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Evaluation of soil fertility status by using Parker's Nutrient index of Meriema and Tsiesema villages of Kohima district, Nagaland, India

K.K.Tiwari[1*] and Neikhriehunuo Theiinuo[2]

[1*] Department of Chemistry, Kohima Science College, Jotsoma, Kohima, Nagaland

[2] Department of Chemistry, Kohima Science College, Jotsoma, Kohima, Nagaland

Abstract

Soil fertility status of Meriema and Tsiesema village of Kohima district is investigated by estimating various parameters such as available nitrogen, potassium, phosphorus, organic carbon, water holding capacity, pH, Electrical conductivity and sulphur by analyzing 12 samples. Result shows that all the selected soil samples are slightly acidic in nature and have high content of organic carbon, low content of phosphorus and sulphur and medium content of nitrogen and potassium. Present study will not only help in solving fertility related problems of the soil of the studied area but would also help the farmers to decide the type of fertilizers to be used for enhanced production.

Keywords: *Organic carbon (OC), Soil organic matter (SOM), Electrical conductivity (EC), Water holding capacity (WHC), Kohima*

1. Introduction

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. According to Vijay A.et al.(2019) the availability of soil nutrients for plant growth and yield production is a function of different parameters, including soil p^H ,soil organic matter, texture and soil biological activities Nutrient index method and fertility indicator can be used to evaluate the fertility status of the soil (Khadka et al.,2016; Amepu et al.,2017; Singh et al.,2018).The quality and productivity of any soil depends on the concentration of fertility parameters like C, N, P and K and their effect on physical , chemical and biological properties of the soil (Cao et al.,2011).The soil fertility status under different cropping sequence can also be assessed by using nutrient index approach (Singh et al.,2016). Soil rich in organic nutrients and minerals are ideal soil for farming. Soil test finding can be used for fertilizers recommendation and maximizing profit by selection of suitable crop according to availability of nutrients in the soil and production of more yield of the crop. The quality of soil is controlled by physical, chemical and biological components of the soil and their interaction (Sacchan and Krishna, 2018).The aim of soil fertility management is to keep soil physically, chemically and biologically in good health to increase the crop production and also to sustain it. Soil fertility is a dynamic property. Chemical degradation of soil reduces the nutrient supply to the crop which results the less production of crop. Erosion, leaching and crop removal can cause loss of nutrient. Different cultural practices, excessive use of fertilizers and improper irrigation can also cause the depletion of soil quality. Continuous cultivation of soils reduces SOM by facilitating interaction of physical, chemical and biological process because they increase its decomposition rate.

Soil organic matter is one of the important factors which determines the soil quality, its chemical and biological properties and serves as a source of plant nutrients. Besides soil carbon, soil nutrient availability also plays a crucial role in sustaining soil quality and plant productivity (Quinton et al.,2010).

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Identifying the state of nutrients in the soil before sowing a crop offers a solid foundation for estimating the crop's nutrient requirement for the desired production level (Denis et al.,2017).Good vegetative growth as well as addition of organic matter into the soil may increase the organic content in the soil (Patil and Narayana,1990).The use of fertilizers without considering the soil fertility status and crop requirement may adversely affect both soil and the crops(Ray et al., 2000).Objective for the present work is to find the fertility status and nutrient index of the soil of two villages of Kohima district i.e. Meriema and Tseisema village. Nutrient index was calculated on the basis of nitrogen, phosphorus and potassium content in the soil samples. This study will help our understanding and knowledge of the soil of said villages and wise use of available agricultural land for optimum and healthy production of crops.

2. Materials and methods:

Kohima is the capital city of Nagaland state and agriculture is the main occupation of the resident. Meriema and Tseisema villages from where the soil samples were collected for the present study are inhibited by Angami Naga tribe. Samples were collected from paddy field before harvest session. The location of study areas are shown in figure 1.

Fig : 1 location map

The most common technique called as V-shaped method was used to collect the soil samples for this study .Sample information sheet, tray, bucket and plastic bags were used for sampling purpose. In this method V-shaped cut was made after cleaning the surface of sampling spot and uniform thickness of 1.5 cm slice of the soil was taken. The collected soil samples were mixed and stones, plant residue were removed. Samples were air dried and thoroughly mixed after passing through sieve (Nounamo et al.,2000). Different methods were used for assessment of various parameters for determining fertility status and nutrient index and methodology used are shown in table -1.

Table-1: showing the methods used for assessment of various parameters

Sl.No.	Parameters	Method
1	Available Nitrogen	Alkaline permanganate
2	Available Phosphorus	Spectrophotometry
3	Available Potassium	Flame photometry
4	P^H	P^H meter
5	Electrical conductivity	Conductometry
6	Sulphur	Spectrophotometry
7	Organic carbon	Wet digestion
8	% of moisture	Oven dry wet
9	Water holding capacity	Oven dry wet

3. Results :

a. Available Nitrogen (N) and phosphorus (P) : Nitrogen was estimated by using Subbiah and Asiaja method (1956). Data so obtained are shown in table-2 and are graphically represented in fig -2. Whereas phosphorus was estimated by using Bray and Kurtz method (1945) and data obtained is shown in table -2 and graphically represented in fig -3.

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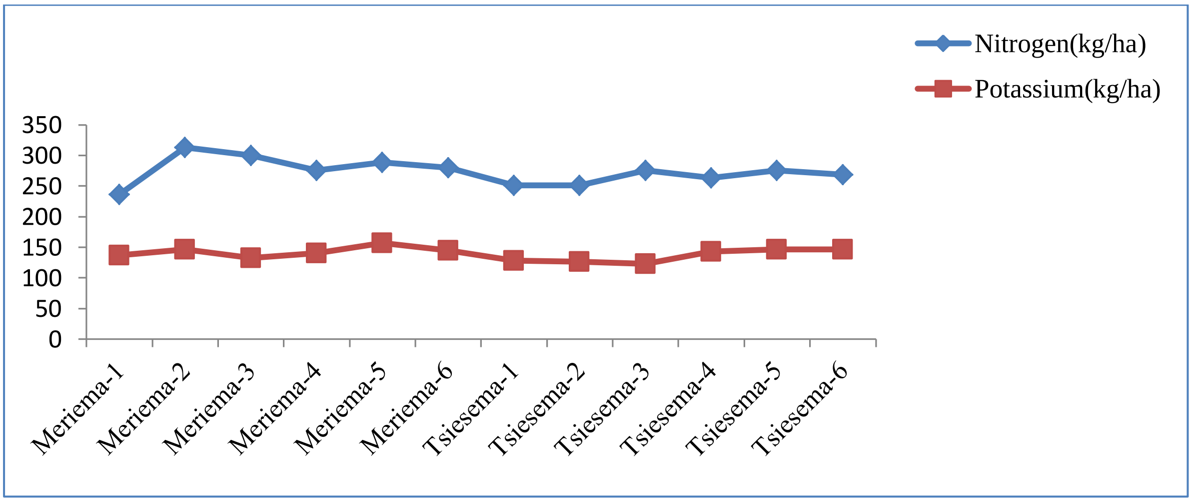

Fig : 2 Graphical representation of Nitrogen and Potassium in analyzed soil sample.

Table- 2: showing data of availability of Nitrogen (N), Phosphorus (P) and Potassium (K) in the soil samples

Location	Nitrogen kg/ha	Remark Gov.Ind.	Phosphorus kg/ha	Remark Gov.Ind.	Potassium Kg/ha	Remark Gov.Ind	P^H	Remark
Meriema-1	236.34	Low	10.528	Low	136.64	Medium	6.5	Slightly acidic
Meriema-2	313.5	Medium	9.296	Low	146.94	Medium	6.4	Slightly acidic
Meriema-3	300	Medium	8.624	Low	132.72	Medium	6.7	Slightly acidic
Meriema-4	275.88	Low	8.344	Low	140.11	Medium	6.1	Slightly acidic
Meriema-5	288.42	Medium	9.128	Low	157.36	Medium	6.8	Slightly acidic
Meriema-6	280.12	Medium	8.886	Low	144.53	Medium	6.4	Slightly acidic
Tsiesema-1	250.8	Low	8.456	Low	128.01	Medium	6.6	Slightly acidic
Tsiesema-2	250.8	Low	7.952	Low	126.89	Medium	6.8	Slightly acidic
Tsiesema-3	275.88	Low	10.08	Low	122.64	Medium	6.6	Slightly acidic
Tsiesema-4	263.34	Low	9.24	Low	143.47	Medium	6.7	Slightly acidic
Tsiesema-5	275.88	Low	8.568	Low	146.49	Medium	6.8	Slightly acidic
Tsiesema-6	268.44	Low	8.568	Low	144.44	Medium	6.7	Slightly acidic

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Table -3: showing the values of EC, Sulphur, organic carbon (O.C) and moisture

Location	EC dS/m	Sulphur	%of O.C	Y= Cx1.3	Remarks Gov.Ind.	O.M= Y x1.724	% Moisture = Loss in wt x100 / oven dry wt. of soil
Meriema-1	0.17	2.45	0.93	1.2	High	2.06	7.04
Meriema-2	0.12	1.8	1	1.3	High	2.24	
Meriema-3	0.11	2.22	0.97	1,26	High	2.17	
Meriema-4	0.19	1.95	0.95	1.23	High	2.12	
Meriema-5	0.15	2.71	0.91	1.18	High	2.03	
Meriema-6	0.16	2.65	0.98	1.27	High	2.196	
Tsiesema -1	0.12	1.97	1.13	1.46	High	2.51	7.54
Tsiesema -2	0.14	2.31	1	1.3	High	2.24	
Tsiesema -3	0.16	2.93	0.93	1.2	High	2.06	
Tsiesema -4	0.13	2.33	0.95	1.27	High	2.18	
Tsiesema -5	0.13	2.41	1.04	1.35	High	2.32	
Tsiesema -6	0.13	2.42	1	1.3	High	2.24	

Table-4: showing the value of Water holding capacity

Location	Water holding capacity				
	Day-1 % value	Day-2 % value	Day-% value	Day-% value	Day-5 % value
Meriema	14.75	12.57	10.78	7.14	6.18
Tsiesema	14.65	10.68	8.5	6.38	6.01

b. Available Potassium: Potassium was estimated in soil samples by flame photometer method suggested by Tooth and Prience in 1949 and data with remarks are shown in table- 2 and graphically represented in fig. -2.

c.P^H: P^H was measured by using P^H meter and data obtained are shown in table-2 and graphically represented in fig.-3

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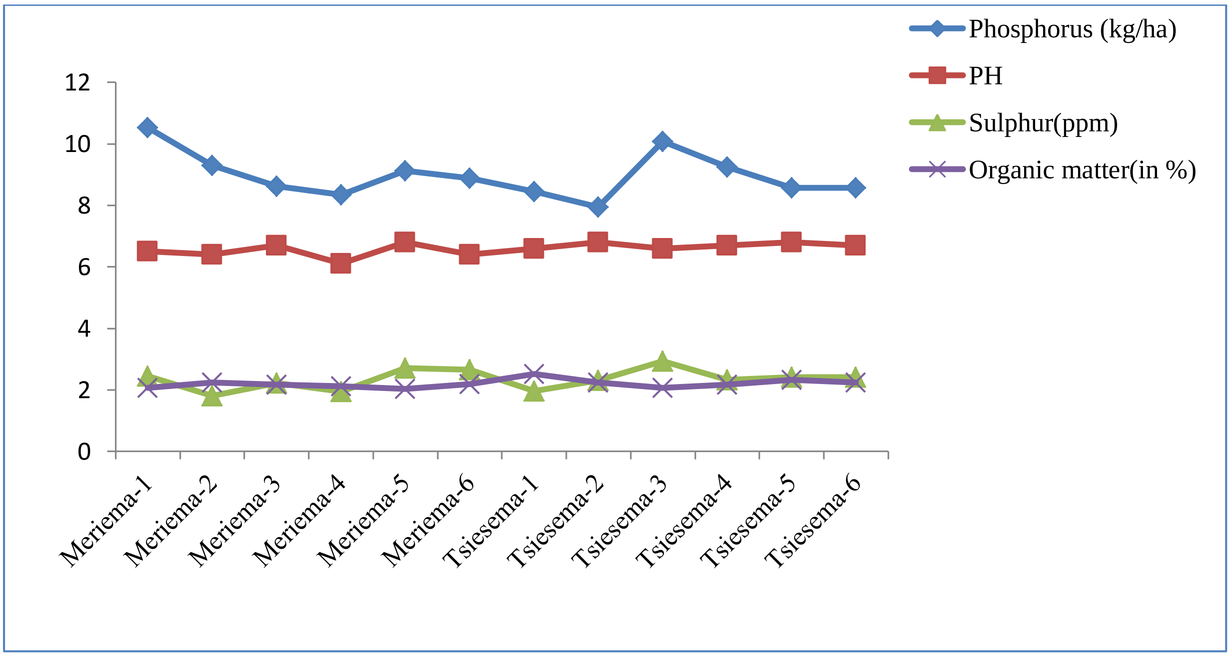

Fig.3: Graphical representation of Phosphorus, Sulphur, P^H and organic matter in analyzed soil sample.

d. Electrical conductivity (EC): It was measured by Conductometry method and result obtained are shown in table-3 and graphically represented in fig.-4.

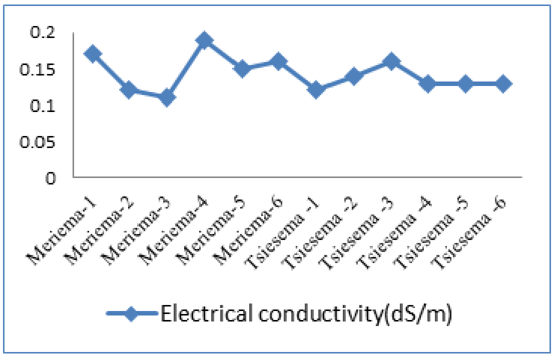

Fig. 4: Graphical representation of electric conductivity in analyzed soil sample.

e. Sulphur: Sulphur was estimated in soil samples by flame photometer method and results obtained are shown in table- 3 and graphically represented in fig.3.

f. Organic carbon: : It was obtained by wet digestion method proposed by Walkely and Black .It involves a rapid titration procedure for estimation of organic carbon content of the soil and results obtained are shown with remarks in table -3 and graphically represented in fig-3.

g. % Moisture: % of moisture was determined by oven dry wet procedure and data obtained is shown in table -3.

h. Water holding capacity (WHC): It was also determined by oven dry wet procedure and data obtained for successive five days are shown in table-4. The lowest reading of % of moisture on successive days is taken as field capacity or WHC.

4. Discussion:

Deficiency of nutrients:

When plant nutrient level is below the required amount and imbalance with other nutrients then it is considered as deficiency of plant nutrients. It can be due to continuous farming, leaching, crop removal, denitrification and volatilization.

Nutrient index

Three different classes are assigned to soil on the basis of nutrient index i.e. low, medium and high nutrient status. Nutrient index was calculated by using Parker's equation given in 1951.

Nutrient index (NI) = $\frac{nl\times1+nm\times2+nh\times3}{nt}$

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Table-5: Showing the nutrient index value with remarks

Location	Nutrients	NI	NI Fertility status(Gov. India,2011)
Meriema	N	1.66	Low
	P	1	Low
	K	2	Medium
Tsiesema	N	1	Low
	P	1	Low
	K	2	Medium

Where nl, nm, nh are number of soil coming under low, medium and high range of nutrient and nt is the total number of soil samples under observation for a given area. Parker has classified the nutrient index values of soil less than 1.5 as 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 modified these values as less than 1.67 as low nutrient index fertility status, between 1.67 to 2.33 as medium and more than 2.33 as high nutrient index fertility status. Nutrient index value was calculated and presented in table -5. On the basis of nutrient index value their nutrient index fertility status is given in same table as low, medium and high.

Nitrogen is the most abundant mineral nutrient in plants. Nitrogen deficiency in plants results in marked reduction of growth rate. Nitrogen deficient plants have short and spindly growth and leaf area is small. The nitrogen content and fertility status in Meriema is low to medium range whereas in Tsiesema village it is in low range which can be attributed to continuous farming and leaching of the soil. Nitrogen is the basic need of plants for growth and development. Nitrogen content can be improved by using fertilizers having higher nitrogen and besides it can be improved by planting nitrogen fixing plant and manure. Phosphorus is much less abundant in plants as compared with nitrogen and potassium.

Phosphorus is essential for growth, cell division, root lengthening, seed and food development. Phosphorus concentration and fertility status is low in all the soil samples investigated from both the villages. Low concentration of phosphorus may be attributed to the removal of soluble phosphorus due to excessive rain. Phosphorus concentration can be improved by using manure and phosphate fertilizers. Potassium is the second most abundant mineral nutrient in plants after nitrogen. Its deficiency causes slow growth and low yield of crop. Potassium content and fertility status in both the villages is in medium range. Potassium deficiency can be corrected by using fertilizers like potassium chloride and potassium sulphate. The less variability in the amount of available P in the soil samples indicates that these parameters are less prone to change in land use and cover (Wubie,2013). P^H of soil refers its acidity or alkalinity and it is an important indicator of soil health. In nature, there is a natural tendency towards soil acidification, the rate of which often increases under leaching, intensive cropping and persistent acid forming acid fertilizers. Strong acidification leads to soil degradation. P^H values of soil samples indicate that the soils are slightly acidic in nature which may be due to the no or less use of acidic fertilizers. Decomposition of organic matter by microorganism leading to release of organic acids like –COOH and –OH may be the one of the reason for acidic nature of the soil (Lalrinfela et al.,2016).

Electrical conductivity (EC) is the measure of ionic transport in solution between two electrodes. It is the specific conductivity of a soil water suspension at definite ratio. It provides information about the amount of water soluble salts present in the soil. Variation in temperature, water content, soil texture and cation exchange capacity can change the electrical conductivity of the soil. Manure and compost can increase the electrical conductivity of the soil. EC value in the soil samples collected was found low value which indicates that these soils samples have no salinity effect. Low electrical conductivity of the study area might be due to inherent factors like soil minerals, climate, soil texture and leaching of soluble salts due to excessive rain fall (Borooah et al.,2020). EC values are less than 0.8 which indicates that it is normal soil. The lower value of EC can be attributed to leaching of salts from soil due to excessive rain. Plants root absorb sulphur primarily as sulphate ion. Sulphur deficiency resembles that of nitrogen. Plant deficient in sulphur is small and maturity in cereals is delayed. Observed value of sulphur is less than 10 ppm which indicates that the soil samples are sulphur deficient. Intensive cropping without sulphur fertilization may be the cause of low sulphur content. Soil organic matter is produced by decomposition of living also or dead organism. Organic carbon is source of soil nutrient such as nitrogen, phosphorus and sulphur. Organic carbon content is high in the soil samples of both villages .It is attributed to the use of manure and decomposition of litters. Soil fertility can be improved by using organic and inorganic fertilizers.

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Percentage (%) of soil moisture of studied soil samples are in between the range of 7.04 to 7.54.Moisture content according to Veinhmeyer and Hendrickson (1931), signifies the upper level of water available to the plants in the soil. Water makes soil solution by dissolving salts which acts as medium for supplying required nutrients to the plants.

5. Conclusion:

From the soil sample analysis it can conclude that the soil fertility status is different in the studied villages due to differences due in nutrient content. Study further suggests that the examined soil is rich in organic carbon, medium in potassium and low in phosphorus and sulphur. Nitrogen concentration as well nutrient index values are in low whereas nutrient index values for potassium is in the medium range. The P^H of soil samples is lower than 7 which indicate that the soil is acidic in nature. Results indicate that there is a scope for improvement of the soil fertility status. Hence application of manure ,balanced use of fertilizer, proper cropping system and nutrient management is required to enhance the soil fertility status as well as for optimum level of crop production.

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