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Study of soil's nature by pH and soluble salts through EC of Kalol-Godhra taluka territory

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ABSTRACT

This physico-chemical study of soil is based on various parameters like pH, conductivity, Total Organic Carbon, Available Nitrogen (N), Available Phosphorus (P_2O_5) and Available Potassium (K_2O). This study lead us to the conclusion of the nature and nutrient's quantity of soil of Kalol and Godhra Taluka, District- Panchmahal, Gujarat. Results show that average all the villages of both these taluka have medium pH indicate neutral nature of soil and low Electrical Conductivity suggest absence of critical soluble salts which are injurious to crop. This information will help farmers to decide acidic or basic nature of soil and presence of soluble salts. From this data the farmers will be aware of the problems related to soil nature, nutrients and amount of fertilizers to be added to soil to make the production economic.

Key words: Quality of soil, pH, Electrical Conductance.

INTRODUCTION

Soil test based nutrient management has emerged as a key issue in efforts to increase agricultural productivity and production since optimal use of nutrients, based on soil analysis can improve crop productivity and minimize wastage of these nutrients, thus minimizing impact on environmental leading to bias through optimal production. Deficiencies of primary, secondary and micronutrients have been observed in intensive cultivated areas. Several States including Andhra Pradesh, Gujarat, Haryana, Karnataka and Uttar Pradesh have made commendable progress in soil testing programme in various ways such as expansion of soil testing facilities, popularization of the programme in campaign mode, development of soil fertility maps and use of information technology in delivering soil nutrient status and appropriate recommendation to farmers. This compendium is an effort to put together existing status of soil testing facilities state wise and highlight main issues in soil testing programme Compendium on soil health [1]. Soil is important to everyone either directly or indirectly. It is the natural bodies on which agricultural products grow and it has fragile ecosystem [2, 3].

The soil samples from 10 different villages of tribal area surrounding Dahod were collected. The physicochemical properties such as moisture content, specific gravity, pH measurement and estimations of Mg^{2+}, Na^+, K^+ and Cl^-, HCO_3^-, PO_4^{3-}, NO_3^-%of soil were studied by Dabhi et al [4]. One of The communication deals with quality of soil of Dahegam Taluka. Soil samples were collected from forty different villages of Dahegam Taluka. Quality characteristics of soil such as pH, Electrical Conductivity (EC), Calcium (Ca^{2+}), Magnesium(Mg^{2+}), Bicarbonate (HCO_3^-),Chloride(Cl^-), Total Organic Carbon, Available Nitrogen (N), Available Phosphorus (P_2O_5) and Available

Potassium (K_2O) were determined as per standard methods. Results show that 20% soils are deficient in organic carbon whereas 95% soils are deficient in available potassium [5].

Soil acidity is measured on the basis of the salt pH of the soil. The pHs measures the active acidity in the soil and indicates whether limestone applications are needed. To determine the amount of reserve acidity or limestone requirement to neutralize the soil acidity, the milli-equivalents of neutralizable acidity is measured by the Woodruff Buffer [6]. Plant nutrient availability is strongly tied to the activity of H^+, or pH in the soil solution. Decreasing soil pH directly increases the solubility of Mn, Zn, Cu, and Fe. At pH values less than approximately 5.5, toxic levels of Mn, Zn or Al (a non-nutrient element common in soils) may be released. The availability of N, K, Ca, Mg and S tend to decrease with decreasing pH since conditions which acidify the soil such as weathering and plant uptake also result in removal of these nutrients or in decreased microbial activity. The effects on P and B are primarily indirect as well, since the availability of these nutrients depends on formation of less soluble compounds with Al, Fe, Mn and Ca, which are affected by pH . As a result, P and B availability decrease at both very low and very high pH, with maximum availability in the range of pH 5.5 to 7.0. These reactions bind P much more strongly than B, with the result that available B can be readily leached from soil [7a].

Most salt-affected soils occur in the arid and semiarid climates where rainfall is not sufficient to dissolve and leach salts such as Cl, SO_4, HCO_3, Na, Ca, Mg and K below the root zone. They are particularly prevalent in irrigated regions where improper irrigation and drainage methods are used. Sodium is of particular note, since it can be toxic to plants and detrimental to soil structure. Salt problems in soils usually develop from 1. salts already present in the soil 2. high groundwater tables (including brackish water intrusion) 3. salts added in irrigation water [7b]. 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. Consequently, EC correlates strongly to soil particle size and texture [8]. Measurement of pH and electrical conductivity (EC) parameters provides valuable information for assessing soil condition for plant growth, nutrient cycling and biological activity. Soil and crop management practices have a significant effect on pH and EC and are considered good indicators of change. Elevated pH values can indicate potential losses of nitrate and subsequent water contamination. The tendency for soil acidification can suggest insufficient use of ammonical fertilizers and increased leaching losses[9]. The Electrical Conductivity (EC) of a solution is a measure of the ability of the solution to conduct electricity. The EC is reported in either milli mhos per centimeter or the equivalent decisiemens per meter. When ions (salts) are present, the EC of the solution increases. If no salts are present, then the EC is low indicating that the solution does not conduct electricity well. The EC indicates the presence or absence of salts, but does not indicate which salts might be present. For example, the EC of a soil sample might be considered relatively high. No indication from the EC test is available to determine if this condition was from irrigation with salty water or if the field had been recently fertilized and the elevated EC is from the soluble fertilizer salts. To determine the source of the salts in a sample, further chemical tests must be performed. The EC can also be directly used in the body of literature which is continuously growing concerning plant productivity under the effects of salinity. The older term soluble salts should be avoided by county Extension laboratories [10].

Present study is an attempt to find out the nutrient’s quantity in soil of Kalol and Godhra Taluka, District-Panchmahal, Gujarat. This information will help farmers to decide the amount of fertilizers to be added to soil to make the production economic. The objective of this paper was to analyze the trend in fertility status of soils of kalol and Godhra taluka of Gujarat State.

MATERIALS AND METHODS

The soil test data are the best source available to assess soil nature and soluble salts status. Eighteen villages from kalol and one from Godhra taluka covering North, South, East and West, were selected for this study. A representative soil sample was collected from each village which represents soils of 4 to 10 farm’s depending upon area of village. Representative soil samples were collected following standard quadric procedure and taken in polythene bags. In laboratory these samples were analyzed for different chemical parameters following standard methods. AR grade reagents and double distilled water were used for soil analysis. Results were compared with standard values [11, 12, 13] to find out the nature of soil weather it is acidic neutral alkaline or alkali and the presence of soluble salts through electrical conductance measurement.

The pH [14] is very important property of the soil express the acidity or alkalinity measured by pH meter works on the principle based on Nernst equation. It consists of two electrodes 1. Glass electrode or indicator electrode and 2. Calomel electrode or Reference electrode. When both this electrodes are dipped in aqueous solution under test, the potential is developed in the solution. That potential difference between both the glass and the reference electrode is measured by pH meter. This can be given by

$$pH = E / 0.0591 \text{ at } 25^0C$$

for experimental process take 20 gm soil in 100ml beaker. Add 40 ml of distilled water and stir intermittently with glass rod for 30 minutes. Place a known standard buffer solution in a beaker and immerse the electrode. See that the electrodes do not touch the wall of the beaker. With the help of the adjustment knob, put the instrument needle at the known pH of the buffer solution and adjust. The buffer is then removed and the electrodes are carefully washed with distilled water. Immerse the electrodes in a beaker containing the soil-water suspension and measure the pH. Remove it wash with distilled water and dip into a beaker containing distilled water. Based on pH values soils are classified into four categories Acidic, Normal, Alkaline and Alkali (Table 1).

The electrical conductivity [15] of soil is measured from soil: water (1:2) ratio by weight. The soluble salts are estimated from Electrical Conductivity (EC) of aqueous soil extracts. EC is a measure of the ability of a salt solution to carry electrical current by the migration of ions under the influence of electric field. Like metallic conductor, solution also obey Ohm's law. The unit of electrical conductivity is dS m^{-1}, which is the reciprocal of resistance in Ohm's cm^{-1}. Weigh 20 gm soil in 100ml beaker. Add 40 ml of distilled water and stir intermittently with glass rod for 30 minutes. Allow the soil suspension in the beaker to settle for about half an hour. Calibrate the instrument using standard KCl (1.41 dS m^{-1}) solution. Rinse and immerse the cell in soil suspension and measure EC of given sample. Based on EC values, soils are rated in four category like Normal, Critical for salt sensitive crops, Critical for salt tolerant crops and Injurious to most crops.

RESULTS AND DISCUSSION

Table 1 represents pH values of soils Based on pH meter determination are classified into four categories Acidic, Normal, Alkaline and Alkali. It is the permissible standard according to Anand Agricultural University. Soil health card project of agriculture department of Gujarat government have consider normal and Alkaline range as Medium or normal. Table 2 represents Electrical Conductivity standards which is classified as Normal, Critical for salt sensitive crops, Critical for salt tolerant crops and Injurious to most crops. This research is classified for number of samples lies in the category low, Medium and high for pH and EC. The EC Range varies from < 1.0 Normal, 1.0 – 3.0 Medium and > 3.0 Injurious to crops. For soil health card project this is the permissible limit. Experimental values of quality characteristics especially pH and Electrical Conductivity of soil of the Kalol and Godhra Taluka are presented in the Table 3. This table represents the number of samples lies in Low, Medium and High pH range. The same table represents the Electrical Conductivity of the soil for all these 19 villages. Data presented in Table 3 shows that soils of few villages contain low pH value and no soil sample of any villages have high range of pH. Average all samples have lower Electrical Conductivity. Table 4 indicates the Status of pH and Electrical Conductance in the soil of Panchmahal District.

All this results suggest good quality of soil of Halol and Godhra taluka territory and is discussied on the following bases- Soil pH is a measure of the active acidity (H^+) at a point in time. The more H^+ held on the soil, the greater the acidity of the soil. It is essential for determining the lime requirement. Values may vary significantly from season to season, and are influenced by lime, fertilizer additions, cultural practices and climatic conditions. The pH value is strongly related to BS-% within a soil testing class, and can be used as an indicator or index of certain chemical reactions occurring in the soil. At very low pH, solubility of Al, Mn and Zn increase, and can become toxic to sensitive plants. At high pH values, the solubility of Mn, and to a lesser extent Zn and Cu, can become so low that plants are unable to obtain adequate supplies from the soil. Few soil samples found acidic nature in our research. These soils were acidified over thousands of years by inputs of acids from atmospheric sources (carbonic sulfuric and nitric acid), plant exudates and the decay of plant and animal residues, and removal of basic cations by the natural processes of leaching and crop removal. In agricultural soils, organic and ammonical forms of N or S are converted to nitrate or sulfate by microorganisms, releasing acid in the process. These acidic inputs and leaching cause minerals to dissolve as soil pH decreases. This in turn releases cations such as Al^{3+}, Mn^{2+} and Fe^{3+}which can react with water to release more H or replace basic cations on the exchange complex. These displaced basic cations are taken up by plants, or are leached away, and the base saturation is lowered. Soils act as weak acids, with only a small portion of their potential acidity present in the active form. The amount of actual H^+ present in solution is a very small part of the total acidity until pH is less than 3. Exchangeable Al, Mn and Fe metals, along with pH dependent charges on organic matter and clay edge sites constitute the major sources of potential acidity (also called the reserve or total acidity). The reserve acidity, in conjunction with the exchangeable bases help buffer or enable the soil to resist rapid changes in pH. Plants growing in acid soils must be able to contend with high levels of Al and Mn, and low availability of P, Ca, and Mg. Beneficial microorganisms do not compete well under these conditions, and are replaced by fungi. Since most crops are intolerant of these conditions, the soil must be amended to make the rooting environment more hospitable.

Table 1: based on pH values soils are rated as below

Category	Range of pH value	Suggestion for remedy
Acidic	<6.5	Requires liming for reclamation
Normal	6.5- 7.8	Optimum for most crops
Alkaline	7.8 – 8.5	Requires application of organic manures
Alkali	>8.5	Requires gypsum for amelioration

Table 2: based on EC values soils are rated as below

Range of EC	Rate of Soils
<0.8 dS m^{-1}	Normal
0.8 – 1.6 dS m^{-1}	Critical for salt sensitive crops
1.6 –2.5 dS m^{-1}	Critical to salt tolerant crops
>2.5 dS m^{-1}	Injurious to most crops

Table 3: pH and Electrical Conductance Study of the soil of Kalol and Godhra taluka territory District: Panchmahal TALUKA: 1 to 18 – Kalol and 19- Godhra

Sr No	Village Name	Number of samples	No of samples in LOW pH	No of samples in MEDIUM pH	No of samples in HIGH pH	No of samples in LOW EC	No of samples in MEDIUM EC	No of samples in HIGH EC
1	Ghusar	375	92	283	0	375	0	0
2	Alindra	168	1	167	0	168	0	0
3	Kalantra	119	0	119	0	119	0	0
4	Royan	134	6	128	0	134	0	0
5	Barola	96	0	96	0	96	0	0
6	Fansi	87	0	87	0	87	0	0
7	Navagam	35	0	35	0	35	0	0
8	Zaradka	95	0	95	0	95	0	0
9	Paruna	313	1	312	0	313	0	0
10	Karada	254	0	254	0	254	0	0
11	Neshda	224	16	208	0	224	0	0
12	Jetpur	351	2	349	0	351	0	0
13	Katol	363	13	350	0	363	0	0
14	Chimnapur	163	0	163	0	163	0	0
15	Naranpura	176	0	176	0	176	0	0
16	Boru	282	4	278	0	282	0	0
17	Alva	912	0	912	0	912	0	0
18	Jeli	431	0	431	0	431	0	0
19	Ambali*	422	0	422	0	422	0	0
		5000				5000		

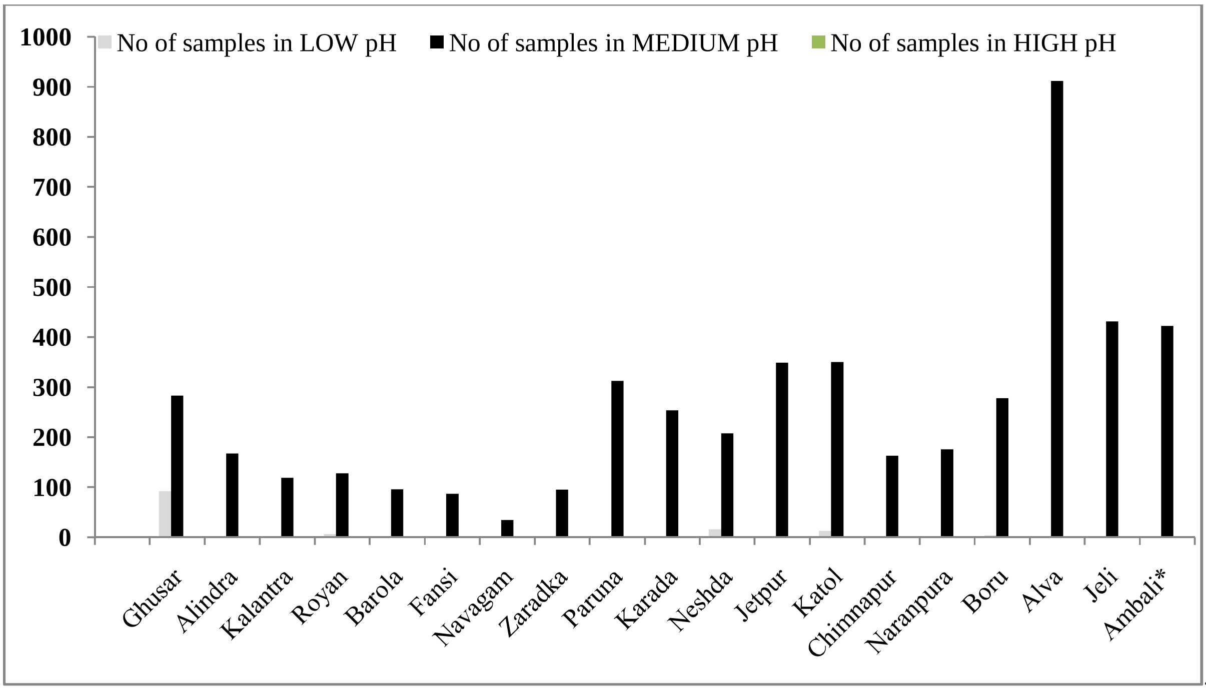
During the nitrification process, two H^+ cations are liberated which can accumulate and significantly reduce the pH of the soil. The application of any fertilizer which carries part of its N in the ammonium form will ultimately decrease the soil pH due to the nitrification process. The continued use of ammonium sulfate will drastically reduce the soil pH of agricultural soils. Ammonium nitrate and urea will also cause a decrease in soil pH, but not to the same degree as ammonium sulfate. In order to not induce problems with soil acidity through the use of ammonium fertilizers, it is recommended that a well planned liming program be an integral part of the farming enterprise. In other form The major soil mineral colloids are comprised of the alumino-silicate clays, and the oxides and hydroxides of Al and Fe. These minerals may contribute both negative and positive charges to the soil, but the soil with negative charge greatly exceeds positive charge, resulting in a net negative charge on soil colloids. Alumino silicate clays exhibit negative charge as a result of alterations within their crystal structures. This type of charge is called permanent charge, and does not vary with soil conditions such as pH, salt content or content. The amounts and kinds of clay minerals determine the quantity of negative charge contributed by the clay-sized fraction. As soil pH increases, the quantity of negative charges increases. This increase is called pH-dependent charge, and results from neutralization of hydrogen ions from SOIL-OH (hydroxyl) groups at the broken edges of clay structures.

[Clay -Al - OH]o + OH^- => $[Clay\ Al\text{-}O]^-$ + HOH[water].

In more highly charged clays, the increase is insignificant.

The acceptable pH range varies for each soil class. The target pH represents the soil pH that is best for most crops growing on soils of that class. The target pH is 6.0 for the mineral soil class (with exception of cotton and most vegetables), 5.5 for the mineral -organic soil class, and 5.0 and for the organic soil class. As organic matter content increases from class to class, the amount of Al and the potential for toxicity decreases, and optimum plant growth can be achieved at lower pH.

Figure 1: Numbers of samples of all 19 villages of Kalol and Godhra taluka lies in Low, Medium and High pH range

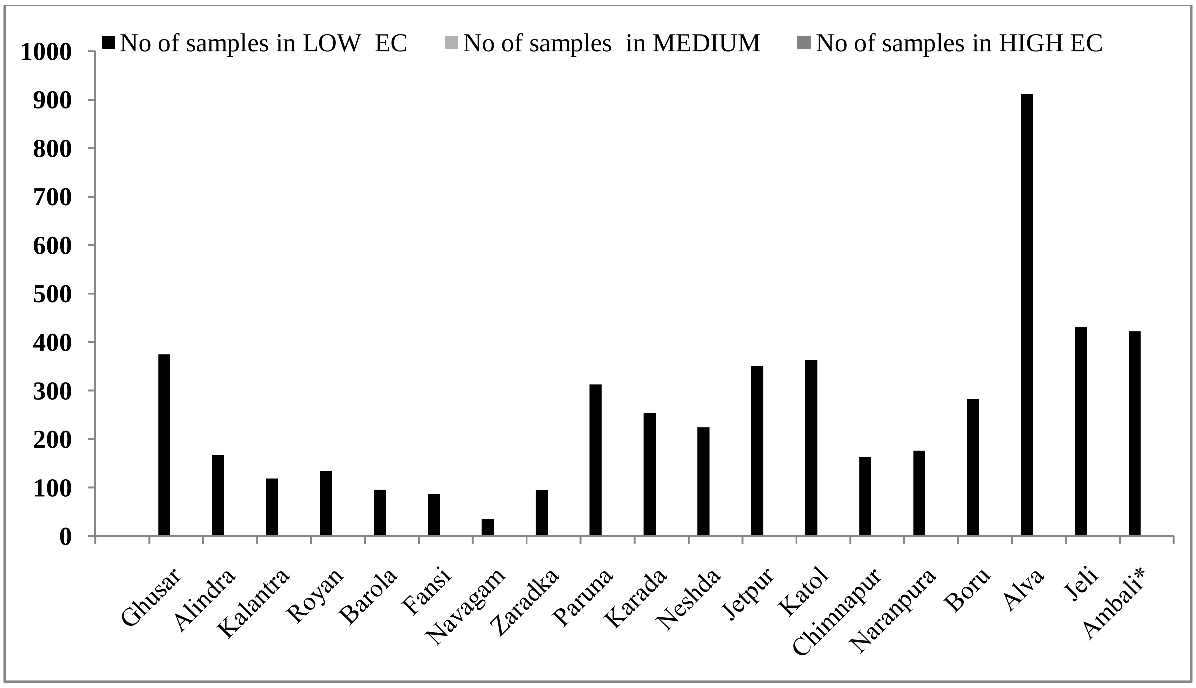


Soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics. Soils in the middle range of conductivity, which are both medium-textured and have medium water-holding capacity, may be the most productive. Since water holding capacity typically has the single greatest effect on crop yield. Differences in soil properties are some of the most obvious reasons for yield variability. Soil EC has the potential to estimate variations in some soil physical properties in a field. Yield maps are frequently correlated to soil EC, as shown in Figure 5. In many situations, these similarities are explained through differences in soil. The water-holding capacity of the soil is a major factor affecting yield, and the yield map will likely show a strong correlation to the soil EC. In general, soil EC maps may indicate areas where further exploration is needed. Most likely, soil EC maps give valuable information about soil differences and similarities, which makes it possible to divide the field into smaller management zones. Zones that have consistent EC readings are areas that have similar soil properties and can be grouped together for soil sampling and management. From our research EC data used for 1) How, with field verification, soil EC can be related to specific soil properties that affect crop yield, such as topsoil depth, pH, salt concentrations, and available water-holding capacity; 2) Soil EC maps often visually correspond to patterns on yield maps and can help explain yield variation; and 3) Other uses of soil EC maps (Table 3, 4 and figure 2), including developing management zones, guiding directed soil sampling, assigning variable rates of crop inputs, fine tuning NRCS soil maps, improving the placement and interpretation of on-farm tests, salinity diagnosis, and planning drainage remediation.

Table 4: Status of pH and Electrical Conductance in the soil of Panchmahal District

Sr. No	Taluka	Total No of Samples	Category of pH and EC					
			Low pH	Medium pH	High pH	Low EC	Medium EC	High EC
1	Kalol	4578	135	4443	0	4577	1	0
2	Godhra	422	0	422	0	422	0	0
3	Panchmahal District	5000	135	4865	0	4999	1	0

Figure 2: Numbers of samples of all 19 villages of Kalol and Godhra taluka lies in Low, Medium and High Electrical Conductance range



CONCLUSION

This can be concluded from this study that the pH and Electrical Conductivity of both this taluka is under permissible or accepted limit, so it is good for crop yield. Thus this study evaluate soil fertility status for making lime addition and fertilizer recommendations. To classify soil into different types of soil groups, fertility groups for preparing soil maps and soil fertility maps which are presented in form of graphics. To identify the type and degree of soil related problems like salinity, alkalinity and acidity etc. and to suggest appropriate reclamation/ amelioration measures. To find out suitability for growing crops and orchard. To find out suitability for irrigation. To study the soil genesis.Farmers practicing precision agriculture can now collect more detailed information about the spatial characteristics of their farming operations than ever before. In addition to yield, boundary and field attribute maps, new electronic, mechanical, and chemical sensors are being developed to measure and map many soil and plant properties. Soil EC is one of the simplest, least expensive soil measurements available to precision farmers today. Soil EC measurement can provide more measurements in a shorter amount of time than traditional grid soil sampling. The use of soil EC measurements represents an alternative to intensive soil sampling and could both improve the resolution (increased sampling density) and reduce the cost of soil maps. Soil EC maps can be used to define management zones reflecting obvious trends in soil properties. Each zone can be sampled and treated in-dependently.

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