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Comparative study of soil nutrients and soil fertility status of the terrace farming soil during pre-harvest and post-harvest under Mima Village of Kohima District, Nagaland.

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Abstract

In the context of this research, soil fertility status of pre-harvest soil and post-harvest soil were analysed to assess the potentiality of the soil to supply nutrients for healthy growth of plants. Soil is the source of nutrients for crops. The soils were slightly acidic to moderate with pH ranged from 5.7-6.5 and electrical conductivity (EC) ranged from 0.021 to 0.205 dS m^{-1}. Negative correlation was observed between soil pH and EC. The soils organic carbon (OC) was high and low to medium content in available nitrogen and potassium. OC ranged from 0.76 to 1.40 (%) and nitrogen ranged from 188.10 to 501.60 kg ha^{-1} respectively. The available potassium (K) is in low to medium range and low to high in phosphorus (P) content. Micronutrients were found to be ranging from deficient to sufficient in content. Water holding capacity were also determined. Study suggested the proper management of water run-off and maintenance of land use for better sustainable agriculture and prevention of nutrients losses.

Key words: Electrical Conductivity (EC), Nutrient index (NI), Micronutrients, Organic Carbon (OC), Kohima.

Introduction

Intensive cropping practices result in substantial nutrient removal from the soil, potentially reducing its long-term productivity. Imbalance and inadequate use of chemical and fertilizers, improper irrigation and various cultural practices also deplete the soil quality rapidly (Medhe *et. al*, 2012). Soil productivity and sustainability depends on its physical, chemicals and biological properties (Somasundarum *et. al*, 2013). Determination of fertility status of the soil of a particular area or a region is a significant aspect in the factors of sustainable agriculture.

Crops growth in upland regions is hindered primarily by inadequate water management and insufficient irrigation systems. Understanding the distribution of the properties of soil at the field scale is significant for refining the practices of agricultural management and assessing the effects of agriculture on environmental quality. Seasons and plant species have significant impact on abundance of soil microbial community and hence nutrient availability (Kumar *et. al*, 2021). Change in soil chemical properties in the form of phosphorus (P) mineralization-immobilization of organic P are strongly influenced by seasonal variations in temperature, moisture, plant growth and root activity, and by organic matter accumulation from litter fall (McGrath *et. al*, 2000). Significant modifications in soil properties are influenced by land use systems in tropical areas, in which agriculture have a major contribution (Bordoloi *et. al*, 2022).

Nagaland, known for its hilly terrain situated in the North-Eastern part of India. Terrace cultivation of paddy are extensively practiced by the indigenous people of Kohima, Nagaland. Hence, the present study was undertaken to study the seasonal effects on soil nutrients and fertility status in terrace soil.

STUDY AREA-

Area: Mima Village, Kohima

Mima village is located in the circle of Jakhama of Kohima District, Nagaland, India. It is situated 5 km away from Jakhama, sub-district headquarters and about 17 km away from Kohima, district headquarter respectively. The latitude 25.591221^0 and longitude 94.110229^0 are the geo-coordinate of the Mima Village. The altitude is 1085.5001438 m.

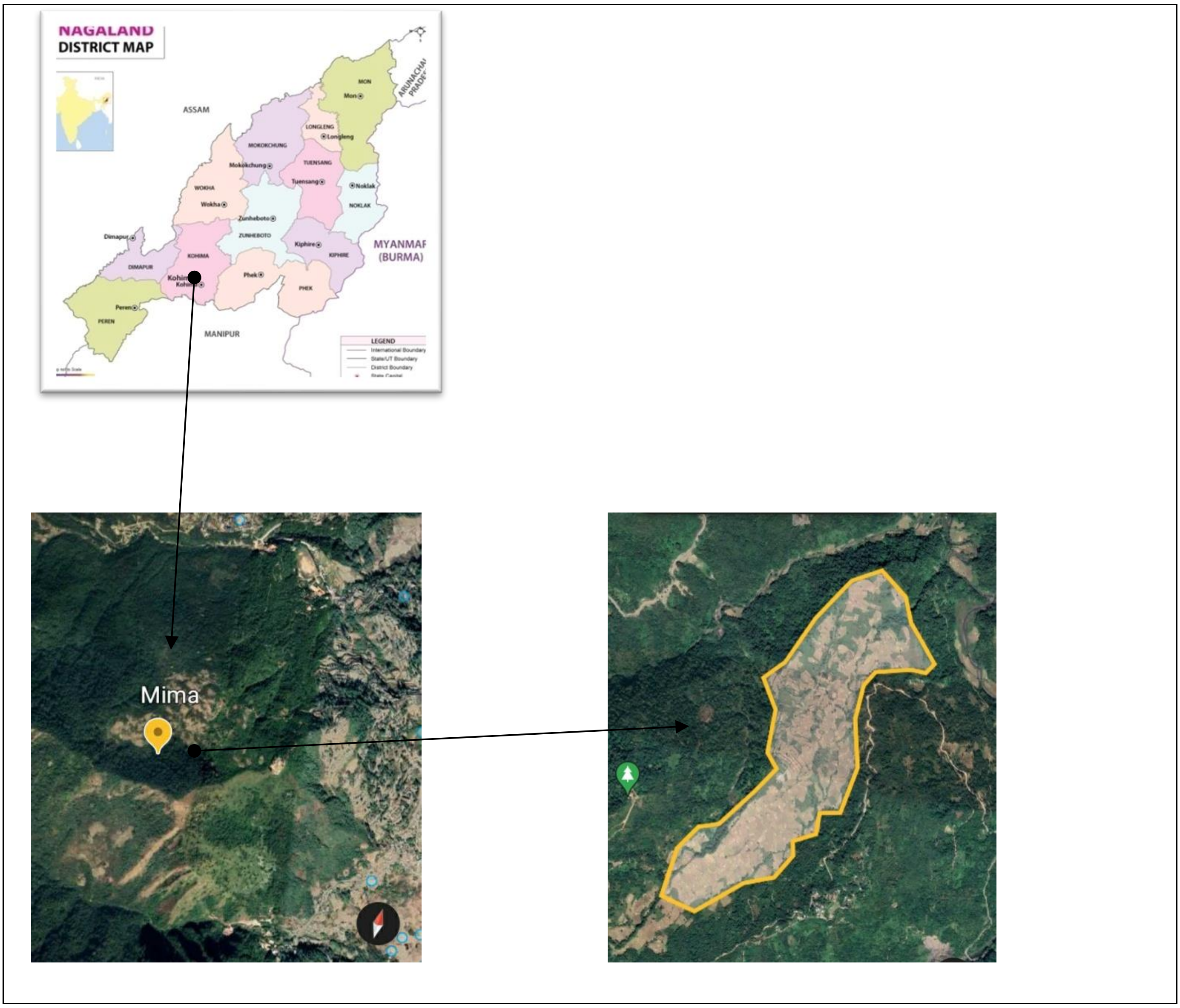

Figure-1: Location map of Mima Village, Nagaland

METHOD AND MATERIALS

The soil samples used in the analysis were collected from paddy fields in the month of November 2023 (Post-harvest) and May 2024 (Pre-harvest). 16 soil samples (M-1 to M-16) were collected using the V-shape method during both the season.

Table 1: Methodology of soil analysis.

Sl No.	Parameters	Method
i	pH	pH Metry
ii	Electrical Conductivity (EC)	Conductometry
iii	Water Holding Capacity (WHC)	Oven Dry Wet
iv	Nitrogen (N)	Alkaline potassium permanganate method
v	Phosphorus(P)	Bray and Kurtz method
vi	Potassium (K)	Flame Photometry
vii	Organic Carbon (OC)	Wet Digestion Method
viii	Micronutrients (Zn, Fe, Cu and Mn)	Atomic Absorption Spectroscopy (AAS)

RESULTS AND DISCUSSION

Soil pH

The pH of the soil during pre-harvest was found to be lower (5.7-6.1) as compared to the pH of soil collected during post-harvest season (6.1-6.5). Compared to post-harvest, pH levels showed a slight reduction during pre-harvest season. Elevated microbial activity during pre-harvest season might have accelerated organic matter decomposition, releasing organic acids and causing a temporary pH decrease in soils. The data obtained are shown in table-2.

Electrical Conductivity

The data showed in table-2 revealed the EC value of the soil samples on the basis of season viz. pre- harvest and post-harvest season. The soil electrical conductivity (EC) of pre-harvest varied from 0.101-0.205 dS m^{-1} while post-harvest soil varied from 0.021-0.048 dS m^{-1} which indicates higher EC content in pre-harvest soil. However, the soil contains low level of salt and the salinity effects can be neglected. In addition, the result shows that the soil EC increases with decreases in soil pH irrespective of season.

Water Holding Capacity

The soil water regime plays a crucial role in plant growth, impacting photosynthesis, carbon allocation, microbial activity, and nutrient cycling. The water-holding capacity of sandy soil is relatively low, making frequent irrigation essential for crops cultivated on sandy terrain. The water holding capacity was reported as 21%. The determination of water holding capacity of soil depends on the soil texture and available pore spaces.

Organic Carbon

Soil carbon content is an indicator of soil quality and affects not only productivity, but also the microbial and invertebrate's community (Rousseau *et. al*, 2012). On the basis of season viz. pre-harvest and post-harvest, the data presented in table-2 shows the SOC content was found to be high in all the soil samples. The data revealed that the OC increases considerably in pre-harvest soils. The higher OC during pre-harvest may be due to rich and varied below ground and above ground availability of plant biomass. The organic carbon content varied from 1.17% to 1.82 % and 0.76% to 1.0 % under pre and post-harvest soil respectively. High organic carbon in soils of Nagaland was also reported by (Jena *et. al*, 2022), and (Bier *et. al*, 2018) and (Phucho *et. al*, 2023) in the soils of Kohima.

Table 2: Soil pH, EC and OC values of post and pre-harvest.

	pH		EC (dS m^{-1})		OC (%)	
Samples	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**
M-1	6.2	5.7	0.025	0.101	0.94(H)	1.60
M-2	6.5	5.8	0.033	0.113	0.82(H)	1.52
M-3	6.4	5.9	0.032	0.105	0.82(H)	1.17
M-4	6.5	5.7	0.026	0.112	0.86	1.36
M-5	6.4	6.1	0.048	0.125	0.78	1.33
M-6	6.4	5.8	0.027	0.132	0.92	1.20
M-7	6.3	6.1	0.027	0.123	0.76	1.22
M-8	6.3	5.7	0.057	0.205	0.98	1.24
M-9	6.4	5.7	0.026	0.132	0.88	1.33
M-10	6.5	5.8	0.021	0.165	0.76	1.45
M-11	6.5	5.9	0.022	0.162	1.00	1.52
M-12	6.2	5.7	0.028	0.145	0.80	1.40
M-13	6.4	5.8	0.028	0.142	0.88	1.66
M-14	6.2	6.1	0.029	0.123	0.83	1.62
M-15	6.3	5.8	0.030	0.136	0.85	1.82
M-16	6.1	5.9	0.028	0.143	0.80	1.76

Nitrogen (N)

The nitrogen content of soil samples of post-harvest season varied from low to medium while medium content of nitrogen in all the soil samples of pre-harvest season. Low available nitrogen content in agricultural lands maybe due to soil runoff and leaching. The cultivation practices such as tillage operation and removal of residues after crop harvest is the main factor that attributed to lower accumulation of organic biomass which result lower available content under paddy field land use system especially during post-harvest season. (Bordoloi *et. al*, 2022) reported similar findings of lower available nitrogen under paddy land use system. The data shown in table-3 revealed that the nitrogen content varied from 188.10 kg ha^{-1} to 300.96 kg ha^{-1} and 288. 42 kg ha^{-1} to 501.60 kg ha $^{-1}$ of post and pre-harvest soil respectively.

Phosphorus (P)

Phosphorus is a most important element present in every living cell (Tale *et. al*, 2015). Available phosphorus was recorded as low to medium content under the post-harvest soil and medium content in all the samples under pre-harvest soil. The pre-harvest soil recorded higher available phosphorus ranging from 36.43 kg ha^{-1} to 66.69 kg ha^{-1} while post-harvest soil ranged from 12.11 kg ha^{-1} to 39.17 kg ha^{-1}. The values obtained are revealed in table-3. The high available phosphorus content in the pre-harvest soil maybe attribute to positive soils reaction and high organic matter contributing to the development of organophosphate complexes and layering of aluminium and iron particles by humus. Similar data was also revealed by (Sharma *et al*. 2015), (Amenla *et. al*, 2010) in soil of some other part of Nagaland, India.

Potassium (K)

The pre-harvest soil recorded the higher available potassium content ranging from 151.648 kg ha $^{-1}$ to 190.624 kg ha $^{-1}$ while the post-harvest soil was recorded as 51.968 kg ha^{-1} to 160.160 kg $^{-1}$. The comparatively higher content in available potassium of pre-harvest may be attributed to release of labile K from organic residues during pre-harvest season. Table-3 shows the data obtained. It has been reported that the most important chemical pool that contributes to the rice and wheat nutrients are the exchangeable K. Similar data were also obtained by (Sarker *et. al*, 2002), (Sharma *et. al*, 2012), (Tiwari *et. al*, 2022)

Table-3: Soil N, P and K values of post and pre-harvest.

	N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})	
Samples	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**
M-1	225.72 (L)	338.58(M)	37.01(M)	40.68(M)	67.424(L)	158.256(M)
M-2	200.64(L)	452.44(M)	12.57(L)	36.43(M)	64.400(L)	140.000(M)
M-3	250.80 (L)	336.04(M)	17.99(L)	39.01(M)	79.408(L)	190.624(M)
M-4	300.96(M)	388.74(M)	12.11(L)	37.10(M)	44.912(L)	175.616(M)
M-5	288.42(M)	326.04(M)	18.22(L)	36.98(M)	129.024(M)	151.648(M)
M-6	213.18(L)	338.58(M)	12.74(L)	37.09(M)	160.160(M)	189.504(M)
M-7	313.50(M)	463.98(M)	16.45(L)	38.67(M)	132.944(M)	171.696(M)
M-8	300.96(M)	501.60(M)	37.71(M)	66.39(M)	98.336(L)	136.416(M)
M-9	263.34(L)	338.58(M)	31.80(L)	56.08(M)	51.968(L)	150.416(M)
M-10	213.18(L)	300.96(M)	14.57(L)	41.01(M)	134.360(M)	162.288(M)
M-11	238.26(L)	388.74(M)	35.48(L)	61.78(M)	143.360(M)	174.944(M)
M-12	200.64(L)	300.42(M)	39.17(M)	59.85(M)	122.080(M)	191.296(M)
M-13	250.80(L)	463.98(M)	12.28(L)	38.06(M)	54.432(L)	137.536(M)
M-14	200.64(L)	388.74(M)	27.94(L)	40.78(M)	79.408(L)	176.512(M)
M-15	188.10(L)	288.42(M)	20.68(L)	45.8(M)	124.656(L)	148.512(M)
M-16	238.26(L)	388.74(M)	13.65(L)	37.08(M)	73.920(L)	168.448(M)

(where, M=Medium range, L=Low range)

Nutrient index of soil.

By determining the soil's nutrients content, the soils were categorized into three types: low, medium and high. (Parker *et. al*, 1951) formulated the following equation which was employed for estimating the nutrient index of the soils.

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 categorised as to low, medium and high.

Table-4: Nutrient Index of pre-harvest and post-harvest soil.

Season	Nutrients	NI values	Nutrient Fertility status
Pre-harvest	N	2	Medium
	P	2	Medium
	K	2	Medium

Post-harvest	N	1.25	Low
	P	1.19	Low
	K	1.38	Low

Micronutrient

(Bandyopadhyay *et. al*, 2018) 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. The micronutrient- Zinc (Zn) were found to be deficient in content while the other three micronutrients viz, Iron (Fe), Manganese (Mn) and Copper (Cu) were sufficient in the soil samples of post-harvest season. The adequate content of micronutrients promotes photosynthesis in plants, nitrogen fixation and other enzymes activities. The table-5 revealed the data obtained through analysis.

Table-5: Fe, Zn, Mn and Cu values of the post-harvest soil samples.

Samples	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
M-1	24.08(S)	0.30(D)	5.07(S)	2.72(S)
M-2	29.33(S)	0.50(D)	4.12(S)	0.56(S)
M-3	17.64(S)	0.22(D)	17.17(S)	0.40(S)
M-4	24.17(S)	0.18(D)	19.42(S)	0.69(S)
M-5	21.77(S)	0.21(D)	12.57(S)	0.76(S)
M-6	8.72(S)	0.11(D)	8.87(S)	0.24(S)
M-7	9.49(S)	0.12(D)	16.08(S)	0.23(S)
M-8	27.50(S)	0.41(D)	6.81(S)	0.65(S)
M-9	25.40(S)	0.25(D)	2.41(S)	0.60(S)
M-10	11.67(S)	0.22(D)	13.32(S)	0.26(S)
M-11	25.07(S)	0.29(D)	16.89(S)	0.77(S)
M-12	22.11(S)	0.36(S)	15.88(S)	0.82(S)
M-13	19.59(S)	0.27(D)	16.91(S)	0.34(S)
M-14	43.41(S)	0.45(D)	9.96(S)	0.89(S)
M-15	47.48(S)	0.30(D)	3.39(S)	0.79(S)
M-16	30.96(S)	0.11(D)	19.91(S)	0.40(S)

(where, S=Sufficient, D=Deficient)

CONCLUSION- The study was carried out to compare the soil fertility and soil nutrients of pre-harvest and post-harvest soil. Based on the obtained values of NI, it can be concluded that the nutrient fertility status of pre-harvest soil is higher than that of the post-harvest soil. The higher fertility status of pre-harvest soil may be due to the larger biomass and organic matter during the pre-harvest season. Accordingly, proper management of water runoff during post-harvest season and utilization of proper biomass can be done to ensure sustainable agriculture and increase productivity.

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Conflict of interest

Author declares no conflict of interest.

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