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RESEARCH ARTICLE

ANALYSIS OF PHYSICO-CHEMICAL PARAMETERS OF SOIL FROM TEROGVUNYU VILLAGE AND HENBENJI VILLAGE UNDER TSEMINYU DISTRICT, NAGALAND

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Abstract

To know the fertility status of soil, its Physico-chemical parameters was investigated through chemical analysis. Soil samples from two locations Terogvunyu village and Henbenji villages of Tseminyu district of Nagaland, India were collected to determine various parameters. Results obtained by analysis shows that p^H of soil samples were less than 7 which indicates that the soil samples are in the range of slightly acidic to moderately acidic. Nitrogen and Potassium were in the low to medium range where as Phosphorus was in the range of low to high content. Organic matter content was in the high range where as electrical conductivity and Sulphur content in the soil samples were in the low range. Micronutrients Iron, Manganese, Zinc, Copper and Boron were in sufficient amount where as Chloride content was in the range of high to very high. Water holding capacity and % of moisture were also determined. Study recommends the use of selected and limited amount of fertilizers to improve the fertility status of the selected locations to get high yield and better quality of products.

Introduction:-

Soil can be defined as the layer of loose sediments made up of mineral and organic particles formed on the earth's surface due to various factors which includes climatic, topographical factors, weathering of rocks, etc over a period of time. Its function as medium for plant growth as well as for building of human structures, participation in water, nitrogen, carbon cycles, water and nutrient reservoirs makes soil an important natural resource. Fertile soils have an adequate and balanced supply of elements sufficiently labile or available to satisfy the needs of plants (Foth and Ellis, 1997). To generate sustainable crop production from a plot of land it is important to maintain the accepted levels of soil fertility. This can be done so by 3 steps, the first being soil sampling and soil analysis followed by interpretation of the data and the final step being addition of required nutrients in the form of manures and fertilizers to achieve optimal crop yields. Soil testing reveals the current fertility status of the soil and provides information regarding nutrient availability in the soil that forms the basis for the fertilizer recommendation for increasing crop yields and to maintain the optimum soil fertility (Singh et al, 2018).Therefore it is necessary to assess the fertility status of the soil before crop planning for judicious use of required nutrients.

The nutrients present in the soil can be classified into mineral (supplied by soil) and non mineral (Carbon, oxygen and hydrogen supplied during photosynthesis) nutrients. The mineral nutrients is divided into two groups called major or macronutrients which includes nitrogen(N), phosphorus(P), potassium(K), calcium, magnesium, sulphur and micronutrients like iron, boron, manganese, copper, zinc, molybdenum, nickel and chlorine. Their availability is

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affected by factors such as volatilization, erosion of soil, immobilization of nitrogen, leaching, soil acidity, denitrification and uptake of nutrients by crops. With the plethora of information that is available and to which more is being added every day, it is up to us to utilize it, not just for personal benefit but also to create sustainable practices that is beneficial for the people as well as the environment.

Study Area:

A mountainous state, Nagaland is located in the north eastern part of India and bordered by Assam, Manipur and Arunachal Pradesh. Nagaland is one of the smallest states of India. Tseminyu is a district of Nagaland and mainly inhabited by Rengma Nagas. Of the 10 soil samples collected, 5 samples were collected from Terogvunyu village (TV_1, TV_2,TV_3, TV_4,TV_5) and the remaining 5 from Henbenji village(HV_6,HV_7,HV_8,HV_9,HV_{10}). The study areas are Terogvunyu village and Henbenji village under Tseminyu district, Nagaland. The two villages are separated by a distance of 4km. These areas are characterized by thick forests, heavy vegetation and rocky terrain.

Figure 1:- Map of Nagaland state and Tseminyu district.

Figure 2:- Location map of Terogvunyu village and Henbenji Village.

The study of any soil sample means to gain information about that particular sample. The sample itself may not be a representative of the entire soil mass which is what we are interested in. Information attained from the sample is of use if it gives information about the general soil mass and the information obtained may or may not be representative depending on how the soil sample is collected.

Materials And Methods:-

Ten soil samples were collected from two neighboring villages, namely, Terogvunyu village and Henbenji village. After selecting the location where sample is to be collected, surface of sampling spots were made clean and a V-shaped cut to remove about 4-5 inches of soil with the help of a spade were done to collect the soil samples.

Table 1:- Showing the methods used for estimation of various soil parameters.

Sl no	Parameters	Method
i	pH	pH metry
ii	EC	Conductometry
iii	Potassium	Flame photometer
iv	OC	Wet Digestion

v	Chloride	Silver Nitrate Titration
vi	Phosphorus	Spectrophotometer
vii	Sulphur	Spectrophotometer
viii	Nitrogen	Kjeldahl distillation method
ix	Moisture Test	Oven dry wet
x	WHC	Oven dry wet
xi	Micronutrients	AAS and Spectrophotometer

Results and Discussion:-

Soil Moisture

The water content of soil which can also be referred to as its moisture content, gives an indication of the presence of water in the soil and the test carried out to detect this is called soil moisture test. Soil moisture is an important part of a soil's three phase system which is made of minerals (solid), water (liquid) and air pockets (gas). Soil moisture is a critical property where its abundance or deficiency will determine the survival of plants as well as the fertility of soil. In the study table, it is observed that the soil moisture % ranges from 7.53-15.80 % which can be considered low in percentage. It is observed that Terogvunyu village has a higher soil moisture percentage as compared to Henbenji village. As mentioned above, the low moisture content and EC correlation was shown with low soil moisture percentage and low EC. This occurs because conduction of current is faster with higher moisture content. Overall moisture content for soil of Terogvunyu Village is higher than Henbenji village.

Water Holding Capacity:

The amount of water that can be absorbed per gram of soil is said to be the WHC of that particular soil. This feature of soils is mainly controlled by soil texture and SOM. Soils with higher content of fine texture like silt and clay have higher water holding capacity while those with larger particles like sand have lower WHC. In case of organic matter, increase in the organic matter content can result in increase in the WHC. In the agriculture sector, the study of WHC of soil helps to determine the required moisture content for that soil to ensure proper plant growth as all water around the root zone cannot be taken up by the plant because it is held tight by the soil particles. The study helps to read if soil water can be readily used by crops or not. The values of the WHC of the soil samples from the two villages show that the values range from 43.86% to 22.39% from Terogvunyu village and 46.46% to 23.02% for Henbenji village.

Table 2:- Water holding capacity of soil samples.

Sample	Day 1	Day 2	Day 3	Day 4	Day5	Day 6	Day 7
Terogvunyu Village	43.86	40.84	35.83	32.82	26.64	23.18	22.39
Henbenji village	46.46	37.95	34.40	28.98	25.59	23.91	23.02

Soil pH:

The measure of a soil's alkalinity or acidity is called the soil pH. The pH of soil affects the nutrient uptake for plants. This can be seen in the case of use of NPK fertilizers. Uptake of nitrate (NO_3^-) by plants is best at lower pH while (NH_4^+) is absorbed more efficiently at a neutral pH. pH plays an important role in influencing the availability of nutrients for uptake by plants. Nutrients are readily available when soil pH falls under the neutral range, 6.5–7.5. The soil samples collected under Terogvunyu village gave a mean pH value of 6.12 while those from Henbenji village had a mean value of 6.04. Based on the study of the pH table and the above pH values, it is assessed that the soils of the two villages are slightly acidic in nature. Studies by Dutta et al., (2017), Bordoloi et al., (2022), Sangtam et al., (2017), Kumar et al., (2016), of the soils of various districts in Nagaland indicate that the soils in the state tend to be highly to slightly acidic in nature. The value of pH of the investigated soil samples are shown in table – 3.

Electrical Conductivity

The ability to conduct electrical current by soil is called soil EC. Cations (Ca^{2+}, Mg^{2+},K^+) and anions (Cl^-,NO_3^-) of dissolved salts can conduct charges and carry electrical current. Hence, the EC of soils can be determined by the concentration of ions. Plant growth is not directly affected by soil EC but it can be used as an indirect indicator for the nutrient amount available for uptake by plants and salinity levels Higher the concentration of salt ions, greater is the ability to conduct electrical charges. EC is mainly used as a measure to check the salinity of soil. EC of the soil samples collected is below 0.10, thus conclusion can be made that the soil salinity is negligible which implies that the salt content in the soil is very low. The value of EC of the investigated soil samples are shown in table – 3.

Organic Carbon

The summation of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and well decomposed substances is called SOM (Brady and Weil, 1999). SOC is a part of the organic matter. As carbon comprises the largest component of OM thus making it easier to measure SOC. It is observed that total SOC increases with annual precipitation as it stimulates plant biomass production and warm temperature decreases SOC content as it increases the rate of decomposition. Application of manure/composts and sowing of summer and/or winter cover crops can increase SOC while burning, harvesting or removal of residues will lead to decreased SOC content. OC was obtained by wet digestion method proposed by Walkely and Black (1934) and the data obtained are shown in table-3. High content of organic matter was also reported by Ram et al., (2017), Singh et al., (2017), Dutta et al., (2017), Bier et al., (2018), Aiko and Tiwari (2021) in soils of some part of North-Eastern State, India.

Macronutrients

Elements that are required by plants in relatively large amounts are called macronutrients. Essential macronutrients are N, P, K, S, Calcium and Magnesium. Excess of macronutrients in the soil will affect the availability of micronutrients.

Available Nitrogen

The most abundant plant nutrient, N is the building block of proteins, nucleic acids and protoplasm and needs to be taken up from the soil in the form of ions like NO_3^- and NH_4^+ by plants. N helps in growth of strong foliage and plays a role in development of plant leaves. It also imparts the green colour to plants as it assists with chlorophyll production. Despite this, N along with P and K, are common deficient nutrients of soil because of which they need to be introduced through fertilizers. N was estimated by Subbiah and Asiaja method (1956) and the data obtained are shown in table-3 with remarks. Similar results were also obtained by Singh et al., (2017), Sentimenla (2020), Tiwari and Sangtam (2022) for the soils in some other part of Nagaland.

Table 3:- Observed value of pH, EC, N, OC, OM, P, K and Moisture % in soil samples.

Samples	pH reading	EC(mS /cm)	% of OC	% of OM	P (kg/ha)	K (kg/ha)	N (kg/ha)	Moisture%
TV_1	6.00	0.04	2.11	3.63(H)	3.51(L)	160.66(M)	288.42(M)	14.88
TV_2	6.10	0.03	3.12	5.39(H)	5.10(L)	137.28(M)	250.80(L)	12.16
TV_3	5.90	0.03	2.17	3.74(H)	5.61(L)	94.76(L)	263.34(L)	10.19
TV_4	6.10	0.02	2.70	4.65(H)	7.71(H)	90.50(L)	275.88(L)	15.80
TV_5	6.50	0.02	2.68	4.62(H)	8.12(H)	156.57(M)	288.42(M)	7.53
HV_6	6.00	0.04	1.36	2.34(H)	4.02(L)	130.20(L)	225.40(L)	10.18
HV_7	6.80	0.04	2.45	4.23(H)	6.63(L)	135.48(L)	338.58(M)	7.50
HV_8	6.10	0.02	2.41	4.16(H)	11.99(M)	185.61(M)	263.40(L)	11.98
HV_9	5.70	0.02	1.97	3.39(H)	12.11(M	173.46(M)	250.80(L)	9.93
HV_{10}	5.60	0.03	2.47	4.27(H)	6.31(L)	179.98(M)	338.58(M)	7.73

[High (H), Medium (M), Low (L)]

Available Phosphorus:

Second importance nutrient P, is an essential macronutrient involved in growth processes. For many organic compounds like phosphates, nucleic acids, proteins, phospholipids, etc. it is an essential component. P tends to be the most common limiting nutrient in soils especially in the state of Nagaland .This is supported by the low to medium levels of phosphorus in all the soil samples except for soil samples TV_4 and TV_5. The high phosphorus levels in these two samples are assumed to be due to the accumulation of manure nutrients in the soil. Bray and Kurtz method (1945) was used to estimate P and data obtained is shown in table – 3 with remarks.

Available Potassium:

K, a macronutrient plays a vital role in nutrient and water uptake, its transport and growth under harsh conditions. It has many functions in plant nutrition and growth that influence both yield and quality of the crop (Kow and Nabwami, 2015). A reason for K deficiency is that K fertilizers lacks attention and farmers generally believe that K fertilizers do not effectively increase crop yields compared to N and P fertilizers (Zewide and Reta, 2021). K was estimated by flame photometer and data obtained is shown in table – 3. Similar results were also revealed by Bier et al., (2018), Sentimenla (2020), Tiwari and Seb (2022).

Available Sulphur:
While NPK are important components for crops, to attain more nutritious crops, S is needed. It assists in chlorophyll and protein production, oil synthesis in seeds, enzyme activation and it improves protein and oil percentage in seeds. In S deficiency, the symptoms first appear on the younger leaves and its appearance of symptoms indicates a serious condition because even without the appearance of symptoms, crops can undergo a distinct decrease in yield. Sulphate containing fertilizers tend to provide S for soil application. They have the advantage of supplying sulphur in the form of SO_4^{-2} which is immediately available for uptake by plants. S was estimated by spectrophotometer and data obtained is shown in table – 4.

Micronutrients
Chloride occurring in soils and plants as an anion is classified under micronutrients and considered as a toxic when it accumulates at high concentrations. Being part of the essential elements needed for plant growth, its presence regulates water relations, assists in greater leaf expansion, increase in biomass production, and better efficiency in water and N use by the plant. Cl^- deficiencies in soils do not occur commonly, when it is limited to areas with low rainfall. Data for Cl^- content in soil is shown in table -4.Nutrients necessary for plant growth but small amounts required compare to macronutrients such as N, P, K and Mg are called micronutrients. Boron, chlorine, Cu, Fe, Mn, Mo and zinc fall in this category. Their function is to act as enzyme activators for plants and to activate the enzyme, a specific micronutrient is required. It also assists in photosynthesis. Micronutrient deficiencies mostly occur not because of the insufficient level in the soil but because sufficient amount is not available to the crop. Study of the micronutrient levels in the soil has also shown that there is sufficient micronutrient content present in the soil samples. Micronutrients were estimated by Atomic absorption spectrometry and spectrophotometer and data obtained are shown in table – 4.

Table 4:- Observed values of Fe, Zn, Mn, Cu, B, S, and Cl^- in soil samples.

Sample	Fe	Zn	Mn	Cu	B	S(ppm)	Cl^- (ppm)
TV_1	104.471(S)	8.103(S)	46.088(S)	4.518(S)	4.78(S)	2.295 (L)	57.14(VH)
TV_2	101.362(S)	6.260(S)	37.82(S)	4.451(S)	2.22(S)	1.913(L)	36.73(H)
TV_3	94.431(S)	2.048(S)	23.997(S)	4.495(S)	5.07(S)	1.721(L)	35.69(H)
TV_4	97.278(S)	21.635(S)	35.445(S)	5.124(S)	1.76(S)	2.186(L)	42.25(H)
TV_5	100.650(S)	21.307(S)	28.666(S)	4.553(S)	1.97(S)	2.168(L)	63.82(VH)
HV_6	118.342(S)	8.878(S)	39.224(S)	5.570(S)	1.03(S)	1.339(L)	64.37(VH)
HV_7	103.331(S)	7.372(S)	48.921(S)	2.030(S)	1.97(S)	1.849(L)	61.98(VH)
HV_8	96.595(S)	10.669(S)	49.707(S)	2.390(S)	1.28(S)	0.892(L)	51.28(VH)
HV_9	98.067(S)	12.348(S)	55.94(S)	2.158(S)	5.31(S)	1.533(L)	54.54(VH)
HV_{10}	93.340(S)	9.543(S)	63.163(S)	5.904(S)	1.60(S)	1.211(L)	32.49(H)

[Remarks: Sufficient(S), Deficient (D), High (H), Very high (VH), Low (L)]

Deficiency of Nutrients
For normal functioning and growth, all plants require a range of essential nutrients. When nutrient levels are outside of this range, it affects the plants and caused decline is overall health due to deficiency or toxicity. When nutrient levels present are unable to meet the requirements of the plant, it is considered as deficiency of nutrients. There is a complex inter relationship between soil properties like pH, organic matter, soil moisture, other nutrients and nutrient availability. For P, it is required in high concentration during early cell division stages and its deficiency can cause stunted and weak growth and K, as it activates enzymes that is necessary for metabolism, its deficiency can affect plant growth. It has been observed that excess of macronutrients can lead to deficiency of other nutrients. Excess of P can lead to decreased uptake of Fe, Mn, Zn with Zinc deficiency being the most prevalent under this condition. Excess of K levels, due to cation imbalance, can lead to reduced levels of Mg and in some cases, Ca. High levels of non essential nutrients like As, Cd, Pb can be harmful to plants as well as causing essential nutrient imbalance in them.

Nutrient Index of soils:
The concept of NI (Parker et al, 1951) has been used for area wise comparison of soil fertility levels of different sites. Soils are classified into three categories which is based on the soil tests taken for different nutrients in the samples. The classes low (Nl), medium (Nm), high (Nh) and total number of samples analyzed (Nt) are used to calculate the nutrient index.

Nutrient Index (NI) = $\frac{Nl \times 1 + Nm \times 2 + Nh \times 3}{Nt}$

Parker (1951) has classified the nutrient index values less than 1.5 as indicative of low nutrient status and between 1.5 to 2.5 as medium while higher than 2.5 as high nutrient status. Ramamoorthy and Bajaj (1969) has categorized these values as less than 1.7 indicative of low fertility status, between 1.71 to 2.33 as medium and more than 2.33 as high fertility status.

Table 5:- Nutrient Index of soils of Terogvunyu village and Henbenji village.

Sample location	Nutrients	NI values	NI fertility status
Terogvunyu village	N	1.4	Low
	P	1.0	Low
	K	1.6	Low
Henbenji village	N	1.4	Low
	P	1.4	Low
	K	1.6	Low

Conclusion:-

On the basis of values obtained of all the parameters and NI, it can be concluded that these soils need improvement in nutrient contents. On the basis of present study it is advised to use chemical fertilizers as well as organic manures to get high yield of their crop .Farmers and growers, by knowing the NPK content will be able to know amount and type of fertilizers to be used for different crops, and will also help in environment protection as well as water conservation.

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Authors declare that there is no conflict of interest.

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