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Assessment For The Fertility And Physico- Chemical Properties Of The Soil Of Pfiichama And Phesama Village Under Kohima District, Nagaland

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Abstract

Macro and micronutrients content were investigated through chemical process to check the fertility status of soils of Pfiichama and Phesama village of Kohima district of Nagaland. p^H values of these two villages were in between 4.8 to 6.7 which indicates that these soils are strongly to moderately acidic in nature. EC values were in the range of 0.11 – 0.14 which implies that the salinity effect is negligible. Nitrogen content was in the very low to medium range, Potassium, chloride and organic carbon content were in the high range where as Phosphorus was in low to medium range and sulphur contents were in the low range. Iron (Fe), Zinc (Zn), Manganese (Mn), Copper (Cu) and Boron (B) contents were in sufficient range. Water holding capacity and % of moisture were also determined. Assessment of the soil's fertility and nutrient content was done to provide a measure of the nutrients that are present or contribute to a particular soil. On the basis of physicochemical analysis and Nutrient index value study recommends the use of limited and selected amount of fertilizers to improve the fertility status of the selected locations to enhance the production and quality of crop.

Key words: Electrical conductivity (EC), Kohima, Macro nutrients, Micro nutrients, Nutrient Index (NI), Phosphorus (P), Soil organic matter (SOM), Water holding capacity (WHC).

Introduction

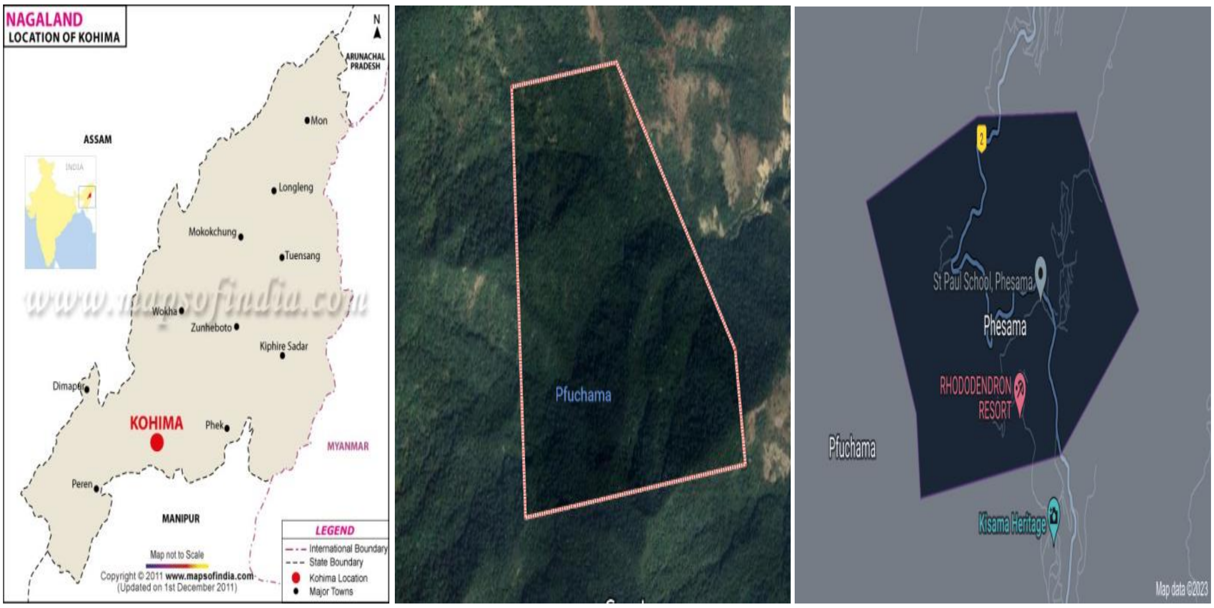
All terrestrial living forms are supported by soil, which is the incredibly thin yet priceless skin that covers our globe. Soil also provides nutrients for aquatic and marine ecosystems. . In order to support the development of macro and micro flora and fauna, soil function as a self-regulating, slowly evolving biogeochemical system. Soil serves as a living filter for human waste in addition to its fundamental duty in promoting, nurturing, and sustenance of all forms of life. The environmental foundation for soil chemistry is provided by the organic part of the soil. Soil element that is crucial to soil chemistry is the solid-liquid phase where the majority of chemical reactions occur. Soil moisture supports microbial and plant growth. The physical characteristics of the soil have a significant impact on plant growth; this link is easier to comprehend than one involving plant nutrition. Investigated soil health factors are such as pH, EC, and OC that influence the availability of nutrients for crop yields and profitability. Grisso (2009) demonstrated the relationship between soil and various soil characteristics that influenced crop production, including topsoil depth, pH, salt contents, and accessible water holding capacity. Soil pH has effect on soil biogeochemical processes in a natural setting. It is important to pay close attention to the soil's composition, chemical and biological changes, physical characters, and responses to various additives. Rainfall, climate, time, plant and animal variables all affect the different soil qualities. A variety of factors and indicators, including bulk density, soil texture, pH, water holding capacity, soil organic matter, available P, electrical conductance, available

N, exchangeable potash, and concentration of micronutrients, can be used to assess the soil's quality and productivity in agriculture. There is decomposition of organic matter, release of carbon dioxide, fixation of Nitrogen, mineralization of Nitrogen, Sulfur, Phosphorus, formation of humus as well as organo-metallic complexes, etc. Soil analysis provides the information about the soil and with this information sheet we can add correct amount of nutrient to yield the desire crops production. Determination of physico- chemical properties and available nutrient status of the soil of an area is vital for improving sustainable productivity (Sachan and Krishna, 2021).

STUDY AREA

Pfiichama Village is a small village in the southern region of Kohima District, Nagaland, India. It is 9.2km away from the Capital of Nagaland. Five soil samples labelled as Pf_1, Pf_2, Pf_3, Pf_4 and Pf_5 were collected from Pfiichama Village to analyse the different properties of soil. Phesama Village is in Southern Zakhama Tehsil of Kohima District of Nagaland, India. It is located at a distance of 10.1 km from the state capital Kohima. Soil samples labelled as P_1, P_2, P_3, P_4 and P_5 were collected from paddy fields of Phesama Village for the analysis of various parameters.

Fig- 1: Location map of Pfiichama village and Phesama Village under Kohima district



Methodology of soil analysis

The soil varies from one location to another. The soil samples were analysed using various methods from laboratory. For each chemical analysis, one to ten gram of soil samples was used.

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

Sl. number	Parameters	Method
i	pH	pH metry
ii	Electrical conductivity	Conductometry
iii	Potassium	Flame photometer
iv	Organic carbon	Wet Digestion

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

Results and discussion

Soil pH

pH can change various soil properties. The various chemical processes such as ion mobility, hydrolysis, hydration, dissolution, reduction/oxidation reaction etc. can be understood by the knowledge of soil p^H. A suitable p^H is very important for healthy plant growth. It has been observed that alkaline soils are deficient in nutrients like Zinc, Copper, Boron and Manganese but strongly alkaline soil are high in sodium. Poor plant growth is often seen in highly acidic soil. Nutrient is most efficiently taken up by plants when the soil is near a neutral p^H thus healthy growth of plant is seen in a p^H range of 6.5 to 7.5.

The soil samples are found to be slightly acidic to strongly acidic. Due to extensive rainfall and the leaching of bases into the lower horizon, the entire region's soil is acidic. Similar outcomes have been observed by Dutta et. al, (2017), Bordoloi (2018), Bier et. al, (2018)), Manpoong and Tripathi (2019), Aiko and Tiwari (2021) in the North-Eastern region of India.

Electrical Conductivity Electrical conductivity of soil measures the aptness of soil solution to carry electrical current. EC of soil is dictated by the concentrations of various ions which conduct electrical current by carrying electrical charges. EC is utilised to estimate the salinity of soil in agriculture. EC can also be employed to estimate other properties such as moisture and depth of soil in non-saline soil. It is expressed in Desi Seimens per meter. EC is also employed as a substitute measure soil drainage condition, water holding capacity, soil texture , thickness and cation exchange capacity. EC has been found to be correspond to the concentration of K, Na, chloride, sulphate, ammonia and nitrate in soil.The data for EC reading of the soil samples from Pfiichama village and Phesama village shows that the reading fall below 1 i.e., the content of salts in these samples is <0.15 which indicates that salinity effect is negligible, except for more sensitive crops. Data obtained by analysis have been shown in table -2.The excessive rainfall and irrigation water leaching of soluble salts may be the cause of the soils' low EC and can be increased by adding organic manure. The EC of the two locations is in the order of Phesama Village > Pfiichama Village.

Available Nitrogen (N)

Nitrogen, in the universe, has been found to be the seventh most abundant element which is essential for all living creatures and is the most important nutrient for plants required in enormous amount for crop production. The building block of plant structures are mostly a constituent of Nitrogen. The growth of the root and development of crops are stimulated by Nitrogen. N can either be in organic

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or inorganic form. While the organic form comprises about 98%, it is not consumed by plants which results in the conversion into nitrite followed by nitrate in soil. N in soil is determined by using Micro-Kjeldahl distillation unit which converts all organic N to ammonia.

The available Nitrogen in the soil samples of Pfiichama was found to be ranging from 150.48 to 112.86 Kg/ha which is reported to be very low while the soil samples of Phesama Village ranged from 300.96 to 238.26. It is concluded that the overall available nitrogen ranges from very low to medium. For estimation of mineralizable nitrogen method suggested by Subbiah and Asija (1956) was used because of its rapidity and data obtained by analysis have been shown in table -2. Similar results were also obtained by Sentimenla (2020), Tiwari and Sangtam (2022) for the soils in some other part of Nagaland. Low availability of nitrogen may be due to high level of carbon in the soil, heavy rainfall or over irrigation and can be raised by the supply of urea, ammonium sulphate or compost and putting leguminous plant.

Available phosphorus (P)

Plants absorb P from the soil as Phosphate ion ($H_2PO_4^-$ and HPO_4^{--}). $H_2PO_4^-$ is usually more dominant in soil under acidic condition. Like N, P is also categorised into organic and inorganic which appears to vary widely and together forms the total soil P. Organic P is found to be high in the top soil and lower in the sub-soil. The inorganic P occurs in the form of apatite, iron complexes. Both the organic and inorganic Phosphorus has very low solubility, allowing the only a small amount to be in solution at a given time. The availability of P in soil is found to be affected by a number of properties associated with the release and fixation of P and is found to increase due to weathering, desorption etc and decrease due to erosion, precipitation, run off. Lack of Phosphorus prevents the growth of shoots. P content can be increased by using phosphate fertilizers. Animal wastes generally have high content of phosphorus. Bray's method (for acidic soil) suggested by Bray and Kurtz (1945) was used for estimation of Phosphorus nutrients and data obtained is shown in table – 2. Similar results were also revealed by Patil et. al, (2017), Sentimenla (2020), Tiwari and Seb (2022) also reported similar results. While the latter which is found to be high in available P could be brought about by the various farming practises used by the farmers.

Table 2: Observed value of pH, EC, Nitrogen and Phosphorus in soil samples

Samples	p^H values	Remarks	EC values	Available Nitrogen	Remarks	Available P(Kg/ha)	Remark
Pf_1	5.0	Strongly acidic	0.11	112.86	Very Low	33.31	Low
Pf_2	4.8	Strongly acidic	0.12	125.40	Very Low	32.50	Low
Pf_3	4.9	Strongly acidic	0.11	137.94	Very Low	25.51	Low
Pf_4	5.0	Strongly acidic	0.12	150.48	Very Low	33.31	Low
Pf_5	4.8	Strongly acidic	0.13	150.48	Very Low	25.51	Low
P_1	5.2	Strongly acidic	0.12	238.26	Low	75.77	High
P_2	6.7	Slightly acidic	0.14	238.26	Low	79.85	High
P_3	6.4	Moderately acidic	0.13	300.96	Medium	71.77	High
P_4	6.5	Slightly acidic	0.14	288.42	Medium	75.77	High
P_5	6.2	Moderately acidic	0.12	250.40	Low	78.41	High

Available Potassium (K)

Potassium is one of the most abundant and major nutritional elements that is found in soil and needed by plants in large amounts. Potassium is present in adequate quantities in the most soils but only fraction of it can immediately be utilised in plants. Weathering intensity and the parent material are two parameters on which the content of Potassium soil largely depends upon. K has many functions in plant nutrition and growth that influence both yield and quality of the crop (Kow and Nabwami, 2015).

In the evaluation of soil samples from two villages, it has been observed that the soil samples were found to be high in K content. K a macronutrient is an essential element for plant growth. This study shows that the K content in the soil samples from Pfiichama and Phesama village ranges from 260.96 Kg/ha to 293.21 Kg/ha and 241.58Kg/ha to 287.50 Kg/ha respectively. It is estimated with the help of flame photometer (Toth and Prience, 1949) and data obtained is shown in the table – 3.

Available Sulphur(S)

Another nutrient essential for the growth of plants is Sulphur which is the fourth major nutrient for plants following Phosphorus, Nitrogen and Potassium which is exclusively found in the form of Sulphate and is responsible for the maintaining the electrical neutrality of soil. There are various methods to analyse the S content in soil. The evaluation of the soil samples from two different villages shows that S content is low. S also plays an important role in plant growth. . Calcium sulphate, thio-sulphate, ammonium sulphate are used to treat sulphur deficiency. Low sulphur content may be a result of leaching. Sentimenla (2020) and Singh et. al, (2017) reported similar results.

Soil Organic Carbon

Soil organic matter is any matter originally produced by living organism that goes back into the soil and goes through the decay process. Most of the organic matter in the soil is from plant tissue. Soil organic matter also plays a crucial role in the determination of the soil's physical condition and affects the chemical properties of soil, in particular the cation exchange property. The key component in soil organic matter is carbon. Soil organic carbon is determined by titration method by using diphenylamine indicator. This method is also known as Wet Digestion method. In the evaluation of the soil samples from the two locations it has been observed that the overall content of Organic Matter in the soil samples was found to be high. This may be due to the crop residues, manure and decomposition of organic matter and high rainfall. The health, fertility, and ecosystem services including food production of the soil depend on soil organic carbon. More organic carbon in the soil means that it will probably be more fertile and better able to filter and cleanse water. Similar results were observed by Namei et. al, (2016), Singh et. al, (2017), Bier et al (2018), Aiko and Tiwari (2021) in North -East India.

Available Chloride

Chloride is not frequently considered to be a necessary nutrient. The ability of chloride to move in soil is so high and is thus used to measure soil water movement. The excess of chloride can diminish the utilization of agricultural land by lowering the fertility of soil. Chlorides in soil exist as a free anion which does not easily precipitate out. Chlorides tend to float in the solution of soil rather than being absorbed to soil minerals. The chloride content in soil samples are obtained by titrating against Silver

Nitrate solution by using Potassium Chromate as an indicator. From the evaluation of the soil samples from the two villages the chloride content has been found to be high in the given soil samples. Micronutrient chloride is necessary for a variety of functions in plants, including photosynthesis and growth. Chloride content may be high due to heavy rainfall which causes leaching. Leaching of soil by non-saline water may help reduce chloride in soil. Data obtained is shown in table-3and similar results were observed by Tiwari and Nagi (2023) for the soil of other villages of Kohima district.

Soil Moisture

Soil Moisture can be defined as an indicator which determines the amount of water present in soil. Soil moisture acts as an important parameter in controlling the reciprocity of water and energy of warmth through the process of transpiration of plants and evaporation of soil among the land surfaces. The amount of moisture available in the soil following evaporation, run-off and leaching decreases as a result of which measures are needed to maintain soil moisture in arid and regions that are humid. With the proper steps being taken it can result in proper utilization of water content in the soil by the plants. The soil samples of Pfiichama village were found to have a moisture content of 15.67% and Phesama village 17.11%.

Table 3: Observed value of K, S, OC, OM, Chloride and moisture% in soil samples

Sample No.	Available K (Kg/ha)	Available S (ppm)	O.C %	Y=O.Cx1.3	OM%=Y x1.724	Chloride in ppm	Moisture%= $\frac{Loss\ in\ weight\ X\ 100}{Oven\ dry\ wt.of\ soil}$	Mean of Moisture %
Pf_1	293.21(H)	2.337 (L)	1.23	1.59	2.74(H)	38.85(H)	15.39	15.67
Pf_2	261.40(H)	1.962(L)	1.40	1.82	3.13(H)	31.10(H)	14.37	
Pf_3	287.50(H)	1.712(L)	1.12	1.45	2.49(H)	39.05(H)	16.34	
Pf_4	260.96(H)	1.887(L)	1.18	1.53	2.63(H)	33.00(H)	16.51	
Pf_5	277.98(H)	2.737(L)	1.20	1.56	2.68(H)	21.80(H)	15.74	
P_1	287.50(H)	2.000(L)	1.82	2.36	4.06(H)	29.25(H)	16.19	17.11
P_2	241.58(H)	2.862(L)	1.85	2.40	4.13(H)	38.00(H)	14.21	
P_3	246.38(H)	2.737(L)	1.92	2.49	4.29(H)	33.15(H)	16.58	
P_4	246.38(H)	2.037(L)	1.89	2.45	4.22(H)	40.95(H)	23.24	
P_5	287.50(H)	2.737(L)	1.85	2.40	4.13(H)	38.85(H)	15.37	

(H = High, L = Low)

Water Holding Capacity:

The capacity of soil to hold certain amount of water for crop usage can be termed as “soil water holding capacity”. When the amount of water is less in the soil, it demands the need for irrigation and precipitation resulting in the soil to be replenished. The two essential constituent that regulate the water holding capacity of soil are soil texture and organic matter. The WHC is favoured by larger surface area. WHC stands as one of the deciding factor for the type of crop to be grown, routine irrigation and the amount of fertilizer that should be applied. Some amount of water that seeps into the soil remains while some are mobile and passes through the soil due to the variation in size, number and pore continuity. Optimal aeration and increased water circulation are supported by fertile soils. It encourages the growth of micro- and macro-organisms in the soil, which help break down and release nutrients in a way that plants can easily absorb. Because it introduces humus to soil, organic matter affects water retention, structural integrity, and microorganism life.

Table-4: Observation table for Water Holding Capacity of soil.

Sample Location	Percentage (%) of moisture in soil						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day7
Pfiichama Village	45.48	42.33	37.87	35.42	29.88	27.96	27.05
Phesama Village	50.35	43.63	41.13	37.98	26.70	23.45	23.05

According to the data obtained the water holding capacity of Pfiichama village is higher than that of Phesama village, i.e, 27.05% and 23.05% respectively.

Micronutrients:

Micronutrients are vital plant nutrients that are present in tissue in minute levels but crucial for the growth and development of plants. Seven of the 16 necessary elements, namely Iron, Manganese, Boron, Zinc, Copper, Molybdenum, and Chlorine, are utilised in extremely minute amounts by field crops and are hence referred to as micronutrients. Both macronutrients and micronutrients are critical for plant growth. Micronutrient deficiencies can be detected by visual symptoms on crops and by testing soils and plant tissues. The most reliable micronutrient soil tests are for zinc, boron, copper, and manganese. Boron, iron, zinc, manganese and copper have been tested where boron test was done by Hot water extractable method and the latter four were done using AAS.

Table-5: Amount of available Boron, Iron, Zinc, Manganese and copper in soil samples

Sample	Iron	Zinc	Manganese	Boron	Copper	Remarks
Pf_1	114.111	13.29	64.504	1.16	14.436	Sufficient
Pf_2	116.304	8.974	39.797	1.35	14.459	Sufficient
Pf_3	115.951	12.013	24.385	1.11	13.683	Sufficient
Pf_4	116.016	11.818	28.127	1.16	14.780	Sufficient
Pf_5	117.803	13.833	32.494	1.08	11.850	Sufficient
P_1	117.835	18.957	43.972	1.82	9.914	Sufficient
P_2	95.250	11.527	12.564	2.09	5.490	Sufficient
P_3	109.813	24.377	34.288	2.20	5.994	Sufficient
P_4	109.413	23.275	43.772	3.75	5.468	Sufficient
P_5	104.403	13.305	46.501	1.33	5.887	Sufficient

The present study revealed that the soil samples from both Pfiichama and Phesama Village had sufficient micronutrients (iron, zinc, boron, manganese and copper). Soil samples from Pfiichama were found to be ranging from 114.111 to 117.803 for Fe, 8.974 to 13.833 for Zn, 1.08 to 1.35 for Boron, 32.494 to 64.504 for Mn and 11.850 to 14.780 for Cu. While for Phesama it was observed at 95.250 to 117.835 for Fe, 11.527 to 24.377 for Zn, 1.33 to 3.75 for B, 12.564 to 46.501 for Mn and 5.468 to 9.914 for Cu. Similar results were observed by Tiwari and Nagi (2023).

Nutrient index of soil

Following the recommendations made by Ramamoorthy and Bajaj (1969), the nutrient index was classified and calculated as follows:

N.I = (1 x A) + (2 x B) + (3 x C) / TNS, where A = Number of samples in low category; B = Number of samples in medium category; C = Number of samples in high category, and TNS = Total number of samples under investigation. To assess the fertility state of soils of Pfiichama Village and Phesama Village, the nutrient index with regard to available N, available P, and available K was utilised.

Table-6: Nutrient Index of Pfiichama and Phesama Village

Sample Location	Nutrients	NI Values	NI Fertility status (govt of India 2011)
Pfiichama Village	N	1.0	Low
	P	1.0	Low
	K	3.0	High
Phesama Village	N	1.4	Low
	P	3.0	High
	K	3.0	High

Conclusion

It is useful for farmers to know the NPK contents of their soil so that they will be able to know how much and which fertilizer should be added to get better quality and good yield. Soil analysis helps farmers to make better use of fertiliser, reducing soil hazards like damaged lands and raising long-term farm profitability. Investigated soil health factors are, moisture content, water holding capacity, pH, EC, micronutrients and OC that influence the availability of nutrients for crop yields and profitability. Consequently, it offers a farm management tool that may enable the farmer to increase yield, lower operating costs and improved environmental risk management are involved.

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