serving as an indicator of the potential impact of water on soil permeability, the Kelley's ratio (KR) ranged from 0.08 to 0.024 Meq L^{-1}. The KR is a measure of the sodium hazard in irrigation water, with lower values indicating a lower risk of sodium-related issues in soil and crops. The range of the irrigation water quality index value ranged from 44 to 157 Meq L^{-1} it was determined that 100% of the samples are in suitable range for irrigation.

Keywords: Soil physico-chemical properties; pH; nitrogen; phosphorus; potassium; irrigation water quality analysis.

1. INTRODUCTION

"Soil and water are two important natural resources for plant growth development. Soil provides the mechanical support and nutrient reservoir necessary for plant growth. Water is essential for plant life process. Effective management of these resources for crop production an understanding of the relationships between soil and water" [1].

"Soil serves as a natural medium for plant growth, dependent on factors like adequate water, temperature, nutrients, and low toxic concentrations. It comprises 50% pore space (air and water) and 50% solid phase, with 45% mineral matter and 5% organic constituents. (Soils and Plant Nutrients)" [1].

"Soil consists of layers, known as soil horizons, which encompass weathered mineral materials, organic matter, air, and water. The formation of soil is a complex result of the combined influences of climate, topography, organisms (flora, fauna, and human activities), and parent materials (original rocks and minerals) over time. Consequently, soil exhibits unique properties, different from its parent material, including variations in texture, structure, consistency, color, chemical, biological, and physical characteristics" [1].

"Soil plays a crucial role in broader concepts encompassing vegetation, water, and climate within the realm of land. Moreover, in the case of ecosystems, social and economic considerations come into play as well (FAO). The significance of soil as a non-renewable dynamic resource cannot be overlooked, as it constitutes unconsolidated minerals and organic matter, including water and air, within the uppermost layers of the Earth's surface. It plays a critical role in maintaining terrestrial ecosystems, which support all life".

"The soils physicochemical properties of soil hold immense importance in facilitating a plant's ability to extract water and nutrients. The product of biochemical weathering of parent material, soil formation is influenced by factors such as climate, organisms, parent material, relief, and time" [2]. High-quality soils not only yield better food and fiber but also foster the establishment of natural ecosystems and enhance air and water quality. Physical properties, such as shape, structure, size, pore space, organic matter, and mineral composition, directly impact the supporting capability, movement, retention, and availability of water and nutrients to plants. Additionally, they influence root penetration, heat & air-flow, and interact with then chemical and biological properties of the soil. Soil and water constitute fundamental resources for plant growth and agriculture. However, despite Earth's extensive water coverage, only a minute fraction is available for human consumption due to environmental stress caused by developmental activities.

Irrigation water quality significantly impacts soil quality and crop growth. With only 1% freshwater available, its quality, influenced by sediment and salt quantities from various sources, affects osmotic potential, hindering root water absorption. The quality of irrigation water significantly impacts crop yield and soil characteristics, influenced by diverse factors like climate, environment, and soil composition [3]. Analysis of water quality involves assessing physical, chemical, and biological properties [4]. critical for plant health and environmental preservation. Irrigating crops with sewage water containing heavy metals poses severe health risks to consumers and farmers. The suitability of irrigation water depends on dissolved constituents, with lower divalent ions deemed better. Urbanization and industrialization exert pressure on water resources, especially groundwater, leading to compromised quality and health hazards. India's heavy reliance on groundwater for drinking necessitates thorough quality assessment. Extensive research on the Water Quality Index (WQI) aids in evaluating and managing groundwater resources, essential for sustainable usage amid increasing pollution concerns [5].

We aimed to study the physico-chemical properties of soil and water collected from various locations in the Phulpur block of Prayagraj. Understanding and optimizing these properties are crucial for sustainable agricultural practices, ecosystem health, and the preservation of this invaluable resource.

2. MATERIALS AND METHODS

2.1 Location

The location of the Phulpur is located at 25°55'10''N and 82°08'84'' E.

2.2 Soil and Climate

“In the Phulpur block of Prayagraj District, the climate is moderate both in the winter and summer seasons in the delta area. The normal maximum and minimum temperatures recorded are 36.20°C to 19.0°C respectively. The annual rainfall is between 1045 and 1170 mm in Northern Uttar Pradesh. Districts of the Southern Uttar Pradesh state receive less rain during the Southwest monsoon. Uttar Pradesh contains various soil types, some of which are red soil, Alluvial soil, Black soil, Saline soil, Sandy coastal soil, and rocky hill soil, while red soil is the most abundant among these soils. These soil types allow the planting of a variety of fruits and vegetable crops such as mangoes, Lemon, coconut, sugarcane, paddy, Maize and Chilies” [1].

2.3 Sampling and Analysis

The soil and water sample collection was carried out from the Phulpur block of Prayagraj district in Uttar Pradesh selecting 9 villages. Soil samples were collected randomly from a site of each village using soil khurpi by composite sampling method at depths of 0-15cm, 15-30cm and 30- 45cm. The sample ware air dried and 9 Water ground sample were collected and processed for physicochemical test.

2.4 Method of Water Sampling and Preservation

The sample collection of Irrigation water was done in a sterilized bottle. Nine water samples were collected from nine villages in the Phulpur block of Prayagraj district and analyzed in the Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology & Sciences, Uttar Pradesh. 2-3 drops of nitric acid were also added to the samples to stop the microbial growth.

2.5 Statistical Analysis

The data was recorded during the course of investigation were subjected to statistical analysis by analysis of Completely Randomized Design (CRD) as per the method of “Analysis of Variance” (ANOVA) technique.

3. RESULTS AND DISCUSSION

3.1 Physical Properties of Soil

The Soil Textural class was identified by Sandy Loam. The sand, silt and clay ranges were 75.12

Table 1. Procedure used for physico-chemical analysis of soil and water

A. Physical analysis

S. No.	Parameters	Scientist
1	Soil Textural Class (Sand, Silt, Clay)	Bouyoucos, [6]
2	Bulk Density (Mg m^{-3})	
3	Particle Density (Mg m^{-3})	
4	Pore Space (%)	Muthuvel *et al.,* [7]
5	Water Holding Capacity (%)	

B. Chemical analysis

S. No.	Parameters	Scientist
1	Soil pH	Jackson, [8]
2	Electrical Conductivity (dS m^{-1})	Wilcox, [9]
3	Organic Carbon (%)	Walkley and Black, [10]
4	Available Nitrogen (kg ha^{-1})	Subbiah and Asija, [11]
5	Available Phosphorus (kg ha^{-1})	Olsen *et al.,* [12]
6	Available Potassium (kg ha^{-1})	Toth and Prince, [13]
7	Exchangeable Ca and Mg (Meq $100g^{-1}$)	Jackson, (1973)

C. Chemical analysis

S. No.	Particulars	Scientist
1	pH	APHA (1992)
2	EC (dS m^{-1})	APHA (1992)
3	Carbonate and Bicarbonate (Meq L^{-1})	APHA (1992)
4	Chloride (Meq L^{-1})	APHA (1992)
5	Calcium + Magnesium (Meq L^{-1})	APHA (1992)
6	Calcium (Meq L^{-1})	APHA (1992)
7	Potassium (Meq L^{-1})	APHA (1992)
8	Sodium (Meq L^{-1})	APHA (1992)

to 71.46%, 18.36 to 14.45% and 11.08 to 9.18% respectively. Bulk Density was varied from the 1.22 to 1.41 Mg m^{-3}. Bulk density increased with the increase soil depth in some sites due to an increase in compaction in the subsurface comparatively. The Particle Density varied from 2.291 to 2.452 Mg m^{-3} (Table 2). The increase in the particle density is due to soil depth, water quality, and their interaction.

The Pore Space (%) ranged from 41.6 to 48.2 %. The pore space was found to decrease with increase in depth attributed to increase in compaction in the subsurface. The Water Holding Capacity (%) ranged from 36.60 to 43.30 % (Table 3). "The water holding capacity value decrease with increase in depth because of soil compaction and reduction in pore space. Soils vary in their water holding capacity according to their structure, texture, Organic carbon content and bulk density relationship to total pore size distribution" [1].

3.2 Chemical Properties of Soil

The pH and EC (Table 4) of soil were found to be normal. The organic carbon (Table 5) content decreased with increase depth, and this is due the addition of plant residues and farmyard manures to surface horizons rather than lower horizons. The available Nitrogen content (Table 5), The available new nitrogen decreased with the increase in soil depth. The available Phosphorus content (Table 6), was low in all blocks. The available potassium content (Table 6) are low to medium ranges. The available calcium and magnesium content (Table 7), Calcium and magnesium both increase the soil pH as its availability increases in soil.

Table 2. Bulk density and particle density (Mg m^{-3}) of soil in different villages of phulpur block of Prayagraj district at 0-15cm, 15-30cm and 30-45cm depth

Villages	Bulk Density (Mg m^{-3})			Particle Density (Mg m^{-3})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
V1	1.34	1.36	1.38	2.313	2.318	2.325
V2	1.23	1.27	1.29	2.325	2.328	2.335
V3	1.3	1.33	1.35	2.291	2.297	2.305
V4	1.28	1.32	1.34	2.367	2.372	2.379
V5	1.23	1.25	1.27	2.323	2.327	2.335
V6	1.24	1.27	1.29	2.385	2.389	2.393
V7	1.35	1.39	1.41	2.452	2.456	2.461
V8	1.22	1.24	1.26	2.354	2.358	2.363
V9	1.27	1.3	1.32	2.336	2.340	2.344
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.*023192*	0.*068908*	NS	-	-
Depth (15-30cm)	S	0.021781	0.064714	NS	-	-
Depth (30-45cm)	S	0.013274	0.054034	NS	-	-

Table 3. Pore space and water holding capacity (%) of soil in different villages of phulpur block of prayagraj district at 0-15cm, 15-30cm and 30-45cm depth

Villages	Pore Space (%)			Water Holding Capacity (%)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
V1	43.60	42.70	41.60	38.48	37.21	36.60
V2	45.70	44.20	43.80	40.57	39.20	38.80
V3	46.10	45.37	43.80	40.91	39.37	38.80
V4	45.80	44.38	43.42	40.60	39.38	38.42
V5	47.90	45.20	44.80	42.72	41.20	40.80
V6	47.80	46.29	45.80	42.69	41.29	40.80
V7	46.70	46.20	45.90	41.58	40.50	39.90
V8	45.60	44.00	43.80	40.40	39.65	38.80
V9	48.20	46.39	45.67	43.30	42.39	41.67
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.746195	2.217064	S	0.588079	1.747273
Depth (15-30cm)	S	0.612464	1.819724	S	0.580013	1.723306
Depth (30-45cm)	S	0.671345	1.992669	S	0.591988	1.758888

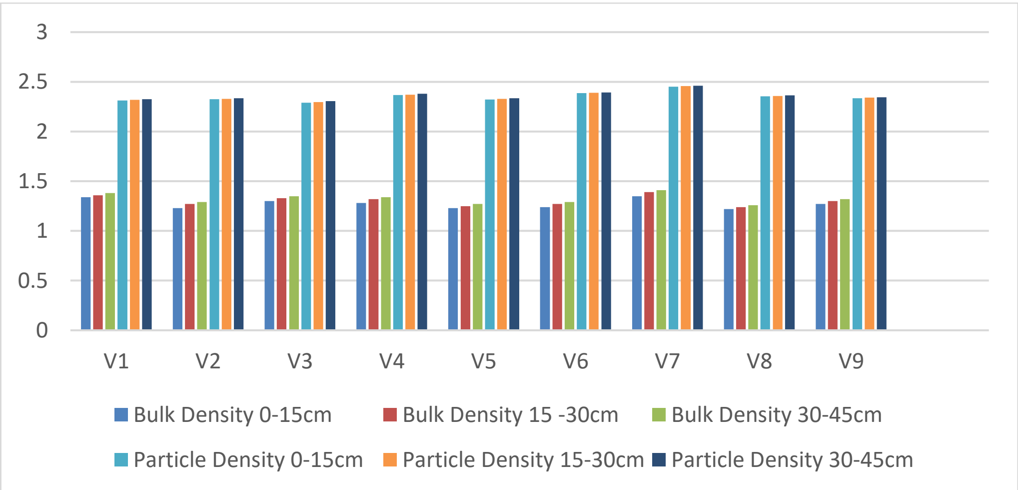

Fig. 1. Bulk density, particle density of soil in differentvillages of phulpur block of prayagraj district at 0-15cm, 15-30cm and 30-45cm depth

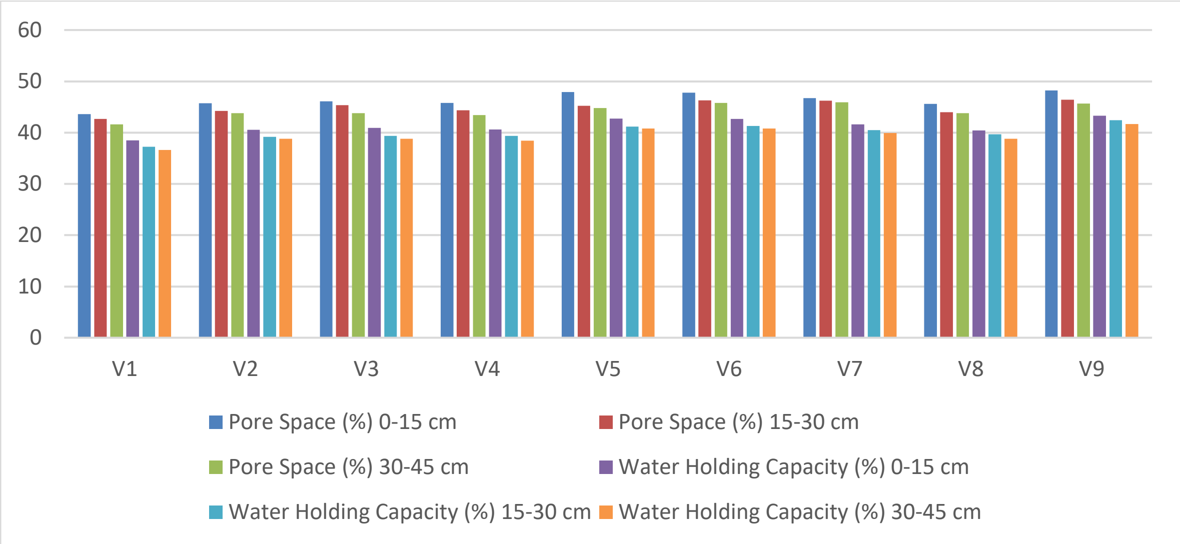

Fig. 2. Pore space and water holding capacity of soil in differentvillages of phulpur block of prayagraj district at 0-15cm, 15-30cm and 30-45cm depth

.Table 4. Soil pH and EC (dS m^{-1}) of soil in different villages of phulpur block of prayagraj district at 0-15cm, 15-30cm and 30-45 cm depth

Villages	Soil pH			Soil EC (dS m^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
V1	7.80	7.82	7.83	0.38	0.33	0.30
V2	7.26	7.29	7.31	0.35	0.33	0.30
V3	7.30	7.32	7.33	0.32	0.29	0.26
V4	7.67	7.69	7.72	0.35	0.30	0.25
V5	7.23	7.31	7.30	0.30	0.25	0.23
V6	7.78	7.81	7.81	0.33	0.30	0.28
V7	7.76	7.78	7.79	0.34	0.30	0.26
V8	7.79	7.79	7.80	0.35	0.32	0.29
V9	7.80	7.81	7.84	0.31	0.28	0.24
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.097750	0.097750	S	0.003846	0.011426
Depth (15-30cm)	S	0.080484	0.239130	S	0.004817	0.014313
Depth (30-45cm)	S	0.078097	0.232039	S	0.003031	0.009004

Table 5. Soil OC and available nitrogen of soil in different villages of phulpur block of prayagraj district at 0-15cm,15-30cm and 30-45cm depth

Villages	Organic Carbon (%)			Nitrogen (kg ha^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
V1	0.45	0.43	0.41	275	253	238
V2	0.40	0.39	0.38	270	253	237
V3	0.37	0.36	0.34	264	238	217
V4	0.35	0.34	0.33	227	197	180
V5	0.34	0.33	0.31	224	204	187
V6	0.32	0.30	0.29	218	198	180
V7	0.42	0.40	0.38	255	231	207
V8	0.38	0.37	0.36	244	224	206
V9	0.39	0.37	0.36	237	207	194
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**

Villages	Organic Carbon (%)			Nitrogen (kg ha^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Depth (0-15cm)	S	0.005356	0.015913	S	2.965617	8.811301
Depth (15-30cm)	S	0.005727	0.017015	S	3.620043	10.75570
Depth (30-45cm)	S	0.018892	0.013723	S	3.508801	10.42518

Table 6. Available phosphorus and potassium (kg ha^{-1}) of soil in different villages of phulpur block of prayagraj district at 0-15cm, 15-30cm and 30-45 cm depth

Villages	Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
V1	19.00	14.60	13.00	158	140	132
V2	21.00	17.89	14.60	169	156	141
V3	19.56	16.87	13.10	165	154	146
V4	18.00	16.45	12.20	230	219	207
V5	17.40	14.40	12.20	203	195	177
V6	22.50	19.20	16.10	191	171	159
V7	17.70	12.60	11.10	231	216	194
V8	15.00	12.33	10.80	225	214	192
V9	17.00	15.56	11.20	159	140.5	135
	F-test	**S.Em. (±)**	**C.D@5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.281225	0.835561	S	3.081863	9.156684
Depth (15-30cm)	S	0.216823	0.644215	S	2.545029	7.561670
Depth (30-45cm)	S	0.308520	0.916659	S	2.427219	7.211638

Table 7. Exchangeable calcium and magnesium of soil in different villages of phulpur block of prayagraj district at 0-15cm, 15-30cm and 30-45 cm depth

Villages	Exchangeable Calcium (Meq 100g^{-1})			Exchangeable Magnesium (Meq 100g^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
V1	4.00	3.81	3.48	2.07	1.91	1.79
V2	4.40	4.10	3.77	2.44	2.31	2.13
V3	4.10	3.84	3.62	2.55	2.35	2.23
V4	5.20	4.90	4.70	2.72	2.55	2.39
V5	5.50	5.20	4.90	2.65	2.49	2.30
V6	5.15	4.93	4.61	2.16	1.92	1.80
V7	4.75	4.54	4.29	2.00	1.87	1.76
V8	4.11	3.85	3.63	1.94	1.78	1.66
V9	4.76	4.52	4.31	2.07	1.91	1.79
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.06334	0.188192	S	0.027845	0.082731
Depth (15-30cm)	S	0.08778	0.240301	S	0.031072	0.092318
Depth (30-45cm)	S	0.54626	0.162301	S	0.031052	0.092261

3.3 Chemical Properties of Water

The result is displayed in Tables 8 and 9. The pH and electrical conductivity were moderately suitable for irrigation purpose (Table 8). The carbonate & bicarbonate of water are moderately suitable for irrigation. The chloride of water moderately or not suitable for irrigation. As per the guideline of FAO, [14-17]. 0 –2 Meq L-1 is the range for potassium concentration in water samples. All the sites have low to medium phosphorus & potassium content. As per the ICMR guidelines in (1975) 6.0 Meq L-1 is the desirable limit Exchangeable Calcium and magnesium content for total hardness and suitable range for irrigation which state that most of the water samples from Phulpur block are suitable for irrigation purpose in terms of hardness (Table 8). Calcium and magnesium both increases the soil pH as its availability increases in soil. The sodium absorption ratio (SAR) values, indicated low to moderate levels of sodium content in the water samples. The soluble sodium percent (SSP) values providing further insight into the sodium content in the water. The residual sodium carbonate (RSC) values low to high hazard range suitable for irrigation purpose. The permeability index (PI) values serving as an indicator of the potential impact of water on soil permeability. The Kelley's ratio (KR) values are a measure of the sodium hazard in irrigation water and suitable range for irrigation. The irrigation water quality index value determined that all samples are in suitable range for irrigation [18-20].

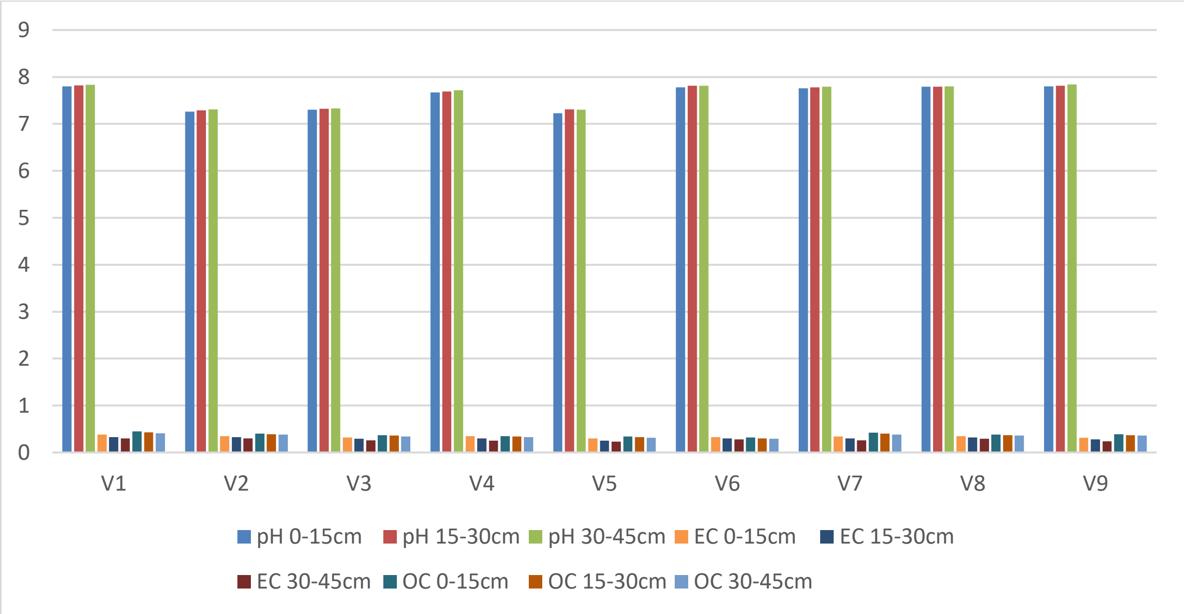

Fig. 3 .Soil pH, EC and organic carbon of soil in different villages of phulpur block of prayagraj district at 0-15cm, 15-30cm and 30-45 cm depth

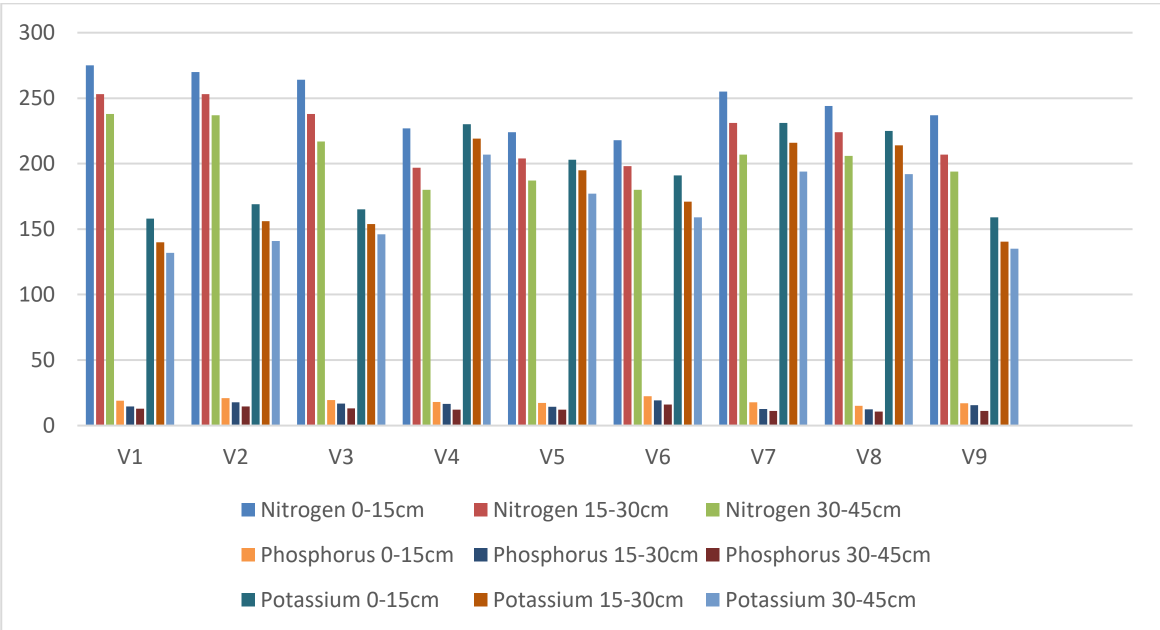

Fig. 4. Available nitrogen, phosphorus and potassium of soilin different villages of phulpur block of prayagraj district at 0-15cm, 15-30cm and 30-45 cm depth

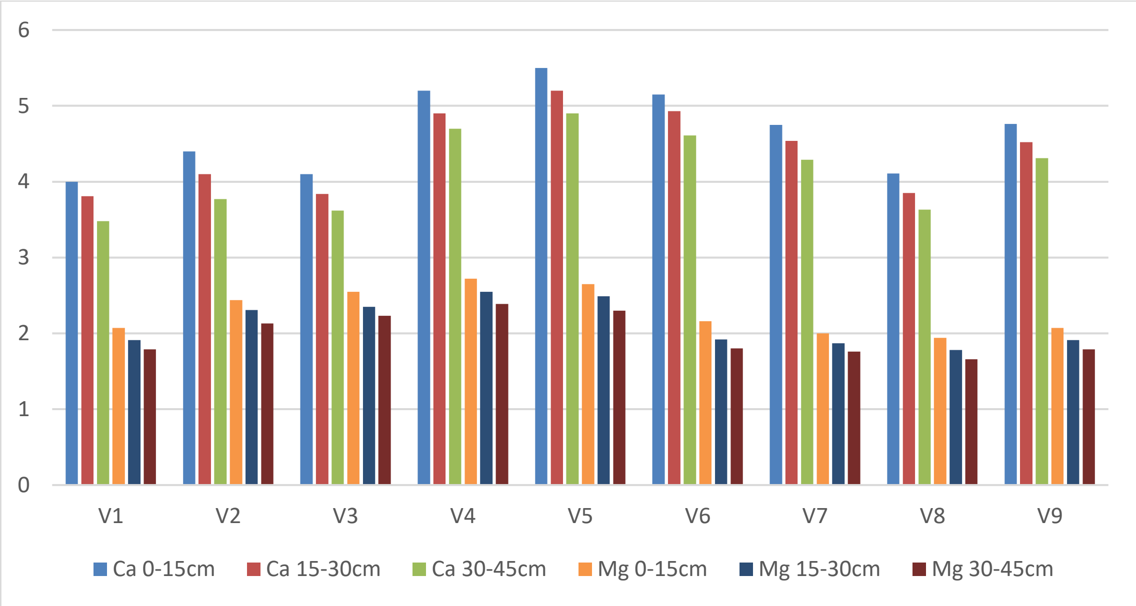

Fig. 5. Exchangeable calcium and magnesium of soilin different villages of phulpur block of prayagraj district at 0-15cm, 15-30cm and 30-45 cm depth

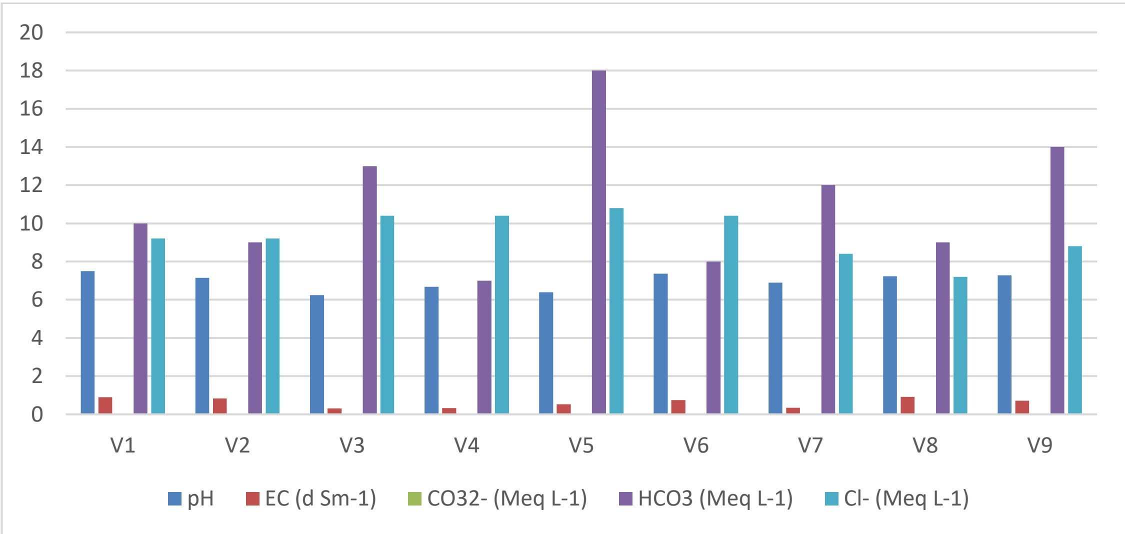

Fig. 6. pH, EC, $CO3^{2-}$, HCO3 and Cl^- of water sample different villages of phulpur block of prayagraj district

Table 8. Results of chemical parameters of water in phulpur block in prayagraj district

Village	pH	EC (dSm^{-1})	$CO3^{2-}$ ($Meq L^{-1}$)	HCO^3 ($Meq L^{-1}$)	Cl^- ($Meq L^{-1}$)	Ca ($Meq L^{-1}$)	Mg ($Meq L^{-1}$)	Ca+Mg ($Meq L^{-1}$)	K+ ($Meq L^{-1}$)	Na+ ($Meq L^{-1}$)
V1	7.5	0.9	0	10	9.2	8	3.4	11.4	0.12	0.17
V2	7.14	0.83	0	9	9.2	5.6	3.2	8.8	0.15	0.21
V3	6.24	0.31	0	13	10.4	7.4	3.6	11	0.17	0.15
V4	6.68	0.33	0	7	10.4	4.6	2.8	6.4	0.15	0.2
V5	6.4	0.53	0	18	10.8	7.0	3.6	10.6	0.1	0.08
V6	7.37	0.75	0	8	10.4	4.2	2.7	6.9	0.05	0.21
V7	6.9	0.35	0	12	8.4	5.3	3.1	8.4	0.07	0.1
V8	7.23	0.92	0	9	7.2	6.7	2.5	9.2	0.09	0.12
V9	7.28	0.72	0	14	8.8	6.8	3.2	10	0.07	0.08
F– test	**S**	**S**	**NS**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.Em.(±)	0.95457	0.011479	-	*0.175286*	0.11492	0.088363	0.034269	0.06968	0.001428	0.001452
C.D.@5%	0.28491	0.34104	-	*0.520801*	0.341445	0.262541	0.101818	0.47893	0.004243	0.004315

Table 9. Results of Irrigation water quality parameters of phulpur block in prayagraj district

Village	SAR (Meq L^{-1})	SSP (Meq L^{-1})	KR (Meq L^{-1})	PI (Meq L^{-1})	RSC (Meq L^{-1})	IQWI (Meq L^{-1})
V1	0.07	2.48	0.015	29	-1.4	44
V2	0.10	3.93	0.024	34	0.2	110
V3	0.06	2.83	0.014	39	2.0	140
V4	0.09	3.59	0.021	36	-2.4	115
V5	0.03	1.67	0.008	56	7.4	121
V6	0.10	2.84	0.024	28	-0.9	57
V7	0.04	1.47	0.009	47	0.6	78
V8	0.05	2.23	0.013	33	-0.2	134
V9	0.03	1.48	0.008	47	4.0	154
F– test	**S**	**S**	**S**	**S**	**S**	**S**
S.Em.(±)	0.001211	0.03453	0.000214	0.018542	0.04866	0.34587
C.D.@5%	0.003599	0.102594	0.000635	0.055093	0.144577	0.37446

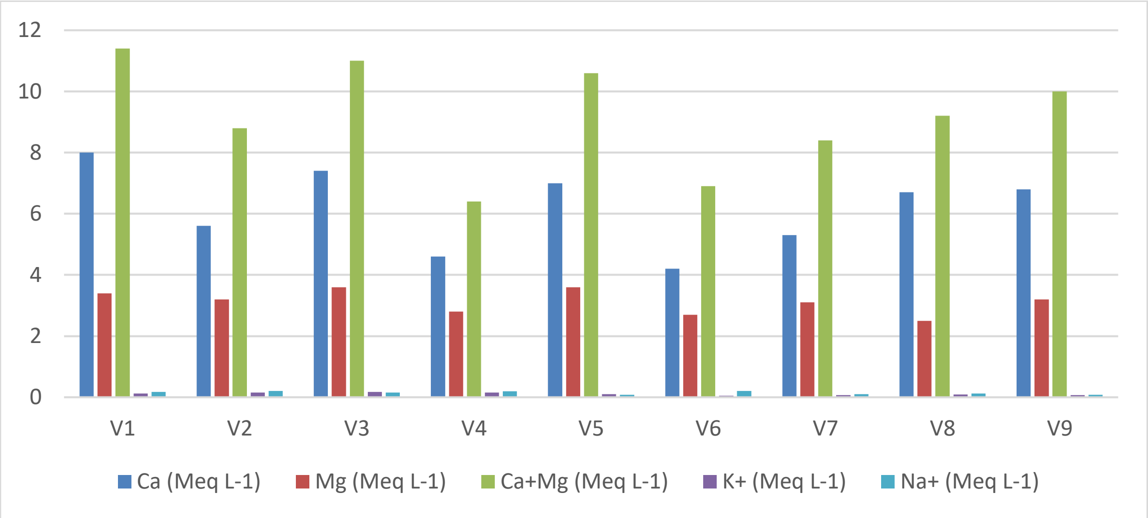

Fig. 7. Ca, Mg, Ca+Mg, $K^+$and Na^+ of water sample different villages of phulpur block of prayagraj district

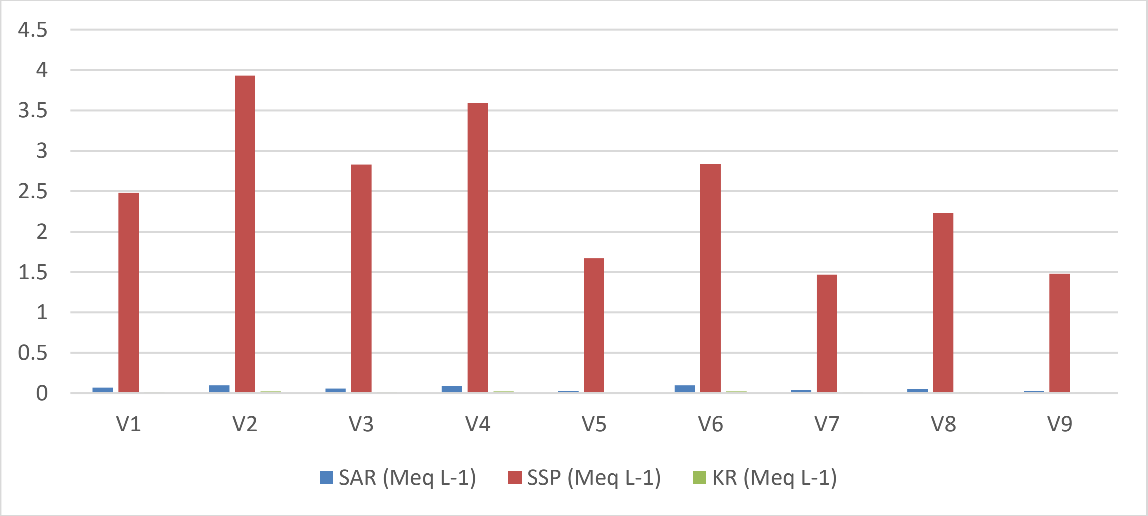

Fig. 8. SAR, SSP and KR of irrigation water quality parameters of phulpur block in prayagraj district

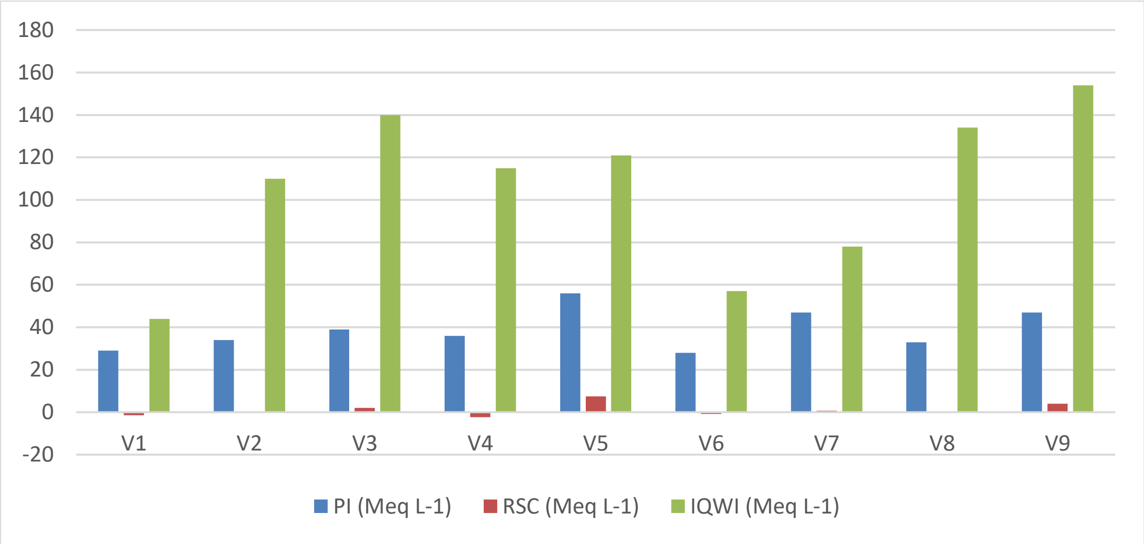

Fig. 9. PI, RSC and IQWI of irrigation water quality parameters of phulpur block in prayagraj district

4. CONCLUSION

According to the soil and water test results of Phulpur block, Prayagraj, provide valuable insights into the soil and water quality parameters, highlighting important considerations for suitable agriculture. The soil pH is neutral to slightly alkaline in condition. On the soil complex the dominant cation is calcium. The physical properties of both surficial and sub-surficial soils were normal as the bulk density value is normal. The water holding capacity is medium to high. The soils' overall fertility level was low, medium, and high in nitrogen, phosphorus, and potassium, respectively. Since the soils were calcareous and intensely alkaline, any acid-forming amendments and organic materials were required to alleviate nutrient deficit and promote soil productivity. The water pH was found to be slightly acidic to neutral and all the water samples showed very low sodium hazard. The alkalinity of water samples has shown that 77.77% of sample are suitable and 33.33% of samples are not suitable for irrigation. The total hardness of the water samples was a moderate range of soluble salts in the water sample indicating moderately suitable for irrigation. Irrigation water quality index samples have shown that 100% of the samples were in Suitable condition for irrigation purposes.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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