Society for Science and Education
United Kingdom

TNC Transactions on Networks and Communications

Volume 7, No. 6
ISSN: 2054 -7420

Study of PH and Electrical Conductivity in Soil of Barnala District (Punjab, India): Deleterious Effects on Human Lives

Dr. Kamalpreet Kaur
Department of Chemistry, Assistant Professor, Guru Gobind Singh Khalsa College Bhagta Bhai Ka Bathinda, Punjab(INDIA)
k.kdhaliwal.dhaliwal@gmail.com

ABSTRACT

The purpose of this study was to determine the pH and electrical conductivity in soil of different villages of barnala district (Punjab,India) and their harmful effects on human health. Samples of soil were collected from agricultural fields of four different villages of barnala region such as Rure ke kalan, Gunas, Handiaya and cheema from five different layers(0-10 cm; 10-20 cm; 20-30 cm; 30-40 cm and 40-50 cm depth).There are three industrial sites in barnala district and these four villages are located near to these industial sites. In this study, adverse effect of different industries on fields of these four villages were investigated. Handiaya village has high values of pH and electrical conductivity while Gunas and Cheema villages have lowest value of electrical conductivity and pH respectively. when textile effluent reaches the soil or underground water it causes bad effect on human health such as people may suffer from alkalosis which is due to high pH and can lead to arrhythmia which means irregular heartbeat. Alkalosis can induce a coma, it may cause seizures and malfunctioning of kidneys. Due to large value of Electrical conductivity activity of soil micro-organism declines so, the important microbial processes, such as nitrogen cycling, production of nitrous and other N oxide gases, respiration, and decomposition; populations of plant-parasitic nematodes can increase; and increased nitrogen losses.

Keywords- Soil contamination, Physico-chemical parameters, pH, electrical conductivity

1 Introduction

Measuring of pH and electrical conductivity (EC) parameters will provide valuable information for assessing soil condition for plant growth, nutrient cycling and biological activity. Soil pH measurement is useful because it is a predictor of various chemical activities within the soil. As such, it is also a useful tool in making management decisions concerning the type of plants suitable for location, the possible need to modify soil pH (either up or down), and a rough indicator of the plant availability of nutrients in the soil. 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 millimhos 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 electrical conductivity 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. Frequent use of

DOI: 10.14738/tnc.76.7585
Publication Date: 28th Dec 2019
URL: http://dx.doi.org/10.14738/tnc.76.7585

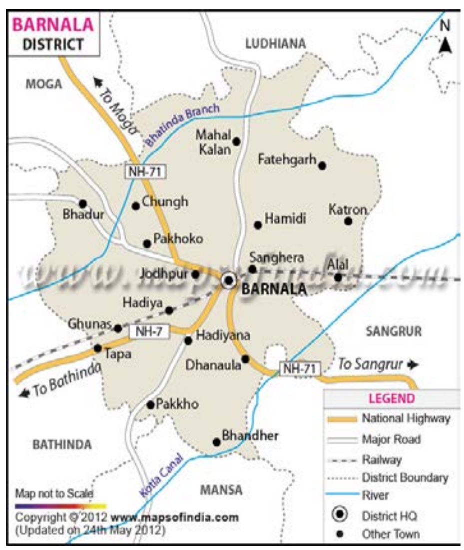
irrigation water will directly influence the salts in the soil profile. Salts are influenced by factors such as rainfall content and timing, internal soil drainage, and irrigation practices. Usually, rainfall contains low amounts of salts and acts to dilute salts that are present in the soil. If the rainfall is of sufficient volume or duration, and the soil has internal drainage, the added rainfall is enough to leach salts from the soil. During drying conditions, water is lost from the soil due to evaporation, and salts are effectively concentrated. If irrigation water contains appreciable salts, then intensive management is required to produce healthy plants.

2 Material and methods

Barnala(Punjab,India) is situated between 30° 23’ North and 75° 33’ East. It has a mean elevation of 227 metres (745 feet).It is located on the Bathinda-chandigarh highway (no-7) and the Jalander-Rewari national highway (no-71),The Sirsa-Ludhiana state highway (no-13) are passes through it. It is 65 km from Bathinda and 85 km from Ludhiana.According to 2011 census, the total population of Barnala district is 595527.It was 526931 in 2001.

The sampling time was between 4:30 to 5:30 on 9th November 2016.Plastic polythene bags were used to collect soil samples

MAP OF BARNALA DISTRICT



3 Sample collection

Soil samples were collected from agricultural fields of four villages such as Rure ke kalan, Gunas, Handiaya and cheema which are present near to industrial sites. These four villages are located in Barnala district (Punjab, India).Soil samples were collected from five sampling depths 0-15 cm, 15-30 cm, 30-45 cm, 45-60 cm and 60-75 cm. . Five sub-samples were taken within an area of 100 m² from each sampling location. About 1 kg weight of each sub- sample were collected.

Determination of pH-

It is determined by pH meter.

Principle- The pH is measured electrometrically by means of an electrode assembly consisting of one glass electrode and one calomel reference electrode

with a saturated potassium chloride.

Potassium chloride is used for the salt bridge because of the fact that the transfer of K+ and Cl^- ions takes place at the rate in true solution. The pH determination by this method is based on the assumption that the potential recorded is totally due to the potential difference across the glass membrane brought about the difference in H+ ion activity, between solution inside and outside the glass electrode. The outside solution is hydrochloric acid.

Interference-Several factors are known to affect the pH- value of a particular sample. Prominent amongst these are soil-water ratio, Soluble salt concentration, CO2 pressure, exchangeable actions and temperature. With the dilution of soil suspension, its pH increases. Increases in salt concentration in general decreases pH, In alkaline soils, the pH is influenced by exchangeable cations.With increase in temperature, pH decrease. The effect of temperature is controlled with instrument having temperature compensation system.

Apparatus- pH meter that is a high impedance voltmeter calibrated in terms of pH, balance sensitive to 0.001 gm, general laboratory glass wares.

Reagents –

1 Buffer solutions- Of pH values namely 4.00,7.00 and 9.20

2 Buffer solution pH 4.0 (at 25°C)-Dissolve 5.106 gm of potassium hydrogen phthalate in distilled water and dilute to 500ml with distilled water.

3 Buffer solution pH 7.0 (at 25°C)- Dissolve 1.678 gram sodium dihydrogen phosphate in distilled water and make up to 500 ml with distilled water.

4 Buffer solution pH 9.2 (at 25°C)- Dissolve 9.54 gm of sodium tetraborate (borax) in distilled water and dilute it 500 ml. Pure chemical CRM/ AR grade shall be used. Buffer solutions can also be prepared from (available commercially) buffer tablets or powder. Standard pH buffer solutions(CRM) are preferred.

Procedure-

A) preparation of soil sample-

1. 1.The sample received from the field shall be prepared.All aggregations of soil particles shall be broken down , thoroughly mixed and received on a suitable sieve(2mm).
2. Take 30 gm of the soil from the sample as prepared above in a 100ml beaker, add 75ml distilled water. Stir the suspension for few minutes. Cover the beaker with which glass and allow to stand for one hour, with occasional stirring. It shall be again stirred well immediately before testing.

B) Operation-

1. Calibration of pH meter- The pH meter shall be calibrated by means of standard buffers. Attach pH electrode with pH meter set the temperature compensating knob and confirm that electrode is completely filled with standard KCl solution. Allow pH meter to warm up for 15 minutes.The

instrument is then set with standard buffer solution of value pH-7.0 shall be cross checked with another standard pH buffer solution pH 9.2 or 4.0

2. Testing of sample- Remove the electrode from the standard buffer solution, rinse it with distilled water and wipe/ dry with tissue paper. And then immerse it in the soil water suspension (1:2.5) ratio. Record pH meter reading. Two or three reading of the pH shall be taken with brief stirrings in between each reading. The readings should agree with ±0.05 pH units and should reach a constant value in about one minute. After final pH reading, remove the electrode from the ash suspension ,wash with distilled water , wipe it with tissue paper and check once again the calibration of pH- meter with one of the standard buffer solution. If the instrument is out of adjustment by more than 0.05 pH unit, it shall be set to the correct adjustment till consistent readings are obtained.

Determination of specific electrical conductivity-

Principle-Air dried soil is extracted with water at 25°C at an extraction ratio of 1:2 (m/v) to dissolve the electrolyte EC of the suspension extract is measured temperature affects conductivity as such increase in temperature promotes dissection with a consequent rise in conductivity, hence it is conveniently reported at 25°C.

Interference- Temperature affects electrical conductivity,which vary by absent 2% per day we Celsius. High silica contents give relatively low value of electrical conductivity.

Apparatus/ instrument- Conductivity meter giving direct reading of conductance and having automatic temperature compensation built in the instrument. Conductivity Cell, analytic balance,Thermometer, Shaking machine, Beakers.

Reagents- Potassium chloride solution (0.01M)-Dissolve 0.7456 gm of of AR/CRM grade KCl dried at 80°C for 1 hour in water and dilute it to 1000 ml.The specific electrical conductivity of this ash is 1413µ mhos/cm at 25°C.

Procedure-

A) Preparation of sample- All the aggregation of air derived particles shall be broken down, thoroughly mixed and sieved on a 2mm sieve. The electrical conductivity of soil is commonly measured in saturated extract and 1:2 soil water extract.

Preparation of soil saturation extract-

1. Take 100 gm of air dried soil sample sieved through 450 micron IS sieve in a beaker. Add distilled water slowly and stir the contents with spatula adding more water if required, till it attains the saturation stage.
2. Allow the beaker to stand as such for 2-3 hour and check the saturation stage (and for coarse texture soil, 4 hours time is sufficient). At saturation , soil paste glistens as it reflects light, flows slightly when the beaker is tipped and slides freely and cleanly off the spatula .There should be no free flowing water on the soil surface.
3. Transfer the saturation soil paste to a Buchner funnel with whatman No. 40 filter paper and the Buchner funnel attach to vacuum pump. Collect the extract. If the extract is turbid, re-filter the extract.

4. Transfer carefully all the aliquot of extract in a 100 ml volumetric flask and make up to the mark with distilled water. Add 4-5 drops of 0.1% sodium hexametaphosphate.To prevent the precipitation of calcium carbonate upto standing. (there may be increase in Na concentration due to addition of sodium hexametaphosphate but less than 0.5 ppm).

B) Weigh 20 gram of the ash and transfer it to 100 ml beaker.Add 40 ml of distilled water. Shake the soil water suspension for 30 minutes with a glass rod.

C) Measurement of electrical conductivity of the suspension-

1. warm up the instrument for 15 minutes calibrate the instrument with standard KCl (0.01M) solutions and adjust the all content of electrical conductivity meter.In case where correction for all content and temperature factor is not provided in instrument compare the cell constant as follows.

   K=Xs / Xm

   Where,

   K= cell constant

   Xs = specific conductivity of standard KCl (0.01M)

   Solution ,known value i.e 1413µmhos/cm at 25°C.

   Xm= Observed EC value of the standard KCl solution.

2. Adjust the all constant of the electrical conductivity meter and the temperature. Take the test soil suspension sample in a beaker.Record the exact temperature of the sample rinse the conductivity cell with the distilled water and increase it in soil sample take reading of conductivity.

D) Calculations-

Electrical conductivity (EC) µmhos/cm at 25°C=EC of suspension in µmhos/cm at 25°C × Cell constant (K) at 25°C.

4 Results and discussion-

Values of pH and electrical conductivity of soil water ratio-1:2 are given in tables

Table 1 of Site A

Depth of Soil (cm)	pH	EC
0-15	8.2	450
15-30	8.5	457
30-45	8.7	460
45-60	8.8	466
60-75	8.9	470
Mean ± S.D	8.62 ±0.277	460.6±7.79

Table 2 of Site B

Depth of Soil (cm)	pH	EC
0-15	8.1	202
15-30	8.3	209
30-45	8.6	212
45-60	8.8	217
60-75	9.0	220
Mean ± S.D	8.56 ± 0.364	212±7.03

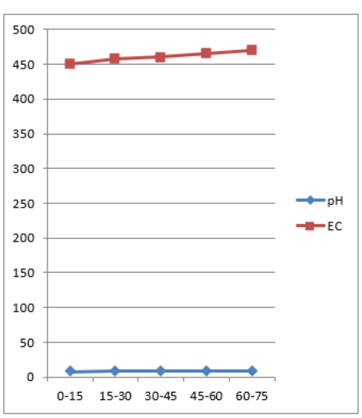
Table 3 of Site C

Depth of Soil (cm)	pH	EC
0-15	8.0	1206
15-30	8.2	1213
30-45	8.4	1221
45-60	8.6	1227
60-75	8.8	1230
Mean ± S.D	8.4 ± 0.316	1219.4±9.91

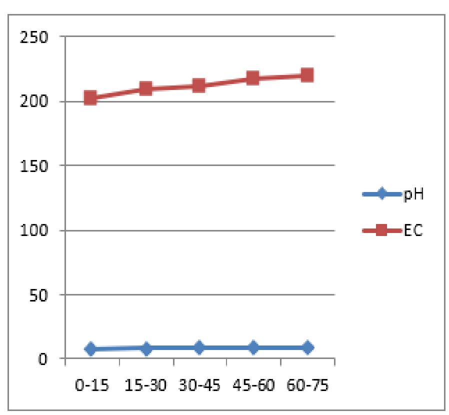
Table 4 of Site D

Depth of Soil (cm)	pH	EC
0-15	8.0	503
15-30	8.1	508
30-45	8.2	516
45-60	8.4	522
60-75	8.5	530
Mean ± S.D	8.24 ± 0.207	515.8±10.77

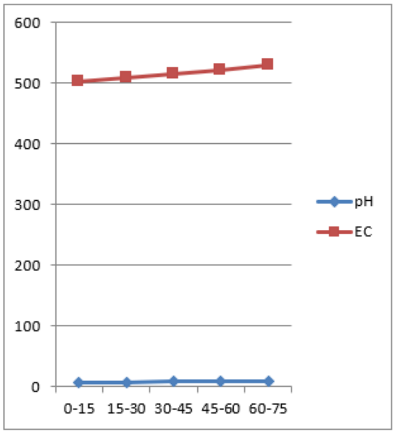
With the increase of depth of soil values of pH and EC increases. These four sites corresponds to the four villages of barnala district. Site C has maximum value of pH and EC.



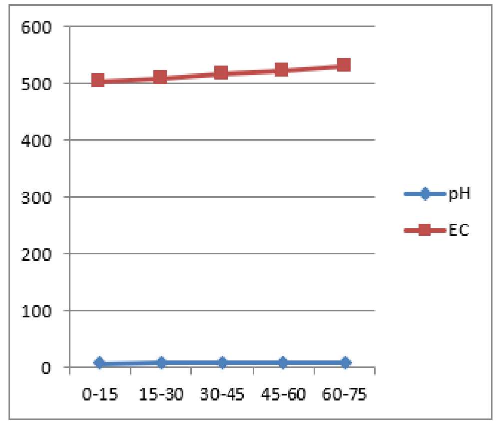
Graph of Site A



Graph of Site B



Graph of Site C



Graph of Site D

Five depths of soil are considered such as 0-15 cm, 15-30 cm, 30-45 cm, 45-60 cm, 60-75 cm in four different villages or sites.

5 Statistical analysis

The data obtained subjected to statistical analysis. In statistical analysis, a correlation developed between pH and Electrical conductivity by using KARL PEARSONS Coefficient of correlation.

Calculation of KARL PEARSON's Coefficient of correlation

Correlation coefficient between two parameters such as pH (X) and Electrical conductivity(Y) are calculated as

$$r = \frac{\Sigma xy}{\sqrt{X^2 + y^2}} = -0.35984$$

Where $x = X - \bar{X}$, $y = Y - \bar{Y}$, $\bar{X} = \frac{\Sigma X}{n}$, $\bar{Y} = \frac{\Sigma Y}{n}$

where n is the number of sites

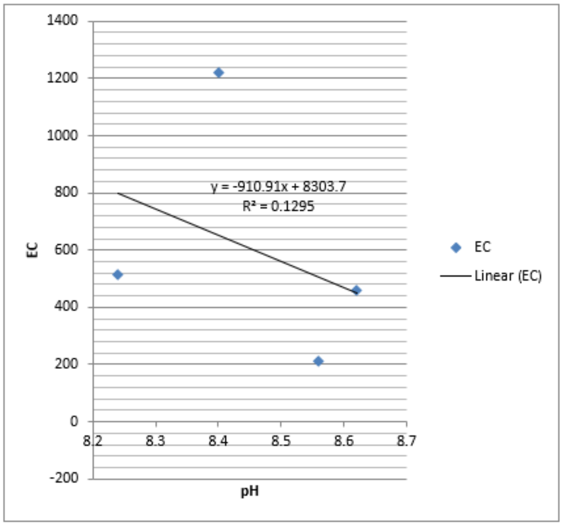
For good correlation value of r should be between $-1 < r < 1$.

Calculation of Regression equation: The term regression stands for some sort of functional relationship between two or more related variables. It measures the nature and extent of correlation and predicts the unknown values of one variable from known values of another variable. Following regression equation is used to established correlation between pH and Electrical Conductivity (EC).

$$Y - \bar{Y} = b_{yx} (X - \bar{X})$$

The above equation called regression line equation of Y on X and byx called regression coefficient of Y on X and calculated as

$$b_{yx} = \frac{\Sigma XY}{\Sigma X^2}$$



Harmful effects of pH

High pH means alkalinity. When negatively ion chemicals such as sulphate, phosphate, carbonate etc.

According to the World Health Organization, there are more harmful effects on human health when pH value is high that is when alkalinity is high. It may cause skin , eye and mucous membrane irritation.

When pH level of human body increases, this condition is known as alkalosis which can cause arrhythmia or an irregular heartbeat. This may occur when body hyperventilates.when pH level of body become high then carbon dioxide become low and sodium bicarbonate level become high. This may cause breathing rate increases and difficulty occur in breathing. Chest pain and palpitations may occur.Alkalosis can induce a coma if pH level become high. Metabolic alkalosis can cause imbalanced electrolyte levels in the body even potassium level become very low. This condition is called hypokalemia.This may lead to problems in kidneys, heart and digestive system. Respiratory alkalosis can cause seizures.

Aquatic life also suffer from pH extremes.Fish die when pH level increases above 10.

High pH level of water can corrode pipes.

Conductivity is related to the concentration of ions.These ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulphides and carbonate compounds. Compounds that dissolve into ions are called electrolytes. More ions are present more will be the electrical conductivity.

Electrical conductivity is directly related to the concentration of salts dissolve in water and therefore related to the Total Dissolved Solids (TDS). It is difficult to measure Total Dissolved Solids in the field, the electrical conductivity is used to measure the Total Dissolved Solids.

Distilled water has no dissolved ions, so it does not conduct electricity and its electrical conductivity will be zero.

Harmful effects of high electrical conductivity-

1. Disturbance of the salt and water balance in children may occur.
2. Heart and renal problems may take place.

3. Laxative effects may occur if sulphate concentrations become high.
4. Aesthetic problems of water occur with Electrical conductivity value higher than 150 ms/m and taste of water become salty.
5. It become difficult to quench thrist when value of electrical conductivity of water become higher than 300 ms/m.
6. It causes crop yield decreases.

Due to large value of Electrical conductivity activity of soil micro-organism declines so, the important microbial processes, such as nitrogen cycling, production of nitrous and other N oxide gases, respiration, and decomposition; populations of plant-parasitic nematodes can increase; and increased nitrogen losses.

6 Conclusion

From the above result and discussion it is concluded that values of pH and Electrical Conductivity of soil sample taken from site C is higher .These may have harmful effect on humans when the chemicals seep from white ash into agricultural soil and underground water such as people may suffer from alkalosis which is due to high pH and can lead to arrhythmia which means irregular heartbeat. Alkalosis can induce a coma, it may cause seizures and malfunctioning of kidneys. Due to high electrical conductivity people may suffer from heart and renal problems.

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