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Physicochemical Analysis of Soils from Eastern Part of Pune City

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Abstract:
Soil is a natural body of mineral and organic material differentiated into horizons, which differ among themselves as well as from underlying materials in their morphology, physical make-up, chemical composition and biological characteristics. In Pune city due to industrialization and other anthropogenic activity the soil from its eastern part has been polluted. The The sewage water in the Mula - Mutha River flows through the Manjari village and hence it is felt necessary to carry out the soil analysis to understand the pollution levels of the soils in the adjoining area. Since plants depend on the soils for their nutrients, water and minerals supply, the soil type is a major factor in determining what types of plants will grow in a any area. In the present study the analyses of soil samples collected from the sugarcane field of Manjari, Hadapsar , and Phursungi located in the SE part of the Pune city which is influenced by the solid waste disposal as well as industrial effluents. In the first place soils samples from 12 representative locations were collected for their analysis. Physical parameters like pH, Electrical conductivity (EC), organic carbon (%) and chemical parameters like phosphorus, potassium, copper, iron, manganese, zinc and boron were anlyzed. From this study it has been revealed that there is excessive dose of phosphorous and potassium into the soil because most farmers are using excessive chemical fertilizers. Similarly Cu, Fe, Mn and Zn concentration has also been seen higher than the normal range and due to poorer drainage conditions of this area making soil alkaline. Thus it is concluded that variable concentrations of various parameters and irregular distributions of micronutrients may be attributed due to the added fertilizers during the crop formation.

Keywords: Anthropogenic contamination, Micronutrients, Soil analysis, Pune

1.0 Introduction:
In Pune city due to industrialization and other anthropogenic activities the soil from eastern part of city gets polluted. The Mula-Muthariver carries sewage water of Pune city through from Manjari village and hence it is more relevant to carry out soil analysis (Chavhan and Wagh, 2013). Soil is an unconsolidated material of the earth's crust in which terrestrial plants grow if water and temperature are adequate with minimum available nutrients. According to Joffe (1949) the soil is a natural body of mineral and organic material differentiated into horizons, which differ among themselves as well as from underlying materials in their morphology, physical make-up, chemical composition and biological characteristics (Solanki and Chavda, 2012). Soil can develop from weathered rocks, volcanic ash deposits or accumulated plant residues. Soil thus form a substrate for plant growth which performs many functions essential to life and in general, most plants grow by absorbing nutrients from the soil whose ability to do this depends on the nature of the soil. Soil formation is a constructive as well as destructive process (Pujar*et.al*., 2012) the predominant destructive process are physical and chemical breaking down of materials, plants and animal structures which result in the partial loss of more soluble and volatile products. Soil types are a major factor in determining what types of plants will grow in a certain area as plants use inorganic elements from the soil such as nitrogen, potassium and phosphorus. However microorganisms like fungi, bacteria and other microscopic life forms available within the soil are also vital and hence soil is a dynamic medium made up of minerals, organic matter, water, air and microorganisms. The nature of soil primarily depend upon its continued change under the effect of physical factors like the parent material, time, the climate, the organic activity in it etc. (Solanki and Chavda, 2012). Since soil is made up of such diverse materials like weathered rock particles and organic

material (humus), it can be classified into various types based on the size of the particles it contain (Tan, 1996; Ganguly, 2007). The modern concept of soil quality is the ability to sustain plant and animal productivity, to increase water and air quality and to contribute plant and animal health (Doran, and Zeiss, 2000; Emnova, 2004). Although all physico-chemical properties are involved in soil functioning, bio chemical properties tend to react most rapidly to get change in the external environment (Nannipieri*et al,* 1990; Trasar-Cepeda et al, 2008). The objective of this study is to 1) to analyze the soil samples of SE part of Pune city 2) to investigate the effects of anthropogenic activity on the crop productivity, 3) to study the effect of sewage water of Pune city carried by Mula-Mutha river through Manjari village on the soils, 4) to evaluate the effects of excessive use of chemical fertilizers by the farmers on the characteristic of soils in SE of Pune, and 5) to find out the effects of irrigation process and drainage patterns on the soil fertility.

2.0 Materials and Methods:

2.1 Study Area:

Pune, the seventh largest city in India by population, lies between latitudes 18^0 31'N & $22^0$45'N and longitudes $73^0$52'E & $32^0$9'E with an altitude of 559m above the mean sea level and covering approximately 243.84 km^2 area. The waste disposal site (Fig. a) is a non-engineered open dump looking like a huge heap of waste up to a height of 20m. The solid waste disposal site (73^o 55' to 74^o 00'N and 18^o 25' to 18^o 32' E) is situated at elevation ranging between 550 to 660m above mean sea level on the eastern slopes of a small topographic high (Sayyed and Wagh, 2011 & 2013).

2.2 Methods:

The present study deals with the analysis of soil samples from sugarcane field which were collected in a period 2009 - 2010 from Manjari, Hadapsar and Phursungi villages situated towards SE of Pune city and this region is affected by the solid waste disposal as well as industrial effluents. This study was primarily focused on testing of soil quality from 12 representative sampling stations (numbered as 1 to 12) and the analytical results were expected to be representative for the entire field. The surface contaminated soil material were removed using spade or khurpi (Gupta, 2007) and for sampling V shaped holes were dug for collecting a uniform 2 cm thick slice of soil up to a depth of 22cm. which were collected in a plastic bucket. Samples collected were thoroughly mixed on a piece of clean cloth, air dried and the lumps were broken using wooden pestle and mortar (Tandon. 1993). Particles were disaggregated, crushed and sieved with 10 mesh diameter, stored in glass bottles and labelled.

pH values were determined using Equiptronics pH meter as described by Jackson (1967). For this 20 g soil sample was mixed with 40 ml distilled water in 1: 2 ratio. The suspension was stirred intermittently with glass rod for 30 minutes and left for one hour. The combine electrode was inserted into supernatant and pH was recorded.pH value as a measure of the hydrogen ion activity of the soil water system and expresses the acidity and alkalinity of the soil. It is a very important property of soil as it determines the availability of nutrients, microbial activity and physical condition of soil.

Electrical conductivity (EC) expresses ion contents of solution which determine the current carrying capacity thus giving a clear idea of the soluble salts present in the soil. The electrical conductivity of a soil samples was determined on an Equiptronics digital electrical conductivity bridge for which 20g soil was added in 40ml distilled water. The suspension was stirred intermittently for half an hour and kept it for 30 minutes without any disturbances for complete dissolution of soluble salts. The soil was allowed to settle down and then conductivity cell was inserted in solution to take the reading to record the EC values.

Organic matter is useful in supplying nutrients and water to the plants and also provides good physical conditions to the plants. The quantity of organic carbon in the soil was estimated by using modified Walkey- black method (Walkey and black, 1934) as described by Jackson (1967). 1g finely ground dry soil sample was passed through 0.5mm sieve without loss and was taken into 500ml conical flask. To this 10ml of 1N potassium dichromate and 20ml con. H_2SO_4 were added and the contents were shaken for a minute and allowed to set aside for exactly for 30 minutes and then 200ml distilled water, 10ml phosphoric acid and 1ml diphenylamine indicator were added. The solution was titrated against standard ferrous ammonium sulphate till colour changes from blue violet to green. The blank titration was also carried without soil.

In soils available phosphorus is found as orthophosphate in several forms and combinations but only a small fraction of it may be available to plants. Available phosphorus was estimated by Olsen's method (Olsen *et al*, 1954) modified by Watanbe (1965). The reagent for Olsen's P was 0.5 M $NaHCO_3$ (pH 8.5) prepared by dissolving 42g $NaHCO_3$ in distilled water and made up to 1 lit. The pH was adjusted at 8.5 with 20% NaOH solution. 2.5g of air dried soil was weighed into 150ml Erlenmeyer flask, 50ml of Olsen's reagent (0.5 M $NaHCO_3$ Solution, pH 8.5) and one teaspoonful of activate charcoal were added. The flasks were shaken for 30 minutes and contents were filtered immediately through Whatman filter paper (No. 41). 5ml of the filtrate was taken out by pipette into 25ml of volumetric flask and was neutralized with 1: 4 H_2SO_4 using p-nitrophenol as indicator and the volume was made up by adding distilled water. After addition of few crystals of stannous oxalate blue colour developed and intensity of blue colour was read in photoelectric colorimeter within 10 minutes at a wavelength of 730nm. A blank was run without soil.Potassium in soil water has been estimated by flame by preparing the standard solutions of potassium (ppm) and feeding the diluted extract in flame photometer for recording the reading for standard and sample with K filter.

Micronutrients like Cu, Zn, Fe, Mn are estimated by using Atomic Absorption Spectrophotometer employing standard methods (Trivedy and Goel, 1984). Micronutrients include iron, manganese, zinc, copper, boron, chlorine and molybdenum. The term refers to plant's needs, not to their abundance in soil. They are required in very small amounts but are essential to plant health in that most are required to speed up plant's metabolisms. They are generally available in the mineral component of the soil and the method commonly used for determination of available micronutrients in soil samples is by Lindsay and Norvell (1978) This method consists of use of DTPA (Diethylenetriaminepentaacetic acid) as an extractant which has been widely accepted for the simultaneous extraction of micronutrients like Zn, Cu, Fe Mn in neutral and alkaline soils. Most commonly used method for available boron is hot water extraction method as given by Berger and Truog (1939) which has been modified by (Gupta, 1967) in which boiling the soil with water is employed. The extracted boron in the filtered extract is determined by azomethine-H colorimetric method.

3.0 Result and Discussion:

An examination of soil samples (Table 1) shows that the values for pH range from 7.32 to 8.52 (Fig. b) indicating that the soils are alkaline and under such conditions the solubility of minerals decreases creating nutrient deficiencies in the soils. Plant growth is therefore limited by deficiencies in iron, manganese, zinc, copper and boron. Electrical Conductivity value ranges from 0.20 mS/cm to 3.02 mS/cm (Table 10), however sample No. 6 shows excess content of soluble salts which may due to excess use of fertilizer like P and K. Electrical conductivity is used to estimate thesoluble salt concentrations in soil and is commonlyused as a measure of salinity. Soil with EC below 0.4mS/cm are considered marginally or non-saline, whilesoils above 0.8 mS/cm are considered severely saline.The soils under analysis were found moderately saline except sample Nos. 4, 7, 10 and 11 (Fig. b).

The organic carbon (%) ranges from 0.38 to 1.5 % (Fig.b).The organic soil matter includes all the dead plant materials and live or dead animals. Most living things in soils, including plants, insects, bacteria and fungi, are dependent on organic matter for nutrients and energy. Soils have varying organic compounds in varying degrees of decomposition. Organic matter holds soils open, allowing the infiltration of air and water, and may hold as much as twice its weight in water.Phosphorus is one of the key macronutrient required for plant growth and metabolism. Inorganic phosphate supplied to the soil as a fertilizer is rapidly converted into unavailable form. Soluble P converted into insoluble phosphate involves microorganisms. Phosphorous in the present soils vary from 10 Kg/hectare to 172.9 Kg/hectare (Fig. b) the highest value in sample No. 6 may be due to use of excessive phosphorous fertilizers. Application of phosphorus (P) is necessary for maintaining a balance between the other plant nutrients and ensuring the normal growth of the crop.Potassium fixation occurs when soils dry and the potassium is bonded between layers of clay. Under certain conditions, dependent on the soil texture, intensity of drying, and initial amount of exchangeable potassium. From the analyzed samples potassium ranges from 112 Kg/hectare to 840 Kg/hectare (Fig. b) indicating sufficient K in most of the sample except sample No 4 and 12.

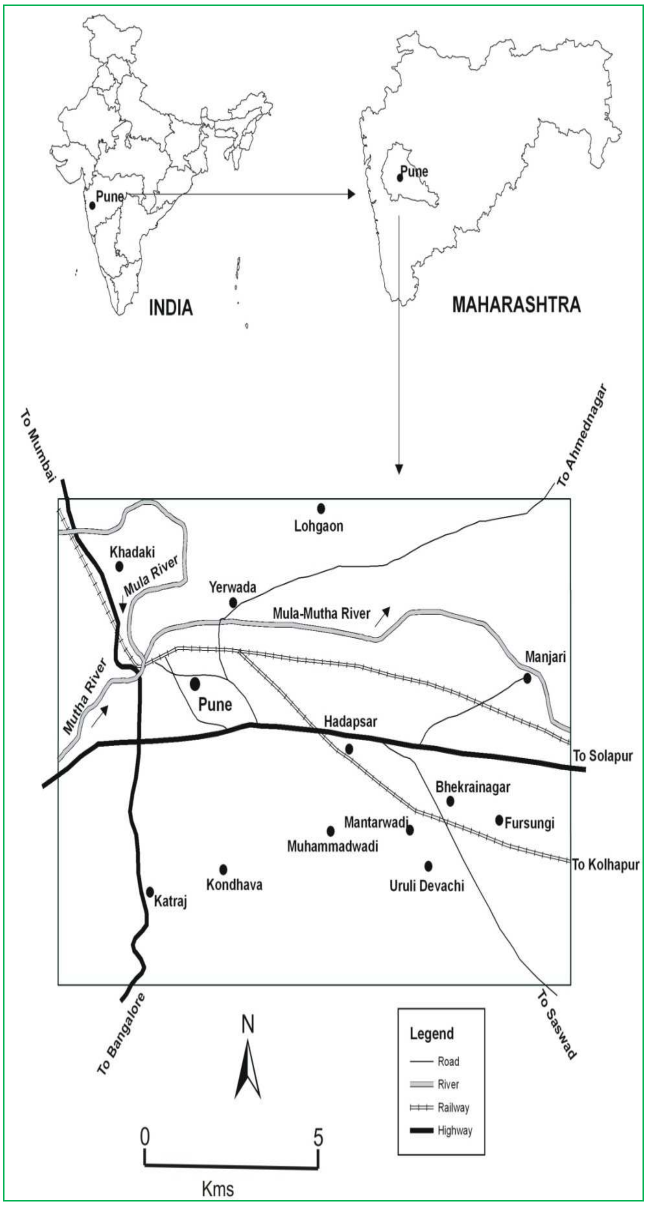


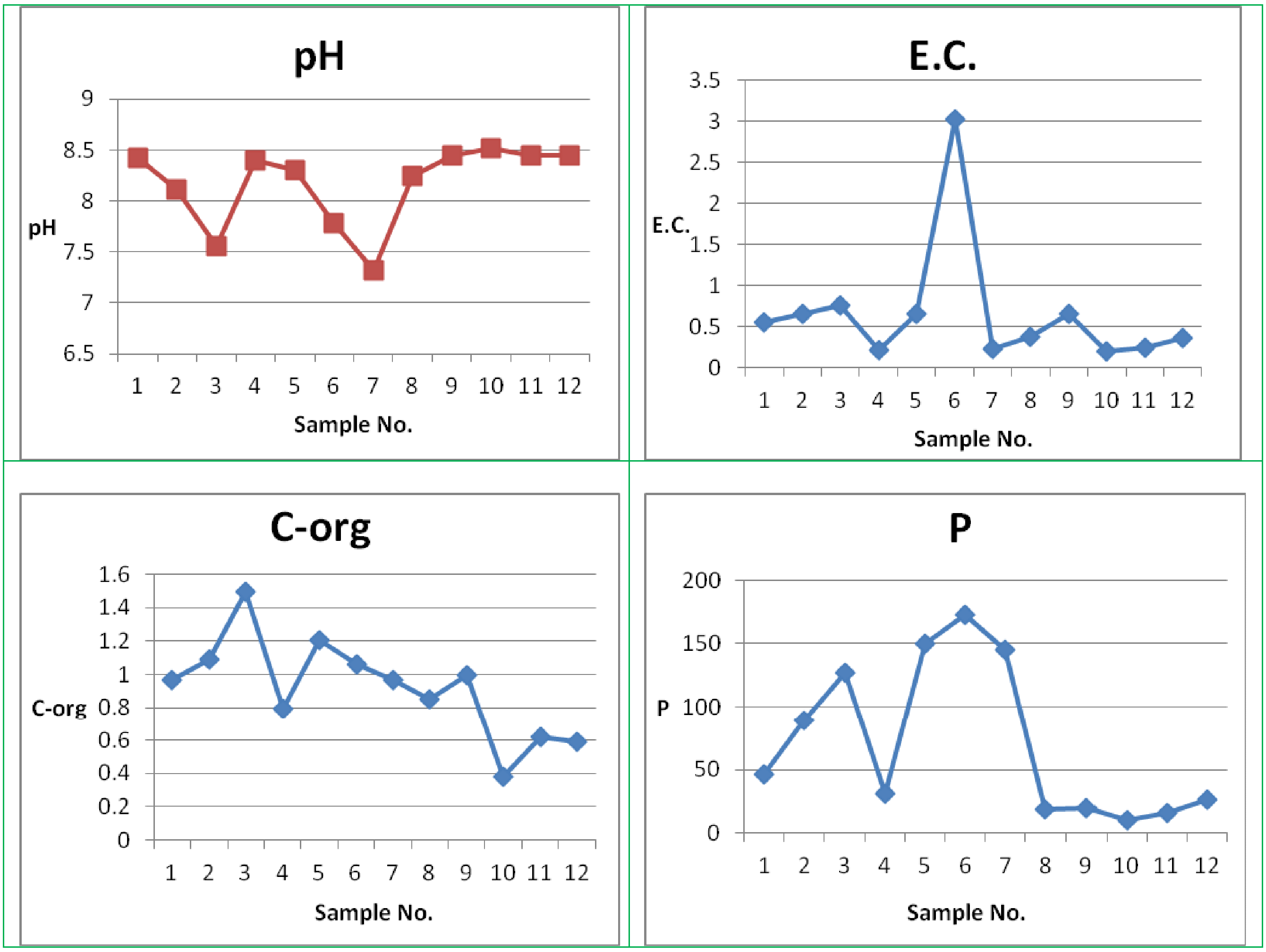
Figure : a. Location map of and soil samples collected villages Manjari , Hadapsar , and Phursungi from(SE) Pune (after Sayyed and Wagh, 2011 & 2013)

The Copper is an essential micronutrient for normal plant growth. The copper content of most plant is generally between 2 and 20 ppm in the plants. As copper is strongly bound to soils it is very immobile and hence the plant roots are frequently higher in copper concentration than other plant tissues. In the soils under study the concentrations of Cu range from 2.02 ppm to 36.51 ppm (Fig .b).Iron is essential for chlorophyll and protein formation, photosynthesis, electron transfer oxidation and reduction of nitrates and sulphates and other enzyme activities. Iron is one of the most common nutrients for plant growth and development because it exists in low-soluble form that is hardly available for plants. Table 1 and Figure c shows the variation of the Iron content from 3.08 ppm to 23.04 ppm in the soils from the area.Manganese has oxidation influenced by both chemical and microbiological factors. Its activities has many enzyme reaction involved in the metabolism of organic acids P and N it is also involved in the photosynthesis and protein synthesis and also, manganese function along with Fe (Lindsay and Norvell, 1978) in formation of chlorophyll. Table 1 shows the variation of the manganese content in the soils from the area from 12.36 ppm to 23.28 ppm.Zincdeficient plants are sensitive to pathogenic fungal root diseases (Graham, and Webb, 1991). Improvement of Zn nutritional status of plants reduces the exudation of such compounds from roots and increases resistance to fungal root diseases. The zinc concentrations range from 0.32 ppm to 5.62 ppm (Fig.c) indicating that in most of samples Zn is higher than the normal range of soils. The concentrations of boron in the soils range from 0.08 ppm to 0.54 ppm. (Fig. c).

Table: 1: Showing the variation in different parameter of soil samples from southeast of Pune city

Sample No .	pH	E.C.	C-org	P	K	Cu	Fe	Mn	Zn	B
1	8.42	0.55	0.97	46.4	392	6.62	5.62	12.84	2.26	0.32
2	8.11	0.66	1.09	89.1	280	25.24	16.08	17.50	5.20	0.20
3	7.55	0.76	1.50	126.8	728	36.51	18.16	22.66	5.62	0.52
4	8.40	0.21	0.79	31.4	168	2.20	6.86	16.00	0.78	0.40
5	8.30	0.66	1.21	149.6	392	26.8	15.48	19.94	5.38	0.32
6	7.78	3.02	1.06	172.9	840	9.10	17.6	23.28	4.62	0.28
7	7.32	0.23	0.97	145	448	13.8	23.04	22.34	5.54	0.54
8	8.24	0.38	0.85	19.0	448	4.06	9.94	19.80	0.64	0.16
9	8.44	0.66	1.00	19.7	224	2.02	3.08	12.36	0.62	0.48
10	8.52	0.20	0.38	10.0	748	2.02	5.24	13.88	0.32	0.08
11	8.44	0.24	0.62	16.3	392	4.26	7.28	17.94	0.90	0.08
12	8.45	0.37	0.59	26.7	112	4.98	6.98	18.22	0.78	0.20

EC- mS/cm. C- org-%, P & K- Kg/hectre, Cu, Fe, Mn, Zn and B. - ppm



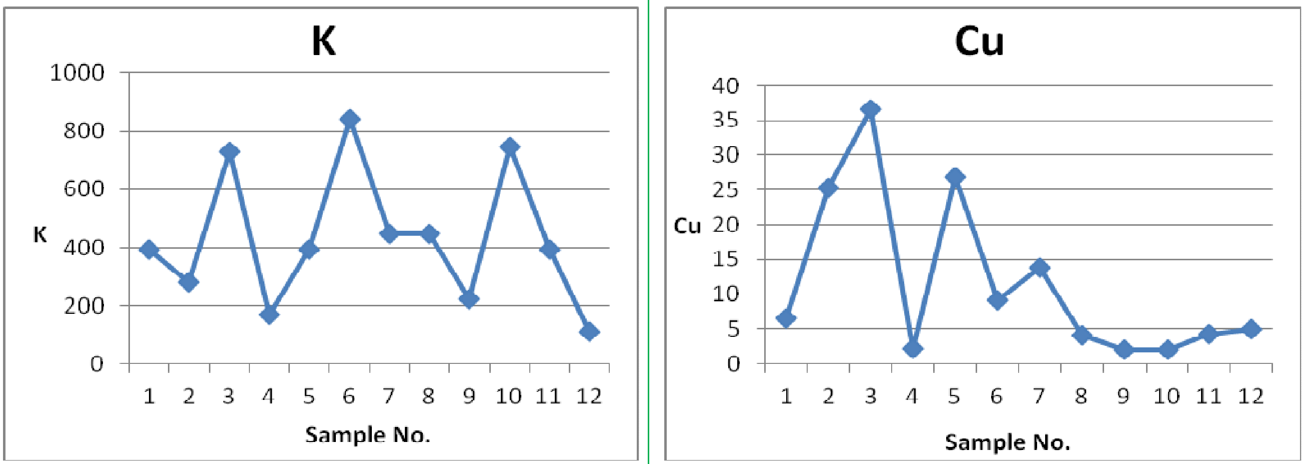


Figure: b). Variations of parameters like pH, EC, C-org, P, K and Cu in soil samples.

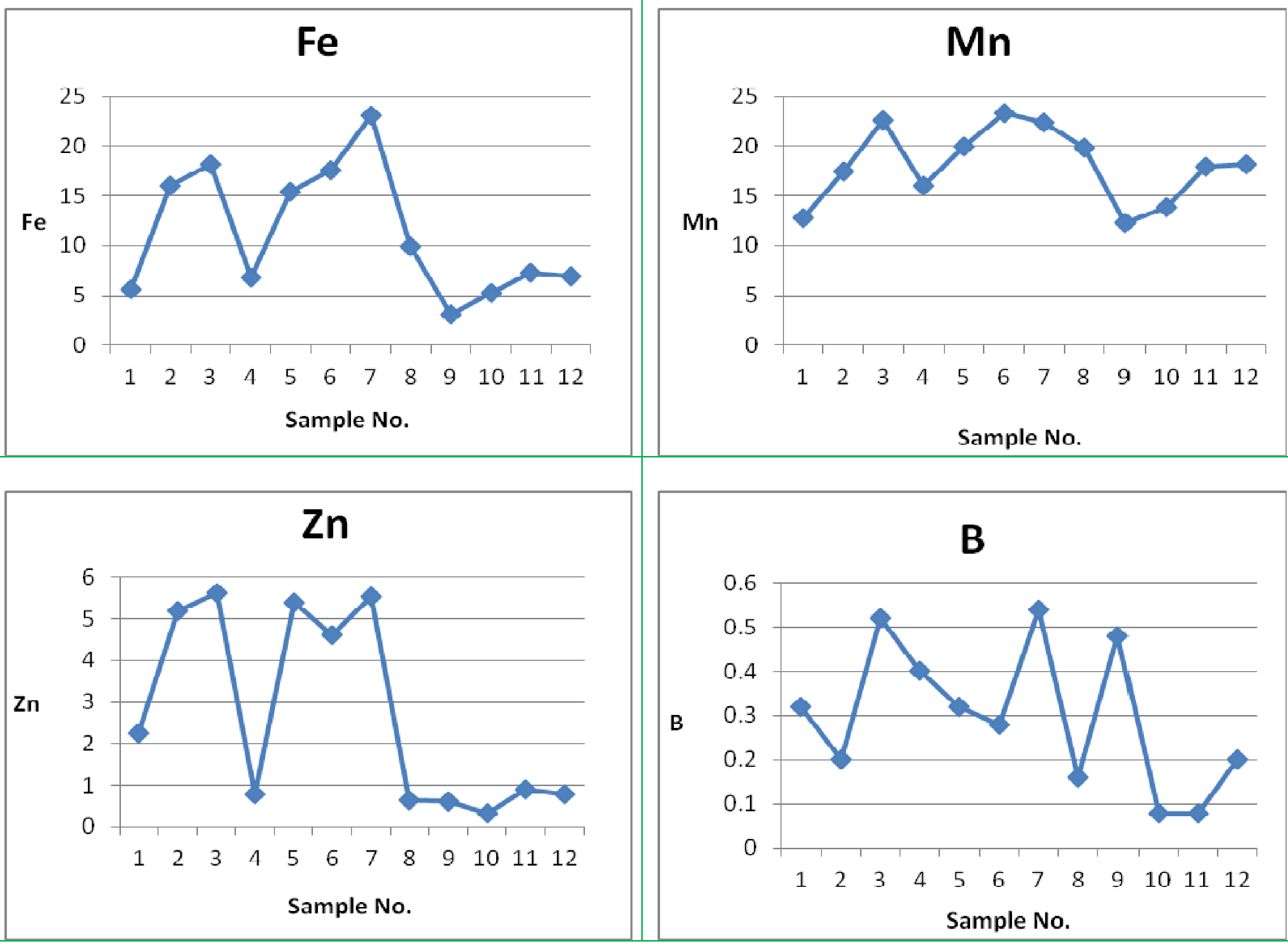


Figure: c). Variations of parameters like Fe, Mn, Zn and B in soil samples

4.0 Conclusions:

1) The physico-chemical analysis of the soil samples from Manjari, Hadapsar and Phursungi villages towards SE of Pune city have influence of the uncontrolled solid waste disposal practice as well as industrial effluents. The main crops are sugarcane and onion.

2) Most of the farmers are using excessive chemical fertilizers and the too much dose of such fertilizers in few soils has rendered high values of P and K. The retention of K could also be due the

clay minerals formed by chemical weathering of basalts which is the parent material for the soil.
3) The values the Cu, Fe, Mn and Zn are higher than the normal range in most of samples of soil which could be due to poor drainage conditions in this area which also makes the soil alkaline
4) Use of acidic fertilizers and organic manure can be a remedy which can raise the crop yield.
5) Monitoring of micronutrients in the soils should be done periodically as it can be an efficient way to assess the qualitative and quantitative abundances of the metal concentrations.

5.0 Acknowledgment:

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