Study of Macronutrients and Micronutrients of soil from Tsonzunphen Village and Gukhanyu Village under Tseminyu District, Nagaland, India.

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Abstract: The present investigation aims to analyze the soil micronutrients and macronutrients including various soil physico-chemical parameters from two location, Tsonzunphen village and Gukhanyu village under Tseminyu district. Study of micro- and macro-nutrients in soil provides information that is useful for soil quality improvement. The soils were moderately acidic with pH ranging from 5.7 to 6.3 and electrical conductivity ranging from 0.026 to 0.053 dS/m. The result shows low in nitrogen, phosphorus and sulphur, high in organic carbon and chloride, low to medium in potassium and sufficient soil micronutrients content. Water holding capacity and moisture percent was also determined. Nutrient index (NI) value was also ranging from low to medium.

Index Terms: Micronutrients, macronutrients, water holding capacity, nutrient index, Tseminyu, Nagaland.

INTRODUCTION

Soil is a dynamic layer containing porous medium with biological activity that forms the top most layer of the Earth's crust. In soil chemistry, soil colloids have a significant property such as the soil tiny size that have surface area which is relatively high having charge which can absorb cations. This not only plays a role in cation exchange capacity but can maintain the water-holding capacity and the structure of the soil. Also, high base saturation of soils is considered to be more fertile which usually have 100 % base saturation when the pH is above about 6.5. Lower base saturations are observed in the areas with higher rainfall than areas with lower rainfall as bases leach out of the soil because of rainfall. Soil collectively acts as a medium for plant growth by allowing the nutrients to be available for the plants to take up. The nutrients are transported from the soil to plants roots through root interception, mass flow or diffusion base on its chemical form. Environmental factors such as water, temperature, and light are also included in the requirement of plant nutrients balance and not only nutrients. Chemical soil analysis is performed for several possible reasons like determining the content of essential plant nutrients i.e., Nitrogen (N), Potassium (K), Phosphorus (P), Sulphur (S), pH, electrical conductivity (EC), soil organic matter (SOM), water holding capacity (WHC). The major nutrients include carbon, oxygen, hydrogen, phosphorous, nitrogen and potassium. Secondary nutrients such as calcium, magnesium and sulphur whereas iron (Fe), zinc (Zn), boron (B), manganese (Mn), copper (Cu), chloride (Cl^-) and molybdenum are called micronutrients. Evaluation of fertility status of the soils of an area or a region is important aspect in the context of sustainable agriculture [1]. The physical and chemical properties determine suitability of soil for planned use and management requirements to keep it most productive to a limited extent, the fertility of a soil determines its possible uses and to large extent of its yields [2]. The differences in the soil physical, chemical and biological properties contributes in soil texture and color which makes some soils either red or black, shallow or deep, fine or coarse texture. Imbalance and inadequate use of chemical and fertilizers, improper irrigation and various cultural practices also deplete the soil quality rapidly [3]. The quality of crop and suitable crop grown can be predicted by determining the soil health and its proper maintenance. Thus, the investigation of parameters and processes which effects on soil to function efficiently as a component of a sound ecosystem is done in soil quantity analysis [4].

Certain elements that are present in the soil freely are taken up by the plants as pollutants. Although they might not be required, they might promote plant development. These include mercury, silver, bromine, tin, radium, lithium, strontium, beryllium, vanadium, barium, and silver. A plant has a deficiency when the amount of a crucial nutrient it contains is insufficient for optimal growth, or when there is an unbalanced intake of other nutrients. This condition leads to poor yielding. Nutrient loss occurs as a result of crop removal, erosion, leaching, denitrification, and volatilization. Soil erosion results in the loss of phosphorus. High temperatures and wind speed up the volatilization of nitrogen into easily lost ammonia

STUDY AREA

Nagaland state is situated in the extreme northeast, India. The study areas are Tsonzunphen village and Gukhanyu village under Tseminyu district of Nagaland. Six soil samples were collected at each site for analysis.

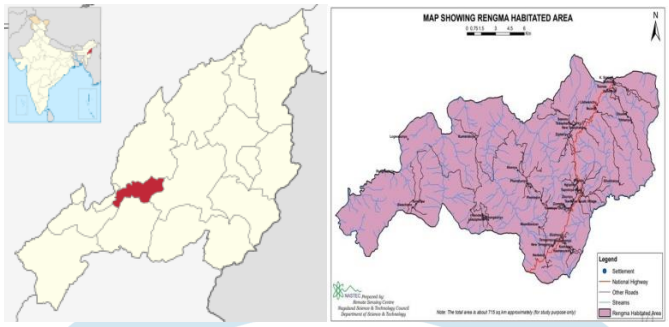

Fig.1 Map of Nagaland state and Tseminyu district.

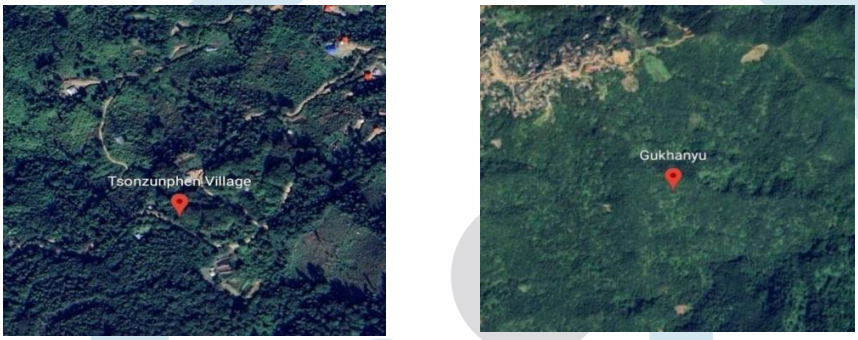

Fig. 2 Location map of Tsonzunphen Village and Gukhanyu Village

METHODS AND MATERIALS

The six (6) samples each were collected from Tsonzunphen (T-1, T-2, T-3, T-4, T-5, T-6) and Gukhanyu village (G-1, G-2, G-3, G-4, G-5, G-6) under Tseminyu district of Nagaland. The most widely used method, known as the V-shaped method was applied for the soil samples collection.

Table 1 Methods for the analysis of soil analysis

Sl No.	Parameters	Method
i	pH	pH Metry
ii	Electrical Conductivity	Conductometry
iii	Water Holding Capacity	Oven Dry Wet
iv	Moisture	Oven Dry Wet
v	Nitrogen	micro-Kjeldahl distillation method
vi	Phosphorus	Spectrophotometry
vii	Potassium	Flame Photometry
viii	Organic Carbon	Wet Digestion
ix	Sulphur	Spectrophotometry
x	Chloride	Silver Nitrate Titration
xi	Boron (B)	Spectrophotometry
xii	Micronutrients (Zn,Fe, Cu and Mn)	Atomic Absorption Spectroscopy (AAS)

RESULTS AND DISCUSSION

Water Holding Capacity

When the soil pore space is occupied with water and the drainage is limited than the concentration of water in the soil is called as water holding capacity. However, the amount of water that the soil can detain for the plants root to utilize for specific period of time is called as available water holding capacity. The soil texture and available pore spaces in soil determines the water holding capacity. Compared to soils with high water holding capacity, low WHC soils require higher rates because water penetrates into the soil profile more quickly. The water holding capacity for sandy soil is lower as compared silt and clay soils. Hence frequent irrigation will be required for crops grown in sandy lands. The WHC of the soil of Tsonzunphen village was observed to be ranging from 19.34% to 23.57 % and 41.88% to 19.38% for Gukhanyu village. The observed readings were mentioned in Table 2.

Table2 Water Holding Capacity readings for the soil samples.

Samples	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Tsonzunphen	49.34%	44.17%	39.30%	33.19%	28.79%	24.06%	23.57%
Gukhanyu	41.88%	37.13%	32.90%	29.50%	24.50%	20.71%	19.38%

Moisture Content

The soil moisture is generally referred to as water contained in the unsaturated soil surface of the earth and is an indicator of the water quantity existing in soil. Moisture of soil is an important factor in controlling the interchange of water and warmth energy through plant transpiration and soil evaporation among the atmosphere and the land surface. As a result, the evolution of climate and the formation of precipitation greatly depend on the soil moisture. In addition, the data of soil moisture can be applied for water reservoir concentration, advance deficiencies advice, estimation of crop yield and planning for proper irrigation. It was observed that the moisture content of Gukhanyu village was higher compared to Tsonzunphen village with moisture percent of 38% and 34.08% respectively.

Soil pH

The pH value of soil is the measurement of hydrogen or hydroxyl ion activity in the soil solution. The pH of the soil can be used to provide both quantitative and qualitative information about the qualities of the soil. Every crop has a specific optimum pH range. Therefore, some crops thrive in acidic soil and can grow to their full potential there, while other crops do better in soil that is more alkaline. pH affects all physical, biological and chemical properties [5]. The data obtained is shown in Table 3 and graphically represented in Figure 4. It was found that all the soil samples were moderately acidic in both the two villages ranging between 5.7- 6.3. The twelve collected sample showed similar pH range and both soils are suitable for growing crops. Similar results have been reported by [6], [7] and [8] for the soil of Nagaland.

Electrical Conductivity

It is a soil-water suspension's specific conductivity at a certain ratio. It gives details the amount of salt soluble in the soil extract. The EC increases by 1.9% per degree Celsius as the temperature rises. As a result, EC is generally expressed at 25°C for comparison and as a point of reference to obtain correct salinity values. The findings revealed that all the soil samples were non-saline which is suitable for most of the plant to grow. The lowest EC value was recorded under Gukhanyu village with 0.26 dS/m and highest EC value 0.53 dS/m under Tsonzunphen village where the EC value varied from 0.26 to 0.53 dS/m. The result observed were shown in Table 3 and graphical representation in Figure 3.

Soil organic carbon

Carbon is the major component of soil organic matter. Carbon is essential for soil fertility, productivity and quality, its reduction impacts the sustainability of agricultural production ecosystems and is crucial for sustaining the overall quality of the environment [9]. The physical, chemical, and biological characteristics of soil are influenced by soil organic matter. It enhances soil structure and aeration while raising soil fertility, moisture, and nutrient retention capacity. The results revealed higher organic carbon (OC) content in the soil samples from Tsonzunphen varying from 2.54 to 2.68% and lower organic content which varied from 1.93 to 2.11%. Generally, all the soil samples were high in organic carbon content. The observed findings were mentioned in Table 3 and graphically represented in Figure 4. Similar results were observed by [10], [8] and [11] in some part of Nagaland, India.

Soil Nitrogen

Nitrogen is a commonly limiting nutrient for plant growth in tropical soils and its availability is important to soil fertility [12]. The main form of plant available nitrogen is the inorganic forms of soil nitrogen, which is obtained from fertilizer nitrogen and mineralization of organic forms of soil nitrogen. It was observed that the soil samples of both the two villages were low in nitrogen content ranging from 238.26 to 263.26 kg/ha. The values are indicated in table 3 and

graphically represented in Figure 5. Low content of available nitrogen in soil causes the plant looks pale to yellowish green, older leaves senescence and causes low shoot/root ratio due to increased stunted shoot growth and root growth. Similar results were also obtained by [13] and [14] in soils of some part of Nagaland.

Soil Phosphorus

Phosphorus is a crucial and important macronutrient for all living things. Countless metabolic activities, including respiration, photosynthesis, energy production, seed germination and formation depends on soil phosphorus. Generally, it functions as the storage of energy and limits the quantity of nutrients that remain in plant nucleus. Table 3 revealed the data obtained through analysis. The soil phosphorus was found to be low in content. Similar findings were also reported by [15] for the soil of Tuensang district and [14] for the soil of Zunheboto district, Nagaland.

Soil Potassium

Potassium is one of the most prevalent inorganic cations necessary for healthy plant growth. In the soil system, potassium exists in three forms that are in equilibrium: inaccessible, fixed or slowly available, and exchangeable or easily available. Potassium influences how well plants absorb nutrients from the soil by interacting with other nutrient ions in the soil. In addition, potassium is considered as the second most critical element for the growth of plants. The data revealed are given in Table 3 and graphical representation in Figure 5. It shows low and medium content of potassium in the soil of Gukhanyu and Tsonzunphen village respectively.

Table 3 pH, Electrical Conductivity, Organic Carbon, Soil Organic Matter and Nitrogen, Phosphorus, Potassium readings for the soil samples.

Samples	pH readings	EC dS/m	SOC (%)	SOM (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)
T-1	6.2	0.053	2.62 (H)	5.86 (H)	238.26 (L)	8.68 (L)	127.79 (M)
T-2	6.2	0.031	2.66 (H)	5.94 (H)	263.34 (L)	12.11 (L)	141.79 (M)
T-3	5.8	0.030	2.65 (H)	5.93 (H)	250.80 (L)	14.17 (L)	134.40 (M)
T-4	5.7	0.033	2.60 (H)	5.82 (H)	263.34 (L)	8.45 (L)	146.72 (M)
T-5	5.7	0.042	2.54 (H)	5.68 (H)	263.34 (L)	7.31 (L)	134.62 (M)
T-6	5.8	0.039	2.68 (H)	5.99 (H)	250.80 (L)	4.80 (L)	134.73 (M)
G-1	6.3	0.033	2.11 (H)	4.72 (H)	238.26 (L)	5.02 (L)	99.90 (L)
G-2	5.9	0.031	2.09 (H)	4.67 (H)	238.26 (L)	5.48 (L)	81.76 (L)
G-3	5.9	0.036	2.09 (H)	4.67 (H)	238.26 (L)	7.54 (L)	94.75 (L)
G-4	5.8	0.034	2.01 (H)	4.50 (H)	238.26 (L)	6.85 (L)	87.14 (L)
G-5	5.8	0.026	1.93 (H)	4.31 (H)	250.80 (L)	5.71 (L)	101.02 (L)
G-6	5.7	0.048	2.00 (H)	4.48 (H)	250.80 (L)	5.71 (L)	100.01 (L)

H-High, M- Medium, L-Low (Govt.ind.2011)

Nutrient index of soil

By examining the soil's nutrients content, the soils were categorized into three types: low, medium and high. [16] presented the following formula which was employed for estimating the nutrient index of the soils.

$$\text{Nutrient Index (NI)} = \frac{Nl\times1+Nm\times2+Nh\times3}{Nt}$$

Where, Nt= Total number of samples analyzed

Nl, Nm and Nh are the number of soil samples coming to low, medium and high category.

Table 4 Nutrients Index of soil in Tsonzunphen and Gukhanyu

Sample Location	Nutrients	NI values	Nutrient Fertility status
Tsonzunphen	N	1	Low
	P	1	Low
	K	2	Medium
Gukhanyu	N	1	Low
	P	1	Low
	K	1	Low

Micronutrients

Micronutrients also known as trace elements are required by plants in microscopic amounts but the agricultural productivity is affected when they are lacking. [17] revealed that in India, intensive cropping practices to produce high-yielding crop varieties for increasing food grain production has resulted in the rapid depletion of micronutrient availability in surface soil. In plants, micronutrients are considered to operate as enzyme operators. Manganese serves as an electron transport system, an enzyme activator and a structural element of several metalloproteins. Iron is a component of hemoglobin and cytochrome. It is necessary for photosynthesis, electron transport, nitrogen fixation and other enzyme activities. Zinc is needed for both the synthesis of chlorophyll and the production of carbohydrates. The development of proteins as well as activation of several enzymes requires copper. Boron promotes protein synthesis, carbohydrate metabolism and amino acid synthesis. Chloride plays an essential part in osmotic pressure control and photosynthesis in plants.

The availability of micronutrient to plants is greatly affected by soil pH as the increase in pH causes reduction of micronutrients availability. The transformation of micronutrient has been found to be directly or indirectly affect by the soil organic matter. The exchangeable and water-soluble forms increased with the addition of SOM which result increase in micronutrients uptakes. The data obtained for the micronutrients are shown in Table 5 and graphically represented in Figure 6 and Figure 7.

Table 5 Boron, Sulphur, Chloride, Iron, Zinc, Manganese and Copper readings for the soil samples.

Samples	B (ppm)	S (ppm)	Cl (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
T-1	1.39 (S)	3.87(L)	35.5(H)	40.50(S)	1.04(S)	12.40(S)	0.62(S)
T-2	1.78 (S)	5.10(L)	34.5(H)	27.76(S)	0.80(S)	8.86(S)	0.40(S)
T-3	1.62 (S)	1.93(L)	33.0(H)	42.60(S)	1.32(S)	16.32(S)	0.76(S)
T-4	2.11 (S)	3.78(L)	38.0(H)	48.74(S)	2.20(S)	22.16(S)	0.76(S)
T-5	1.72 (S)	4.75(L)	36.5(H)	49.92(S)	0.84(S)	19.90(S)	0.74(S)
T-6	2.14 (S)	4.57(L)	34.5(H)	47.06(S)	1.34(S)	17.12(S)	0.90(S)
G-1	3.03 (S)	2.72(L)	38.5(H)	38.44(S)	1.04(S)	12.46(S)	3.32(S)
G-2	2.32 (S)	4.13(L)	37.0(H)	43.60(S)	1.16(S)	14.18(S)	3.44(S)
G-3	1.60 (S)	2.81(L)	35.5(H)	38.60(S)	0.80(S)	12.28(S)	3.70(S)
G-4	2.04 (S)	2.81(L)	34.5(H)	42.32(S)	3.12(S)	12.86(S)	1.40(S)
G-5	1.67 (S)	3.34(L)	35.5(H)	48.66(S)	1.08(S)	7.34(S)	0.90(S)
G-6	2.07 (S)	3.52(L)	36.5(H)	52.92(S)	1.40(S)	9.46(S)	0.86(S)

S-Sufficient, L-Low, H-High (Govt.ind.2011)

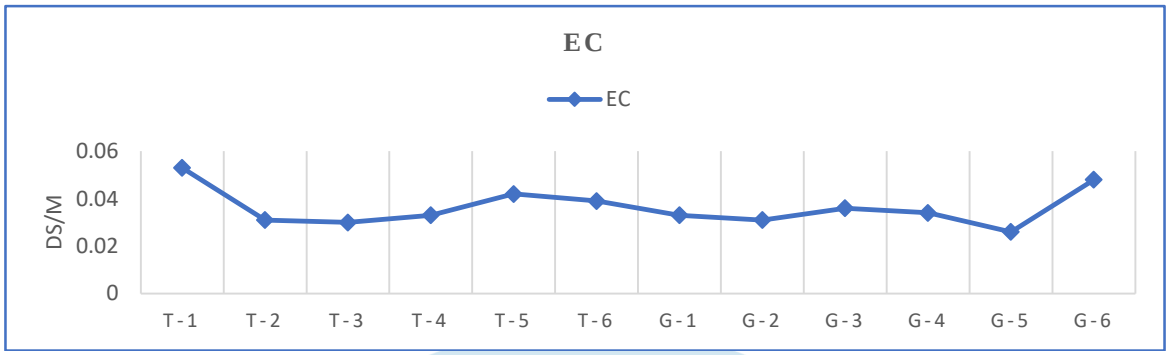

Fig. 3 Graphical representation of EC

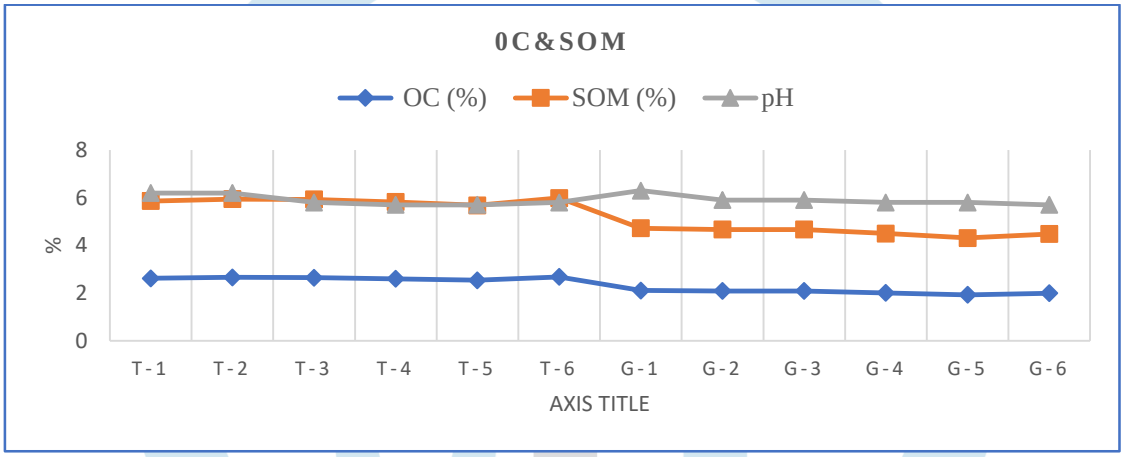

Fig. 4 Graphical representation of OC, OM and pH.

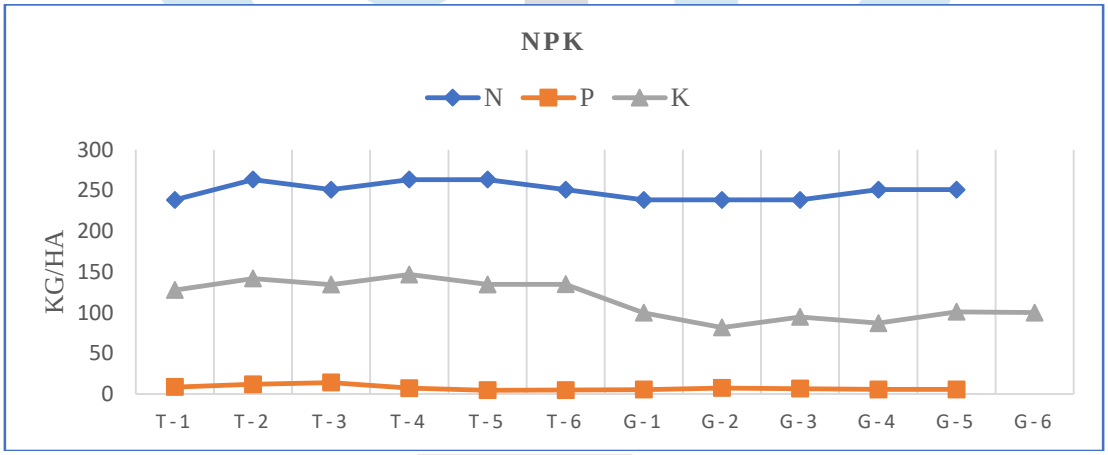

Fig. 5 Graphical representation of Nitrogen, Phosphorus and Potassium.

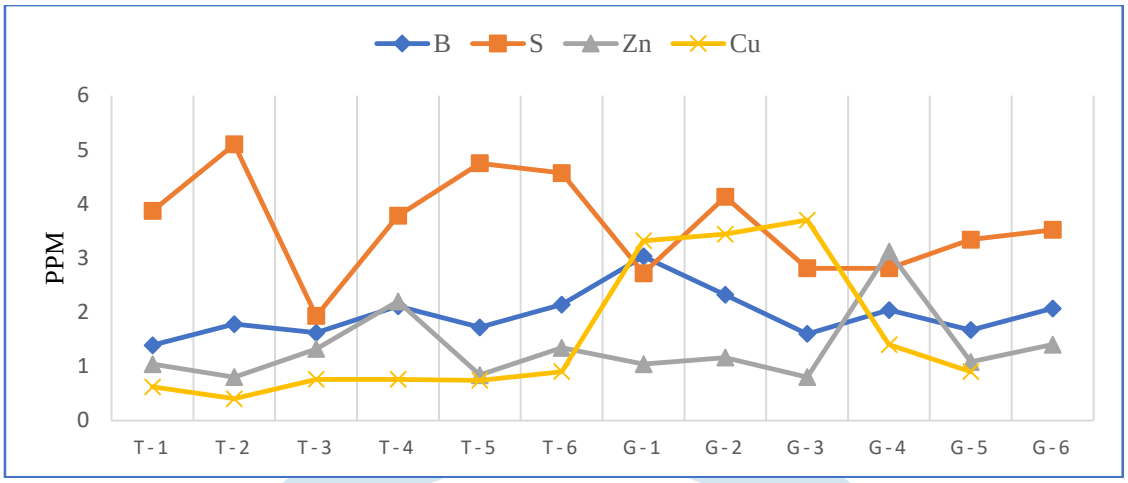

Fig. 6 Graphical representation of Boron, Sulphur, Zinc and Copper.

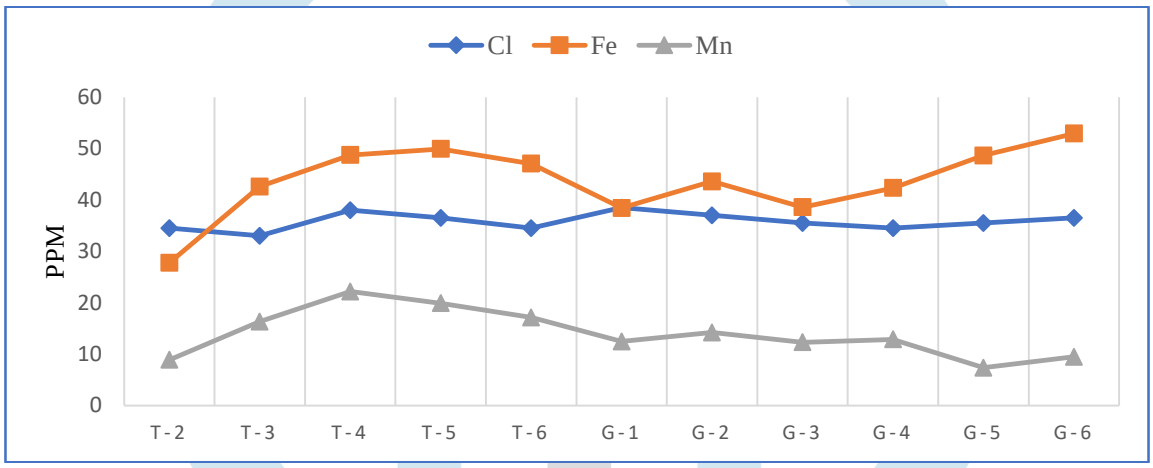

Fig. 7 Graphical representation of Chloride, Iron and Manganese.

CONCLUSION

The soil pH, EC, WHC, OC and moisture along with macro- and micro-nutrients were analyzed and determined for the soil fertility status. Depending on the obtained values of the NI, it can be concluded that the analyzed soil required management and improvement. It advised the utilization of proper organic manures and fertilizers content for high quality and good yield. By determining the NI value, agricultural development can be done by selecting the types of fertilizers for various crops.

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Authors declare that there is no conflict of interest.

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