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Correlation of irrigation water and soil in Telhara and Nandura Tehsils of Purna valley

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Abstract
The present investigation entitled "Correlation of irrigation water and soil in Telhara and Nandura tehsils of Purna valley" was undertaken during 2020-2021 at Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The investigation was carried out to correlate the properties of irrigation water and properties of soil by using saturated soil paste extract in Purna tract in Telhara and Nandura tehsil. Twenty water samples from borewells were collected in post monsoon season (winter) from Telhara tehsil of Akola Disrict and Nandura tehsil of Buldhana District.
The simple correlation studies indicated that the parameters of irrigation water collected from borewell especially in respect of EC, Sodium and bicarbonates have highly correlated with parameters of soil.

Keywords: Saline water, soil, pH, electrical conductivity, paste extract, cations, anions

Introduction
Irrigation water is an essential and vital component of our life support system. It has become one of the important sources of water for meeting the requirements of various sectors of water use including agriculture in the country. At present, groundwater meets 65% of India's water demand and accounts for roughly half of the irrigated area. It plays a vital role over the last decade in country's economic development and in ensuring its food security. In addition, ground water development for irrigation has been recognized as having the potential to play a major role in rural poverty alleviation. The number of mechanized bore wells in India has increased from less than a million in 1960 to about 28 million in 2002 and every year there is an addition of 0.8 million wells (Shah *et al*., 2009) [22].
Water quality affects soil quality both directly and indirectly. The land use pattern changes are based on the quality of soil and water, as they have influence on the crops to be grown. Sustainable crop production can be done by using high-quality irrigation water keeping other inputs optimal. The quality of available ground water in most of the villages is not suitable for sustainable crop production and soil health (Ali *et al*., 2009) [2]. About 48 per cent of the water samples in Gujarat and 20 per cent in Rawalpindi Pakistan (Rizwan *et al*., 2003) [21] were unfit for irrigation.
Irrigation facilities in Purna Valley is increased with introduction of wells, bore wells in last five years. The irrigation water either derived from surface stream or pumped from well contains mineral salts in solution, dissolved from rock or soil over which water have passed. The water is a double-edged weapon in the sense, that it tremendously increases the quantum of yield from the soil but it is also capable of permanently damaging the soil and reducing its production potential beyond recognition and visualization.
The farmers in Purna Valley of Vidarbha region use to give protective irrigation by using bore well water. Presence of monovalent cations in the soil solution or in the percolating water causes dispersion of the soil colloids. The soils of Purna Valley are highly saline to sodic which is not suitable for irrigation even though the farmers of that area are applying irrigation with saline water which may rise again soil salinity and can hamper the soil health in future and also due to increase in different salts in such soils may increase dispersion and logging of pore spaces.
The farmers adopted irrigation in Purna valley without any scientific management. To avoid the adverse effect of salts present in water, present research was carried out.

Material and Methods
The present investigation entitled "Correlation of irrigation water and soil in Telhara and

Nandura tehsils of Purna valley" was undertaken with object to correlate the irrigation water with soil properties by using saturated soil paste extract in Telhara and Nandura tehsils of Purna valley.

Bore wells were identified as the potential source of irrigation water. The water samples were collected by using GPS. The standard procedures were applied to analyze the samples for various quality parameters. The water samples of borewell were collected in post monsoon (winter) (October-February) season. Twenty ground water samples collected from bore well from villages viz. Dapura, Bhamberi, Khaparkhed, Thar, Dahigaon, Manatri BK, Adsul, Talegaon Paturda from Telhara tehsil of Akola disrict and Nimgaon, Dadgaon, Hingna, Narkhed, Zadegaon, Yerali, Belad, Alampur, Pathonda, Parsoda from Nandura tehsil of Buldhana District in Purna valley. Simultaneously soil samples were also collected after irrigation at respective field. The samples were analyzed for various quality parameters at Department of Soil Science and Agricultural Chemistry, Dr. P.D.K.V., Akola during 2020-2021.

Water samples were collected in closed air tight plastic bottles and transported to laboratory for analysis. The samples were analyzed in the laboratory for pH, EC, ionic composition. Different indices were worked out for quality ratings as given by Richards, 1954 [20]. pH of water samples were measured by using glass electrode pH meter (Jackson, 1973) [11]. EC of water samples were measured by using Conductivity Bridge as given by Jackson (1973) [11]. The calcium and magnesium were determined by Versenate titration method as given by Richards (1954) [20]. Sodium and potassium were determined by flame photometer as described by Page *et al.* (1989) [19]. The carbonates and bicarbonates were determined by rapid titration method as outlined by Richards (1954) [20]. Chlorides were determined by titration with standard $AgNO_3$ as described by Richards (1954) [20]. Sulphates were determined by turbedimetric method given by Jackson (1973) [11].

Saturated soil paste and saturation extracts were prepared of selected soil samples as per procedure outlined by Richards (1954) [20] and then extract were analyzed for different parameters as same as parameters of water. The simple correlation between bore well water and paste extract was studied.

Result and Discussion

A. Analysed parameters of irrigation water

1. pH

The results placed in table 1 indicated that the pH of the bore well water was in the range of 7.32 to 9.2. The average value of pH falls under medium limit. The borewell water which exceeds limits of 8.0 reflects that the entire water contains higher soluble sodium and bicarbonates which interfere the hydroxyl ion concentration in water and increased pH values towards alkalinity. Jana (1973) [13] has reported that the higher pH concentration during pre-monsoon season.

2. Electrical conductivity (EC)

The primary effect of high electrical conductivity of water is the major reason for failure of crop productivity. The higher the electrical conductivity lesser the availability of water to plant, even though the soil may show wet, because plant can only transpire "pure" water, therefore, irrigation water with high electrical conductivity reduce the yield potential (Handa, 1969) [8]. The data in respect of electrical conductivity of borewell is placed in table 1. The electrical conductivity of irrigation water i.e., of bore well were in the range of 1.11 to 3.2 dSm^{-1}. In most of the cases it falls under C_3 and C_4 class and was higher than the recommended water quality guidelines for irrigation water use in agriculture as per the criteria given by Richards, (1954) [20] i.e., <0.25 $dSm^{-1)}$ while criteria given by Bhumbla and Abrol, (1972) [7] for Indian clay soil i.e., 1.5 dSm^{-1} for semi tolerant crop and 2.0 dSm^{-1} for tolerant crop.

3. Cations

The values of cations in table 1, clearly indicates that the calcium content in borewell water was in the range of 4.2 to 6.1 meL^{-1}, which was in between the permissible limit (0-20 meL^{-1}) as per the criteria of normal ranking of irrigation water given by Ayers and Westcot (1985) [4]. The concentration of magnesium was 3.1 to 4.9 meL^{-1} in borewell water. Some villages were beyond permissible limit (0-5 meL^{-1}). The higher concentration of magnesium in irrigation water increases the soil pH, which reflected on detrimental effect of magnesium on physical properties of soil. The sodium concentration in bore well water was in between 12.77 to 18.21 meL^{-1} which dominant among all cations in irrigation water collected from borewell. Based on the results obtained in respect of sodium in irrigation water and as per criteria given by Richards (1954) [20], it was classified into S_2 class which having medium sodium hazards. The irrigation water that has high sodium (Na+) content can bring about a displacement of exchangeable cation Ca^{2+} and Mg^{2+} from the clay minerals of the soil, followed by the replacement of the cations by sodium. (Islam and Shamsad, 2009) [10]. The data reveals that potassium concentration was very low in the borewell water and it was in between the permissible limit (0-2 meL^{-1}). The potassium content in borewell water was in the range of 0.04 to 0.14 meL^{-1}.

4. Anions

The data placed in table 1 shows the value of anions. Bicarbonate concentration in borewell water was in the range of 9.1 to 14.1 meL^{-1}. Most of the values in respect of bicarbonates in water sample from borewell were beyond the permissible limit (0-10 meL^{-1}). The bicarbonate content can bring about a change in soluble sodium percentage in irrigation water which, regulates the sodium hazards (Adhikary and Biswas, 2011) [1]. The values obtained reveals that the chloride content in irrigation water from borewell was varied from 4.1 to 12.1 meL^{-1}. The values of chloride exceed the permissible limit of 4 meL^{-1} which indicates the impact of settlement and anthropogenic effect. Adhikary and Biswas, (2011) [1] also reported that the chloride content normally increases as the mineral content increase and may reduce phosphorus availability to plants. The data reveals that the concentration of sulphate was in between 5.3 to 10.5 meL^{-1} from bore well, which was within the permissible limit (0-20 meL^{-1}) given by Richards (1954) [20]. Sulphate is relatively common in irrigation water and has no major effect on the soil other than contributing to the total salt content. However, irrigation water high in sulphate ion reduced phosphorus availability to plants (Khalil and Arther. 2010) [15].

Table 1: Parameters of irrigation water and paste extract

Parameters	Irrigation water			Paste extract		
	Min	Max	Avg.	Min	Max	Avg.
pH	7.32	9.2	8.03	7.46	8.27	8.05
Electrical conductivity (dSm^{-1})	1.11	3.2	2.14	0.81	1.8	1.02
Calcium (meL^{-1})	4.2	6.1	5.19	3.5	4.9	4.16
Magnesium (meL^{-1})	3.1	4.9	3.91	2.9	5.7	4.3
Sodium (meL^{-1})	12.77	18.21	13.91	5.1	8.4	6.7
Potassium (meL^{-1})	0.04	0.14	0.06	0.09	0.99	0.57
Bicarbonates (meL^{-1})	9.1	14.1	10.15	3.2	6.8	5.4
Chlorides (meL^{-1})	4.1	12.1	6.09	1.4	5.6	3.45
Sulphates (meL^{-1})	5.33	10.5	6.76	3.4	7.03	4.06

B. Analysed parameters of saturation paste extract

1. pH_s

The data regarding pH_s of saturation paste extract is placed in the table 1. It was observed that the pH_s of soil samples collected from the area where the field was irrigated with bore well water was in the range of 7.46 to 8.27. The highest pH_s was noted 8.27 which was strongly alkaline at village Parsoda.

2. Electrical Conductivity (EC_e)

The data in respect of electrical conductivity of saturation paste extract is presented in table 1. The electrical conductivity of saturation paste extract (EC_e) of the soil samples irrigated with borewell water was in the range of 0.81 to 1.80 dSm^{-1}. The highest values of EC_e might be due to the continuous use of salt affected water through borewell and noted 1.8 dSm^{-1} in the village Pathonda. Similar results were also obtained by Bharambe *et al.* (2001) [5] in Jayakwadi command area.

3. Cations

The saturation paste extract analysis of soil, indicated the cationic concentration and placed in the table 1. The data reveals that the concentration of calcium from the soil irrigated with borewell water was 3.56 to 4.98 meL^{-1}. The highest calcium and magnesium was noted in Adsul village. The magnesium concentration was in the range of 2.91 to 5.72 meL^{-1} from borewell. In case of sodium content, it ranges between 5.14 to 8.49 meL^{-1}. The highest sodium noted in khaparkhed village with the use of bore well water. Potassium content in saturation extract in borewell was in the range of 0.09 to 0.99 meL^{-1}. The dominance of Na^+ over Ca^{2+}, Mg^{2+} and K^+ ions in the saturation extract of the salt affected soils was also reported by Kotur and Seshagiri (1987) [17] and More *et al.* (1988) [18]. Jain *et al.* (2000) [12] and Bhaskar *et al.* (2005) [6] have also reported the incidence of concentration of Na in the command areas.

4. Anions: The data regarding anionic concentration in saturation paste extract is mentioned in table 1. The data reveals that among the anions, bicarbonate content was in the range of 3.2 to 6.8 meL^{-1} from soil irrigated with borewell, while chloride was in the range of 1.4 to 5.6 meL^{-1}. Similarly, the sulphate concentration in soil was also assessed and it was in the range of 3.4 to 7.03 meL^{-1}. Highest sulphate was noted in Manatri BK village and bicarbonate and chloride in Talegaon Paturda village. Kharde (1992) [16] indicated similar results that the anionic concentration that the bicarbonate ions in saturation paste extract dominated over other anions and showed the average abundance of anions in the order of $HCO_3^- > SO_4^{2-} > Cl^-$.

C. Correlation between irrigation water and paste extract analysis

The simple correlation between borewell water and paste extract studied and data has been placed in table 2. Based on the data, it was observed that Calcium (0.698), Sodium (0.896), bicarbonates (0.857), Chlorides (0.744) and sulphates (0.652) of paste extract has positive correlation with electrical conductivity of borewell water. Whereas, magnesium (-0.157), potassium (-0.596) of paste extract has negatively correlated with electrical conductivity of borewell water. The soluble cations (Magnesium, Sodium) and anions (Bicarbonates, Chloride) have also positive correlation with calcium in borewell water. Soluble bicarbonates (-0.194) have negative correlation with magnesium in borewell water. Soluble potassium (-0.723) of paste extract has negative correlation with sodium in borewell water. Soluble bicarbonates (0.889) and chlorides (0.688) of paste extract have positive correlation with sodium in borewell water while it has negative correlation with potassium in borewell water. Chloride (0.672) has positive correlation with bicarbonates in borewell water. The simple correlation studies indicated that the parameters of irrigation water collected from borewell especially in respect of EC, Sodium and bicarbonates have highly correlated with parameters of soil.

Table 2: Correlation of bore well water and paste extract analysis

	pH_{IW}	EC_{IW}	Ca_{IW}	Mg_{IW}	Na_{IW}	K_{IW}	$HCO_{3\,IW}$	Cl_{IW}	$SO_{4\,IW}$
pHs	1.000								
ECe	-0.055	1.000							
Ca	0.148	0.698*	1.000						
Mg	0.074	-0.157	0.017	1.000					
Na	-0.045	0.896**	0.753**	-0.223	1.000				
K	-0.005	-0.596*	-0.600*	0.246	-0.723**	1.000			
HCO_3	0.027	0.857**	0.740**	-0.194	0.889**	-0.737**	1.000		
Cl	-0.168	0.744**	0.595*	-0.088	0.688*	-0.397	0.672*	1.000	
SO_4	0.126	0.652*	0.614*	-0.358	0.690*	-0.564*	0.654*	0.364	1.000

Where,
IW stands for Irrigation Water.
*Indicates the correlation between borewell and paste extract is significant at 5% probability level
**Indicates the correlation between borewell and paste extract is significant at 1% probability level.

Conclusion

The overall result exhibited that the parameters of irrigation water collected from borewell especially in respect of EC, Sodium and bicarbonates have highly correlated with parameters of respective soil samples in Telhara tehsil of Akola district and Nandura tehsil of Buldhana district during post monsoon season.

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