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Relating apparent electrical conductivity and pH to soil and water in Kanagal surrounding area, Nalgonda district, Andhra Pradesh

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ABSTRACT

Apparent electrical conductivity (EC) of the soil and water profile can be used as an indirect indicator of a number of soil and water. Electrical conductivity of soil and water is recorded is 0.94 to 6.26 dS/m with the mean value of 2.824 dS/m, 1090 to 6560 µS/cm with the mean value of 3028.12 µS/cm respectively. The soil pH values recorded is 7.15 – 8.45 for groundwater samples, hence in water pH values range of 7.46 – 8.08 for groundwater samples.

Keywords: Electrical conductivity, pH, soil and water, Kanagal area

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INTRODUCTION

Agriculture is challenged to produce sufficient food yet conserve the quality of essential soil, water, and air resources. The utility of soil and water electrical conductivity (EC) as indicators of condition and stewardship of farmlands and water resources [19 and 26]. Soil pH is one of the most informative properties of the soil. It is a measure of the hydrogen ion concentration in soil and also determines the solubility and availability of most nutrients in soil [10 and 11]. Extremes of soil pH are not only detrimental to crops but also imply the toxicity or deficiency of some soil nutrients. Use of commercial liming materials to solve problems of soil acidity is expensive, particularly for rural farmers. Researchers have related EC to a number of different soil properties either within individual fields or across closely related soil landscapes. Examples include soil moisture [14 and 25], clay content [29], and cation exchange capacity and exchangable Ca and Mg [17]. Most of the variation in EC can be related to salt concentration for saline soils [28]. In non-saline soils, conductivity variations are primarily a function of soil texture, moisture content, and cation exchange capacity (CEC) [21]. The investigation area is part of the Nalgonda district and consisting granitic rocks of the stable peninsular shield and it is part of Eastern Dharwar Craton, which was formed 2.5 million years ago. The study area comprises of granitic rocks of magmatic origin and they are in both varieties in colour pink and gray. The present study is aim to know the variation of soil pH and EC, to compare with water pH and EC in Kanagal surrounding area of Nalgonda district, Andhra Pradesh.

MATERIALS AND METHODS

Sampling stations

The place of study at which soil and water samples were collected is referred to as "Stations". The study pertains to the quality of Kanagal surrounding areas in Nalgonda district Andhra Pradesh. Sixteen soil and water sampling stations are selected. They are represented as Koya gurondibavi (WS1), Ramachandrapuram (WS2), Kurampally

(WS3), Kotaiahgudem (WS4), Udutalapally (WS5), Ponugodu (WS6), Menduvarigudem (WS7), Lingalagudem (WS8), Lakshmidevigudem (WS9), G.Yadavali (WS10), Regatta (WS11), Shabdulapoor (WS12), Madanapuram (WS13), Dorapally (WS14), Rayibavigudem (WS15) and Matronigudem (WS16).

Sample collection and preparations

The soil and water samples were collected in high-density polyethylene and plastic containers. Prior to use, cans were cleaned thoroughly and rinsed with distilled water. They were dried, cooled, and labeled. Soil was also obtained from the site in sealed plastic containers. The soil was selected from a region where the contaminants are present at trace concentrations and not in the form of a separate non-aqueous phase liquid. 500 grams of this soil were homogenized and used for the desorption experiments. Water samples were filtered with Whatman filter paper grade number 42 before analysis. All necessary precautions were taken during sampling analysis and transportations of water samples to the laboratory [6].

Laboratory Procedures

Measurements of electrical conductivity (EC) is determined on a saturation extract of soil or supernatent liquid of 1:2 soil, water suspension. Electrical conductivity is measured with the help of electrical conductivity meter. The conductivity meter is to be calibrated and cell constant be determined with a Standard Solution of 0.7445 gm of dry potassium chloride of 1 liter of distilled water at 25°C. A 20gm of soil sample is shaken with 40ml of distilled water in a 250ml conical flask for 1hr. The physico-chemical parameters such as pH and electrical conductivity were analyzed using the procedure as per standard method of [1, 8 and 16]. The instrumental methods used for chemical analysis of water are given in Table 1. Sampling sites of the collected water and soils in the Kanagal surrounding area, Nalgonda district, Andhra Pradesh is shown in Table 2.

Table 1. Instrumental methods used for chemical analysis of groundwater in the Kanagal surrounding area, Nalgonda district, Andhra Pradesh

Chemical parameter	Units	Method, instrument (make)	Reagents	Reference
pH	–	pH meter (Systronics)	pH 4, 7 and 9.2 (buffer solutions)	APHA (1992)
EC	µS/cm	EC meter (Systronics)	Potassium chloride	

Table 2. Sampling sites of the collected water and soils in the Kanagal surrounding area, Nalgonda district, Andhra Pradesh

S. No	Sampling Site Names	Soil pH	Soil EC dS/m	water pH	Water EC µS/cm
WS1	Koya gurondibavi	8	1.904	7.62	1590
WS2	Ramachandrapuram	7.68	3.160	7.65	4950
WS3	Kurampally	7.57	5.490	7.83	2200
WS4	Kotaiahgudem	7.87	1.790	8.08	4460
WS5	Udutalapally	7.8	2.90	7.88	2380
WS6	Ponugodu	7.51	2.50	7.77	3650
WS7	Menduvarigudem	7.52	4.60	7.78	2600
WS8	Lingalagudem	7.93	1.40	7.65	2070
WS9	Lakshmidevigudem	7.57	1.580	7.92	1470
WS10	G.yadavali	8.45	2.390	7.46	4560
WS11	Regatta	8	4.30	7.52	4220
WS12	Shabdulapoor	8.23	2.20	7.91	2620
WS13	Madanapuram	7.77	6.260	7.65	5160
WS14	Dorapally	8.11	1.890	7.8	2130
WS15	Rayibavigudem	7.15	0.940	7.76	1090
WS16	Matronigudem	8.16	1.890	7.72	1300
Minimum		**7.15**	**0.94**	**7.46**	**1090**
Maximum		**8.45**	**6.260**	**8.08**	**5160**
Average		**7.8325**	**2.824**	**7.75**	**2903.125**

Soil pH

Soil acidity is expressed as soil pH, using a scale from 0 to 14. Soil pH values below 7 indicate acidic soil, and above 7 indicate basic (alkaline) soil. pH is defined as the negative logaritham of the hydrogen ion concentration in solution. It is determined largely by soil composition, cation exchange processes, and hydrolysis reactions associated with the various organic and inorganic soil components [27], as well as by the CO_2 concentration in the soil gaseous and liquid phase. In the soil, a distinction can be made between actual acidity, which is the H^+ concentration of the soil solution, and potential acidity, which also includes H^+ ions adsorbed to soil colloids. Besides the actual soil fertility, the buffer capacity of a soil is of importance in determining the pH in that hydrogen ions produced by various processes in the soil are buffered by soil colloids. Most soils have pH values between 3.5 and 10 (Figure 1).

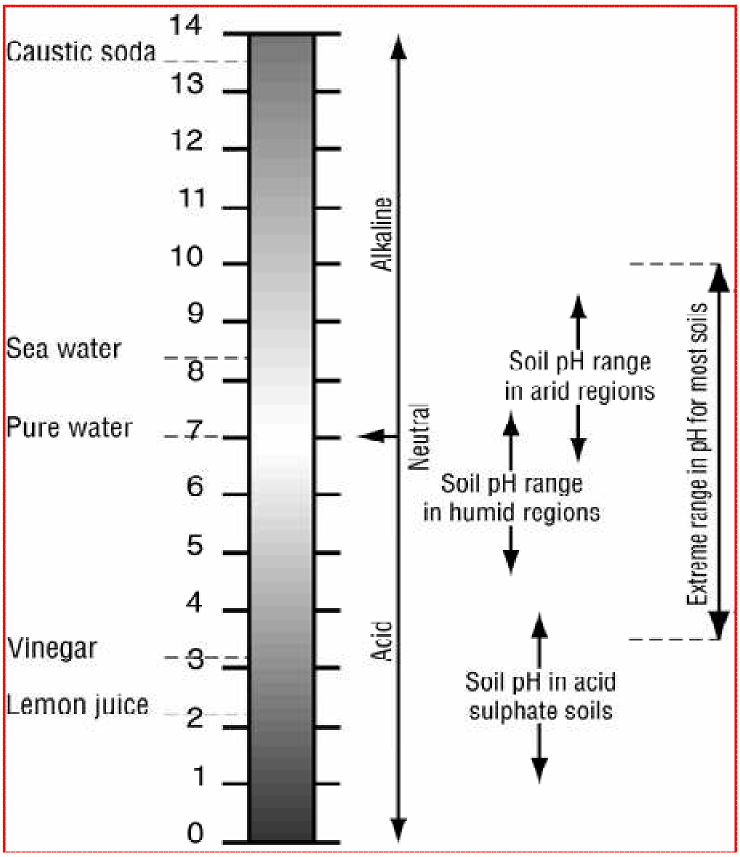

Figure 1. The range of pH values found in soils

Soil pH classifications

Most soils have a pH in the range of 2.0 to 11.0, while soils with sulphuric material may have a pH below 2.0 upon oxidation [24]. Four soil pH ranges are particularly informative:

(a) a pH less than 4 indicates the presence of free acids, generally from oxidation of sulphides;
(b) a pH below 5.5 points to the likely occurrence of exchangeable Al^{3+}. Below a pH of 4.5 a significant amount of exchangeable H^+ is probably present in addition to exchangeable Al^{3+}.
(c) a pH from 7.3 to 8.5 indicates the presence of $CaCO_3$; the presence of strong concentrations of neutral soluble salts, such as NaCl and Na_2SO_4, in a saturated extract is reflected by a high electrical conductivity (EC >4 dS/m).
(d) a pH greater than 8.5 indicates the presence of significant amounts of exchangeable sodium as a result of the presence of sodium carbonate (Na_2CO_3); the electrical conductivity is generally low (EC <4 dS/m).

In the present study, soil pH values range from 7.15 to 8.45 (Table 2) and most of soil pH is represented the presence of strong concentration of neutral soluble salts. Soil pH concentration is shown in Fig. 2 and it explains that more concentration is in northeastern part of the study area.

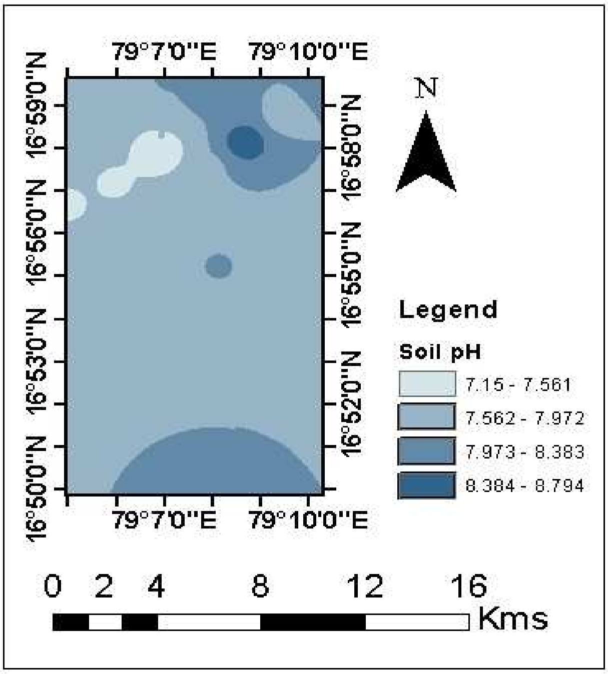

Fig. 2. Concentration of Soil pH

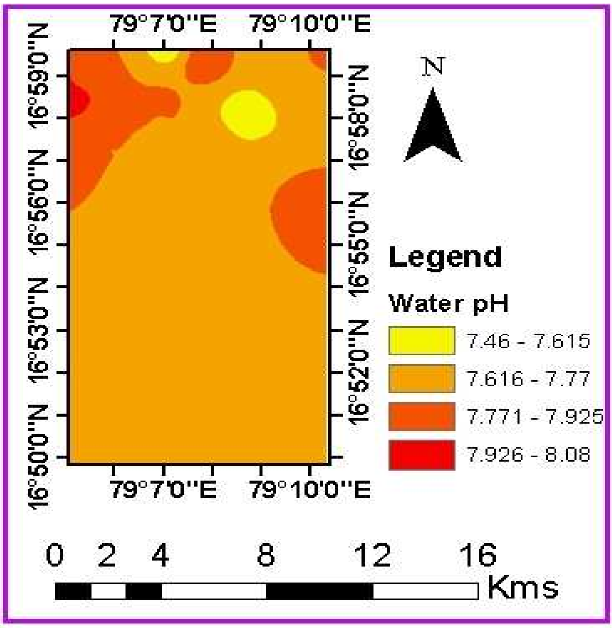

Fig. 3. Concentration of water pH

Water pH

pH value is an important factor in maintaining the carbonate and bicarbonate levels in water. The permissible limit of pH varies from 6.5 to 8.5 for drinking water [5 and 18]. The value of pH (7.46 – 8.08) indicating an alkaline condition of groundwater, in the study area is within the recommended limit of 6.5–8.5 so that the water comes under potable category. The measure of pH is on a scale of 0-14 wherein pH less than 7 is acidic and greater than 7 is alkaline (basic) and exact 7 is neutral. Thus the groundwater samples are, at places slightly more basic values of over 8 are noticed WS1 Koya gurondibavi, WS10 G.yadavali, WS11 Regatta, WS12 Shabdulapoor, WS14 Dorapally and WS16 Matronigudem. The slight alkalinity may be due to the presence of bicarbonate ions, which are produced by the free combination of CO_2 with water to form carbonic acid, which affects the pH of the water [3]. Carbonic acid (H_2CO_3) dissociates partly to produce (H^+) and bicarbonate ions [12]. The pH values increase slightly for groundwater samples in all the sampling stations. The mild alkalinity indicates the presence of weak basic salts in the soil [2]. The low pH does not cause any harmful effect. The water pH concentration is presented in Fig. 3 and it revealed that high concentration is showing in northwestern part of the study area.

Soil Electrical conductivity (EC)

Soil electrical conductivity (EC) is a useful indicator in managing agricultural systems [4]. In actuality, the interpretation of EC of a soil or media must be made considering the plant(s) to be grown. The EC of the soil has little direct detrimental effect on sandy mineral soils or on media. However, EC directly affects plants growing in the soil or media. The impact of EC on plants is also directly affected by water management. The electrical conductivity (EC) is the property that has a material to transmit or conduct electrical current [15]. The apparent soil electrical conductivity (EC) is influenced by various factors such as soil porosity, concentration of dissolved electrolytes, texture, quantity and composition of colloids, organic matter and water content in the soil [21].

The electrical conductivity of soils varies depending on the amount of moisture held by soil particles. Sands have a low conductivity, silts have a medium conductivity, and clays have a high conductivity. Electrical conductivity is an electrolytic process that takes place principally through water-filled pores. Cations (Ca^{2+}, Mg^{2+}, K^+ and Na^+) and anions (SO_4^{2-}, Cl^-, NO_3^- and HCO_3^-) from salts dissolved in soil water carry electrical charges and conduct the electrical current. Consequently, the concentration of ions determines the EC of soils. In general, an EC range of 0–1 dS/m indicates good soil health. Conductivity values above 1–2 dS/m result in reduced growth of salt-sensitive plants and disruption of the microbial mediated processes of nitrification and denitrification [7 and 23]. It varies from about 0.94 to 6.26 dS/m (Table 2) with the mean value of 2.824 dS/m in the study area (Fig. 4) and values of over >2 dS/m are recorded WS2 Ramachandrapuram, WS3 Kurampally, WS5 Udutalapally, WS6 Ponugodu, WS7 Menduvarigudem, WS10 G.Yadavali, WS11 Regatta, WS12 Shabdulapoor and WS13 Madanapuram. Concentration map of EC showing that high concentration is in northeastern part of the study area.

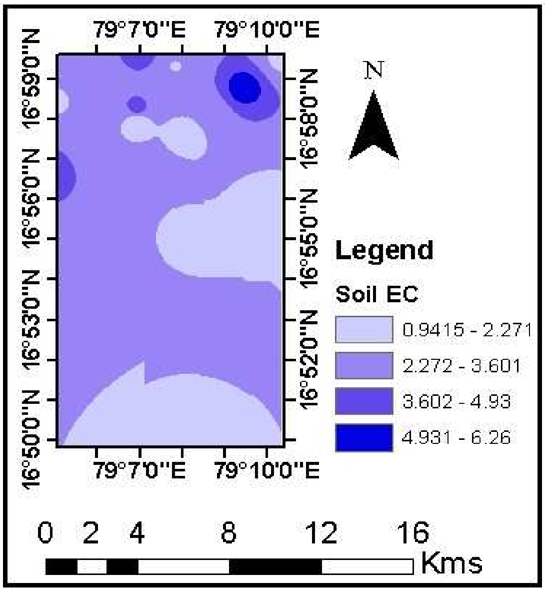

Fig. 4. Concentration of soil EC in dS/m

Water Electrical conductivity (EC)

The importance of electrical conductivity (EC) is its measure of salinity, which greatly affects the taste and has a significant impact of the user acceptance of the water as potable and higher the ionisable solids, the greater will be the EC. Electrical Conductivity (EC) depends upon temperature, ionic concentration and types of ions present in the water [9]. EC is measured in microsiemens per centimeter and is a measure of salt content of water in the form of ions [13]. The maximum permissible limit of EC in groundwater is 1500 μS/cm [5]. It varies from about 1090 to

6560 µS/cm (Table 2) with the mean value of 3028.12 µS/cm in the study area (Fig. 5). Anomalous peaks (>3000 µS/cm) are observed over WS13 Madanapuram, WS10 G.yadavali, WS11 Regatta, WS6 Ponugodu, WS4 Kotaiahgudem, WS2 Ramachandrapuram. Such anomalous values arise from various anthropogenic activities and geochemical processes prevailing in the region. Higher conductivity may be attributed to high salinity and high mineral percentage in groundwater samples, which is generally due to the ion exchange and solubilization process taken place within the aquifers, in addition to the leaching of agricultural runoff [22 and 20]. High EC values encountered at station WS13 may be due to higher rate of pollution of groundwater by the flushing and leaching action of rain, which transfers the surface contamination and high EC is recorded northeastern part of the study area (Fig 5).

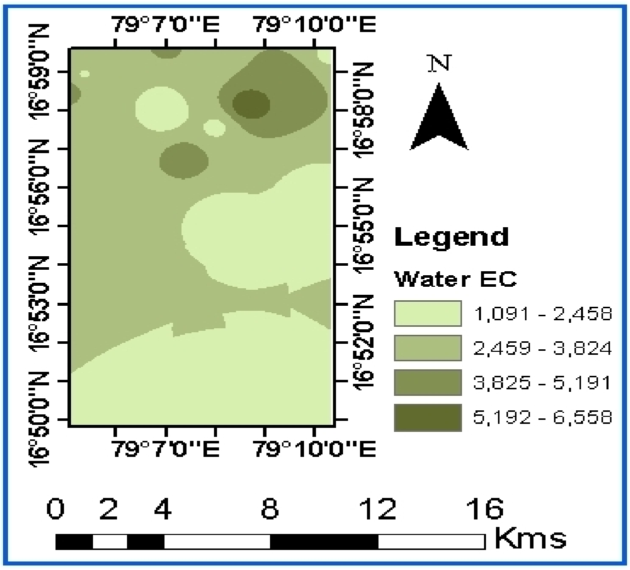

Fig. 5. Concentration of water EC in µS/cm

CONCLUSION

Electrical conductivity and pH to soil and water in Kanagal surrounding area, Nalgonda district, Andhra Pradesh shows that most of soil pH is represented the presence of strong concentration of neutral soluble salts, high and low values recorded in station of WS10 (G.Yadavli) and WS15 (Rayibavigudem) respectively, hence pH of water is range from 7.46 to 8.08, indicating an alkaline condition of groundwater, in the study area, high and low values recorded in station of WS4 (Kotaiahgudem) WS10 (G. Yadavli). The electrical conductivity of soils high and low values recorded in station of WS13 (Madanapuram) and WS15 (Rayibavigudem). Higher conductivity may be attributed to high salinity and high mineral percentage in groundwater samples, high and low values recorded in station of WS13 (Madanapuram) and WS15 (Rayibavigudem).

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