The Pharma Innovation Journal 2023; 12(2): 1495-1502

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(2): 1495-1502

www.thepharmajournal.com
Received: 16-12-2022
Accepted: 15-01-2023

K Ramesh
Assistant Professor (Sl.Gr), CWR, Department of Civil Engineering, Anna University, Chennai, Tamil Nadu, India

E Jamuna
Associate Professor, Agricultural College and Research Institute, TNAU, Thiruvannamalai, Tamil Nadu, India

Corresponding Author:
K Ramesh
Assistant Professor (Sl.Gr), CWR, Department of Civil Engineering, Anna University, Chennai, Tamil Nadu, India

Evaluation of soil fertility status in a rural micro-watershed of Pudukkottai district

K Ramesh and E Jamuna

Abstract
In the present research was to study the soil fertility status from the farmer's field in the micro-watershed of Pudukkottai taluk, Tamil Nadu during January 2021. The processed 15 soil samples were taken from plough depth were analysed for pH, EC, macronutrient, and micronutrients by standard procedures. Results indicated that many of the soil nutrient levels decrease such as pH found to be 5.82 to 8.05, EC ranging from 0.09 to 0.43 dS/m indicated the safe for all agricultural crops, OC was found to be 0.3 to 9.4%, N was found 46.2 to 107.8 Kg/ha, P was found 7.5 to 60 Kg/ha, K was found as 50 to 170 Kg/ha, Zn was found as 0.598 to 0.905 ppm, Cu was found to be 0.566 to 0.906 ppm and Mn was found to be 3.75 to 7.329 ppm. This information of nutrient status will help farmers in improving soil fertility.

Keywords: Soil fertility status, macro nutrients, minor nutrients, micro-watershed, Pudukkottai taluk.

1. Introduction
Soil quality is one of the serious environmental problems. Soil is the most natural resource of the country and it is the sole of infinite living organisms which supports the life of crop plants by acting as a medium for growth along with providing nutrients, water, and air. Soil fertility refers to the inherent capacity of a soil to supply essential nutrients to plants in right proportion for optimum growth. To, sustain food production a responsible level to ensure continued high productivity in the future. This management of soil fertility and nutrient management at optimum level is one of the key factors in achieving high productivity. Now a day's fertility status of soil decreases day by day due to ever increase in human population, land degradation and continuous cultivation for many centuries. Intensive cultivation of high yielding varieties and hybrid coupled with decline in the use of organic manures which has resulted in depletion of nutrients and occurrence of wide spread deficiencies of both macro and micronutrients. Chemical fertilizers may gradually increase the acidity of the soil. For maintaining soil fertility, it is necessary to choose appropriate yield and fertilizer use practices so that over seasons the twin objectives of high yield and maintenance of soil fertility could be achieved. Soil testing has played historical role in soil fertility maintenance and sustainable agriculture. Soil characteristics in relation to evaluation of fertility status of the soil of a region are important aspect to agricultural production. Because of imbalance and inadequate fertilizer use coupled with low efficiency of other outputs. The efficiency of chemical fertilizers nutrients has declined tremendously under intensive agriculture in recent years.

All soils contain mineral particles, organic matter, water, and air. The combinations of these determine the soil's properties. Understanding the soil physic-chemical properties and fertility status is necessary to keep soils at its maximum performing level. Soil chemical tests is one of the effective tools commonly used to assess the fertility status of soils (Agboola and Ayodele, 1987) [1]. The aim of the study is to assess the soil fertility status of micro-watershed in Pudukkotai district on soil nutrient parameters. There are several physical and chemical characteristics which are related to soil nutrients and the fertility of the soil. We focus on some of the common and important properties of soil.

2. Materialsand Methods
2.1 Location of the Study Area
The location of study area in micro watershed coded 4A2B5c1 (Vallathirakottai) in Pudukkottai taluk, central Pudukkottai district of Tamil Nadu state in southern India (Fig.1). Pudukkottai district has boundaries with Trichy on west, Bay of Bengal on east, Thanjavur on north and Sivaganga on south sides. People of the district mainly depends on agriculture as

their main occupation. Temperature ranges between 22^0 C to 41^0 C and climate is hottest in the month of April to June and November to January as the coldest months. The normal annual rainfall of Pudukkottai district is 900 mm and it has the climatic type of tropical maritime and monsoon. The district has very low fertility with alkalinity problems in some location. There is a gradual increase in precipitation from east to Southwest over the district. The normal annual rainfall of Pudukkottai district is 821 mm. Pudukkottai has both irrigated and rainfed crops. Single crops under rainfed situations and two or three crops under irrigation condition. Rice – Rice is the cropping system. Groundnut – Pulses is another system under garden land condition. Soil is one of the natural resources which have the most direct impact on agricultural development. Soil type is clay loam and loam soil.

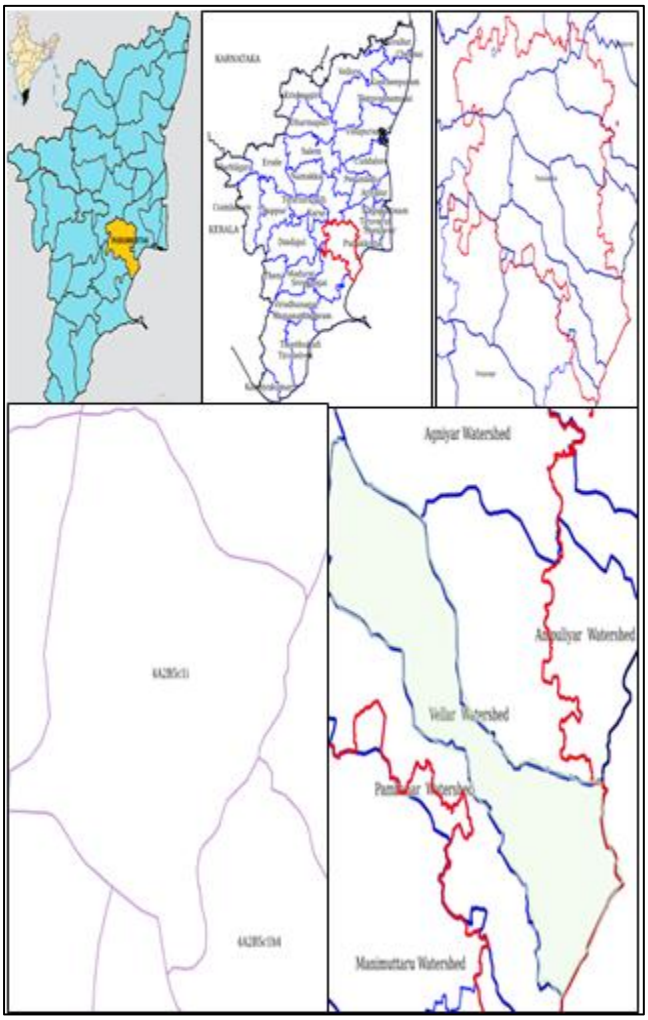

Fig 1: Location of the Study Area

2.2 Soil Sampling

The soil research study was conducted in Pudukkottai district of micro watershed is in Pudukkottai taluk (Table.1). To evaluate the fertility status a surface soil sample was taken from plough depth (0-15 cm) by means of suitable sampling tools from 15 spots after scraping off the surface litter during January 2019 in the study area. For sampling loose and moist soil, the tube auger, spade or Khurpi was quite satisfactory. A V shape cut was made up to the plough layer and a uniform 1.5 cm thick slice was taken out. The bulk sampling was reduced by quartering and about 500 g of the composite sample was retained. The soil was dried in shade at room temperature and put in polythene bags with suitable description and identification marks. Soil samples were air dried (25^0 C- 35^0 C) and stored. Collected soil samples from different location were air dried in shade, crushed, and sieved from <2 mm sieve was analyzed for chemical properties and different nutrients using standard laboratory methods. Global Positioning System (GPS) locations from each sample location were recorded accordingly.

Table 1: Details of selected location

Sample	Latitude	Longitude	Villages
1	10˚ 22' 39.9684" N	78˚ 47' 7.1808" E	Paravapannai
2	10˚ 21' 39.8772" N	78˚ 47' 12.102" E	Agarapatty
3	10˚ 21' 6.75" N	78˚ 47' 25.7892" E	Poosathurai
4	10˚ 20' 59.046" N	78˚ 47' 49.7508" E	Attankudy
5	10˚ 20' 45.0492" N	78˚ 48' 11.214" E	Atangudy
6	10˚ 20' 42.8388" N	78 ˚47' 58.2864" E	Manapatty
7	10˚ 20' 50.7408" N	78˚ 47' 43.4544" E	Perungapatty
8	10˚ 20' 35.0844" N	78˚ 48' 8.4816" E	Thandalai
9	10˚ 21' 8.0676" N	78˚ 47' 55.5036" E	Maravapatty
10	10˚ 21' 7.308" N	78˚ 47' 55.5072" E	Maravapatty
11	10˚ 22' 17.9832" N	78˚ 47' 41.622" E	Nathampannai
12	10˚ 21' 56.7648" N	78˚ 47' 22.7904" E	Chokkoorani
13	10˚ 22' 34.2372" N	78˚ 47' 46.3884" E	Perumalpatty
14	10˚ 23' 4.796" N	78˚ 47' 25.1772" E	Kattiyavayal
15	10˚ 21' 52.7652" N	78˚ 47' 20.742" E	Agarapatty

3. Results and Discussion

Soil testing provides information about nutrient availability in soils which forms the basis for the fertilizer recommendation to the farmers for maximizing crop yields. Fifteen soil samples collected from the study area were analyzed 11 parameters (Table.2). The location wise soil quality results are mentioned in table.1 from the result obtained, following observation can be made.

3.1 Soil reaction (pH)

The pH is an important index of soil which helps in identification of chemical nature of soil (Shalini *et al*. 2003) [2]. Soil fertility are affected by pH nutrient solubility varies in response to pH which predominantly affect the accessibility of nutrients by plants and activity of soil microorganisms (Clark and Baligar, 2000) [3]. There is a strong relationship between soil pH and nutrient availability. Most plants grow best in the pH range between 6.5 -7.5. The availability of some plant nutrients is greatly affected by soil pH. The pH (Fig.2) of soil samples in the micro-watershed ranged from 5.7 to 7.92 (i.e., is moderately acidic to slightly alkaline nature. According to classification of soil reaction suggested by (Brady and Weil, 2005) [4] 4 samples were slightly acidic (pH<6.5) and 11 samples were normal (pH 6.5-8.5). The minimum value of pH 5.7 was observed in Agarapatty village and maximum value of pH 8.05 was observed in Manapatty village. The estimated values of pH were suitable for both plant and microbial growth.

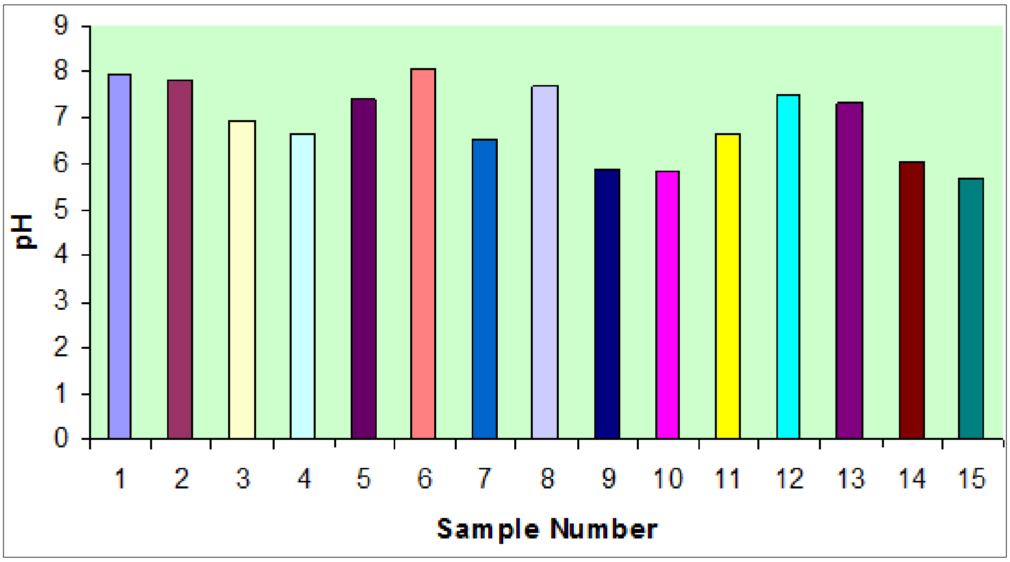

Fig 2: Graphical representation of pH value of soil

3.2 Electrical Conductivity (Soil salinity)

EC can come from irrigation water, fertilizer, composts, and manures. It measures of the number of salts in the soils and character of soil health. Lesser the EC value, low will be the salinity value of soil. The problem in irrigated soils due to high evaporation rates and low annual rainfall leaving salts to accumulate.

Based on the limits suggested by (Muhr *et al*.1963) [5] for judging salt problem of soils, almost all the samples (100%) were found low saline (EC<1.0 ds/m) which is suitable for good growth of plants. In the studied samples, the EC (Fig.3) value were very low range from 0.09 to 0.43 ds/m indicating that the soils were non-saline in nature. The non-saline nature of all soil samples night be due to proper management and inherent properties of soil as also reported by (sharma *et al*. 2008) [6]. Hence, all the soils under the study area are safe for all types of crop production. The low EC may be due to leaching of salts to lower horizons. In all the soil samples EC was lesser than 4 ds/m which was below the safe limit (Sivaprasad *et al*. 1998) [7]

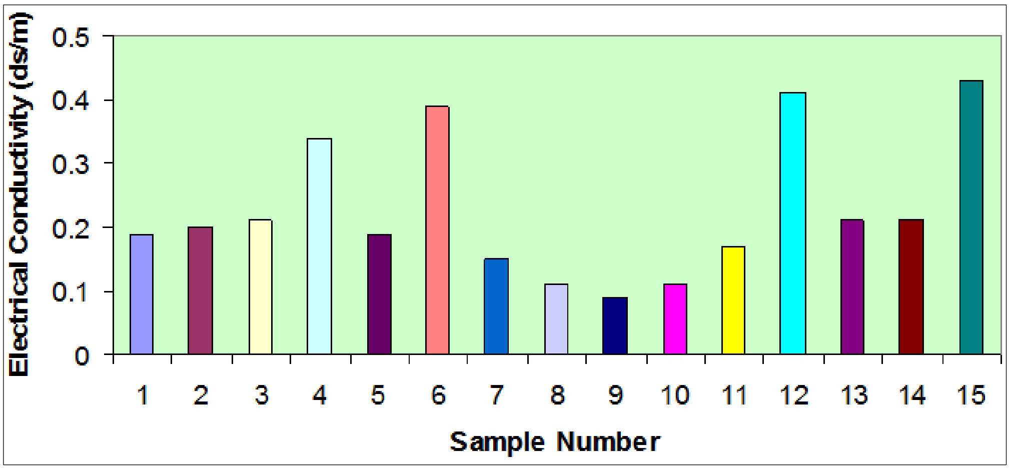

Fig 3: Graphical representation of Electrical Conductivity value of soil

3.3 Soil organic carbon (SOC):

Soil organic carbon enters the soil through the decomposition of plant and animal residues, living and dead micro-organisms as a key indicator of soil fertility. Soil organic carbon is the main source of energy for soil microorganisms. The soil organic carbon release nutrient for plant growth, increasing soil organic carbon improves soil health and fertility (Johnston 2007) [8]. Continuous application of inorganic fertilizers with organic material increased aggregates the organic carbon content in soil (Kanwar and Grewal 1971) [9]. Thus, the soil organic carbon is the main source of energy for soil micro-organisms. The organic carbon plays in maintaining the stability of nutrient, water holding capacity, bind mineral particles together into micro- and stabilizers soil structure making soil resistant to erosion, it will make soil porous allow air, water, and plant roots to move through the soil. In the present study the percentage of organic carbon (Fig.4) ranged from 0.3 (Maravapatty) to 9.4% (Attankudy) in the study area, indicating variable organic content. Depending upon the organic carbon content (%), the quality of soil may be graded as low (<0.5%), medium (0.5%-0.75%) and high (>0.75%). From the observation that majority of samples (13) falling under high category, because this may be due to variable organic content and decomposition rates. Organic wastes are important sources of nutrients to these agricultural lands.

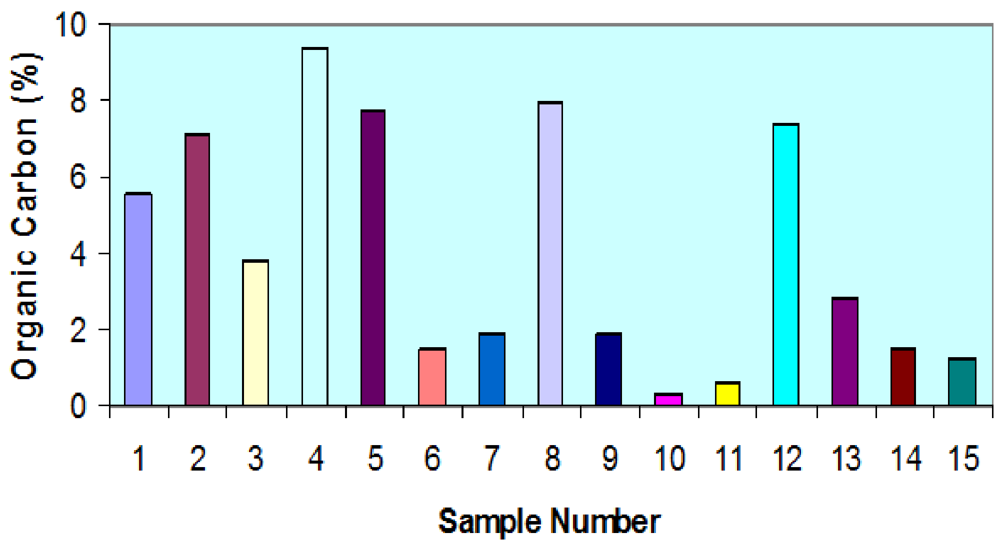

Fig 4: Graphical representation of Organic Carbon value of soil

Table 2: Soil quality in the study areas

Sample. No	EC (dSm-1)	pH	Organic Carbon (%)	Avail. N (Kg/ha)	Avail. P (Kg/ha)	Avail. K (Kg/ha)	Avail. Zn (ppm)	Avail. Fe (ppm)	Avail. Cu (ppm)	Avail. Mn (ppm)
1	0.19	7.92	5.54	79.8	45	78	0.856	3.428	0.856	4.291
2	0.20	7.83	7.12	60.2	50	86	0.877	3.741	0.648	4.731
3	0.21	6.94	3.81	91	7.5	74	0.792	4.125	0.695	7.329
4	0.34	6.67	9.4	91	7.5	74	0.874	4.054	0.631	4.21
5	0.19	7.4	7.753	107.8	12.5	170	0.865	4.02	0.645	5.071
6	0.39	8.05	1.53	88.2	17.5	106	0.869	4.96	0.569	5.58
7	0.15	6.52	1.85	65.8	7.5	50	0.906	4.473	0.631	4.991
8	0.11	7.68	7.91	82.6	12.5	66	0.781	4.125	0.568	3.75
9	0.09	5.86	1.85	46.2	12.5	94	0.866	5.194	0.675	3.81
10	0.11	5.82	0.3	67.2	17.5	70	0.751	4.196	0.588	4.749
11	0.17	6.68	0.603	47.6	17.5	78	0.836	4.125	0.955	3.83
12	0.41	7.5	7.4	43.4	12.5	100	0.857	4.094	0.566	4.249
13	0.21	7.3	2.813	77	60	158	0.598	5.4	0.86	4.936
14	0.21	6.05	1.53	51.8	20	100	0.6	5.366	0.724	4.474
15	0.43	5.7	1.22	46.2	25	62	0.612	5.756	0.906	3.754

Macronutrients

3.4 Available Nitrogen

Nitrogen is the fourth important plant nutrient taken up by plants in greatest quantity next to carbon, oxygen, and hydrogen, but it is one of the most deficient elements in the soil for crop production and referred as universal deficient nutrient (Mengel and Kirkby, 1987; Mesfin, 1998) [10.11]. The plant takes up nitrogen generally as nitrates or ammonium ion under aerobic conditions and as ammonium ions during anerobic conditions. The available nitrogen (Fig.5) status of the micro-watershed was ranged from 43.4 to 107.8 Kg/ha. It shows the soils from the area have low nitrogen status. The nitrogen content is very low (<280 Kg/ha) in all the soil samples in the study area. Even with high organic carbon status of the soils under study, low nitrogen in the soil may be due to the low mineralization of organic matter as the soils. The N content is lower in continuously and intensively cultivated and highly weathered soils. It is clear from the results that the soil samples were found to be deficient in nitrogen and it is essential to apply nitrogen fertilizer and organic wastes as an important source of nutrient to the agricultural fields.

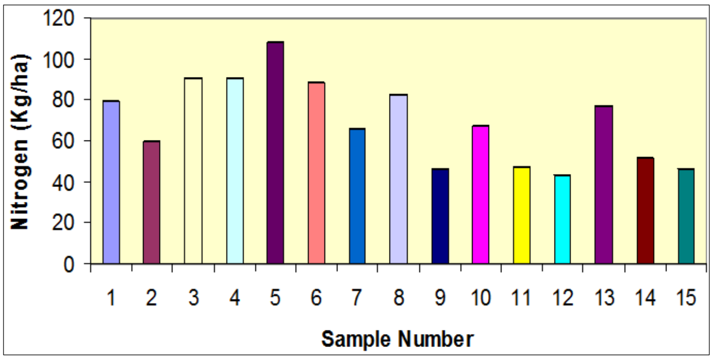

Fig 5: Graphical representation of Nitrogen value of soil

3.5 Available Phosphorus

Phosphorus is the second most important micronutrient available in the biological systems, which constitutes more than 1% of the dry organic weight. It is essential for growth, cell division, root growth, fruit development and early ripening. It is a constituent of several organic compounds including oils and amino acids (Tandon, 1997) [12]. Phosphorus exists in soils in both inorganic and organic forms. Phosphorus is used by the plant for the development of different stage of its growth. The available phosphorus (Fig.6) was ranged from 7.5 to 60 kg/ha. From the observation 3 samples falling under high phosphorus (>25 kg/ha) category status. Nearly most of the 11 soil samples have been shown medium category (10-25 kg/ha) of phosphorus in the area. It helps in energy storage and transfer. Soils from agricultural fields with medium phosphorus content in the study area can be supplemented by applying phosphorus rich fertilizers as required by a specific crop.

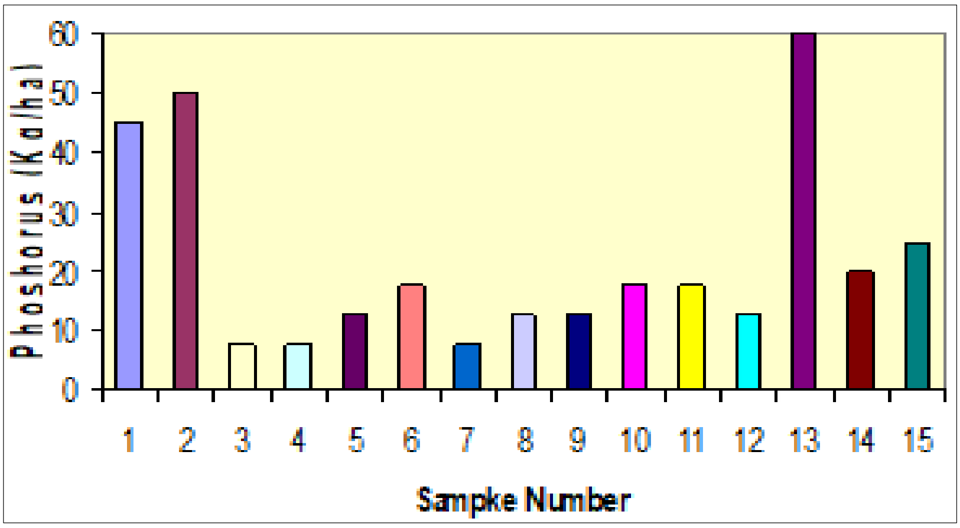

Fig 6: Graphical representation of Phosphorus value of soil

3.6 Available Potassium

Potassium plays an important role in different physiological processes of plants and important nutrient for the production of superior quality crop (Tandon, 1997) [12]. Fine textured soils generally possess large amounts of both the forms (exchangeable and non-exchangeable) of potassium compared to coarse textured soil. It is main role in catalytic in nature. It controls water economy and provides the resistance against several pests, diseases, and environmental stresses. The available potassium (Fig.7) in soils of the study area varied from 50 to 170 kg/ha. The low content of phosphorus in soils due to the low use of potassium fertilizers. From the observation 2 samples were found in medium (108- 280g/ha) category and 13 samples falling under low (<108 kg/ha) category. If the level of nutrient is low, the recommended fertilizer dose or the crops is increased by 25% (Muhr *et al.* 1965) [13].

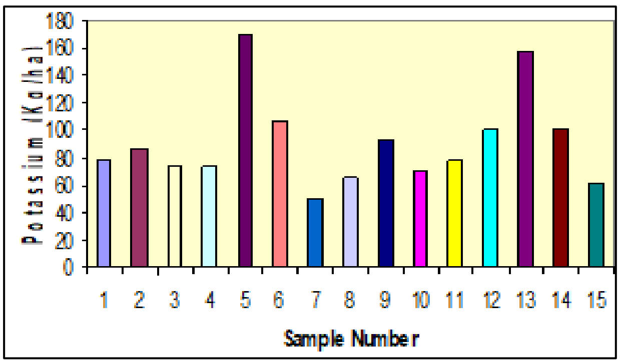

Fig 7: Graphical representation of Potassium value of soil

The soil fertility class of the available potassium content was found to be low in surface soil. The low level of available potassium in surface due to the continuous drain of K from the soil reserve over the years with inadequate supply of chemical fertilizers and manures and high depletion of potassium from soil.

Micronutrients:

3.7 Iron

Iron is an important micronutrient in the life cycle of plant, and plays important role for their various metabolic process (Rout and Sahoo, 2015) [14]. The entire study area the iron (Fig.8) status ranges from 3.43 ppm to 5.76 ppm, i.e., that the iron content was in the low to medium category. 2 samples show medium iron content in the soil status (2-4 ppm) and 13 samples show high (Sufficient) samples (>4 ppm). The low iron content of the soils might be due to precipitation of Fe^{2+} and decrease in its availability. Iron in small amounts is essential for healthy plant growth. Iron deficiencies are mainly manifested by yellow leaves due to low levels of chlorophyll. In addition, uptake of iron decreases with increased soil pH, and is adversely affected by high levels of available phosphorus, manganese, and zinc in soils (Ravikumar *et al*. 2007) [15].

3.8 Zinc

Zinc uptake by plants decreases with increased soil pH, Uptake of zinc also is adversely affected by high levels of available phosphorus in soils (Pulakeshi *et al*. 2012) [16]. The application of zinc increases antioxidant concentration and improves the drought tolerance in plants. Considering the soil test rating for available Zn (<0.5 ppm) as deficient, 0.5-1.0 ppm as sufficient and >1.0 ppm as high in the status of Zn. Zinc (Fig.9) in the study area ranges from 0.598 ppm - 0.906 ppm. Almost all the samples have medium ranges (0.5 ppm-1.0 ppm)

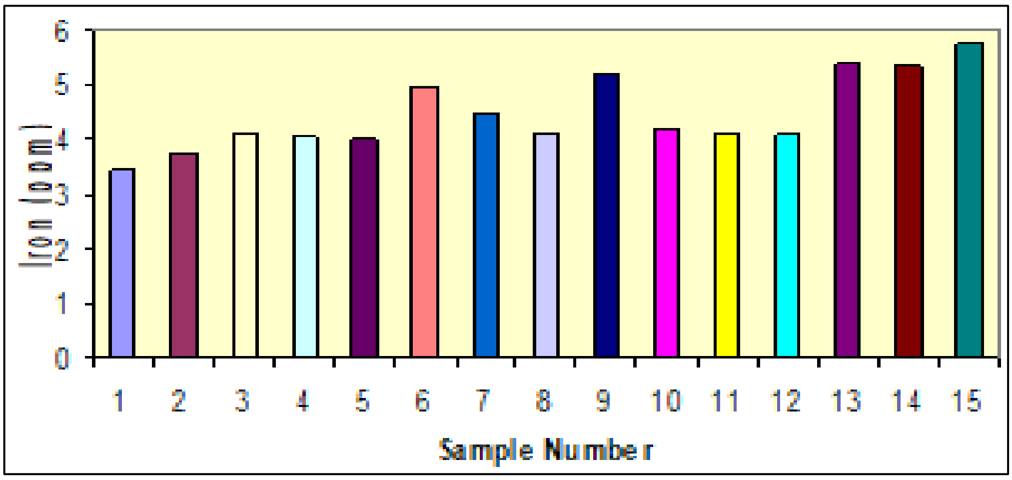

Fig 8: Graphical representation of Iron value of soil

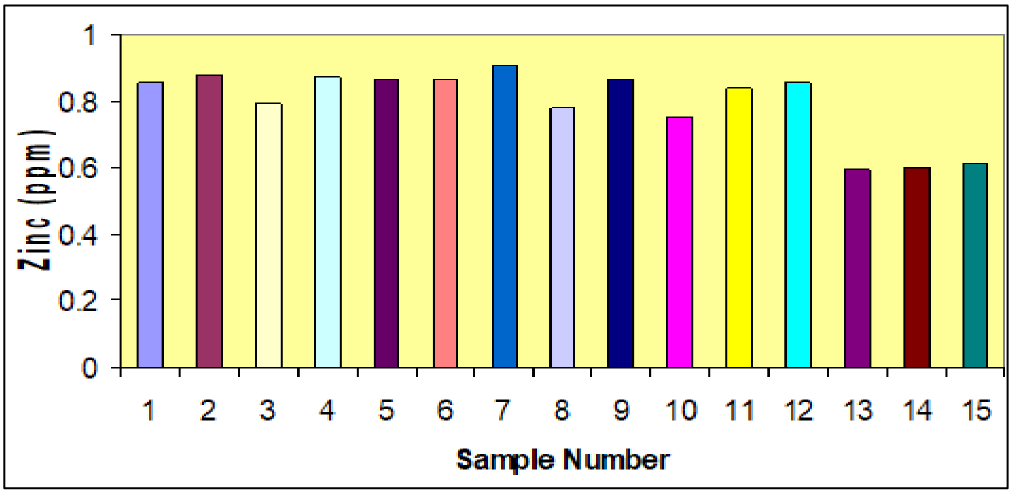

Fig 9: Graphical representation of Zinc value of soil

3.9 Copper

Copper is an essential micronutrient for plant growth and development, although it is also potentially toxic (Yruela, 2005) [17]. In copper rich soils only a limited number of plants have a chance of survival. Because on plants copper is a serious threat to the production of agricultural lands, depending upon the acidity of soil and presence of organic matter. It is a component of a variety of enzymes and plant cell walls, so it is important for plant strength. The deficient level is (<0.5 ppm) and sufficient level is (>0.5 ppm). The copper (Fig.10) content of the soils varied from 0.566 - 0.906 ppm. All the samples show the adequate copper content in the soil.

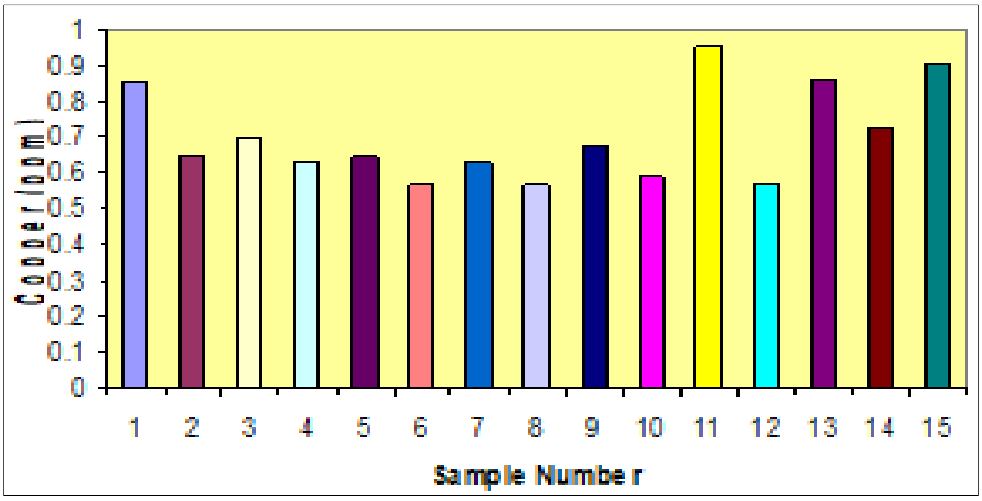

Fig.10 Graphical representation of copper value of soil

3.10 Manganese
Manganese (Mn) is an important plant micronutrient and is required by plants in the second greatest quantity compared to iron. Manganese functions as an activator of an enzyme that is involved in the evolution of oxygen in photosynthesis (Millaleo *et al*. 2010) [18]. The Mn (Fig.11) content of soil samples varied from 3.75 to 7.33 ppm. 15 samples have exceeded >2.0 ppm. The sufficiency levels indicative of these soils might be due to the neutral pH and natural of the parent material as reported by (Prasad and Sahi, 1989) [19].

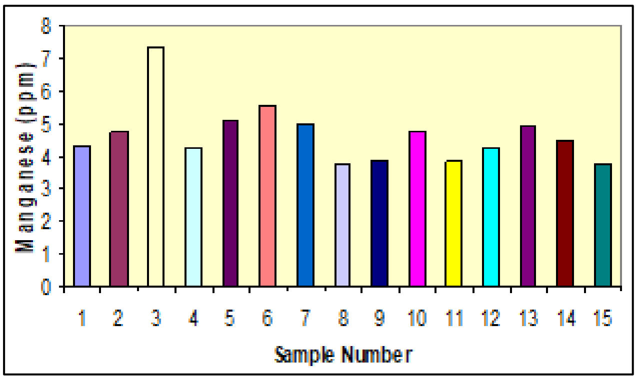

Fig 11: Graphical representation of Manganese value of soil

3.11Nutrient Index
Nutrient index value (NIV) is the measure of nutrient supplying capacity of soil to plants (Sing *et al*. 2016) [20]. Nutrient index value (NIV) was calculated from the proportion of soils under low, medium, and high (Fig.12) available nutrient categories. The index values are rated into various categories viz., low (<1.67), medium (1.67-2.33) and high (>2.33) for pH, EC, N, P, K, OC, Fe, Zn, Cu and Mn. It is found that, the N, K had low nutrient index, whereas, Cu, Zn had medium nutrient index. The P, Fe, Mn had high nutrient index. The rating chart is given in Table.2.

Table 2: Nutrient index ranges and remarks

Nutrient index ranges	Remarks
Below 1.67	Low
1.67-2.33	Medium
Above 2.33	High

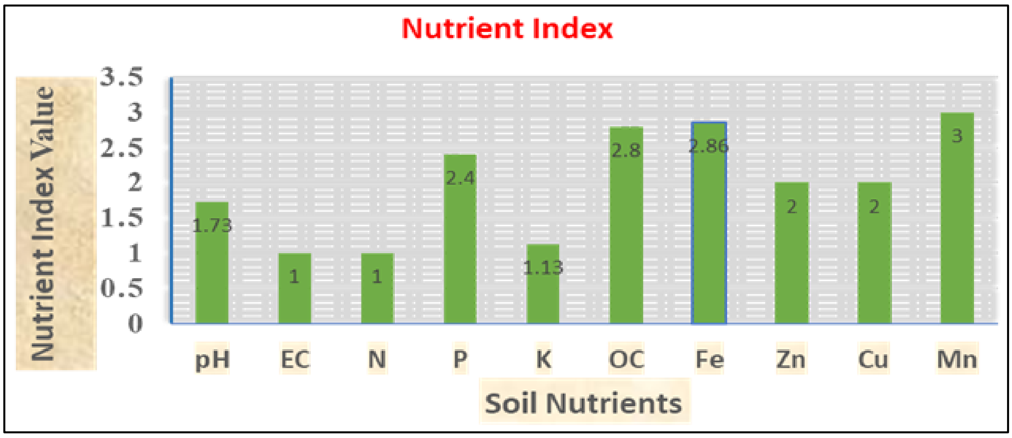

Fig 12: Graphical representation of the nutrient index of soil

4. Conclusion
The study has revealed that the pH of soils was moderately acidic to alkaline range. Electrical conductivity was normal (<1.0 ds/m). Soil organic carbon was medium to high. Available macronutrients (N, P, K) were low, medium, and high. The available of micronutrients was variable. Iron and Manganese was high, Copper and Zinc was medium, this can be due to the irregular distribution of different parameters present in soil. Such type of monitoring of soil samples is beneficial to know the concentrations of various parameters present in soil samples. In order to improve soil fertility status, appropriate measures need to be taken to correct these deficiencies such as the incorporation of organic manures, biofertilizers, judicious use of chemical fertilizers were suggested for farmers regarding the benefits of improving nutrient status.

Acknowledgement
The corresponding author thanks to the Agricultural and Irrigation Engineering students worked on this area.

Disclosure of conflict of interest
The author declares no conflict of interest

5. References
1. Agboola A, Ayodele O. Soil test calibration for upland rice in south western Nigeria. Nutrient cycling Agrosyst. 1987;14:227-234.
2. Shalini Kulshrestha, Devenda HS, Dhindsa SS. Studies on causes and possible remedies of water and soil pollution in Sanganer town of Pink city. Indian Journal of Environmental Sciences. 2003;7(1):47-52.
3. Clark RB, Baligar VC. Acidic and alkaline soil constraints on plant mineral nutrition. In: Plant-environment interaction, ed. R.E. Wilkinson, New York: Marcel Dekker, 2000, 133-177.
4. Brady NC, Weil RR. The nature, and properties of soil (Thirteenth Edition) Macmillan Publishing Co. New York, 2005.
5. Muhr GR, Datta NP, Shankara SN, Dever F, Lecy VK, Donahue RR. Soil testing in India, USAID, New Delhi, 1965, 120.
6. Sharma PK, Sood A, Setia RK, Tur NS, Deepak Mehra, Harpinder Singh. Mapping of macromutrients in soils of Amristar district (Punjab)- A GIS approach 2008. Journal of the Indian Society of Soil Science. 2008;56:34-41.
7. Sivaprasad CR, Reddy RS, Seghal J, Velayutaam M. Soils of Karnataka for optimizing land use. 1998;47:15.

8. Johnston AE. Soil organic matter, effects on soil and crop. 2007;2(3):97-105.
9. Kanwar JS, Grewal JS. Phosphorus fixation Indian Soils: A review. Indian Council of Agrixultural Research, New Delhi, India, 1971.
10. Mengel K, Kirkby EA. Principle of plant nutrition, Panima Publ. corporation, New Delhi, Bangalore, India, 1987, 687.
11. Mesfin Abebe. Nature and management of Ethiopian soils, Alemaya University of Agriculture, Ethiopia, 1998, 272.
12. Tandon HLS. Fertilizer recommendation for Horticultural Crops, FDCO, New Delhi, 1997.
13. Muhr GR, Datta NP, Shankar, Subramoney H, Liley VK, Donahue RL. Soil testing in India U.S. Agency for International Development, New Delhi, 1965, 120.
14. Rout GR, Sahoo S. Role of iron in plant growth and metabolism. Review in Agricultural Sciences. 2015;3(1):1-24.
15. Ravikumar MA, Patil PL, Dasog GS. Mapping of Nutrients Status of 48A Distributary of Malaprabha Right Bank Command of Karnataka by GIS Techniques. I-Major Nutrients, Karnataka J. Agric Sci, 2007;20(4):735-737.
16. Pulakeshi HBP, Patil PL, Dasog GS, Radder BM, Mansur CP. Mapping nutrients status by geographic information system (GIS) in Mantagani village under northern transition zone of Karnataka, Karnataka Journal Agricultural Sciences, 2012;25(3):232-235.
17. Yruela I. Copper in plants, Brazilian Journal of Plant Physiology. 2002;17(1):145-156.
18. Millaleo R, Reyes-Diaz M, Ivanov ML, Alberdi M. Manganese as essential and toxic elemnt for plant: transport, accumulation and resistance mechanisms, Journal of Soil Science and Plant Nutrition. 2010;19(4):470-481.
19. Prasad SN, Sahi BP. Distribution of management in relation to soil properties in some typical soil profiles, Indian Soc. Soil Sci. 1989;37(3):567-570.
20. Singh G, Sharma M, Manan J, Sing G. Assessment of Soil Fertility Status under different cropping sequences in district Kapurthala, J Krishi Vigyan. 2016;5910:1-9.